Waste assessment and application of improvement techniques in UK private housebuilding supply chains

A thesis submitted in accordance with the conditions governing candidates for the degree of

DOCTOR OF PHILOSOPHY

In the University of Wales

By

Ralph Barker

March 2006

DECLARATION AND STATEMENTS

DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed .... (candidate)

Date ....9th June 2006

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated.
Other sources are acknowledged by footnotes giving explicit references.
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ABSTRACT

The UK housebuilding industry has been subject for the past decade or more, to many government initiatives and pressures to improve output, quality and innovation specifically in supply chain management. However the industry is still failing to meet customer and market demands and is in need of improvement.

This work studies the UK private housebuilding industry and assesses its current practice regarding supply chain management. It identifies best practice in UK private housebuilding supply chain management, and current levels of competence. It goes on to determine major causes of waste and successfully applies improvement techniques.

In order to achieve this, the work first locates and appraises secondary data to understand supply chain management, value and waste within the industry and determine best practice. The thesis then adopts a multi-methodology approach using three distinct stages of empirical research consisting of a government funded case study research project, a national survey of UK housebuilders and finally, collaborative fieldwork involving semi-structured interviews and an improvement workshop with a major UK private housebuilder/developer.

The work establishes that there is considerable room for improvement in many areas of the housebuilding supply chain and that material availability and final product quality are key problems. Using a number of improvement techniques, including cause and effect and failure mode and effect analysis (FMEA), the causes of major waste areas are identified and evaluated and corrective actions proposed.

The work demonstrates that a majority of UK private housebuilding can be treated in the same way as other manufacturing industries for process and supply chain improvement and can successfully adopt techniques prevalent in other industries.

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CHAPTER 1
INTRODUCTION

I tell this tale which is strictly true
Just by way of convincing you
How very little since things were made
Things have altered in the building trade

Rudyard Kipling C. 1900

CHAPTER 1 INTRODUCTION

1.1 Chapter Overview

This first chapter begins by setting out the background and the raison d'etre for the work covered in this dissertation. The scope of the work is defined, including the exploration of boundaries, identification of related work that is considered outside the scope of this dissertation and an explanation of the rationale for final boundary setting.

The issues at the core of this research work are presented in terms of the research questions and an overview of the processes employed during the conduct and completion of the work is given. To clarify these further they are illustrated by means of a connectance diagram and a research process sequence flow chart.

The overall structure and chapter sequence of the dissertation is presented. Finally, a resume of why this work is important is given and discussed.

1.2 Rationale and Background

Housebuilding is an important construction sector within the United Kingdom, consuming huge quantities of materials, labour and other resources. Between 1965 and 2000 it represented between 3 and 4% of the UK's Gross Domestic Product (GDP) (Ball 2003) with the top 50 UK housebuilders having, between them, over £ 46,000 million turnover for year ending 2003. However, the total number of permanent dwellings built per year over the period 1965 to 2000 reduced from around 400,000 p.a. to less than 200,000 p.a. (ODPM 2003). This is an indication that the supply of housing is continually lagging behind the demand, resulting in consumer pressure towards the Government and consequential pressure from Government onto the housebuilding industry (Barker 2004).

Over the last few decades not only has the quantity of available housing been a problem, but also the various aspects of quality have needed improvement. For more than ten years the housebuilding industry, as part of the larger UK construction industry, has been subject to review and has been at the receiving end of Government advice on a variety of ways to improve. The Latham Report of 1994 (Latham 1994) signalled a key starter to this campaign for improvement. Much of this advice has been related to, or emanated from, so-called 'best practice' industries such as the aerospace, automotive and electronics industries. Following on from this, Egan (1998 and 2002), set out where the strategic direction and the many techniques for improvement in operations management, manufacturing management but especially supply chain management to aid the industry. This dissertation aims to contribute to improving the housebuilding quality situation through its main theme; that of removing 'waste' in housebuilding supply chains. The contribution of this thesis to the knowledge base is that it extends, and adds value to the knowledge of UK housebuilding supply chains. It also applies improvement (best practice) techniques to issues identified in the Egan report (2002 Chapter 5) regarding waste in supply chains. It provides evidence of the applicability of such 'best practice techniques' in a practical situation to identify waste and so improve the housebuilding process.

Several factors influenced the choice of this topic as the subject for this dissertation. A major reason was that, whilst a research associate at Cardiff University (1998 to 1999), the author was involved in a number projects centred on improving the construction industry. One of these was concerned with the housebuilding industry and this highlighted the issues which needed to be addressed in this sector. The author was fortunate during this time to make contacts that later enabled the formation of a collaborative working relationship with a major UK private housebuilder from whom much of the data collection was made.

The author's background also affected the topic choice. As an ex-work study engineer, ex-production engineer in aerospace and automotive industries, a chartered engineer and having undertaken some building work including a house extension, the author perceived this as an interesting and stimulating topic and a potential source of professional and personal satisfaction. There is no doubt of the social importance of the housebuilding industry and its impact on the quality of life of UK residents. It is therefore a worthy area for contribution to the knowledge base.

Another major reason for selecting the topic of waste in housebuilding was that there is little published work on the holistic view of housebuilding supply chains and therefore research in this area provided an opportunity to fill a gap in current knowledge. This lack of pre-existing underpinning knowledge is clearly demonstrated throughout the dissertation but particularly in the literature review. As well as the growth in knowledge in its own right, this particular topic offered the potential for practical application to bring about improvement.

It is true to say that the choice of topic area was not a 'road to Damascus' experience. That is, the topic did not occur to the author in a moment of inspiration but rather was developed and refined over time. In fact, the specific features of this study emerged from an iterative process that included a wide ranging exploratory literature review and some practical research work in order to understand the current state of affairs in the housebuilding industry. This process is expanded in the Research Methodology Chapter 3.

The research work examined supply chain management in housebuilding using a mixed research methodology approach but nevertheless one that is firmly based on grounded theory. It looked at the larger picture and sought to apply useful and relevant improvement tools and techniques.

The research itself consisted of three main stages of investigation and data collection. First, a case study was undertaken which was a part of a major government funded research project supported by the Engineering and Physical Science Research Council (EPSRC) Innovative Manufacturing Initiative (IMI) and the Department of Environment, Transport and the Regions (DETR). This study was a collaborative project involving Cardiff and Sussex Universities and some nine major practitioners (Barker et al. 2000), this dissertation showing the contribution by the author. Secondly, a national supply chain management awareness survey of major UK private housebuilders (Barker and Naim 2004a) was conducted by the author, which established supply chain awareness, what usage was being made of improvement techniques and identified major supply chain problem areas. Thirdly, in-depth collaborative fieldwork (case-study based) with a major UK private house developer was undertaken by the author. This involved building-site data collection and a subsequent practitioner workshop which analysed root causes and identified improvements.

1.3 Scope and Boundaries

The aim of this dissertation was, from a position of understanding the current state of knowledge and awareness of supply chain management, to investigate the key areas of waste and then to recommend a way of improvement using appropriate improvement methods and techniques.

Unlike traditional approaches this did not concentrate on specific individual areas within supply chains, such as design, purchasing, logistics or IT systems, but rather, took a more holistic, 'big picture' perspective which included all activities and processes used in the housebuilding supply chain.

Waste in the context of this work is neither material waste nor issues central to environmental waste, but rather the definition of waste created by a lack of efficiency or effectiveness in the overall housebuilding processes.

This work concentrates on the UK private or 'speculative' housebuilding sector, as this is responsible for the majority of houses built in the UK, some 89% in 2002/2003 according to UK government statistics (ODPM 2003). Within this sector the focus is on the major housebuilders who build the greatest proportion in the sector. In 2002/2003, some 38 of the major UK housebuilders accounted for approximately 80% of all UK homes (Housing Forum 2003a).

