CHAPTER 3

SUPPLY CHAIN MANAGEMENT CONCEPTS

What is Supply Chain?

The supply chain involves all the parties involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the service providers, manufacturers, executers, and the suppliers, but also the transporters, logistic managers, vendors, subcontractors, warehouses, retailers and the customers themselves. Within each organization, the supply chain includes all functions which are involved in receiving and filling the customer request. These functions include, but are not limited to, delivery of services, product development, marketing, operations, distribution, execution, and finance and customer service.

The primary purpose for the existence of any supply chain is to satisfy customer needs, in the process generating profits for itself. The supply chain conjures up images of product and services or supply moving from suppliers to executers or manufacturers to distributers to retailers to customers along the chain. The term supply chain in the context of a manufacturing or a service provider is a misnomer as it may imply that only one player is involved at every stage. In reality the supply chain is actually a network of various entities at various stages. It is more accurate to use supply chain network or supply chain web for most of the supply chains as shown in Figure 3.1. It is important to realize the continuous flow of information, funds, material and services along the supply chain. The practical supply chains are complex networks and a broad supply chain network as depicted in the figure can further be subdivided in to the small supply chain networks of the each entity of supply chain. e.g. the suppliers may have their own network of sub-vendors and suppliers, likewise distributors manufactures may have cross linked networks existing in their supply chain. There is no commonly accepted definition of supply chain management - it means many different things to many different people and numerous, overlapping definitions exist: Few of them are enumerated as under:
The **supply chain** is the combination of all parties (e.g. external suppliers, partner organisations, internal corporate services units) both inside and outside the organisation, involved in delivering the inputs, outputs or outcomes that will meet a specified organizational requirement.

Supply chain is the term used to describe the linkage of companies that turns a series of basic materials, products or services into a finished product for the client.

All construction companies, be they client, main contractor, designer, surveyor, subcontractor, or supplier are therefore part of a supply chain. Because of the project based nature of construction and the way that procurement normally operates, they are usually members of different supply chains on different projects.

Each company in the chain has a client – the organisation to which the services are provided – but an integrated supply chain will have the objective of understanding and working wholly in the interests of the ‘project client’.

The supply chain may be **inbound into the organization** – an operational requirement for internal customers for example, or it may be **outbound from the organisation** – in
place to deliver wider organisational objectives to provide services for delivery to citizens, or a combination of both.

- The shape of the supply chain employed will vary considerably depending on a range of different considerations.
- The focus of SC can differ from industry sector-to-sector. In construction, the focus is on the early establishment of a fully integrated client-supplier project team. In IT projects, the focus may be on building scope for innovation and flexibility into the SC to cater for changing requirements and rapidly evolving information and communications technologies.
- SCs can be long-term, strategic sets of relationships between multiple, diverse organizations which are carried from project to project, or they can be ad-hoc structures established post-contract award to deliver a discrete, one-off objective.
- SCs can be fully integrated, networks of interconnected companies with common performance and relationship management processes, or they could be characterized by arms length contractor-subcontractor relationships. Each link within the chain can differ in the nature of the interdependencies and the way in which the relationship needs to be managed.
- SCs can be inbound to the organisation – suppliers delivering goods and services into the organisation to support its operational objectives e.g. office furniture provision for an organisation.

**Objectives of Supply Chain**

The objective of the supply chain is to maximize the overall value generated. The value of the supply chain is the difference between what the final product is worth to the customer and the effort the supply chain expends in filling the customer request or the services demanded. For the most of the supply chains the value will be strongly correlated with supply chain profitability, the difference between the revenue generated from the customer and the overall cost across the supply chain. The supply chain profitability is the total profit to be shared across the supply chain. The supply chain success should be measured in terms of supply chain profitability and not in terms of the profits at an individual stage.
Supply Chain Management

All the flows of the information, product or funds generate costs while source of revenue is only the customer. The supply chain management involves the management of these flows between and amongst the stages of the supply chain to maximize total supply chain profitability.

Supply Chain Management is primarily concerned with the efficient integration of suppliers, factories, warehouses and stores so that merchandise is produced and distributed in the right quantities, to the right locations and at the right time, and so as to minimize total system cost subject to satisfying service requirements. -Simchi-Levi

Call it distribution or logistics or supply chain management. By whatever name, it is the sinuous, gritty, and cumbersome process by which companies move, materials, parts, and products to customers.: Fortune (1994)

Supply Chain Management deals with the management of materials, information, and financial flows in a network consisting of suppliers, manufacturers, distributors and customers. : Stanford Supply Chain Forum

Supply Chain Management encompasses every effort involved in producing and delivering a final product or service, from the supplier’s supplier to the customer’s customer. Supply Chain Management includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer. : The Supply Chain Council, U.S.A

Supply Chain Management: Schools Of Thought

Supply chain management as a concept is viewed by different businesses differently. The varied view on SCM are classified broadly under following school of thought.

- Functional school
- Logistics school
Functional school

This view concentrates on the material flow and the value addition process in the different functional departments of the firm and other players in supply chain. This school of thoughts holds the following basic view of the supply chain - the supply chain consists of the individual organization needed to procure material suppliers, transportation providers and other groups. The main concern of supply chain management according to this view is reducing costs in the primary functions. Some of the definitions in this school of thought are as under:

- Supply chain management deals with the total flow of materials from the suppliers through end users.: Jones & Riley(1985)
- Supply chain management covers the flow of goods from suppliers through manufacturer and distributor to the end user.: Houlihan(1988)
- Supply chain management focuses attention on the interactions of channel members to produce an end product/service that will provide best comparative value for the end user.: Cavinato(1991)
- Supply chain management covers the flow of goods from the supplier through the manufacturer and distributor to the end user.: Novack and simco(1991)
- Control the flow of material from the suppliers, through the value adding processes and distribution channels to customers.: Stevens(1990)
- Networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products and distribute the finished products to customers.: Lee and Billington(1992)

