TERRAIN SCANNING METHODOLOGY FOR CONSTRUCTION SUPPLY CHAINS

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ABSTRACT

The paper defines a Terrain Scanning Methodology (TSM) for undertaking a health check of individual businesses and whole supply chains in the construction industry. Building on previous research in a variety of market sectors the TSM aims to minimise resources required in undertaking a diagnostic while still allowing a high degree of scope. The TSM takes into account the constituent flow on the supply chain, the issues governing supply chain change and the level of business process detail. An application of the TSM in a house building supply chain is given and a critical analysis of the TSM undertaken. The paper concludes that while the TSM has its limitations as a stand alone exercise it can be seen as a vital first step for companies to understand and document their supply chains before embarking on a long term supply chain engineering program.

KEYWORDS

Supply chain, business process analysis, process mapping, supply chain engineering, house building

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INTRODUCTION

In the UK, recent government initiatives have been instigated to give "wake up calls" to the construction industry (Latham 1994, Egan 1998). The motivation is to avoid the declines witnessed in other established industry sectors, such as marine, motorcycle and automotive. There is the danger that if the UK construction industry does not develop new ways of working and develop strategies for re-engineering the sector then considerable competitive weakness will materialise. As with other sectors, ingress into the UK market by foreign competition will diminish UK companies' market share and ultimately lead to financial losses, take-overs and/or closures.

A particular focus of the UK government initiatives is to improve the engineering of supply chains. Supply Chain Engineering is the conceptualisation, design (in both steady state and dynamic terms) and subsequent implementation, operation and re-engineering of the supply chain (i.e., the total life cycle engineering of the supply chain). Supply Chain Engineering may thus be regarded as the control and management of key processes such as information flow, order fulfilment and product development that run from final consumption point back through a series of linked companies to raw material producers. In functional terms these activities would include marketing, construction/manufacturing and operations, engineering, design, research and development, purchasing, logistics and IT; in other words a combination of management and engineering.

Unfortunately, due to market forces and/or opportunity realisation, many companies wish to implement "quick fix" solutions to their perceived supply chain problems without necessarily going through a rigorous method of analysis and design prior to implementation. The dangers are that inappropriate solutions are implemented or that the symptoms are addressed rather than the causes.

This paper describes the development, application and critique of a Terrain Scanning Methodology (TSM) used as a diagnostic of individual businesses and whole supply chains in the construction sector. Watson's (1994) adage of Understand, Document, Simplify and Optimise (UDSO) has much in common with other systems engineering methods (Berry et al. 1998b) and is formative in the principles of the TSM. The TSM aids businesses in the Understand and Document stages of UDSO.

The structure of the paper is:

- An explanation of the background to the TSM and its formulation.
- A description of the TSM method and tools and techniques utilised.
- The application of the TSM and the benefits resulting.
- A critical appraisal of the TSM and its role in supply chain engineering.

BACKGROUND

As part of the UK government's initiative to improve construction industry performance research funding is made available to projects involving collaborations between centres of academic expertise and construction companies. One such research project is "Innovation in

Standardised Component Systems in House Building" (COMPOSE), which is under the remit of the LINK Meeting Customers Needs through Standardisation (MCNS) programme and involves nine companies representing different echelons of the house building supply chain.

This paper describes the initial work carried out in one of the research streams, which will eventually define a suitable robust supply chain structure to support the delivery of standardised components in house building. In an ideal scenario the supply chain has to act as a single entity, focused on end customer requirements and ensuring that the product, or service, that is delivered is of the highest quality, at the lowest total cost and is readily available in the shortest possible time. Such metrics define the total value that must be delivered to the end customer (Johansson et al. 1993) which implies that no longer is it possible to simply deliver on any single metric on its own. Added to such metrics there is also a need to consider the health, safety and environmental issues that govern the end customers needs (Evans et al. 1997)

The supply chain as a single entity may be termed the seamless supply chain (Towill 1997). There are different elements that need to be considered if the vision of the seamless supply chain is to be achieved. Such elements govern the scope of supply chain engineering that is required in order to transform a current supply chain state into the vision. The Scope Paradigm has been stated by Berry et al. (1999) as having three dimensions: depth, breadth, and width. Depth defines the integrated infrastructure dimension that governs issues on organisation, people, technology and controls. Width defines the inter-linked flows that constitute a supply chain, namely materials, information, capacity (or resource) and cash. Finally, the breadth defines the discrete level of supply chain change whether that is work processes, business processes, supply chain processes or total network processes.

