

CONSTRUCTION SUPPLY CHAIN TREND ANALYSIS

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ABSTRACT

The paper relates empirical findings from a construction industry supply chain diagnostic to archival evidence on supply chain engineering. Particular attention is drawn to current construction and non-construction industry trends on such issues as supply chain relationships, business process orientation and exchange of personnel. Evidence is given that indicates strategies such as partnering, business process engineering focused on customer needs and co-development yield significant business and supply chain performance improvements. The paper suggests that the exchange of staff and personnel will yield a change in “mindset” and enable a process oriented supply chain for those companies involved in the empirical research.

KEY WORDS

Supply chain, business processes, relationship, personnel exchange, partnering.

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INTRODUCTION

Ever increasing competition within the construction industry has been the stimulus that has forced companies to respond more efficaciously, efficiently and effectively to customers' requirements. However there remain a number of critical issues within the construction industry that need to be considered and rectified. A long list of problems could be itemised including adversarial relationships, lack of trust and commitment, co-ordination problems, training problems, etc. This paper does not intent to undertake an in depth study of all construction industry problems which are already well documented and strategies proposed (Latham 1994, Egan 1998).

The aim of this paper is to highlight the principal areas where improvements could be implemented within construction industry supply chains. This has been achieved by analysing the different tasks and practices of the various disciplines involved in a construction project, such as clients, architects, contractors and manufacturers. The paper specifically relates archival evidence to empirical research findings from action research undertaken as part of a UK government sponsored programme. The structure of the paper is as follows:

- Background and study framework definition where the project concerned is described and the background of the research explained.
- Review of a number of solutions applicable to construction companies, enabling them to improve their businesses, respond more efficiently to customers' requirements and become more competitive. Each proposed solution is presented with a strategy demonstrating how it can be implemented and the benefits that can be expected.
- Future steps that should be taken to progress within the research project. The framework for change is now in place. The authors also propose to companies how they can further focus on and hence improve on their main supply chain problems.

RESEARCH FRAMEWORK

BACKGROUND

As part of a project funded by the UK government the authors are in collaboration with nine industrial partners, each representing a pivotal element of the house building industry supply chain. The project, entitled "Innovation in Standardised Component Systems in House Building" (COMPOSE) encompasses theoretical research but is particularly industry focused. The COMPOSE project is researching a component-based approach to the UK house building industry, investigating ways to improve customer choice and optimising the supply chain processes. The research undertaken by the authors is specifically aimed at determining the appropriate supply chain processes that will support a component-based approach.

The project's industrial partners cover an extensive range of disciplines within the house building industry supply chain, such as the client, main contractor, architect and manufacturer. The overall research process is shown as Figure 1. An initial phase of the research is focused on identifying the principal supply chain trends within the construction

industry. This has been undertaken by analysing established construction industry supply chains and comparing them to that of other industries'. The latter includes automotive, aerospace and electronics. The construction supply chain analysis included a study of supply chain practices from the USA, Scandinavia, UK and the interrogation of a number of publications from a diverse range of conferences, workshops and seminars. Examining supply chain re-engineering strategies and well-documented paradigms such as lean thinking, agility, business process re-engineering and business systems engineering completed the trend research.