Although both private and social housing were included in the first investigative exercise, the work then narrowed down further in the second and third stages to just private UK housebuilding. Although the general construction industry is not the subject of the research in this study, this perspective is included in the literature review for context and discussion. Housebuilding has become the focus of this work as a result of its greater similarity to manufacturing than general construction. Therefore this offers greater potential for transfer of best practice from a production setting where processes and supply chain are regarded as exemplars. Another reason is that the author's background and knowledge in manufacturing, from both an engineering and an operations perspective, assisted in the research activities. Finally, it was recognised early in the research that housebuilding is meeting neither Government nor society's expectations in terms of both output and quality levels and this adds to its importance as a subject for study and improvement.

1.4 Questions for the Research

The main aim of this work is to investigate and develop improvement methods and techniques to evaluate 'waste' and its causes, within the context of the private UK housebuilding industry. Here, waste is defined by the author as 'the totality of all materials and resources not needed in carrying out the process of housebuilding'. The research questions which underpin the main theme and provide direction to the work are:

Q1. What is supply chain management in housebuilding and what is accepted as current best practice?

Q2. What is the current level of supply chain management competence in housebuilding supply chains, including the adoption of best practice?

Q3. Which are the significant causes of waste for major UK private housebuilders?

Q4. What are the key methods and techniques that can be adopted for improvements?

These questions provided central focus to activities and chapters of the dissertation. Figure 1.1 shows which chapters and work have answered the questions and how the work streams and chapter descriptions combine together to provide fuller answers. The figure also shows to some extent the progression followed in the research although this is expanded further in the next section below.

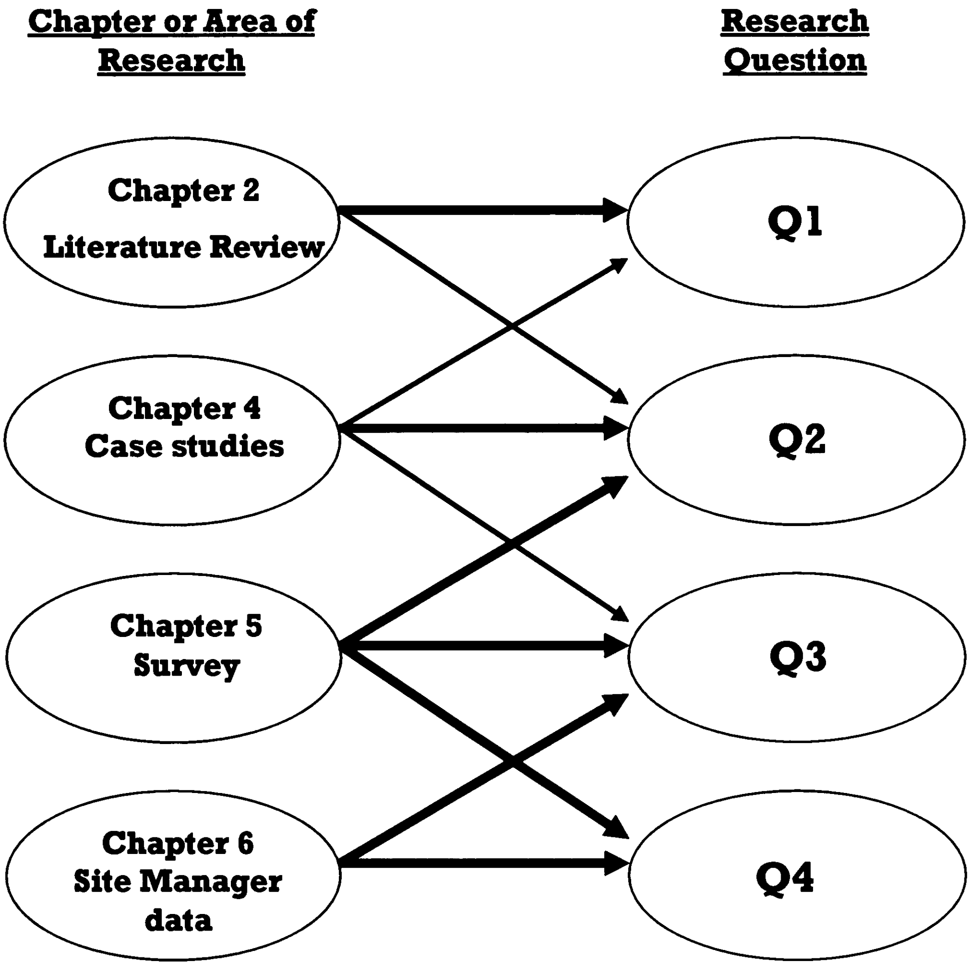

Figure 1.1 Connectance Diagram. Source – author

Note: The thicker arrows show important Connectance and thin arrows weaker Connectance.

1.5 Process of Research

The overall aim of this work evolved and was formulated in an iterative process as knowledge and understanding of the topic area increased until the decision to focus on waste in housebuilding supply chains was arrived at. In order to elicit greater usefulness and to concentrate on the contribution to knowledge this focus was further refined to major UK private housebuilding because these are the predominate players in the field and therefore can have the greatest affect on the UK housebuilding industry.

This emergent research process is illustrated in Figure 1.2 and depicts what is in essence, a quasi-grounded theory approach based on response to a particular described situation rather than an initial theoretical framework. The figure shows where the literature review supported the exploratory work centred on the Meeting Customer Needs through Standardisation (MCNS) research project. This work included a data collection methodology termed Terrain Scanning Methodology (TSM) and helped develop the understanding that, generically, housebuilding supply chains were unsophisticated compared with exemplars in previously published research. Confirmation of the situation in the UK regarding supply chain awareness and competence was investigated by the second empirical study undertaken. This work led in turn to an in-depth, more qualitative approach, in collaboration with a major housebuilder (developer), so as to define the problems at building site level that affect the overall housebuilding supply chains. Finally, research by means of an expert workshop, assessed and evaluated the site-based findings and using various improvement techniques, recommended a way forward.