A rigorous supply chain engineering programme requires a systematic framework that is based on strategic need and allows for thorough analysis of the supply chain prior to change implementation. While the Scope Paradigm is exemplary there is always the danger of "paralysis by analysis" (Johansson et al 1993) which leads to too much time on the analysis, taking up too much resource required for operations with no solution ever in sight.

In order to ensure that the Scope Paradigm is implemented there is a need to develop a methodology that addresses the three depth, width and breadth dimensions to enable adequate understanding and documentation (using Watson's UDSO (1994)) of the supply chain while minimising valuable time and resources. Thus, the TSM has been developed as part of the COMPOSE research project to:

- understand and document the industrial partners' current practices in relation to their supply chain
- find areas of improvement at
  - ♦ individual work and business process levels
  - ♦ supply chain and network levels
  - ♦ a house building industry level via generalisation of the TSM application outputs
- find opportunities to support and promote the use of standardised components via standardised supply chain processes

- provide radical and innovative "quick hits" (not "quick fixes") and recommendations for long term change programmes

The TSM has been developed with the needs of the construction industry in mind. It is an adaptation of a "Quick Scan" methodology developed by the Cardiff Logistics Systems Dynamics Group (LSDG) in conjunction with an automotive systems manufacturer and an international consultancy (Lewis et al. 1998). The TSM also builds on the systems engineering expertise of the LSDG that has seen analysis, re-design, re-engineering and implementation of new processes in a variety of market sectors including construction, steel, electronics, automotive, fast moving consumer goods and aerospace. The methods, tools and techniques have most recently been documented in Berry et al. (1998a, 1998b).

METHODOLOGY AND TOOLS

An overview of the TSM process is shown in Figure 1. The initial visit aims to introduce the TSM philosophy, establish the key contacts for questionnaires and interviews, identify two representative products/services and for both of these one supplier and one customer. Top level business process and supply chain information is also obtained, often in the form of flow charts, where available. If necessary the location for the main TSM visit is also ascertained. Assurances of confidentiality and anonymity are discussed and given as necessary.

Figure 1: TSM Overview

A week prior to the TSM visit, three questionnaires are sent to the respective personnel. One questionnaire is aimed at internal operational information while the other two are aimed at the supplier and customer interfaces. Confirmation via telephone of receipt prior to the TSM visit is made which also is utilised to answer any queries about the questionnaires. Despite the lack of heterogeneity amongst supply chain members a consistent approach to questionnaire and interview format is adopted to allow a valid comparative study to be undertaken wherever possible in order to determine relevant supply chain practices.

The TSM visit consists of checking through questionnaires, walking and mapping the business and supply chain process, and carrying out semi-structured interviews. Data assimilation and initial analysis occurs immediately following the TSM visit to facilitate accurate recall and recording. This is followed by a more in-depth analysis where most, if not all, data collected is transposed onto a single sheet to ease understanding. At this stage reference to a database of business process and supply chain knowledge is made (Hong-Minh et al. 1999). The analysis is concluded with a brainstorming session to identify "beauty spots" / "hot spots" and potential improvements for the companies concerned. The analysis is then systematically scrutinised and relevant outputs decided. "5 Whys", "cause and effect" or "influence diagram" modeling may represent the outputs of some of the analysis.

A main area of comparison is the level of relationship (or partnership) with customers and suppliers and also the degree of information technology (IT) used in communication. A simple 2-by-2 matrix, based on a "rating scale" output from the questionnaires, is constructed for comparison (Fig 2). Definitions of two metrics are shown in Table 1.