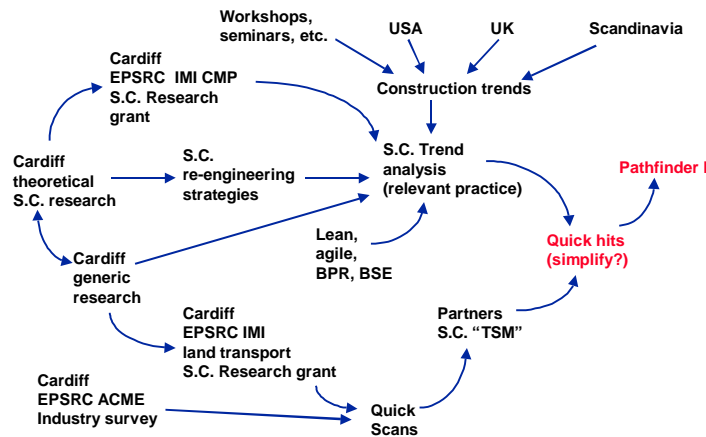


Figure 1: The supply chain research process

TERRAIN SCAN MAPPING RESULTS

A methodology named Terrain Scanning Methodology (TSM) has been developed for the project with the purpose of analysing the industrial partners' supply chains. The principal constraints during the TSM process were the limited lead-time available to the researchers. The methodology employed aims at giving a holistic overview of the partners' current supply chain processes. The procedure provides the opportunity to identify the key problems and relevant good practices for each industrial partner. The main criteria incorporated in the TSM were material/service flow processes, information flows, customer interfaces, supplier interfaces and the measure of performances utilised by each company (Barker et al. 1999).

The results of the TSM undertaken allowed both individual and collective conclusions to be presented to the project partners. This paper concentrates on relating the TSM outputs to relevant supply chain practices and to assess their generic implications. Three main outputs have been identified as follows: to change the "mind-set", to become process orientated and to exchange personnel.

To change the "mind-set": The TSMs clearly showed a problem in the construction culture, namely the presence of poor/adversarial relationships between key players, such as the client, main contractors, architects and sub-contractors. A low level of trust and commitment unfortunately accompanies these poor relationships.

To become process orientated: The second main output arising from the TSMs is the departmentalised method of operation within the house building industry. Most of the

companies visited have clearly defined departments each concentrating on the different aspects of a construction project. This functional silo approach hampers the companies' ability to be fully customer focused, as there is no holistic view of the supply chain.

To exchange personnel: The TSMs enabled the researchers to identify several good practices within the group of industrial partners. Unfortunately the companies involved do not practice the process of sharing information in relation to good practices and consequently are unable to benefit from learning from each other's experiences. It has also been highlighted that these companies are not fully aware of each other's work, workload and their subsequent problems.

The third section of this paper will show how, via a case based approach, these problems could be resolved and what benefits could then be expected from the implementation of the subsequent recommendations.

OUTPUTS

Each TSM output recommendation is presented, by first giving a brief definition of what the authors mean, then example cases are presented and finally the benefits that can be expected are summarised.

TO CHANGE THE "MIND-SET"

"Partnership"

It is important to review the different definitions that exist for the term "partnering" by identifying the main characteristics usually present in any definition. As the first TSM output identified, the relationships between the different disciplines involved in a construction project cannot be qualified as being good; they tend to be adversarial with an evident lack of trust and commitment. The problems developed from this kind of "mind-set" include:

- Communication/information problems: as the different trading partners cannot completely trust each other, they try to limit the exchange of information as much as possible. Consequently, due to a lack of co-ordination they often have insufficient or incorrect information to complete their work and thus do not respect each other's deadlines.
- Win-lose relationship: companies try to procure benefits out of their relationships and often finish with a lose-lose relationship. Contracts are often the fallback used to gain recompense when problems arise.
- Poor quality/late completion: as a result from a lack of commitment between trading partners, the work is often of a poor quality requiring a time consuming checking process. In the same way, the companies are not committed to completing their work on time and consequently will not fulfil their professional obligation and meet the agreed deadlines.

One solution to these problems, which can be summarised under the term changing the "mind-set", can be accomplished through what some people call partnering. As Pokora and Hastings (1995) have defined it, "*partnership is... very much an attitude of mind and one that requires fundamental changes in behaviours that have characterised the construction*

industry for the last 25 years”. A literature review provides many different definitions of partnership. The most frequently exercised definition proposed by the Construction Industry Institute’s Partnering Task Force (1991) and the National Economic Development Council (1991) is as follows:

“A long term commitment between two or more organisations for the purpose of achieving specific business objectives by maximising the effectiveness of each participants’ resources. This requires changing the traditional relationships to a shared culture without regard to organisational boundaries. The relationship is based upon trust, dedication to common goals, and an understanding of each other’s individual expectations and values. Expected benefits include improved efficiency and cost effectiveness, increased opportunity for innovation, and continuous improvement of quality products and services.”