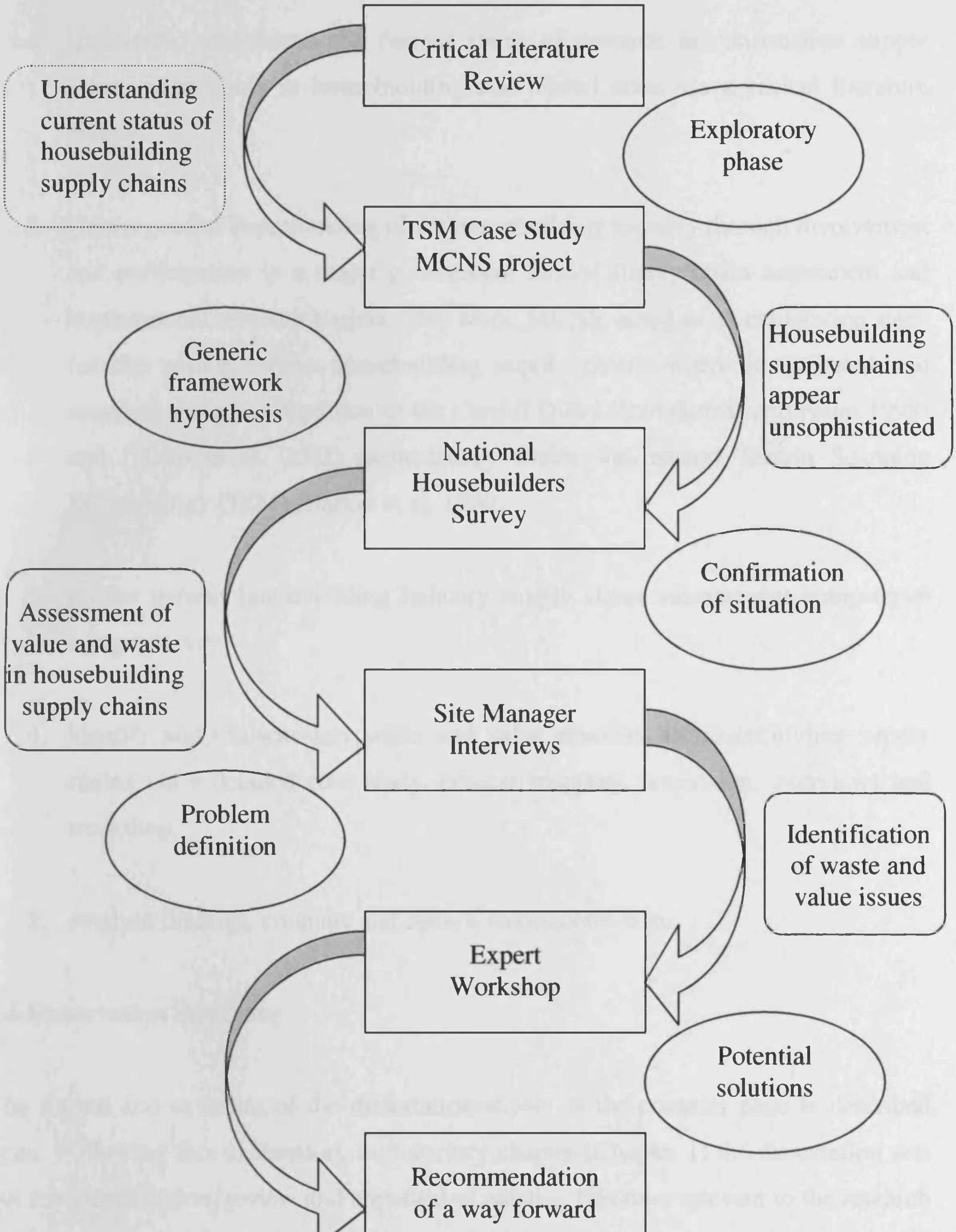

Figure 1.2 Research Process Outline. Source - author

This emergent research process, which formulated the research questions above, can also be described by the following sequence of activities:

1. Understand and assess the current status of research in construction supply chains particularly in housebuilding and related areas via a critical literature review.

2. Gain a general understanding of the housebuilding industry through involvement and participation in a major government funded supply chain assessment and improvement research project. This work, MCNS, acted as an exploration stage for the author, where housebuilding supply chains where investigated and assessed using an adaptation of the Cardiff Quick Scan (Lewis and Naim 1998) and (Naim et al. 2002) methodology which was named Terrain Scanning Methodology (TSM) (Barker et al. 1999)

3. Assess current housebuilding industry supply chain management competence using a survey.

4. Identify and evaluate key waste and value elements in housebuilding supply chains via a detailed case study, process mapping, discussion, interviews and workshop.

5. Analyse findings, compare and deduce recommendations.

1.6 Dissertation Structure

The format and structure of the dissertation shown in the contents page is described here. Following this explanatory introductory chapter (Chapter 1) the dissertation sets out the identification, review and appraisal of existing literature relevant to the research (Chapter 2), especially in the context of the initial research question shown above. The next section is the research methodology chapter (Chapter 3) which explains the research philosophy and demonstrates how the formulation of the research strategy was developed in parallel with some of the fundamental literature review and knowledge gathering activities. The research chapter also explains the three strands of data collection and investigation and specifically argues their relevance and appropriateness in addressing the research questions.

The next three chapters (Chapters 4, 5 and 6) present the data collection and findings for each of the three research elements. These are presented in chronological order as they were actually conducted. The discussion chapter (Chapter 7) synthesises and reviews the research findings and compares the knowledge found by the research with that assessed and critiqued in the literature review.

In conclusion, the final chapter (Chapter 8) re-visits the research questions and draws together the various themes and discussion to demonstrate and explore overall meaning, and argues the significant contribution this work makes in understanding the industry's awareness of supply chain management and application of improvement techniques to housebuilding supply chains.

CHAPTER 2
LITERATURE REVIEW

Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it.

Dr Samuel Johnson, quoted in Boswell's Life of Johnson, 18 Apr. 1775

CHAPTER 2 LITERATURE REVIEW

2.1 Chapter Overview

The literature review laid out below critically assesses existing published information available as secondary and tertiary data relevant to the key themes of this dissertation, namely waste or inefficiency in housebuilding supply chains. As described in more detail in the subsequent chapter on research methodology (Chapter 3) it was necessary for the author to have a comprehensive understanding of all topics relevant to the research work. Carrying out the literature review was an essential learning process that started very early to establish an initial knowledge base and continued throughout this work as the methodology evolved, the need for knowledge grew and the research became more refined. It was also necessary to be aware of current developments in secondary data, as ongoing and new research was published which was potentially relevant to this work, making it necessary to 'top-up' the literature review throughout the duration of the research. Indeed, a consummate academic needs to continually update their knowledge in this way.

It has been put forward that there are two major reasons for undertaking a literature review; to review and to reference (Saunders et al. 2003:43) and (Jankowicz 2000:159). The review allows the generation and refinement of research ideas for the direction of the research being undertaken, including the critical review of existing data as part of the research project proper. Secondly, referencing allows existing work to be used to provide context and authority to the research. As stated by Jankowicz (2000:159):

"Knowledge doesn't exist in a vacuum, and your work only has value in relation to other people's. Your work and your findings will be significant only to the extent that they're the same as, or different from, other people's work and findings".

Being aware that the review should be more than a mere list of 'what I have read' (Bell 1999:92), the author has endeavoured to ensure that the assessment of the relevance and sufficiency of information is included and that the review organises, classifies and critically appraises previous work. This is necessary in order to provide sufficient background knowledge, establish boundaries and create a framework that supports the aims of this research (Saunders et al. 2003:46).

In the author's opinion another vital reason for undertaking the review is to establish how the existing literature is able to contribute (or not) to the research questions outlined in the introductory chapter above. That is, how well it succeeds in providing a definition of what supply chain management in housebuilding is and what is accepted as good practice; in establishing current competence levels and best practice adoption; in identifying causes of waste and in suggesting key methods and techniques for improvement. Of course, this was the subject of continual re-appraisal as the research evolved and the questions and research methodology became more refined.

The structure of the literature review presented below, as shown in the contents listing, begins with a review of the basics of supply chain management in order to provide an understanding of supply chains and define the important issues in the successful management of supply chains. This establishes and defines the key foundation of knowledge on which the dissertation builds, as the preliminary to aid the development of more specific, relevant, and detailed topics to meet the main aim of the dissertation.

The review moves on in the second section, to explore the construction industry perspective and describe the characteristics of an innovative environment, with a resume of the progress towards this currently seen in construction supply chain management. This body of existing work often encompasses that of housebuilding itself and so many issues here are relevant and applicable.

The third section gives the background and overview of the UK housebuilding industry per se, including an analysis of the need for housing, and the current problems encountered in trying to meet this demand plus other key factors and requirements, such as quality.

Next, housebuilding supply chain literature itself is reviewed, explaining current knowledge and understanding, together with the current initiatives, highlighting especially several enquiries and reports initiated by the UK Government.

A key element of this dissertation centres on the concepts of waste or inefficiency and so the literature review discusses definitions and the shared common understandings of waste and value.

Various generic improvement techniques derived from the literature are then listed, categorised and discussed. Those most relevant to the aims of this work are critiqued in more detail.

Finally, best practice in supply chains, construction supply chains and housebuilding supply chains is reviewed and discussed.