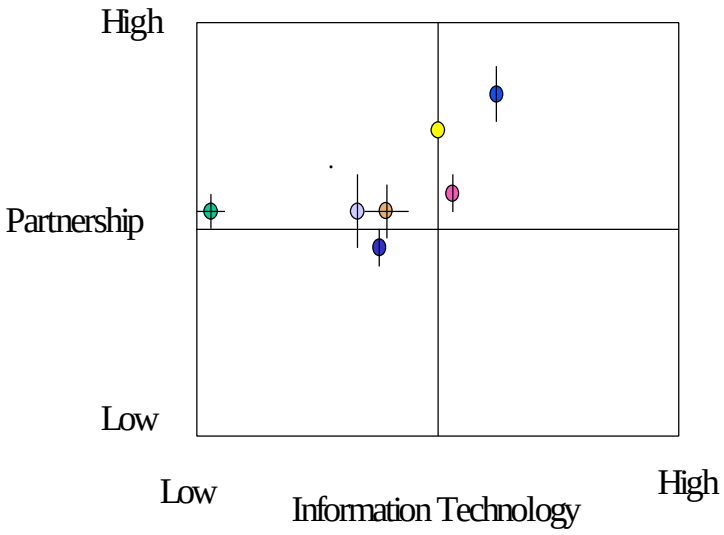

Figure 2: 2x2 Matrix

Each company receives individual feedback outlining "beauty" and "hot" spots, potential areas for improvements and overall conclusions. Discussion and comments are obtained regarding the presentation and the underlying supportive reasoning. Permission is also sought to declare "relevant/best practices" to other companies in the same supply chain who have also participated in a TSM exercise.

The TSM is undertaken in as short an activity time as possible so as to maximise the diagnostic opportunity. The breakdown is approximately a total of four days per company, with only two days of actual personnel contact time. At the moment the TSM team consists of two full-time researchers, the aid of off-line support from the rest of the academic team when required plus part-time involvement of company personnel during the TSM process.

The TSM attempts to triangulate data as much as possible. Thus data sources utilised encapsulate four main areas, namely:

- **Opinion**: personal thought and ideas obtained via interviews and brainstorming sessions
- **Archival**: obtaining previous analysis undertaken by the companies, company literature and documentation
- **Analytical**: analysis of readily available data such as stock or inventory profiles, resource utilisation, time series of company measures of performance (MOPs)
- **Empirical**: process mapping and flow charting, recursive input-output analysis, issuing questionnaires

Triangulation, including repeat and reverse questioning, aimed to verify the "as is" rather than the "as perceived" business and supply chain processes. The main areas targeted are: Material flows; Information flows: MOPs; Customer interfaces; Supplier interfaces

Table 1: Summarizing the TSM in Terms of Relationship Types and Degree of IT Utilization

"Relationship" is evaluated via questions on:
Trust: an expectation that your trading partner will behave in a predictable and mutually acceptable manner. [Sako (1992)]
Commitment: are you and your partner committed to fulfilling your and their obligations for the contract or product life even though there are easily accessible alternatives. [author's definition]
Joint R&D programme: working together and sharing expenditure for a common goal of possible future benefits. [author's definition]
Open book: Do you and your trading partners allow your cost structures to be viewed, discussed and analysed by each other with the intent of mutual cost reduction. [author's definition]
Degree of IT is determined by ascertaining:
How the information is transferred between the concerned company and their customers and suppliers
The type of information transfer: paper, telephone, fax, e-mail, EDI, other

APPLICATION

As part of the COMPOSE project nine industrial partners have participated in a TSM application. They each represent different members of a house building supply chain and include a system integrator, a plumbing manufacturer, a heating and ventilation systems provider, a fit out consultant, a roofing system provider, an architect, a public sector landlord, a social housing contractor and a private sector speculative house builder.

The TSM was applied over a four month period between October 1998 and January 1999. Examples of the tools in action are given in Figures 3 and 4. An important feature of the TSM is the ability to transfer between high-level supply chain process maps as given in Figure 3 and lower level work process representations as given in Figure 4. The process maps enabled questioning of activities, their sequencing and the transformations undertaken of the supply chain's constituent flows. They aided in developing dialogue between the research (facing in) and the industrial participants (facing out).