Bennett and Jayes (1995) have a slightly different approach as they identify partnering as a management tool. Cowan et al. (1992) define project-based partnering as: *“a method of transforming contractual relationships into a cohesive, project team with a single set of goals and established procedures for resolving disputes in a timely and effective manner.”*

The previous definitions originate within the construction industry. However, the authors believe that a definition taken from the automotive industry can be applied to any industry including the construction industry. *“In a partnership, customer and supplier commit to continuous improvement and shared benefits, by exchanging relevant information openly and by resolving problems together rather than by finding a new trading partner”* (Department of Trade and Industry, 1992).

There are numerous definitions of partnering. While the authors agree with these in principle, it seems that a significant point is omitted. Partnering has to be a mechanism employed as a means of satisfying the end-user. This means that companies must co-ordinate their efforts and work together embracing a supply chain point of view. Starting from defining the customer’s needs, translating those need into a product/service requirements, the procurement of raw material, through to the delivery of the finished product/service (house, building, road, bridge, etc.) to the end customer. The relationship between the various disciplines within the construction industry has to be based on trust, mutual commitment, understanding of each other’s individual expectations, open book culture (open exchange of information) with clear up front problem resolution.

Case Studies

The various examples in the literature review refer to the use of partnering within the construction industry as well as in other industries. These examples answer the fundamental questions why and how partnering is used, and what benefits can be expected through its implementation by companies willing to enter into a partnership.

Ellram and Krause (1994) have carried out an interesting and important study, where they compare manufacturing and non-manufacturing companies. This study refers to “supplier partnering” (SP) being defined as *“an ongoing relationship between firms which involves a commitment over an extended time period, and a mutual sharing of information and the risks and rewards of the relationship”*(Ellram and Krause 1994). The study was undertaken using an in-depth survey sent to a variety of companies including chemical and related products,

electronics and electronic equipment, industrial equipment and machinery, banks and banking services, air transportation, trucking and warehousing.

The study indicates that non-manufacturing companies have had longer relationships with their trading partners than manufacturing firms (Ellram and Krause 1994). In the same way, the authors have identified the same characteristic within their own group of COMPOSE companies. Non-manufacturing companies (including client and architect) have tended to have longer business relationships with their “partners” (customers and suppliers) than the manufacturing companies.

The Ellram and Krause (1994) survey presents the main reasons why companies enter into a partnership. One of the principal motives for entering into a “supplier partnering” relationship for non-manufacturing companies is the delivered price of the item/product class. Another factor that is worth considering is a reduction of internal procurement procedures and its resulting costs, which is ranked third by the non-manufacturing firms. In the case of the construction industry, partnering has been promoted as a means of avoiding the tender procedure.

Finally, Ellram and Krause (1994) indicate the estimated improvement resulting from SP. Both manufacturing and non-manufacturing companies showed considerable reduction of incoming defects (from 6.4 to 21.2%), percentage on time delivery (from 22.9 to 25.6% improvement), cycle time reduction (from 7 to 24.7 days) and percentage of orders received complete (from 15.6 to 16.8% improvement).

Ellram and Krause (1994) thus provide us with a good insight of the reasons why companies move towards partnering and the benefits these companies have enjoyed since entering a partnership relationship. It is however important to examine a case taken from the construction industry. The relationship between Newydd Housing Association (client) and E. Turner & Sons (main contractor) is a suitable case for analysis (CPN report E819B 1998). This represents an example of a social house building industry supply chain. The project consisted of 450 houses, split into 8 phases (3 new-build and 5 refurbishment). The contractor, E. Turner & Sons won the tender on price alone and had an adversarial approach to house building. The results were clearly not satisfactory as indicated in Table 1. The first two phases (Phases 1 and 3) under-performed and the programme over-run, inducing increased costs. In addition, there were many major complaints from the tenants.

A need for change was clear. Obviously, the client was not getting value for money by choosing the lowest tender price. The client and the main contractor, with the aim of improving the quality of work and reduce costs, decided to adopt partnering. Hence they created a team encompassing the client, the design team, the project manager, tenant associations and the main contractor. The tenants were because they were returning to their refurbished dwellings. During a workshop on partnering they all agreed on mutual objectives.