Logistics School

The logistics school of thought concentrates on the linkages between the different functional areas of the supply chain. The supply chain is the set of the facilities through which a product
passes on its way to end customers. The objective of this school of thought is to lower the logistics costs. Some of the definitions in this school of thought are as under:

- Supply Chain is used to refer the chain linking each element of the production and supply process from raw material through to the end Customers. Scott & Westbrook (1992)
- Technique that looks at all the links in the chain from raw material suppliers through various levels of manufacturing to warehousing and distribution to the final customer. Turner (1993)

**Information School**

This school of thought concentrates on the flow on information up and down the supply chain. This information may be demand and the sales data or advances shipment notices invitatory availability etc. The objective here is to minimize the information processing cost. Some of the definitions in this school of thought are as under:

- SCM is really an operations approach to procurement. It requires all participants of the supply chain to be properly informed. With SCM, the linkage and the information flow between various members of the supply chain are critical to overall performance. Johannson (1994)
- A supply chain is a system, the constituent parts of which include materials suppliers, production facilities, distribution services, customers linked together via the thje feed-forward of materials and the feedback flow of the information. Towill, Naim & Wikner (1992)

**Integration view**

This is the most comprehensive view of the supply chain which brings all the activities involved in serving the customer for the point of origin to the point of customer. The school of thought advocates that business processes should be integrated across the supply chain to serve customers cost effectively. One of the definitions in this school of thought is as under:
Supply chain Management is an approach whereby the entire network from suppliers to the ultimate customer, is analyzed and managed in order to achieve the best outcome for the whole system: Ellram & Cooper(1993)

Decision Phases in a Supply Chain

Successful supply chain management requires many decisions relating to the flow of information, product and funds. These decisions fall into three categories or phases, depending on the frequency of each decision and the time frame over which a decision phase has an impact.

Supply Chain strategy or design

During this phase, accompany decides how to structure the supply chain over the several years. It decides what the chain’s configuration will be, how the resources will be allocated and what processes each stage will perform. Strategic decisions made by companies include the location and capacities of production and ware-housing facilities, the products to be manufactured or stored at various locations the mode of transportation to be made available along different shipping legs and the type of information system to be utilized. The firm must ensure that the supply chain configuration supports its strategic objectives during this phase. Supply chain design decisions are typically made for the long term and are very expensive to alter on short notice. Consequently when the companies make these decisions, they must take into account uncertainly in anticipated market conditions over the next few years.

Supply Chain planning

For decisions made during this phase, the time frame considered is a quarter to a year. Therefore the supply chain configuration determined in the strategic phase is fixed. This configuration establishes constraints within which planning must be done. Companies start the planning phase with a forecast for the coming year of demand in different markets. Planning includes decisions regarding which markets will be supplied from which locations subcontracting, inventory of policies to be followed and the timing and size of marketing
promotions. Planning establishes parameters within the supply chain will function over a specified period of time. In planning phase the companies must include uncertainty in demand, exchange rate, completion over this time horizon in their decision. Given a shorter time horizon and better forecasts than the design phase, the companies in the planning phase try to incorporate any flexibility built into the supply chain in the design phase and exploit it to optimize performances. As a result of planning phase, companies define a set of operating policies that govern short term operations.

Supply Chain Operations

The time horizon here in weekly or daily and during this phase companies make decisions regarding individual customer orders. At the operational level, supply chain configuration is considered fixed and planning policies are already defined. The goal of supply chain operations is to handle incoming customer’s orders in the best possible manner. During this phase firms allocate inventory or production to individual orders, set a date that an order is to be filled, generate pick lists at a warehouse, allocate an order to a particular shipping mode and shipment, set deliveries schedules of trucks, and place replenishment orders. Because operational decisions are being made in short term, there is uncertainty about demand information. Given the constraints established by the configurations and planning policies, the goal during the operation phase is to exploit the reduction of uncertainty and optimize performance.

The design, planning and operations of a supply chain have a strong impact on overall profitability and success. The close coordination between the design and management of supply chain flows (product/services, information and cash) is essential for the success of the supply chain.
Supply Chain Performance: Achieving Strategic Fit

Competitive and Supply Chain Strategies

A company’s competition strategic defines the set of customer needs that it seeks to satisfy through its products and services. The company’s competitive strategy will be defined based upon the customer priorities. Competitive strategy targets one or more customer segments and aims to provide products and services and satisfy the customer needs.

A supply chain strategy determines the nature of procurement of raw materials, transportation of materials to and from the company, manufacture of the product or operation to provide the service and the distribution of the product and services to the customer, along with any follow up service. Additionally, in each company, the strategies will also be devised for finance, accounting, information technology, and human resources. Supply chain strategy includes what many traditionally calls supply strategy, operations strategy, and logistics strategy, decisions regarding inventory, transportation, operating facilities, and information flows in the supply chain are all part of supply chain strategy.

Achieving strategic fit

For any company to be successful, its supply chain strategy and competitive strategy must fit together. Strategic fit means that both the competitive and supply chain strategies have the same goal. It refers to consistency between the customer priorities that the competitive strategy hopes to satisfy and the supply chain capabilities that the supply chain strategy aims to built. The issue of achieving strategic fit is key consideration during the supply chain strategy or design phase.

To achieve strategic fit, a company must ensure that it supply chain capabilities support its ability to satisfy the targeted customer segments. There are three basic steps to achieve strategic fit.

- Understanding the customer and supply chain uncertainty
Understanding the customer and supply chain uncertainty: First a company must understand the customer needs for each targeted segment and the uncertainty the supply chain faces in satisfying these needs. These needs help the company define the desired cost and the service requirements. The supply chain uncertainty helps the company identify the extent of disruptions and delay the supply chain must be prepared for. To understand the customer, a company must identify the needs of the customer being served. In general the customer demand from different segments may vary along several attributes as follows.