Within each section an assessment is made as to how well, and in what way, the available literature contributes to solving the research questions. A view on gaps in the evidence is presented and an assessment of the impact this had on the direction of this research is given.

2.1.1 Literature Review Methodology and Approach

The literature retrieval process began with the basic search query which was adapted, refined, expanded as appropriate in response to the particular aspect of the research being explored. Some thought was given to the ways that the search could be improved depending on different sources used, such as the use of synonyms.

Figure 2.1 shows the listings of 'search terms' (sometimes referred to as 'keywords' – (Saunders et al. 2003):56) used for searching secondary and tertiary data, at different times throughout the research. The selection and use of the terms varied depending upon the phase of the research work and what was being sought. They were also adapted to suit the resource being searched and how this related to the key research questions. The terms recorded here are not completely exhaustive, but do give an indication of the width and breadth of the searches carried out. The terms are shown in the three different 'concept' categories that were most often used during searching.

The first concept category captures the core topic of 'supply chain' and related terms and reflects the fact that this research work focuses on the complex reality of the holistic supply and operational aspects of housebuilding. Next, the business or industry sector that was relevant to the research aims was considered, so the more general construction term which included housebuilding was used as well as the more specific equivalents of housebuilding. The third category qualifies the research further by adding relevant terms to specify particular issues directed by the research questions, in particular relating to waste, improvement etc.

Concept 1	Concept 2	Concept 3
Supply chain	Construction	Improvement, benefits, problems
Supply	Housebuilding	Performance, standards, best practice
Networks	Housing	Waste, inefficiency, efficiency,
Clusters	Houses	Value, uncertainty, variability
	Homes	Time, time compression, or T C T (Total Cycle Time)
	Building	Site managers, foreman
	Dwellings	

Figure 2.1 Key Search Terms. Source - author

In general, the fewer concepts (or words representing a concept) combined using AND as a Boolean operator then the greater the 'recall' i.e. overall number of references found, whereas the greater the number of concepts used the fewer 'hits' are found but these are more likely to be useful; increasing the search's specificity or precision. Within each concept the larger the number of alternatives or synonyms, the more 'hits' were found. Various combinations were tried to ensure that the optimum balance between the number of 'hits' versus relevance of 'hits' were found. Much of the rationale for effective information retrieval and critical appraisal of the literature is related to the following conceptual representation used extensively in other scientific information retrieval such as health care.

$$\text{Usefulness of information} = \frac{\text{relevance x validity x importance}}{\text{work}}$$

Source - (Shaughnessy et al. 1994)

2.1.2 The Review Process

Various resources were used for retrieving information and references. Initial literature searching took place at the outset of the research when the author was a research associate. Subsequent searching continued throughout the research progress, using a variety of resources and search strategies depending on the particular need. Resources and techniques used included electronic searching of bibliographic databases and datasets, including citation/abstract sources only (with subsequent full text retrieval using hard copy library and electronic document delivery systems), electronic full text resources such as Emerald, Indexes to Theses and various relevant conference proceedings. In addition, electronic academic gateways were used, such as Social Science Information Gateway (SOSIG), various other internet resources, library catalogues OPACs (Online Public Access Catalogues) giving access to print research in the form of journals, books, news services, etc.

Internet searching was also carried out seeking specialist organisations relevant to the topic, such as research and academic organisations, construction and housebuilding web sites and related UK Government sites. General internet search engines were also utilised including Google and Google 'Scholar'. Follow up of references quoted within other articles and sources was carried out (so called 'pearl string' searching) and this increased the number of relevant documents, adding to the underpinning knowledge base of this research. In addition 'hand searching' of potentially relevant paper sources was carried out. Finally, contact and discussion with other researchers within the field provided a valuable check of material covered and further supply.

Bibliographic reference management software, 'Endnote', was used by the author to produce a database to store and retrieve all references used in this research. Indeed, during the process of initiating, extending and revisiting reference material for this research the database was a useful tool in identifying new, and avoiding duplicated material. It is recommended (Saunders et al. 2003:73) that not only the bibliographic details be recorded but also a summary of the content and supplementary information. This latter point being particularly useful in understanding relevance and aiding efficient retrieval from over 600 references stored.

A particular problem encountered during the searching was the fact that the language generally used to describe the topics of interest and hence the relevant search terms are quite unspecific (or woolly) compared to say technical or medical terminology. This resulted in a large number of irrelevant articles being retrieved initially. As well as the extensive use of broad and narrow searching techniques a considerable amount of reading and intellectual filtering by the author was required.

The critical review of the literature found using these techniques, categorised appropriately, is covered in the rest of this chapter.

2.2 Supply Chains and Supply Chain Management

The purpose of this section is to give a brief review of supply chains and supply chain management from a generic perspective. It includes their link with logistics and covers important issues regarding relationships between buyers and sellers and organisations themselves.

2.2.1 Supply Chains

There is a great deal of published material on supply chains and supply chain management which includes many definitions and ways of viewing 'supply chains'. The origins appear to stem from the area of logistics with Houlihan (1984) being the first to adopt and use the terminology. The earliest definition found by the author for 'supply chain' is:

"The integration of various functional areas within an organisation to enhance flow of goods from immediate strategic suppliers through manufacturing and distribution chain to the end user".

(Houlihan, 1987).

What is interesting here is the emphasis on 'within an organisation'. Perhaps this is a reflection on this first attempt at definition, however most subsequent definitions adopt a broader approach that includes different companies and organisations. An even earlier publication by Jay Forrester does not use the supply chain terminology but does state that:

"Management is on the verge of a major breakthrough in understanding how industrial company success depends on the interaction between the flows of information, materials, money, manpower, and capital equipment".

(Forrester 1958)

Forrester then goes on to illustrate a production-distribution system consisting of a factory, warehouse, distributor and retailer including information and material flows. This is the earliest representation of a supply chain found by the author.

A clear, but nevertheless early definition of supply chains by Stevens:

"a system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via the feed forward flow of materials and the feedback of information".

(Stevens 1989)

This very basic representation is illustrated in Figure 2.2, similar to Stevens (1989) but with commercial aspects added (payment):

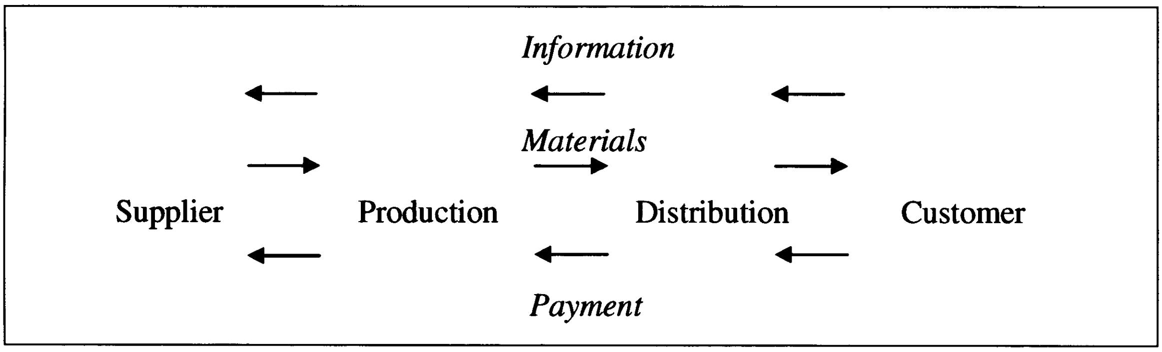

Figure 2.2 Basic Supply Chain Representations.

Source – adapted from Baily et al (2005:92)

A selection of other definitions and descriptions are given below:

Macbeth and Ferguson (1994:3) do not really give a definition as such but state that:

"the business need is a multifaceted one where the complex interaction of many participants in different organisational groupings all have an impact on the eventual outcome. This complexity forces us to rise from our immediate surroundings to see the business in a much wider context. We call this the supply chain to capture the idea of linked activities (within and across organisational boundaries) from raw material to final consumer".