The next two phases (Phases 5 and 4) in Table 1 show a considerable improvement in performance. The six-week delay in completion of Phase 5 was due to delays during transition from traditional to partnership working; quality and costs were not a problem. The budget and programme were constantly monitored, the design was developed against the budget and a problem resolution procedure was agreed (CPN report E819B 1998). This indicates that partnering in house building projects is achievable and rewarding as it can bring some tangible improvements in terms of completion and budget.

Table 1: Newydd Housing Association and E. Turner & Sons results
 (Sources: CPN Report E819B 1998 updated by David Benson February 1999)

	Phase 1	Phase 3	Phase 5	Phase 4
Cost	+18%	+15%	-5%	Under cost
Delivery	+14 wks.	+16 wks.	+6 wks.	On program
Major complaints	13	18	nil	nil

Benefits

The previous examples illustrate that partnering (by their own definitions) brings significant improvements for all parties involved within the supply chain. The relationships are based on trust, openness, commitment and mutual understanding. Furthermore, the Newydd Housing Association and E. Turner & Sons case showed that our earlier definition of partnering (Section 3.1.1) is relevant. All the constituent parts of our definition are present and they also agreed to extend the team-working relationships to the sub-contractor and suppliers and, most important of all, they focused on the end-customer.

The principal benefits that can be achieved by entering into a partnership can be summarised as; on-time delivery (hand-over), on-budget completion, value for money, end-customer satisfaction, improved quality, improved working relationships (team-work spirit), reduced conflicts, etc. In conclusion, it appears that partnering, as defined by the authors in Section 3.1.1, is a potential solution to the problems identified by the TSM and should be given serious consideration by all construction disciplines keen to change and improve their business processes.

TO BECOME PROCESS ORIENTATED

Business Process Orientation

During the TSMs, the researchers noticed that most companies were departmentalised. Consequently barriers emerge between each discipline of their business. As a result such firms cannot establish a process view of their work, neither can they fully focus on their customers needs and requirements. The organisation is too often rigid and this creates a burden for the company (Christopher 1992). In addition, each activity carried out by the company is sequential; an order goes from one department to another to be processed. To amend this problem, such activities should be conducted in parallel where appropriate rather than in sequence along a single line of command (Christopher 1992).

Business process orientation has to be seen as a tool to improve the delivery of goods and services to the end customers (Hammer and Champy 1993). Although focusing on customer requirements is not a new concept to construction firms, they often have difficulties interpreting the meaning of customer value into the processes (Gann and Senker 1998). Business process re-engineering looks at the real value-adding activities that can be offered to the customer within the core process activities (Evans et al. 1995). There are three essential points which constitute business processes: 1) process always has a customer, internal or external, 2) processes may cross organisational borders, and 3) process must be evaluated from the customers point of view (Hammer and Champy 1993).

Case Studies

The literature review identified numerous case studies and examples that show the benefits to be expected, and the improvements achieved after implementation. One example of improvements was presented by Parnaby (1994), with the results being adapted by Evans et al. (1997). This case study looked at several business processes such as Product Development Process (PDP), Product Introduction Process (PIP) and Information Control Process (ICP). The most interesting case is the PIP of aerospace actuation systems as it is very similar to a construction process. The PIP is comparable with the construction process as it has to go through different phases such as conceptual design, detail design, choice of suppliers, production process, etc. The results are significant: 43% reduction in PIP costs, 95% reduction in changes per drawing, 15-20% reduction in product costs and 30% reduction in PIP lead time.

One example in the construction industry is that of Skanska AB, a major Swedish contractor and developer, who developed a business process approach with the purpose of improving and reducing their lead times. Skanska implemented a new management tool titled Think Total Time, or 3T. 3T is a process that forces Skanska to delegate responsibility and authority. The main drivers are client focus, dedication and willingness to change (Skanska undated). 3T ensures satisfied customers, the right quality and lower costs and greater job satisfaction for everyone. Quantitative improvements are significant. During a design-construct joint venture for a hydroelectric plant, Skanska completed the work 2 years ahead of schedule and the electricity generated during that time was worth 30% of the construction costs. A road structure replacement has been finished within 9 weeks instead of 13 weeks; i.e., 31% faster.