- The quantity of product and services required in each lot or order
- The response time or the time of execution of a service that a customer is willing to tolerate.
- The variety of product or services needed
- The service level required
- The price of product or service.
- The desired rate of innovation in the product
- The desired level of quality of the product or service.

Understanding the supply chain capabilities: There are many are types of supply chains, each of which is designed to perform different tasks well. A company must understand what its supply chain is designed to do well. The study of the characteristics of the supply chain and its capabilities is very important. The single idea of which all the characteristics of the supply chain contribute is the idea of a tradeoff between responsiveness and efficiency. The supply chain responsiveness includes a supply chain to do the following:

- Respond to the wide range and attributes of products or services demanded.
- Meet the strict deadlines and short lead times
- Handle large quantities of orders or a large project for execution.
- Meet a high service level
➢ Handle supply uncertainty.

The responsiveness comes at cost. Higher is the responsiveness of the supply chain higher is cost and lower is the efficiency of the supply chain. For every strategic choice to increase responsiveness, there are additional costs that reduce the efficiency. (Figure 3.2 & 3.3)

**Figure 3.2 : Responsiveness Efficiency Frontier**

**Figure 3.3 : Responsiveness - Cost Frontier**
Finding a Zone of Strategic Fit: This is the third and final step in achieving the strategic fit which is to ensure that the capabilities of the supply chain is consistent with the need of the customer. If a mismatch exists between what the supply chain does particularly well and the desired customer needs, the company will either need to restructure the supply chain to support the competitive strategy or alter its strategy.

To achieve complete strategic fit, a firm must consider all functional strategies within the value chain; it must ensure that all functions in the value chain have consistent strategies that support the competitive strategy. All functional strategies must support the goals of the competitive strategy and all sub-strategies within the supply chain such as the manufacturing, inventory, and purchasing must also be consistent with the supply chain’s level of responsiveness.

Thus, firms with different locations along the responsive spectrum must have different functional strategies that support their responsiveness. A highly responsive supply chain must devote all its functional strategies to responsiveness, whereas an efficient supply chain must focus all its functional strategies on efficiency. (Figure: 3.4). Changing the strategies to achieve strategic fit may sound easy enough to do, but in reality it can be quite difficult. It is established that:

- There is no right supply chain strategy independent of the competitive strategy.
- There is a right supply chain strategy for a given competitive strategy.
- The drive for strategic fit should come from the highest levels of the organization. In many companies different group devise competitive and functional strategies. Without proper communication between the groups and coordination by high level management such as the CEO these strategies are not likely achieve the strategic fit. For many firms, the failure to achieve the strategic fit is a key reason for their inability to succeed.
Supply Chain Management Concepts in Construction Industry

What is Construction SCM?

As we have witnessed the discussion of construction supply chain management (SCM) is usually informed by a wide range of definitions. This diversity of definitions and understanding presents a challenge, which this section addresses. In this section the effort has been made to explore wide range of conceptual issues that help understand the nature of supply chains in construction. The premise for this chapter is the move from the *project* and its management, as the main focus for the management of the construction process, towards the *supply chain* and its management as the main focus. The supply chain is the focus for more effective ways of creating value for clients; as a vehicle for innovation and continuous improvement, integration of systems and perhaps even improved, industry-wide, profitability levels.
Value creation is increasingly viewed as a process facilitated through a supply chain – a network of relationships within which firms are positioned. New and Westbrook (2004) suggest that firms in supply chains must build networks so as to provide complementariness between inner and external abilities, that is to say, effective supply chains need to be supported in networks that extend beyond the immediate linkages of exchange in order to create the value in each link. In the same way that individuals are drawn to, or naturally seek, other individuals with skills, knowledge and attributes that they themselves lack, firms are drawn to form collaborative relationships with other firms with skills, knowledge, attributes and perhaps resources that are complementary to the first firm. Just as individuals in society find it difficult to survive isolated from others, isolates in business are vulnerable and may fail in time unless they possess a unique skill or talent which gives them market power (for example a monopoly supplier or oligopoly of few suppliers in a market of buoyant demand). The term supply chain implies a linear process. This linearity, however, exists only at a high level of abstraction. At an applied level, when we explore the nature and operation of supply management, there is limited linearity, clusters of suppliers coming together in series of dyadic exchanges. Social and market exchanges create social and technical systems which, once in place, are observed as dynamic networks of relationships. The juxtaposition of these two aspects of supply chains is shown in Figure 3.5. In construction we observe clients, consultants, contractors and suppliers in the broadest sense positioned as nodes connected by linkages comprising knowledge transfer, information exchange, directions and financial and contractual relationships. These networks are transitory (Pryke and Smyth, 2006) and the flows are iterative (Pryke, 2001); like neural networks the nodes are continually linking and disconnecting depending on the project function to be performed. Each linkage involves flows that produce a response and generate a succession of dyadic or multi-directional flows until a particular function is satisfied and specific issues are resolved.
Fig. 3.5: A typical supply chain network in a construction industry
It would be not out of context to site the example from the UK construction industry to bring home the development of SCM in construction industry. During the early stages of post-Latham (1994) reform in UK construction, major clients were working hard to find better ways to procure and manage construction services. Partnering had real application for the large, experienced clients that had the resources to experiment with innovative systems. British Airports Authority and Slough Estates plc provided corporate and developer client examples of what the industry was striving for during the mid-1990s. The large number of arguments in support of less adversarial relations and partnering arrangements in supply chains have been advocated post-Latham and post-Egan (DETR, 1998), particularly for the large client. And yet the down side of partnering can potentially be a recipe for complacency on the part of service providers (which might include consultants, contractors, subcontractors and material and component suppliers); and higher outturn costs for clients. Large clients were not slow to realise the vulnerable position that they individually and their organisations found themselves in as a result of abandoning the ‘comfort zone’ of traditional competitive price bidding on a contract-by-contract basis. The Machine that Changed the World (Womack et al., 1990) which was a seminal work did not deal with construction at all – it referred to a post-mass-production motor manufacturing industry and embraced and expounded lean thinking. The existence of long-term supplier relationships and the relatively intense management of these relationships were central. Major construction clients began to realise that partnering provided a threat and an opportunity – the threat of escalating costs and poor performance from service providers, but the opportunity to collaborate and integrate within the context of long-term relationships. The construction design and production process has some activities that non-construction manufacturers would recognise immediately – standard and semi-standard components incorporated into a system to provide for example heating, ventilation, lift Installations or perhaps suspended ceilings; these components are delivered to site and fixed together to form a system or sub-system within the building. The management of the design and supply of standard and semi-standard components, assembled at the final assembly place (in our case, the site) enables the principles found in manufacturing to be fairly simply applied to these parts of the construction scheme. Yet the construction team has to deal with an additional, slightly
A slightly uneasy relationship has developed between construction project management and SCM. The problem remained, and still persists, of how the site-crafted element of new buildings is managed – SCM in its purest form does not really help us to procure and organise brickwork and plastering, for example, the so-called ‘wet trades’. Observers (Green, 2006, for example) might dismiss SCM as the current fad or fashion. Yet, casual enquiry with many construction firms confirms a commitment to SCM. But so often organisations have simply changed the titles given to their procurement staff using the words ‘supply chain managers’. SCM involves intensive management activity from a central position within the construction coalition or network either by the client organisation, or by another organization acting as the client’s agent. The time consuming and demanding activities comprising effective supply chain management in construction involve everything ‘from the quarry to the finished project’. It requires capacity and knowledge at the centre and a certain commitment from client organisations to make it effective. Recent research carried out at UCL and involving a number of
major UK construction client organisations, indicated that the examination of sub-supply chain elements to investigate the incremental accumulation of both cost and value proved extremely instructive. Identifying and mapping small sections of the overall supply chain for a construction project and isolating the costs and value added by each actor’s involvement provides the basis for a more enlightened understanding of cost and value in construction projects.