Here then, we see that supply chains encompass not only the entire activities and processes concerned within a business but join these together with those of other businesses into a complex linkage. It is necessary to understand this concept when considering housebuilding supply chains in particular as complexity increases with the numerous clients, contractors, and sub-contractors involved in that industry.

Christopher (1998:15) defines the supply chain as "the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer".

A comprehensive definition from Handfield and Nichols (1999:2) is that "The *supply chain* encompasses all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flows. Material and information flow both up and down the supply chain". They also state that "supply chains are essentially a series of linked suppliers and customers; every customer is in turn a supplier to the next downstream organisation until a finished product reaches the ultimate end user". This definition is very simplistic, describing supply chains as straightforward linear entities in isolation.

As expressed eloquently by Harland (1997), supply chains can be classified under four headings and mean different things to different people. The complexity and length (or span of influence), can vary from an intra-organisational supply chain, to a two organisational one, termed dyadic (buyer and supplier), to one that stretches from the initial raw material to the final customer, that is, through various organisations and processes. Fourthly, there is the concept of the network supply chain, which is a more realistic but more complex concept where many and various suppliers and customers are inter-linked through a web of buyer-seller relationships. This range of definitions (Harland 1997) is shown pictorially in Figure 2.3.

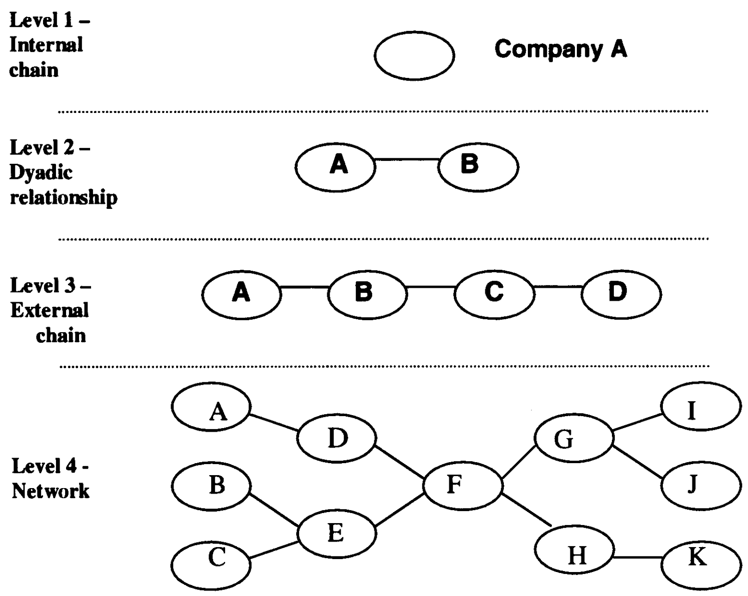

Figure 2.3 System Levels of the Supply Chain Concept.
Source – Adapted from Harland (1997)

This view is also expressed by Cox and Hines (1997:36) who argue that "the chain is an unsatisfactory metaphor: the firm is part of a network".

Lee and Billington (1993) define a supply chain as "a network of facilities that performs the functions of procurement of material, transformation of material to intermediate and finished goods, and distribution of finished products to end customers".

Towill et.al (1992) outlines a supply chain as "a system, the constituent parts of which include material supplier, production facilities, distribution services and customers linked together via feed forward flow of materials and the feed back flow of information".

From the various definitions of a supply chain given above, it can be seen that there are many variations although they may seem to be of a somewhat similar nature. They do, however, illustrate the different perspectives with which supply chains can be viewed. Some people see them in terms of relationships between one buyer and seller, some taking an organisational view, and others looking at the chain of buyer and seller relationships. Some authors such as Harland (1997) move away from the early simple linear model to present that of a network consisting of many nodes as being more realistic and reflecting the true complexity of many business situations. An example of such a situation could be where a business is both a supplier and customer to another business. A straight and simple flow line of businesses is not always the case. Such scenarios can relate to counter-trade and reciprocal trading. The situation really depends upon the industry and the individual businesses concerned. Lamming et al. (2000) says that in the place of the simplistic linear and unidirectional model of a supply chain, networks better describe the real situation of lateral links, reverse loops, two-way exchanges and so on, encapsulating the upstream and down stream activities found in the business environment.

Hughes et al. (1999) believe there are nine types of supply chain that can be identified across a range of sectors, each meeting different types of business needs:

1. Arms length, open competition.
2. Commodity trading: A sells to B sells to C sells to A.
3. Partnering for customer delight.
4. From supplier's suppliers to customer's customers.
5. Lean supply chains and systems integration.
6. Competing constellations of linked companies.
7. Interlocking network supply between competitors.
8. Asset control supply: dominate or die.
9. Virtual supply. No production, only customers.

Some authors propose a systems perspective which is often dynamic. Here, there are many internal and external influences, crossing both internal and external organisational boundaries, and affecting how the system behaves. Systems modelling or simulation work has been carried out to replicate the outcome of various in-puts or influences. Ellram (1990), Towill et.al (1992) and Hammond (1997) are a few examples.

Contemporary thinkers in the field are now starting to look to complexity theory to understand the supply chain concepts Robson (2004), Cox and Mowatt (2004), Dubois and Gadde (2002).

It is clear that supply chains are very complex entities and best represented in their entirety by a systems approach, although sometimes this is not necessary if focusing on only a small section of the supply chain. Although the understanding of the supply chains is broad and varies greatly, most practitioners and academics usually refer to just two or three links in the classic 'chain' representation, in order to concentrate on, or illustrate, particular problems or specific issues.

In parallel with this development of 'supply chain' ideology, Ellram (1990) points out that "During the 1980's the idea of reducing uncertainty by sharing information, exchanging information for inventory" became known. In fact, decades previously some authors (for example Magee 1958:80) realised that sharing information and agreeing requirements would help meet customer needs. Contemporaneously the just-in-time principle used by Toyota (Ohno 1988), reported on in detail by Womack et al. (1990) and further analysed by (Hines 1998), explains how this relational concept gave great benefits to Japanese automotive manufacturers and resulted in competitive advantage over their western counterparts. The supply chain management concept (Ellram 1990) focuses attention on holding inventory in the location and at the level or quantity that is optimal for the entire supply chain, "Clearly exchanging information is central to the supply chain concept".

Lamming (1993); Smith et al. (1998), Christopher (1998), and many others have developed a good descriptive understanding of what supply chains are and the benefits gained from managing them correctly. They stress the importance of appropriate partnering, working as a team, the integration of the supply chain, being 'market-facing', having clear and accurate information flow throughout the chain. All of these aim at eliminating the major areas of inefficiency and ineffectiveness, mainly at the interfaces.

Towill (1997b) puts forward the idea of a seamless supply chain, promoting the ideal of how supply chains should be controlled. For example, in the concept of a seamless supply chain, all participants work as one, and therefore "there are enormous benefits to be obtained by improving information flow and material flow, both being much enhanced via time compression of value added activities and the elimination of non-value added activities". A more detailed coverage of this is given later in Section 2.6. However, having supply chain participants working in collaboration goes against many traditionalist buyer/seller relationships where adversarial culture can be the norm. Understanding such relationships and knowing how to create and develop them for business advantage is often complex and challenging and can be a vital part of managing supply chains which leads on to the next area of review.

2.2.2 Supply Chain Management

A review of supply chain management by Tan (2001) concludes that the literature contains many buzzwords and different definitions. The article maintains that there are really two alternative perspectives on the origins of supply chain management. One, derived from the purchasing and supply background which supports the buying and supply perspective and the other, from transportation and logistics roots which supports the physical transportation and distribution perspective of wholesalers and retailers. This view reinforces some of the early attempts at definition of supply chains especially that from Houlihan (1987) shown in the previous section (Section 2.2.1).