Another well known example can be taken from Doyle Wilson, who by reengineering their business processes improved dramatically their performance in house construction including a lead time reduction from 21 to 4 weeks (Towill 1997). Finally, Ibbs (1994) analyses the case of the US Navy Public Works Centre that had to respond quicker to customer needs. They changed their way of working by moving from a functional approach towards a business processes approach. They reduced their completion time of construction work from 364 days to 127 days; in other words they reduced their lead-time by 65%.

Benefits

The above examples illustrate how process orientation can improve the performance of a company. This process orientation is often undertaken through Business Process Re-engineering, or via lean thinking where the value stream is analogous to a business process. BPR demands the full commitment of the personnel who have to be willing to change. They have to understand that the most important person in the whole process is the final customer who buys the products (e.g. a house) or service. The benefits can be significant and impact notably on lead-times.

The main focus has to be on the customer and finding ways to give the best total value (and not just price or quality or service or lead-time alone) to the end-consumer. If a business has the same main objective to satisfy the customer it becomes easier to work as a single entity and not as separate functions. Once a company has its own house in order, the business

process approach can be extended to include customer and suppliers (Stevens 1989, Evans et al. 1997).

TO EXCHANGE PERSONNEL

Exchanging Personnel

Exchanging personnel between companies is both a symptom and cause of having good relationships and being process orientated. It helps to generate trust between a company and its suppliers, customers and other businesses. It also indicates that the company is willing to learn from each other through cross-fertilisation of knowledge and technology.

Exchange of personnel can be undertaken with a company's supplier when co-developing a new product. It can be used to remove the bottleneck of a product delivery supply chain; the lower or higher echelons in the supply chain can help the company concerned by sharing their human resource, expertise and knowledge. This encourages the companies not to focus just on their own work processes but on the entire supply chain process and act as a whole to compete against other supply chains and satisfy their end customers' needs.

Case Studies

The Machine that Changed the World (Womack et al. 1990) gives examples of companies who have exchanged personnel with the aim of improving their supply chain and satisfy their customers' requirements. For example, "in 1988, Nisshin Kogyo, a leading Japanese brake manufacturer, had a product-development team of 7 engineers, 2 cost analysts, and a liaison person regularly positioned at Honda's research development centre. The team was working on a daily basis with Honda's development engineers on the design of a new Honda car" (Womack et al. 1990). There is also the example of companies transferring production personnel to dealerships when sales are low in order to help in de-bottlenecking the sales system to ensure consistent level schedules on the production system.

In the same way, the Department of the Environment, Transport and Regions (DETR) has an initiative to promote the visit of firms restructuring their current practices to companies who have previously implemented good practices. The objective is "to transfer best practice concepts and real life experiences from host companies that have implemented them to groups of visitors who wish to do so themselves". This indicates that construction industry companies are ready to learn from each other and that a number of them are ready and willing to share their knowledge base so as to learn from others.

Benefits

The advantages of exchanging personnel are not readily quantifiable but there is evidence that allowing personnel to physically co-locate leads to benefits. It has been shown empirically that co-location leads to both oral and written communication which is 35% more effective than oral only and 40% more effective than written only (Dahle 1954). An important element of personnel physically communicating face-to-face is that a social network is developed. It is through these social processes that involve a high degree of interaction and shared experiences that tacit knowledge is communicated (Nonka1994).

An example of the benefits of exchanging personnel and sharing human resource is the improvement of time to market of automotive vehicles. By co-location and co-development

during the design stage Nissan UK has seen 25 per cent faster development times for its current Primera compared to the introduction of the Almera. Also, the pioneer suppliers involved in the co-development exercise have achieved an annual average improvement in their design and development performance of 10.3 per cent compared to 7 per cent performance of all Nissan suppliers (Anon 1999). It should be noted that the design and development phase for car manufacture is analogous with the design phase of construction. Such a phase requires the bringing together of designers, manufacturers, assemblers, financiers, marketing, and sales personnel. That is, bringing together different members of the supply chain whom would normally not be in the same physical location.