It is now established that SCM in construction is more than a management fad and provides the opportunity for substantial improvements in client and stakeholder value and/or reductions in overall costs. It is commonly debated in the construction echelons, whether the SCM is regarded as a new way of conceptualizing the management of projects or whether SCM is regarded as a new technique to be learned. Either way, it is beneficial to from acquire an understanding of some of the basics of SCM and its application in construction industry.

**Supply Chain Management & Project Management**

Project management has evolved through several stages of development, each adding complementary understanding to the existing bodies of knowledge (Pryke and Smyth, 2006):

- **Traditional Project Management Approach** – techniques and tools for application (for example Turner, 1999; cf. Turner and Müller, 2003; and Koskela, 1992; 2000), which tend to have a production or assembly orientation focused upon efficiency.

- **Functional Management Approach** – strategic, ‘front-end’ management of projects (Morris, 1994; cf. Morris and Pinto, 2004), for example programme and project strategies, and partnering (Egan, 1998) and supply chain management (see Green and May, 2003) and other task driven agendas which dovetail with the traditional approach, for example the waste elimination application of lean production (Koskela, 1992; 2000).

- **Information Processing Approach** – technocratic input–output model of managing projects (Winch, 2002).

- **Relationship Approach** – project performance and client satisfaction, achieved through an understanding of the way in which a range of relationships between people, between people and firms, and between firms as project actors operate and can be managed. Relations are
context specific (Pryke and Smyth, 2006). There are different contexts for relationships, which operate at different levels:

- Business-to-business or organisation-to-organisation;
- Organisation-to-individual representing the business: market and other societal relations (see Gummesson, 2001);
- Individual-to-individual: personal and social relations. Personal relations can be characterised as (Pryke and Smyth, 2006):
  - Authority: management and leadership;
  - Task related: function and role;
  - Acquaintance: social obligation;
  - Friendship: social bonding and reciprocation;
  - Sense of identity: who you are (not what you do), such as inheritance and societal recognition – through ownership in business for example. Organisational relations can be characterised as:
    - Individual or personal: the individual represents the organisation;
    - Systematic or procedural: personal relations have been enshrined into an approach or systematic way of proceeding in order that the essence of a relationship is replicated at a general level in the future through social or legal obligation (cf. Wenger, 1998);
    - Strategies and culture help guide the context in which systems operate, guiding the thinking and behaviour of individuals in order that relations through individuals and systems are aligned;
    - Structure of an organisation both reflects relations and governs relations through hierarchy, function and proximity.

The quality of relationships is a key element in the success of a project. The quality may be the product of a range of factors and therefore a consequence of a whole series of dynamic issues. In this way a project team is merely the recipient of those relationships and how they develop both within the project team and with those who are externally feeding into the project. However, relationships are also managed. The study of projects and their supply chains
provides an appropriate context for the analysis of construction projects and programmed within a partnering framework.

**Origins of SCM in Construction**

SCM is inextricably linked with partnering but whether partnering creates the need for SCM or vice versa is a debatable point. It is clear, however, that the discussion of SCM needs to be preceded by a definition of partnering.