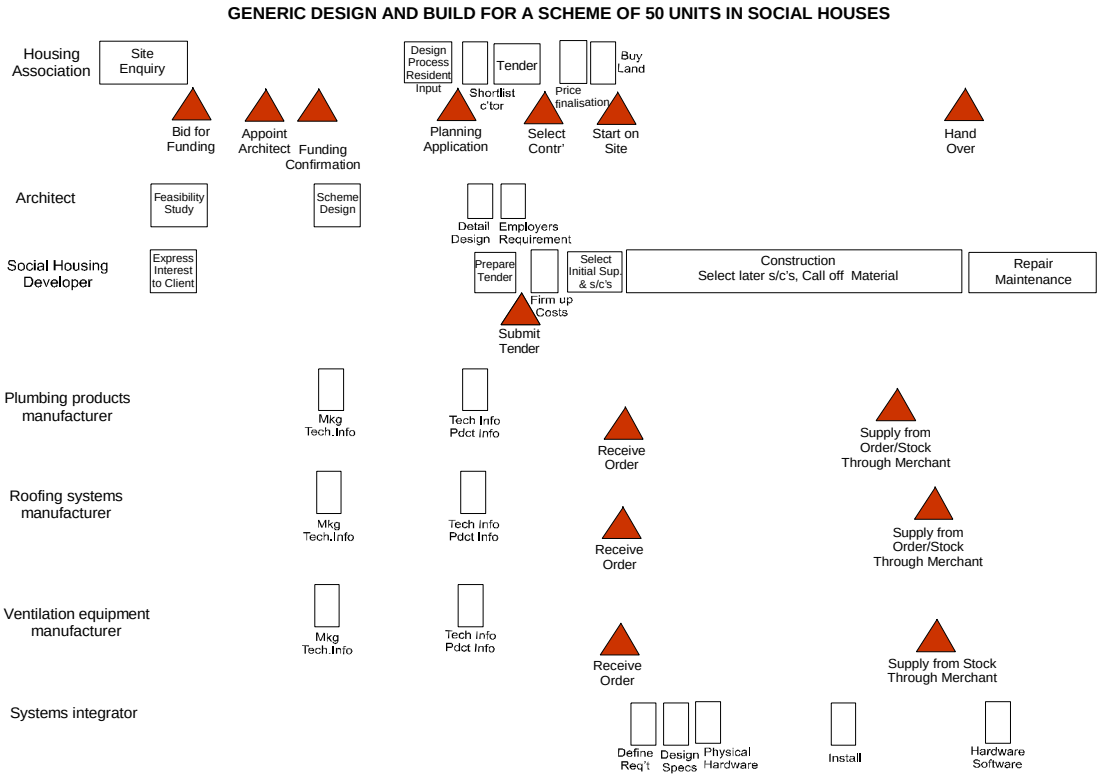

Figure 3: Top Level Supply Chain Process Map

Via subsequent recursive analysis, involving follow up interviews with the industrial partners, it was possible to determine cause and effect relationships for the problems highlighted during discussions. An example of cause and effect analysis in given in Figure 5. Although particular problems may be highlighted by those involved in the supply chain operations, the root causes may not be evident. Figure 5 indicates that the symptom of "adversarial relationship with main contractor" is in fact due to "not aware of the benefits" and "satisfied by the way they work". No one particular player in the supply chain is responsible for the symptom but is attributable to the interaction and dynamics between players in the total supply chain

The separate partners' TSM analyses were collated and a joint feedback session with all partners present undertaken. A number of relevant practices were highlighted from each of the partners, which indicated potential learning opportunities between them. The relevant/best practices are: (1) Partnership with suppliers, (2) Initiating partnership with customers, (3) Customer focus, (4) Continuous improvement culture, (5) Employees training, (6) Project planning, (7) Innovative product development, (8) Working procedures.

As well as highlighting the "relevant/best practices" uncovered in the TSM applications the 2-by-2 Relationship/IT matrix was also presented as shown in Figure 2. The matrix implies that those companies at the top-right are those with best practices in term of fostering better relationships with customers and suppliers and maximizing the opportunities of transferring information with their trading partners through the use of IT (although this may be more appropriate for some than others).