Different authors view supply chain management from different perspectives. Cooper and Ellram (1993) taking a logistics distribution perspective, define supply chain management as "an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user". However Scott and Westbrook (1991) describe it as the chain linking each element of the manufacturing and supply process with raw materials through to the end user, encompassing several organisational boundaries.

Christopher (1998:18), with what seems a purchasing view, provides the following definition "The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole". Another relationship perspective is put forward by Baily et al. (2005:17) who state supply chain management "is about the linkages of the immediate seller/buyer relationships into a longer series of events. A company's suppliers have their own suppliers, and often our direct customers are not our ultimate customers".

Lee and Billington (1993) define a supply chain as "a network of facilities that performs the functions of procurement of material, transformation of material to intermediate and finished products, and distribution of finished products to customers".

There are therefore many different perspectives of supply chain management. Described above we have the distribution view, the materials flow view, the purchasing view, the buyer/seller view and finally a network of facilities view.

Taking a more organisational standpoint, Cavinato and Kauffman (2000:145) state that supply chain management is "an integrated collection of organisations that manage information, cash, and product flows from a point of origin to a point of consumption with the goals of maximising consumption satisfaction and minimising the total costs of the organisations involved".

This array of many and varied definitions and understandings of supply chain management mirrors the number and variation of supply chains that exist. What emerges from the literature is that supply chain management seems to be not the responsibility of any single department, function or business but rather, it should be viewed as an enterprise model. This model includes several different management and business activities such as logistics, transportation, storage, packaging and the actual business conversion processes (operations management), and requires the management of these across many business boundaries. In the other words, the author views supply chain management as an umbrella encompassing many different but related inter- and intra- organisational activities. How far up and down the supply chain the 'management or control' should extend is a matter of debate. Most academics agree that supply chain management extends in essence all the way back to the raw material suppliers and forward to the ultimate consumer.

According to Stevens (1989) the evolution of supply chain management probably occurred through four key stages, as in Figure 2.4. The Figure shows that the first stage was to move away from each activity working in isolation within an organisation, sometimes termed the silo approach, towards what was called a functional integration stage. Then, by combining these key activities, the development moved on to internal integration. Finally, by the involvement of suppliers and customers outside the organisation the stage of external integration was reached and hence the emergence of what is called supply chain management.

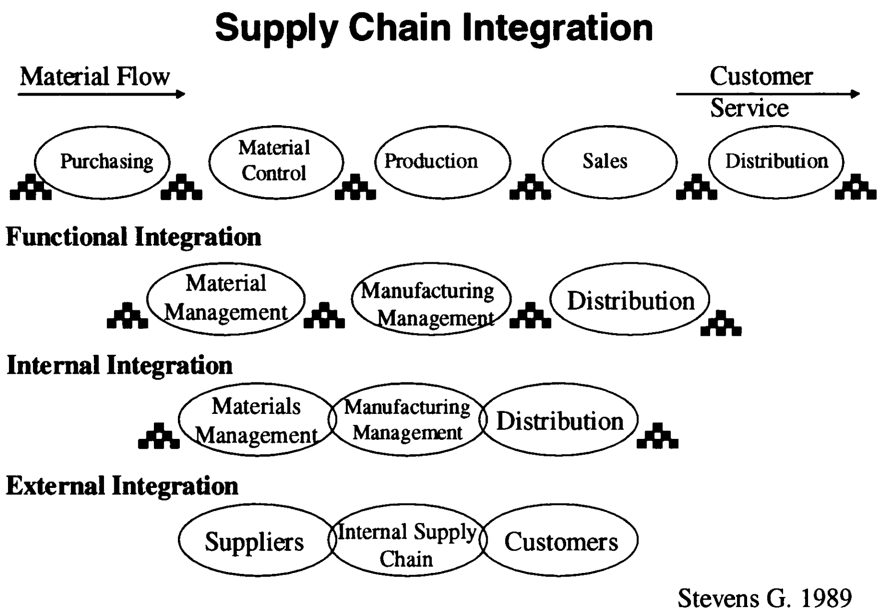

Figure 2.4 Supply Chain Evolution. Source - G Stevens (1989)

Although many companies understand the key concepts of supply chain management to some extent, that is, the integration of activities and processes and working with customers and suppliers, not all are prepared to move totally in this direction. This is not so surprising considering the mistrust which seems typical of normal business environments, the awareness of economic uncertainty, market forces and the cultural backdrop of self preservation. The way that companies view supply chain management shown in Burgess (2001:4) is quite relevant, see Figure 2.5; this investigation work shows there was a spread of understanding of what was supply chain management when the above four stages as defined by Stevens (1989), were used. It showed that many managers, in fact 58%, did not appreciate the need for external integration in supply chain management.

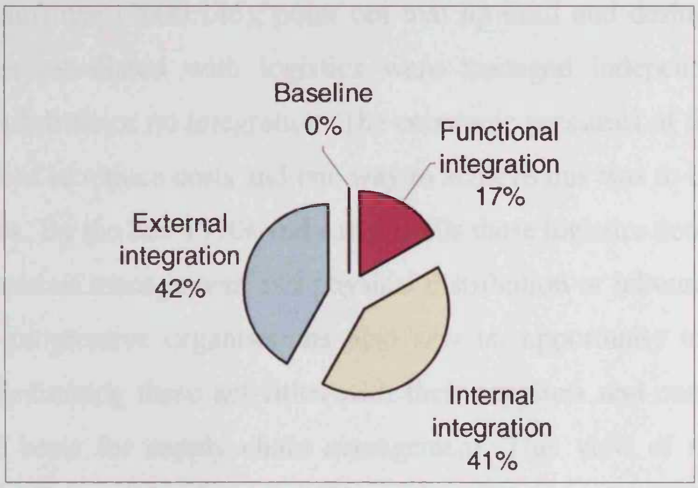

Figure 2.5 Spread of Understanding on Supply Chain Management.
Source – Burgess (2001)

Cavinato and Kauffman (2000:146) believe that many authors use the terms and meanings of 'supply chain management' and 'logistics management' interchangeably. Although this is not felt to be correct, these authors believe it is understandable in that, as said previously, much of the origins of supply chain management come from transportation and distribution. As stated earlier in this chapter several authors (for example Houlihan 1984 and Lee and Billington 1993) believe 'logistics' to be a key origin of supply chains and supply chain management. The Concise Oxford Dictionary (Sykes 1982:594) defines the meaning of logistics as the "art of moving, lodging and supplying troops and equipment", which is much related to supply chain management. Stone (1968) in Rushton et al. (2000) stated "Logistics is the art and science of determining requirements; acquiring them; distributing them and finally maintaining them in an operational ready condition for their entire life". Crompton and Jessop (2001) in the official dictionary of purchasing and supply approved by the Chartered Institution of Purchasing and Supply (CIPS) say it is "the process of managing both the movement and storage of goods and materials from their source to the point of ultimate consumption, and the associated information flows". The Chartered Institute of Logistics and Transport UK (CILT 2005) states that: 'Logistics' is the process of designing, managing and improving such supply-chains, which might include purchasing, manufacturing, storage and of course, transport.

Cavinato and Kauffman (2000:146), point out that up until and during the 1960s the various activities associated with logistics were managed independently by most organisations, with little or no integration. The economic pressures of the 1970s forced many organisations to reduce costs and one way to achieve this was to integrate various logistics activities. By the late 1970s and early 1980s these logistics activities had come to be termed materials management and physical distribution or inbound and outbound logistics. More progressive organisations also saw an opportunity to become more efficient by co-ordinating these activities with their suppliers and customers and this also formed the basis for supply chain management. This view of the evolution of supply chain management conforms to that outlined by Stevens (1989). In order for these changes to occur Cooper and Ellram (1993) maintain that there had to be a shift in the way companies viewed their position in the business world and how they worked with their customers and suppliers. Table 2.1 from Cavinato and Kauffman (2000:148, originally in Cooper and Ellram 1993) compares the traditional attitudes with those that are needed for supply chain management to be successful.