**Partnering In Construction Industry**

*'Partnering involves two or more organisations working together to improve performance through agreeing mutual objectives, devising a way of resolving any disputes and committing themselves to continuous improvements, measuring progress and sharing gains’* Egan (DETR, 1998, page 9)

Loraine (1994), suggests that modern partnering has its origins in the Japanese motor manufacturing of the 1960s and 1970s. The US construction industry began to use partnering in the 1980s, commencing with Shell Oil and Parsons SIP in 1984. Bovis (now Bovis Lend Lease) is credited as being the first construction organisation to be involved in a partnering arrangement (Loraine, 1994) in UK. The characteristics of these partnering arrangements appear to have been long term relationships between manufacturers and key suppliers, and often included maintenance as well as initial installation (similar in concept to the operation of the lift installation sector of the UK construction industry). The process of selecting a contractor on the basis of lowest competitive tender is at the heart of what Winch (2000) describes as the professional system. Winch identifies the way that activities facing the highest uncertainty in the design stages are insulated from the market by the employment of a consultant, reimbursed on a (non-performance related) fee basis. The industry has seen the evolution of control actors (quantity surveyors and clerks of works principally) whose role it was to regulate the activities that remained subject to market forces (Winch, 2000). The industry developed during the latter part of the twentieth century into a low-trust system, in which consultants spent too much of their time ensuring that their professional indemnity insurance cover was not exposed to unnecessary risk, and contractors and their subcontractors adopted
opportunistic behaviour as a means of recovering from unacceptably low tendered profit margins in a context of inappropriately allocated project risks. The motivation for the introduction of partnering, in this case, was related to the need to drive down costs in order to exploit resources that would otherwise have been unprofitable. The broad principles of trust and maximization of each participant’s resources and expertise have become the main focus of partnering agreements used within the industry. Barlow et al. (1997) suggest that there are three main perspectives on partnering:

- A construction process, performance-enhancing tool which draws upon synergy and the maximisation of the effectiveness of each participant’s resources (Barlow et al., 1997).
- A management process involving strategic planning to improve efficiency in large projects, or perhaps a variant of total quality management. Others have emphasised the common goals aspect and partnering as an aid to collaboration.
- The non-contractual governance of construction projects school: Barlow et al., (1997) referred to ‘putting the handshake back into doing business’ implying a move towards trust and informal arrangements (or what is referred to as ‘keeping the contract in the drawer’).

The unique division of labour operating in the construction industry involving designers, contractors and materials suppliers has been cited as a central theme and a focus for reform (see Higgin and Jessop, 1965; Cherns and Bryant, 1984; and Bresnen, 1997, for example). The construction project coalition is a temporary coalition of firms (see Winch, 1989 and 2000). Each firm represents a discrete (contractually defined) role, and when these roles work together, we hope that partnering will modify the roles and the relationships between them. We might, therefore, regard the construction project as a role system (Simon, 1976). A number of the perceived benefits from partnering arise from the ability of this system of roles to improve organisational learning.Partnering is seen by some as a means of removing these artificial divisions, yet the evidence of the effects on actor roles and
relationships is difficult to locate (Bresnen, 2000). There are also varying views about the precise role that contracts and charters play in partnering. One group (notably Quick, 1994; ACTIVE, 1996; Green and McDermott, 1996; cited in Bresnen, 2000) asserts that partnering agreements prevail over the building contract conditions, because of the improved understanding arising out of cross-disciplinary communications. Others (notably Loraine, 1994, referred to above and Roe, 1996, cited in Bresnen, 2000) regard contractual forms of governance as an essential safety net in the event that partnering might fail. The move towards informality in the governance of construction projects – the move away from contract management towards relationship management, has bought with it a demand for methods of effectively managing these new types of linkages between project actors. One of these initiatives was supply chain management.

**Partnering to Supply Chain Management in Construction**

SCM in construction is arguably a more recent innovation than partnering. The Egan report relating to UK construction industry (DETR, 1998) was quite specific in its reference to SCM. The report recommends the adoption of the following features of SCM:

- Acquisition of new suppliers through value based sourcing;
- Organisation and management of the supply chain to maximise innovation, learning and efficiency;
- Supplier development and measurement of suppliers’ performance;
- Management of workload to match capacity and incentivisation of suppliers to improve performance;
- Capture of suppliers’ innovations in components and systems.

**Some Definitions Of Supply Chain Management Relevant To Construction Industry.**

Partnering in its most simple form asks little more of the project actors other than cooperation. Arguably, the industry should be encouraged to abandon the futile pursuit of
adversarial and non-collaborative relationships within the context of a system that will never deliver the customer delight to which the construction industry’s clients aspire and are so often frustrated in achieving. Howell et al. (1996) argue that partnering should be used to facilitate major process re-engineering rather than easing the difficulties encountered in inappropriate systems for the procurement of construction work. This realignment should focus upon the needs of a concurrent design and production process. In order to achieve an output, this re-engineered process must include the management of the various actors in the product supply chain. Views differ as to the nature of this supply chain and it is arguable whether a complex network of organisations working together in a number of non-trade related clusters, are best described as chains and this was referred to at the beginning of this chapter. Figure 1.2 illustrates the relationship between the supply chain and the network of relationships overlaying it. The term supply chain management tends to be used to refer to management processes as well as structures of organisations. Harland (1996) classifies SCM into four categories of use:

- **Internal Supply Chain** – this view of SCM owes a great deal to the work of Porter, (1985) on value chains and is concerned with an intra-firm approach to supply chains that involves the management of materials.
- **Dyadic relationships with immediate suppliers**.
- **The management of a chain of businesses with which you have no direct contractual relationship** (suppliers’ suppliers and a customer’s customer, for example).
- **The management of a network of interconnected businesses involved in the ultimate provision of a product . . . (to) end customers** (Harland, 1996).

Cox and Townsend (1998) cite the activities of Gazeley Properties Ltd as a good example of partnering and SCM. Gazeley, we are informed, ‘. . . attemptsto manage the development supply chain in such a way as to maximise its margin while satisfying its clients’ aspirations in terms of utility and cost’. If we replace the words development supply chain with project, we have a description of what all developers must be doing to remain competitive and satisfy their clients. It is, however, recognised that there is an implication that by using SCM on a
construction project we are doing something more complex than managing a group of subcontractors and suppliers. The relevance of SCM to construction (Pryke, 2001) lies not in the existence of supply chains, but in their exploitation. The management of a supply chain by a developer or contractor, implies the management of actors far removed from the dyadic contractual relationships inherent in construction contracts. Traditional (pre PPC 2000) forms of contract are based on the premise that, as an actor, one is in a relationship with another actor that instructs, pays, has control of a range of performance incentives and therefore manages ones activities. Each actor is therefore is managed by the actor above in the supply chain, and in turn manages the actor or tier of actors below. Exploiting the supply chain involves communication with other actors that have been artificially separated from us by inhibiting contractual conditions. This leads us towards the concept of centrality and SCM. In order to successfully manage any supply chain we need a single actor with the authority to deal with all actors within the supply chain. Cox and Townsend (1998) distinguish the system used by Gazeley Properties (using SCM) and those used by other, more traditional approaches, in the following terms:

- Separation of roles between end-user and fund provider and balancing the needs of these two actors;
- Use of project managers as interface with consultants and contractors;
- Concept design carried out in close consultation with end-users;
- Detailed design may involve input from key suppliers;
- Early participation of main contractors in design.