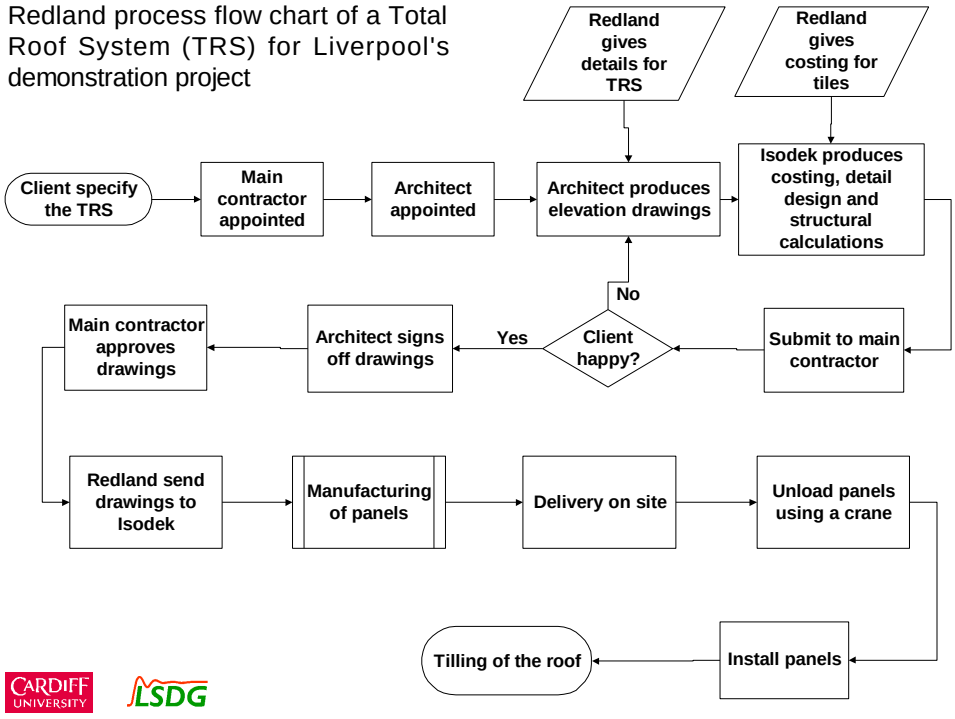

Figure 4: Lower Level Process Map

An important output from the TSM applications was the recommendations for supply chain engineering. These were:

- Relationship/trust/culture: changing the "mind -set"
- Process orientation: total value perspective
- Exchange personnel: overall function, best practices, communication – IT.

Relationship/trust/culture is the way that the partners consider their working situation within the industry and the general attitude to change and improvement. From the initial data gathered there appeared to be somewhat of a difference between manufacturing and non-manufacturing organisations. It seems that in house building relationships with Housing Associations, Architects, Contractors and Sub-contractors are generally contractually based and so indicate little trust. Reference to, or legal use of, contracts with penalty clauses is common. Such an adversarial state of affairs, although obviously based on the experience of difficulties is a potential area of uncompetitiveness. However change is occurring in the industry and many companies are seeing the benefits of, and are moving towards, closer relationships (Construction Productivity Network 1998). The speed of this transition is apparently slow in house building due to several factors such as the market structure, intense competition, price dominance and the simplistic and repetitiveness nature of the process (Barlow 1999). Considerable benefits, such as improved quality, meeting completion dates and reducing overall cost can also be gained from a more open, pro-active culture (Hong-

Minh et al. 1999) where continuous improvement is the norm as indicated by those relevant practice companies in the top-right hand corner of the matrix in Figure 2.

Several of the companies visited appeared to be working on a functional silo approach. That is, areas of activity are compartmentalised and work on a flow principle of passing on the work from one area to the next. Many businesses have now adopted a more process/product principle so as to more easily meet customers requirements. This emanates to the concept of "value" throughout the product or service delivery process and allows the business to realise what activities give added value in their total supply chain.