Factor	**Traditional**	**Supply Chain**
Inventory management	Firm focused	Pipeline coordinated
Inventory flows	Interrupted	Seamless/visible
Cost	Firm minimisation	Landed cost
Information	Firm control	Shared
Risk	Firm focus	Shared
Planning	Firm orientated	Supply chain Team approach
Inter-organisational Relationships	Firm focus on low cost	Partnerships Focus on landed cost

Table 2.1 Attitudes for Successful SCM.
Source - Cavinato and Kauffman (2000:148)

In summary, it is said by many, including Lamming (1993) and Barker et al. (2004) that by working together, sharing information, knowledge and understanding, businesses in the same supply chain or network can be more successful. Indeed, the importance of relationships within the housebuilding industry cannot be overstressed, for as will be shown later, the industry is in many ways like a virtual organisation where many different businesses work together, or should, if they wish the supply chain to be more efficient and effective.

In businesses, especially in relation to goods or services that are core and valuable, there is a realisation of the strategic importance of selecting the correct, but smaller numbers of suppliers, and of forming 'co-makerships or partnerships' as a way of improving efficiency and effectiveness and reducing 'waste' (Lamming 1993).

Many believe (for example Cavinato and Kauffman (2000:18) and O'Marah (2001) that businesses are now becoming more aware of the potential of supply chain management and that business competition is not really company against company but supply chain against supply chain. Forming such relationships is not necessary or possible in every supply situation, but where it is, strategic decisions can be made for sharing information, having common quality improvement goals, sharing the risks (pains and gains), having some agreed level of mutual commitment, and so improving the overall efficiency of the supply chain.

By adopting such supply chain management practice, cost and waste can be minimised creating improved value for the customer (Baily 2005:91). This idea of creating value can be extended into the concept of 'value' or 'value chains' which is explored in detail later in this chapter.

The literature points to several industries and industry sectors that provide exemplars of best practice in supply chain management. The automotive industry, especially the Toyota Production System, is a popular selection being quoted in several key texts (Womack et al. 1990; Lamming 1993; Macbeth and Ferguson 1994; Womack and Jones 1996), as is manufacturing generally and the retail industry (Hughes et al. 1999:84 and Hines et al. 2000). There is little reference to construction or housebuilding supply chains in published information regarding best practice. However, there is one particularly relevant case-study of Doyle Wilson, a housebuilder in the USA, presented in Womack and Jones (1996:29) who adopted some lean principles. This is covered under the Housebuilding Supply Chain Section 2.5.

From what has been described in this section, it is clear that 'supply chain management' is a complex, multi-faceted, holistic concept of controlling the supply side of an organisation.

The author believes that supply chain management can be thought of as an umbrella covering many business activities and operations. A total list of these would be too exhaustive here, but key primary functions are: sourcing, purchasing, inventory control, material and planning control, operation scheduling, operations management, incoming quality control, total quality management (TQM), transportation, distribution (logistics), financial controls and customer care. All of these apply to the individual business but also to all organisations within the supply chain or supply network.

Supply chain management is then, integrative by nature and goes beyond individual business processes and activities. Consequently it includes many related management issues and concepts, as are listed below, of how to manage this philosophy and so gain competitive advantage (Baily et al. 2005):

- Reverse engineering
- Value analysis and Value Engineering (VA & VE)
- Value adding relationships and negotiations
- Supplier integration
- Tiering of suppliers
- Value adding chains
- Lean supply
- Agile supply
- Supply pipeline management
- Value streams
- Network sourcing
- Just-in-Time (JIT)
- Method study and work measurement
- Supplier Management and Supplier Development
- Total Cycle Time (TCT) and Time Compression
- Benchmarking and Key Performance Indicators (KPI's)
- Sustainability
- E-Business, e-commerce and e-procurement

The above list does not include 'improvement techniques' as these are a core theme in this dissertation and are therefore set aside in a separate section within the literature review (Section 2.7). However, the issue of relationships, especially buyer and seller relationship is important in efficient supply chain management. It is the subject of many UK Government initiatives (Latham 1994, Egan 1998 and 2002) to improve construction and housebuilding supply chains, and is therefore reviewed so as to provide a basis for the discussions and arguments that will follow in the dissertation.

This section has provided a basic description, informs the understanding of supply chains and shows that they are very complex and encompass many areas of activity. The literature supports the premise that generally manufacturing is an area where good supply chain management occurs. Whether this good practice is transferable to construction or housebuilding remains to be examined.

2.2.3 Relationships and Partnering

Supply chain management is about managing as well as possible the supply chains or networks already discussed. An important element of this management includes relationships. The business need is multifaceted where complex interaction within supply chain will affect the eventual outcome (Macbeth 1994:3). Companies may integrate backwards along the supply chain by acquiring their suppliers and/or they can integrate forwards by acquiring their distributors or immediate customers. In both cases the company is trying to control all the functions of supply, transformation and demand itself. If this consolidation occurs then the supply chain could be regarded as an inter-organisational supply chain. If companies have not taken ownership of their upstream or downstream organisations then together these organisations form an external supply chain. This then creates a situation where companies who may have previously been in an adversarial position with other businesses now need to work together for mutual benefit. This is the arena where many and different types of commercial relationships exist. The kinds of relationships that exist and how they are managed can drastically affect the efficiency and effectiveness of the supply chain.

Relationships that are to be found within a business environment are many and varied, including internal (as referred to earlier by Stevens 1989); between the organisation and suppliers; between the organisation and customers; and between other related parties like transportation companies, and companies with mutual interests such as alliances. The area of study for this dissertation is concerned with the supply side aspects of housebuilding supply chains and so only the buyer-seller type relationships will be covered in this particular section.

As shown by Macbeth and Ferguson (1994:106) companies can make a strategic decision regarding their contractual arrangements along the internal (vertical integration) and the external (market) continuum as shown in Figure 2.6.