If we paraphrase slightly Christopher’s definition (see above) we have:

*The management of . . . relationships with suppliers . . . and customer to achieve greater customer value at less cost.*

It is argued that this management process becomes supply chain management when it is carried out within a partnering context. Stevens (1989), offers us a model of the transition of the firm from stand-alone organisation to supply chain partners. The four stages are as follows:
• **Baseline organisation** – classical management; motivation by profit maximisation; functional specialisation; slow to adapt to market and slow to exploit innovative opportunities.

• **Functionally integrated company** – starting to focus on customer service; competitive advantage achieved through some internal integration of disparate functions.

• **Internally integrated company** – systems approach to customer service; optimal information flow between departments; medium-term planning; cross-functional management – product focused structure.

• **Externally integrated company** – transparent system of materials and information exchange internally and externally; long-term planning and long-term relationships with partners; use of internal cross-functional management structures, product related; supplier networking groups implemented (Stevens, 1989).

Much of the literature dealing with the subject of SCM, including Stevens (1989), is not related to construction. Relating the four categories of transition to the current construction industry is disconcerting. It is argued that the vast majority of the industry falls firmly into the baseline category. Even those construction organisations where SCM is firmly on the agenda, show only very limited integration of disparate internal functions. In particular, cross-functional management within the organisation and the use of supplier networking groups, are particularly difficult to observe.

‘Bottom–Up’ Design

One of the most important changes that the construction industry must deal with in its evolution into SCM organisations is the recognition of the most appropriate location of specialist knowledge in a number of fields. Applying the principles of lean production to construction must move the location of the leadership in design from the relevant consultant to the most appropriate subcontractor, supplier or group of same. The CRINE report (http://www.crine-network.com/) borne out of the need of the North Sea Oil industry to drastically reduce its costs in the face of plummeting world oil prices, identified some important principles, which many have sought to apply to the UK construction industry. These principles were, in summary:
• Use of performance specifications to communicate interpretation of client’s brief by consultant to subcontractor or supplier;
• Standard forms of contract to emphasise mutuality rather than adversarial positions;
• Use of incentives to deal more fairly with risk allocation within these non-adversarial alliances;
• Simplification of the tendering protocol and the documentation with which it is associated.

SCM articulates a process of design and financial management, the need for which must always have been present. But management of any process or system requires some focal point from which the manager can operate. The division of labour within the construction industry has meant previously that management of the whole process has been fragmented. Design, site production and component manufacture have each been managed separately. The management of these sectors have been poorly coordinated and this is partly because the conditions of contract have traditionally distinguished and separated these sectors. This tends to point to a growing need for one actor to manage the whole design/site production/component manufacture process. In terms of capacity and authority, this actor would need to be either the client or the contractor. SCM introduces a fundamental shift in focus of responsibility and authority within the overall network of project roles. This system of evolving project roles sits within a context of competing and perhaps conflicting governance patterns. A dynamic exists between formal, contractual relationships (which initially define roles and relationships) and the less structured and formalised project management policies, such as partnering and work clusters (which both ultimately shape project roles and the way in which they are connected). These managerial approaches have a fundamental affect on actor roles and the nature and patterns of interactions between these roles. There is a plethora of material exploring the importance and application of project management to construction projects. Increasingly, there is emphasis upon managing programmes of projects. Perhaps the emphasis must now change from the management of projects and programmes to the
management of standing supply chains. Many would argue that integration of process, innovation and radical change in cost and value are only possible through a focus upon the activities of the supply chain.

**Characteristics of Construction Industry**

The construction industry exhibits characteristics that differentiate it from other industrial sectors. Competitive pressures from within the industry, as well as external political, economic and other considerations are forcing the industry to re-examine and improve its performance. An analysis of the key characteristics of the construction industry indicates that the problems facing construction can be categorised into the following five broad areas.

**Fragmentation**

The construction industry has long been recognised as having problems in its structure, particularly with fragmentation, which has resulted in poor performance (Latham, 1994; Egan, 1998). Uniqueness (see also below), immobility and variety are three distinctive features of construction output that flow from the fragmentation in construction. These features, it is argued, are factors in the tendency of the construction industry towards low productivity, poor value for money and mediocre overall client satisfaction (Latham, 1994), especially when compared with other industry sectors. As a consequence of the uncertainty for the main contractor in obtaining continuous work, with the need to accommodate the different features and requirements of each project, subcontracting has been adopted as the dominant approach (Cox and Townsend 1998, p. 21), which by its very nature, results in further fragmentation.

**Adversarial relationships**

The construction supply chain has become increasingly fragmented for the reasons outlined above. Increased fragmentation brings increased transaction volumes at lower average values and inevitably higher levels of opportunism, particularly in the context of low barriers to entry. The industry had become less trusting, more self-interested and adversarial. The adversarial attitude of the UK construction industry has been recognised problem for many years (Cox and Townsend 1998, p. 29). Performance and innovation in construction are significantly hindered by adversarial relationships and fragmented processes. In order to minimise their own exposure
to risk, each party in the supply chain attempts to extract maximum reward for minimum risk that is normally achieved by means of non-legitimate risk transfer (passing risk down to the next level in the supply chain). This way of thinking has resulted in an industry structure with various interfaces, which are points of tension and conflict, which eventually leads to increased cost and reduced efficiency (Cox and Townsend 1998, p. 31).