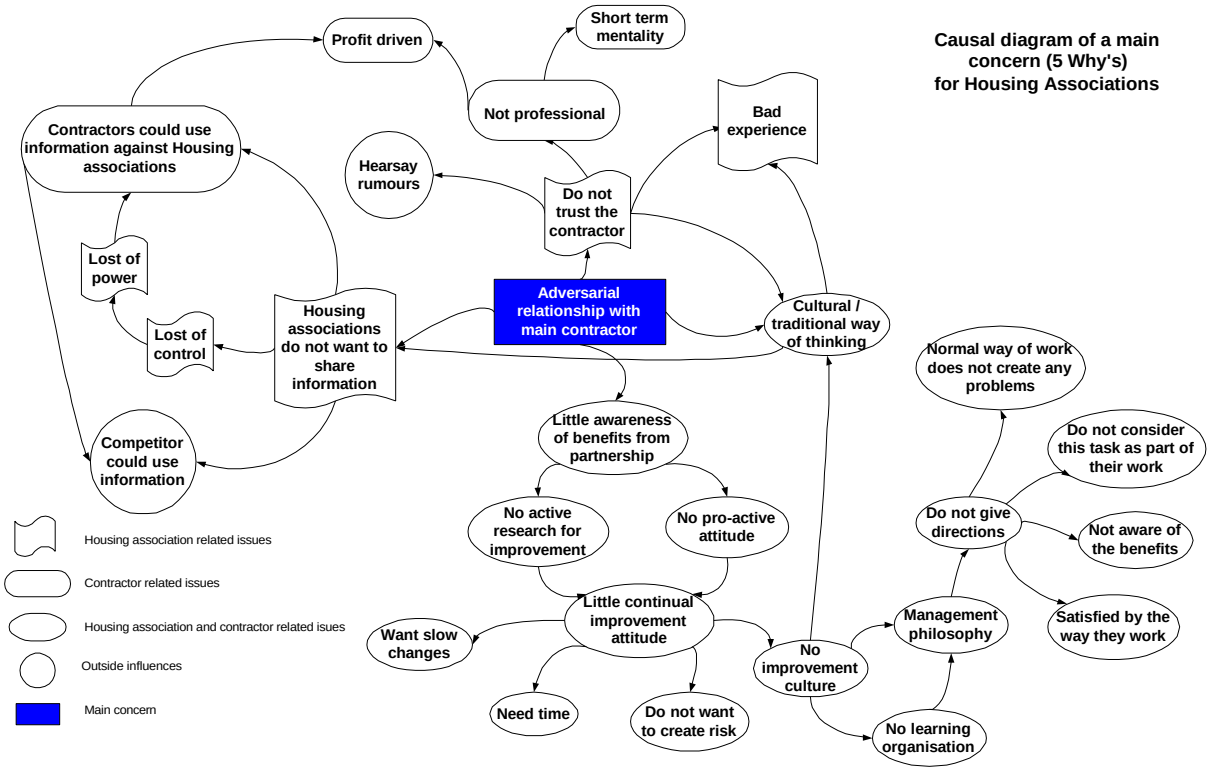

Figure 5: Example of "cause & effect"

The final opportunity really transcends and is a supporting element of the first two. Exchanging personnel, and therefore culture, knowledge and working practices, is the means to improvement in relationships and implies integration of activities to create a process orientated approach to product or service delivery. As outlined by Hong-Minh et al. (1999) much benefit can derive from sharing of best practice ("gains"), and the understanding of customers/suppliers problems ("pains").

CRITIQUE, DISCUSSION, AND CONCLUSION

Before, during and after the TSM application the limitations of the methodology and its associated tools and techniques were discussed. A strengths and weaknesses analysis has been undertaken as shown in Table 2.

The weaknesses were recognised at the outset of the TSM application. There has been a feeling by some of the industrialists that the TSM is only "skin deep". Others, in particular

those at the top-right hand corner of Figure 2, feel that the TSM is an important pre-requisite to change.

Table 2: Strengths and Weaknesses Analysis of the TSM

Strengths	Weaknesses
Quick, saves on time & resources	Low level of detail – not to activity level
Identifies key problems, focuses on specific and critical issues	Limited opportunities for information validation / triangulation
Quick learning curve for process analysis	Mainly focused on short / medium term opportunities
Low "total cost" of undertaking diagnostic	Limited understanding of all the problems in the supply chain
Good holistic overview of current supply chain state	Much of the data based on opinion sources
Not paralysed by excessive analysis	

It should be realised that the TSM is merely the "tip of the opportunities iceberg" as indicated in Figure 6, compared to a true Quick Scan that can lead to a full change programme. Here questionnaires, quantitative data, process maps and interview notes are all used by the Team to identify the root cause of potential supply chain and business process improvement. This deeper than TSM analysis uses brainstorming, cause & effect and centres around the EVA formula as outlined in the Quick Scan Handbook (LSDG et.al.1999).