FUTURE DEVELOPMENTS

During the TSMs, the researchers identified a list of relevant/good practices within the group of industrial partners. A comparison between these different companies in terms of relationships with their customers and suppliers, and in the utilisation of IT (telephone, fax, EDI, etc.) has been undertaken and is summarised in Figure 2. With the aim of developing good practices, firms placed on the left side of the matrix should aim to move towards the top right hand corner.

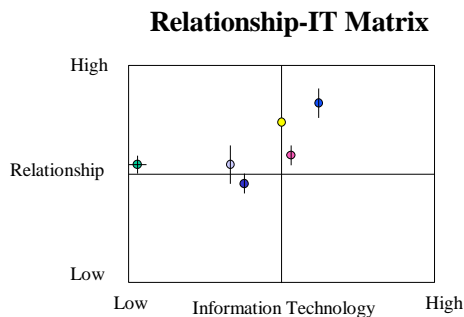


Figure 2: Relationship-IT matrix (Barker et al. 1999)

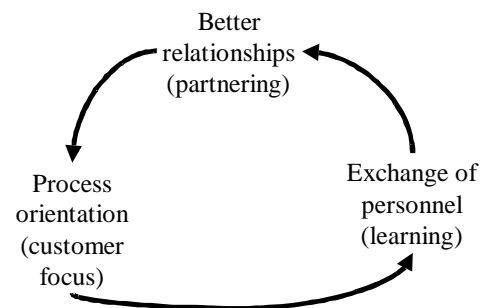


Figure 3: Inter-relationships of TSMs output

One way of transferring relevant practices identified and consequently move towards the top right hand corner of the matrix is to share their knowledge and expertise by exchanging personnel. The researchers are in the process of setting up a workshop, where one host company will present how they changed and developed during the last decade and the improvements that resulted. They will also be able to share their relevant “gains” and “pains”. The next step will be for each company within the COMPOSE project to hold such a workshop. In that way, all the firms will be able to understand each other’s work to a greater degree and learn from each other. An important output from the exchange of personnel is that, although it is a symptom of a change of “mindset” (i.e. better relationships) and process orientation, as can be seen from Figure 3, it is also a root cause.

This should create a team spirit where each participant knows and understands each other. This should lead to a co-location, co-design and the co-development of demonstration builds entitled Pathfinders. However, knowledge is not only transferred through personnel, but can also be facilitated with the exchange of data and information through the use of IT.

Information Technology should facilitate the creation of clear communication channels, it should allow participants to feed forward undistorted information, consequently making the information available to everyone. Nevertheless, IT must be used carefully and operated properly, otherwise dated or incorrect information can be transferred. In such a case, IT could be detrimental to a company's performance, as distorted information would be shared faster.

CONCLUSION

As seen previously, the TSMs undertaken by the researchers during the COMPOSE projects developed three main outputs. The first output considers changing the mind-set of the industry by creating better relationships between trading partners. The second contemplates becoming process orientated by focusing on the delivery of best total value to the end customer. Finally, the TSMs third output introduces the process of learning from each other by sharing information and making the best use of IT, and exchanging personnel in order to share relevant/good practices. The workshops will give the opportunity to all the companies involved in the project to share relevant practices and the appropriate occasion to exchange knowledge and expertise and consequently learn from each other.

Finally, the next step for companies willing to progress and improve their operations is to establish a task force group. The group's priorities should be defined as developing new company strategies with the aim of transforming and improving their current operational performances while encompassing customer orientated practices. This should be implemented as part of their business strategy redevelopment, incorporating the section of their business process they want to improve. Academic researchers can then become part of the task force and offer their input originating from generic research previously undertaken. The UDSO (Understand, Document, Simplify and Optimise) methodology can then be applied in order to improve the company's business and supply chain processes.

This paper demonstrated that construction companies could improve by learning from other industries and by sharing their relevant practices. Within the COMPOSE project, companies have the opportunity to learn from each other and use the academic input to set up task forces within their own organisation or as part of a supply chain group. However this can also be applied to any company wishing to change their current working procedures and practices in order to respond better to their customers requirements and consequently improve their competitive advantage.

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