Figure 3.7 A typical traditional construction Industry structure. Source: Cox and Townsend (1998, p. 33).

**Project Uniqueness**

The construction industry (with the possible exception of some responsive repairs) is a project-based industry. The characteristics of a specific project, and hence its degree of uniqueness, is determined by a number of factors. Consequently, the assessment of these project features determines the resources needed for a project, and selection of the most appropriate supply chains needed to deliver clusters (Gray, 1996) of resources and services for the project as a whole. This diversity and uniqueness means
that construction projects are very often ‘bespoke’ as the requirements and specifications of technologies for specific clients determine their characteristics. Projects involve assembling materials and components designed and produced by a multitude of suppliers, working in a diversity of disciplines and technologies in order to produce a product for particular client. This diversity of product technologies, which has to be reorganised with each new construction project, coupled with discontinuous demand from a large percentage of construction’s clients, accounts for the transient nature of the relationships between the demand and supply side of the industry. In addition, with the increasing shift from on-site to off-site production, managing construction projects involves integrating diverse and complex supply systems in which a growing amount of value of the product is added (Jones and Saad 2003, p. 12).

Separation of design and production

One of the main problems in construction is the extent to which the industry separates design from production. This particular characteristic of the industry is still common in spite of the deficiencies of traditional procurement and the benefits offered by newer and more flexible approaches (Cooke and Williams 2004, p. 2). The separation of the design and production process in the construction industry, particularly in the building sector, and the consequent difficulties that can arise during construction projects, has been the subject of wide criticism by a number of industry reports such as Latham (1994) and Egan (1998). Consequently, there have been many calls to bridge this gap by creating a seamless supply chain whereby the interface between various phases of the project’s life cycle are integrated with one another. It is an anomaly that design and production are commonly separated at the highest tier of the supply chain (main contractor) but commonly integrated in the tiers below this.

Competitive tendering

In most countries, construction companies are selected to undertake construction projects and the price for their work is established by competition (Griffith et al. 2003). Unlike manufacturing, construction projects are not priced and advertised for sale (manufactured speculatively, without prior orders from customers), but instead uniquely priced after a negotiation or bidding process. Since the mid 1990s joint government and construction industry initiatives (Latham 1994; Egan 1998) have encouraged construction clients to adopt different strategies to procure work. Whilst regular, experienced and informed construction clients have begun to adopt alternative procurement strategies, there is little
evidence to show that the majority of inexperienced irregular purchasers have done so. By far the dominant strategy adopted is the traditional design-bid-build approach with the lowest bidder winning the work (RICS 2006). There is no doubt that competition used in this way serves to drive down prices. Adopting ‘low bid wins’ strategies results in a number of undesirable outcomes, particularly where the design is already established. These are:

- Production processes that are geared to lowest cost rather than to ‘right first time’ or to ‘best value’;
- Bidding processes that encourage opportunism - where suppliers will agree to almost any conditions and requirements to get the work and attempt to improve profit levels on the project through reductions in quality of materials, or the negotiation of disproportionately high rates for variation works;
- An inability and unwillingness to cooperate in specialist design, innovation or collaborative problem solving. ‘Low bid wins’ procurement has been blamed for, amongst others, late completion, overspends on client budgets and product / workmanship. Alternatives do exist, but require attitude change within the construction sector and its professions.

Need of SCM in Construction Industry

SCM has a critical role to play in improving overall performance in construction, but remains at a very early stage of development (Jones and Saad 2003, p. 219). However, the industry is becoming increasingly aware of the necessity to change current working practices and the attitudes they represent (Pearson 1999). A number of organisations (for example; Balfour Beatty and Tarmac) within the construction industry and their clients have developed SCM techniques to rationalise their supplier base. Unlike in the construction industry, SCM has been practised widely for many years in other industries, particularly in the manufacturing sector. Effective SCM has helped numerous industry sectors to improve their competitiveness in an increasingly global market place. The SCM in these industries encompasses all those activities associated with processing from raw materials to completion of the end product for the client or customer.

It is usually an on-going process focused upon specific products that are repeatedly manufactured or purchased. SCM consists of a stable group of interacting partners with a
mutual interest in improving product quality and process efficiency. Unlike the manufacturing industry, the construction industry lacks standardisation. Through the use of standard parts and components, the manufacturing industry has been successfully generating greater levels of productivity and quality control. The construction site is effectively an ad hoc factory, temporarily created to manufacture a prototype product (Cox and Townsend 1998, p. 255). To what extent the construction industry can standardise its product is essential to the development of effective SCM. The Supply Chain Council, an independent non-profit organisation, has developed a SCM maturity model (McCormack et al. 2004). The model defines the following SCM maturity levels:

- **Level 1 – Ad hoc** – The supply chain and its practices are unstructured and ill-defined. Processes, activities and organisational structures are not based on horizontal processes, while process performance is unpredictable. SCM costs are high, customer satisfaction is low, functional cooperation is also low.

- **Level 2 – Defined** – Basic SCM processes are defined and documented, but the activities and organisation basically remain traditional. SCM costs remain high, customer satisfaction has improved, but is still low.

- **Level 3 – Linked** – This level can be considered a breakthrough where cooperation between company departments, vendors and customers is established. SCM costs begin decreasing and customer satisfaction begins to show a marked improvement.

- **Level 4 – Integrated** – The company, its vendors and suppliers co-operate on the process level. Organisational structures are based on SCM procedures; SCM performance measures and management systems are applied. Advanced SCM practices, like collaborative forecasting with other members of a supply chain, form. As a consequence, SCM costs are dramatically reduced.

- **Level 5 – Extended** – Competition is based on supply chains. Collaboration between companies is on the highest level, multi-firm SCM teams with common processes, goals and broad authority form.