The TSM literally "scans" the terrain of the supply chain – it does not burrow under the surface. The TSM is even more limited in resources and scope than the "Quick Scan" method developed previously. On the scale of things it is merely a pointer to the possibilities that may be available to a business and its trading partners in the supply chain. It is important that the TSM is recognised as a preliminary stage in a long-term change programme. While avoiding "paralysis by analysis" is an important requirement, it is nevertheless vital that adequate resources are made available to determine cause and effect relationships and the root reasons addressed as part of cohesive strategy. Improvements and re-engineering do not simply happen by osmosis.

The research team believes that those "best practice" companies in the top-right hand corner of the model shown in Figure 2 have much to offer to the rest of the supply chain. In particular, they have already gone a considerable way to satisfying the three opportunity recommendations given in Section 4 and which has generic ramifications for supply chains from many industries including construction (Hong-Minh et al.1999). Therefore, in the spirit of the recommendations the research team has developed a framework for knowledge and technology transfer as indicated in Figure 7. By co-locating supply chain members initially via workshops and then subsequently via change management task forces (or sub-groups) exchange of personnel will result, and in turn will lead to a change in "mind set" and a process orientated approach. There are of course several potential barriers to this change process: trust, confidentiality and willingness to share information, are important ones. The

key driver though, is the firm belief that the change will give some competitive advantage and this is most credible when proposed by other companies in the industry as opposed to academics. The knowledge transfer framework advocated, which is a process for change, will enable a move towards the seamless supply chain vision.

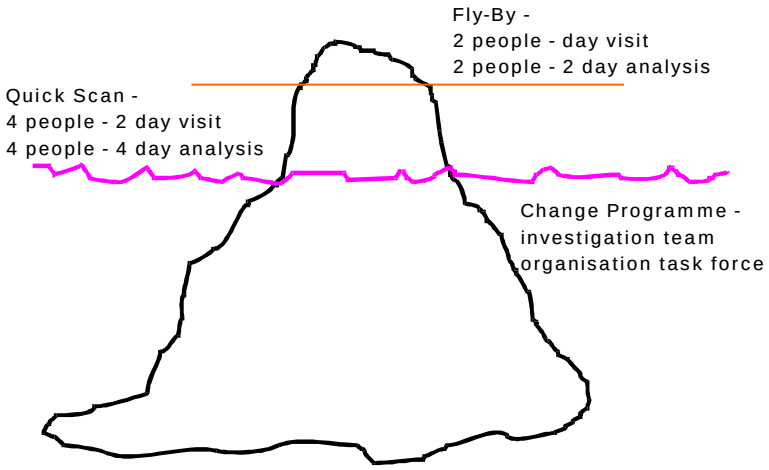

Figure 6: Opportunities Iceberg

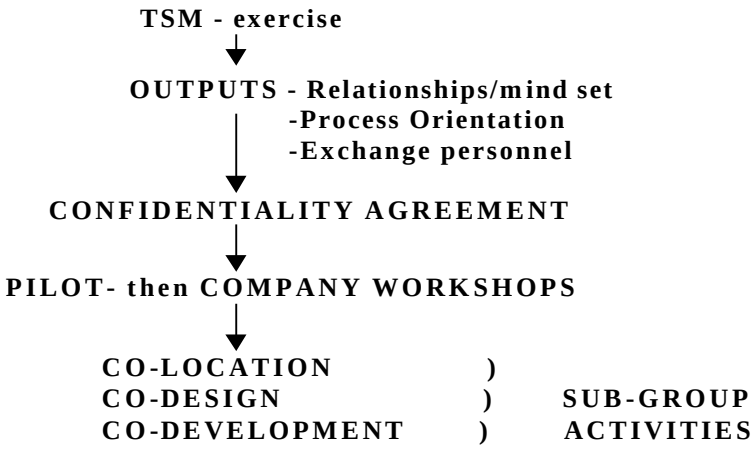

Figure 7: Framework for Knowledge/Technology Transfer

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