The five stages of maturity show the progression of activities toward effective SCM and process maturity. Each level contains characteristics associated with process maturity such as predictability, capability, control, effectiveness and efficiency. Placing the construction industry
within the five levels described above, it can be argued that the construction industry has to some extent utilised SCM techniques for years where ad hoc supply chains of subcontractors are assembled and then disassembled at the end of each project. This basically can be attributed to the one-off nature of construction projects coupled with discontinuous demand. It can be argued that this type of traditional supply network is unlikely to maximise the value for parties involved in the supply chain. The traditional construction project supply chain can be described as a series of sequential operations by groups of people who have limited concern about other stakeholders. Most construction projects are procured through a method by which a defined project forms the focus for a building process carried out by a contractor, who traditionally obtains the work by bidding the lowest price for carrying out the project. The appointed contractor will outsource or subcontract the majority of the work to a number of relatively small subcontractors who will usually win the work on exactly the same basis. The number of subcontractors will vary with the complexity and nature of the project. These contractors and subcontractors typically focus upon meeting their contractual requirements for the lowest possible cost. There may be limited commitment to the client’s primary objectives or to any perceived project team. A parallel, but separate supply chain managed by the client, or client’s project manager, will in most cases include the procurement of the financial resources to support the project and the procurement of the design process itself. Traditional unmanaged supply chains are characterised by short-term focus, with little concern for mutual long-term success; adversarial relationships between customers and suppliers, including ‘win-lose’ negotiations; little regard for sharing benefits and risks; and primary emphasis on cost and delivery, with little concern for added value. As a consequence, the traditional supply chains in a construction project are complex and temporary, involving participants who may not contribute, other than to complete their small, often isolated, part of a one-off project. A team culture focused on the particular needs of the client or the project rarely exists. Different approaches to managing such a supply chain are therefore required if the potential benefits are to be achieved. The culture within which SCM can be developed may not exist in traditional procurement methods, but can be created if the value of such change can be shown to be significant. Despite the limited value and benefits of the ad hoc supply chain structure, it has
worked with varying degrees of success in construction projects, owing to the unpredictable nature of the construction process (Cartlidge, 2004: p. 127). According to Vrijhoef and Koskela (2000), there are four levels, termed ‘roles of SCM’, of implementation of SCM in construction, depending on whether the focus is on the supply to the site, the construction site, or both. Levels of implementation are not mutually exclusive, and in fact, they are often pursued jointly and the descriptions below paraphrase them. One or several supply chain (SC) participants could lead each level of implementation.

- SCM focuses on the impact of the SC on construction site activities and aims to reduce the cost and duration of those activities. The primary concern, therefore, is to establish a reliable flow of materials and labour to the site.
- SCM focuses on the SC itself and aims to reduce costs, especially those related to logistics, lead time, and inventory.
- SCM focuses on transferring activities from the site to earlier stages in the SC.
- SCM focuses on the integrated management and improvement of the SC and site production, that is, site production is subsumed by SCM.

The application of SCM to the construction industry requires a huge effort. It entails developing vertical integration in the design and production process and operations to link the process into a chain focusing on maximizing opportunities to add value while minimising total cost. As this application requires a significant shift in the mind-set of the participants towards collaboration, teamwork and mutual benefits, it is hardly surprising that only few sophisticated applications have been reported in the construction industry (Saad et al. 2001). The extent to which any supply chain performs its functions depends very much on its nature, and the market in which it operates. Hoekstra and Romme (1992, p. 7) provided the following classification of supply chains:

- **Make-and-ship-to-stock.** Products are manufactured and distributed to stock points, which are spread out and located close to the customer.
- **Make-to-stock.** End products are made and held in stock at the end of the production process and from there are sent directly to customers who are scattered geographically.
Assemble-to-order. Only system elements or subsystems are held in stock in the manufacturing centre, and the final assembly takes place on the basis of a specific customer order.

Make-to-order. Only raw materials and components are kept in stock and each order for a customer is a specific project.

Purchase-and-make-to-order. No stocks are kept at all, and purchasing takes place on the basis of the specific customer order; furthermore, the whole project is carried out for one specific customer.

These different classes correlate quite well with different types of market, ranging from the large volume markets such as retail to ‘one-of-a-kind’ markets such as the construction industry. According to Anumba et al. (2000), in the large volume markets it is the supply issues rather than the product development issues which assume greater importance most of the time, whereas in the one-of-a-kind markets the focus is on the product development issues. As a consequence to this, the structure of the company will necessarily have to adapt to these priorities. For example, the large supermarket chains in the UK, in general, have a much larger proportion of resources devoted to supply and forecasting, as opposed to product development, whereas engineering companies in the construction industry have a much larger proportion of resources devoted to engineering and project management. There is a tendency for some construction professionals, and in particular contractors, to focus on capital (or initial construction) cost and it is this focus which underpins and dominates the strategies adopted in managing the existing supply chain. Whilst capital cost is not irrelevant, most clients usually focus upon the value of their project in terms of the business case. It is this value which will form the key success factor for the project.

The value may relate to the performance of the new facility in terms of its function or its worth as an asset. Additionally, it may have a value in the market place at a particular time or over many years. There is a tendency for the long-term objectives of project worth or value to become refocused on the short-term objectives of cost and time once the project or strategic brief has been established (for a discussion on this see Ashworth and Hogg 2000). In SCM, real competition is not between organisations but rather between supply chains. In this way organisations seek to make the supply chain as a whole more competitive through the value it
adds and the costs it reduces overall. Reducing cost and improving value are both important aspects of gaining competitive advantage. The traditional procurement approach sought to achieve cost reductions or profit improvement at the expense of other parties in the supply chain. The approach of transferring costs upstream or downstream does not add any competitive advantage as all costs are ultimately passed to the end user (Jones and Saad 2003, p. 231).