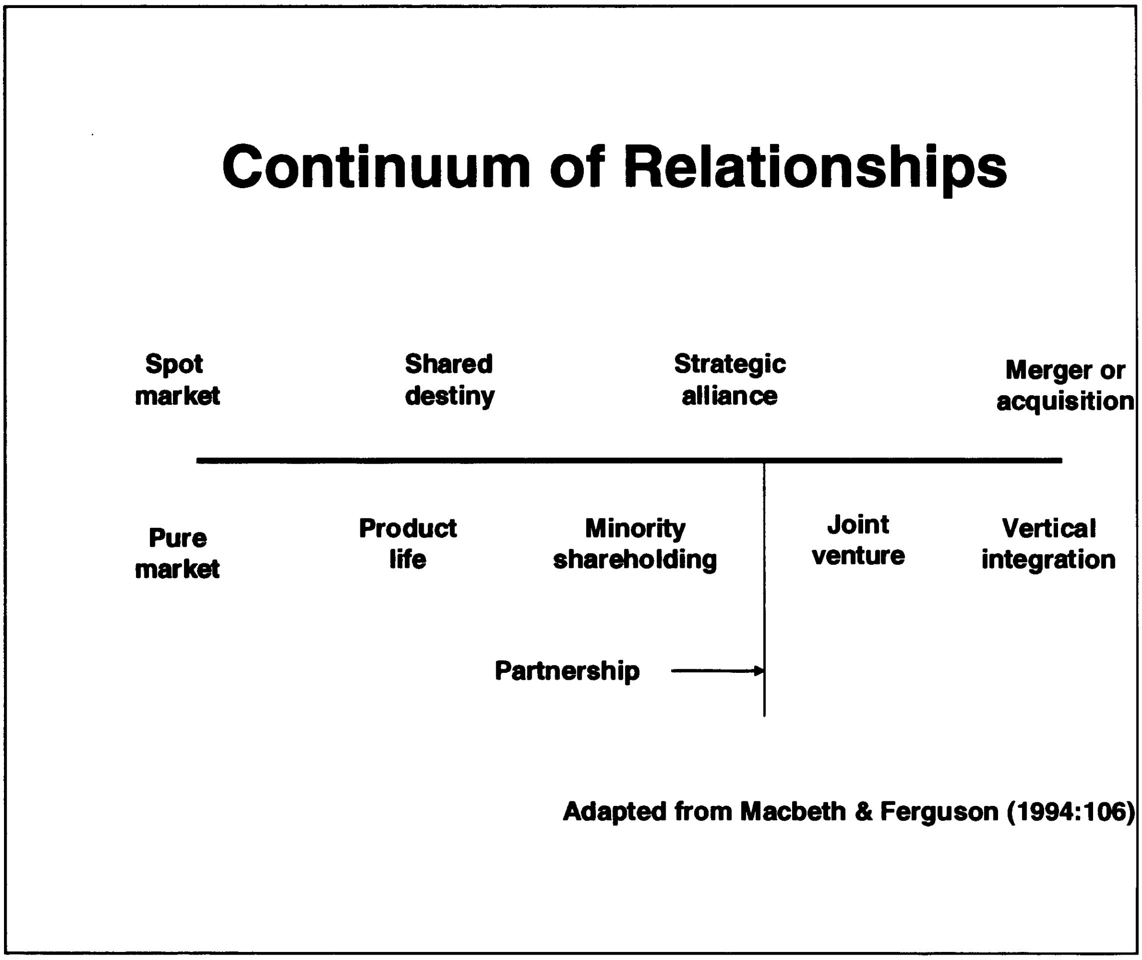

Figure 2.6 Continuum of Relationships. Source - Macbeth and Ferguson (1994:106)

In this situation a business can be purely transactional in buying goods and services or it can be more in control of the buying function via merger or take-over. Between these extremes lies a range of situations or relationships with suppliers where, for example, 'partnerships' can exist. There is much written about the relationships between buyers and sellers, and Saunders (1997:255) believes they can be represented as being a continuum between two theoretical types:

- ACR - Arm's length Contractual Relationship
- OCR - Obligational Contractual Relationship

At the ACR end of this range there also resides what is termed the 'transactional' relationship where nothing more than the basic commercial act of trading, usually money for goods or services, takes place. The opposite end is one of cooperation, trust and mutual improvement, as shown in Table 2.2.

Adversarial	**Collaborative**
Arms length – formal communication	Good and frequent communication
Adversarial attitude	Co-operative attitudes
No trust	Trusting relationship
Aggressive win-lose approach general /negotiations	Problem solving - win-win generally and in negotiation – total cost attitude
Single order/short term based	Long term situation
Little involvement in design etc.	Share information – team approach?
Little share of information	Supplier approval, Q.A., prevention approach
Rely on GI inspection and corrections	

Table 2.2 Relationship Types. Source - Adapted from Saunders (1997:255)

As will be shown later in the dissertation, trust and commitment are important issues in relationships and it is necessary to understand the principles involved before assessing their impact on housebuilding supply chains.

The adversarial relationship (i.e. one where business relationships are seen having some degree of conflict and are characterised by win-lose situations), is said to be the traditional one in commerce (Cavinato and Kauffman (2000:155). Here loyalty and a guarantee of business were uncommon. Such relationships still exist to-day, but many commentators argue that collaborative relationships are more beneficial (Macbeth and Ferguson 1994:118, Saunders 1997:253, Baily et al 2005:190). Many authors discuss the generic benefits of long term relationships like partnership using descriptors such as synergy and symbiosis (Baily 2005:179) or the benefits for purchasing strategies Graham et al. (1994). Some discuss and present the benefits of partnership relationships more specifically related to supply chain management. These relationships include those between shippers and third parties (Ellram and Cooper 1990); those from an automotive and manufacturing perspective (Lamming 1993); from a value chain perspective with 'the Ten Force Partnership Model' (Hines 1993); from an effective perspective supply chain (Harland 1996); and finally from a time compression and dynamic systems perspective (Towill 1995). These and many more publications strongly link the need for sturdy long term relationships or partnerships with supply chain management. Indeed, from reviewing the extensive literature on the subject it is clear that partnerships are very much central to supply chain management. This is not to say that every buyer-seller relationship needs to be a partnership but in the case of goods and services that are key and core to the business and hence to the supply chain, then a long term collaborative relationship appears to be essential. This is shown in the previous Table 2.1 and in the original concept and definition of a supply chain, which implies the sharing of information and direction.

'Partnership Sourcing' is defined by the Confederation of British Industry (CBI) and the Department of Trade and Industry (DTI) in Baily (2005:200) as "a commitment by both customers and suppliers, regardless of size, to a long term relationship based on clear, mutually-agreed objectives to strive for world-class capability and competitiveness". This initiative, established in 1990 by the CBI and led by Sir Derek Hornby, advocated against traditional adversarial relationships with suppliers but promoting the view that collaboration was the way forward for improvements in cost, quality and innovation. This initiative has been successful (Baily 2005:200) in raising awareness of purchasers and supply chain managers, with much information on the concept being promoted by Partnership Sourcing Ltd (PSL) generally and via their web site (http://www.pslcbi.com/).

PSL focuses on both the public and private industry sectors, manufacturing and services, working with small, medium and large enterprises. The organisation (PSL) is a prime business reference for most issues relevant to partnering including various publications, events, case studies, best practice and so on.

Many authors including those shown above present and discuss the merits and principles of partnerships. The following represents the author's summary of what a 'partnership is' and what 'it is not':

- That partnership is: based on long term relationships; focused on total value or cost not just price; aimed at zero defects; related to a reduction of the supply base; a commitment by both parties.
- That partnership is not: a cosy relationship; a reduction on competitive effort; based on price; based on domination; a short term strategy.
- Benefits of Partnership are: reduced supply base administration and control; greater buying power with supplier; greater understanding and relationships leading to better service; improvements on quality, delivery, and costs but mainly value.

This review on partnering proposes that all businesses should adopt it to some degree. However, not all partnering is successful. Boddy et al. (1998), in an empirical study of 100 companies who had implemented or had tried to implement partnering, found that only 46% were successful. This was from a population of companies that had already requested information on 'partnering' indicating that they were from a pro-partnering culture. The work also identified six main barriers to partnering: underestimating the scale of change which partnering involves; underestimating the turbulence surrounding partnering; priority conflicts left unresolved; over reliance on good interpersonal relations; cost benefit and value adding models not defined; and finally insufficient focus on long term benefits. Unfortunately the work does not evaluate or rank these in importance.

Other work based on empirical data from 162 manufacturing businesses (Graham 1994) found that benefits of partnering increased with time and that this was very much the case after a three-year partnership duration.

2.3 Construction Supply Chains

Construction supply chains are very relevant to the core topic of this dissertation. The construction industry in the UK includes a large number and diverse range of businesses and activities, all concerned in some way with building in the environment. An important sub-section of this industry sector is housebuilding. Many argue that housebuilding has much in common with general construction such as roads, bridges, specific buildings and so on, and therefore, is often included in the overall sector term of 'construction'. In particular, this is the case when considering research, research bodies and support infrastructure. This section summarises relevant work in the area of supply chains and supply chain management in the more general construction industry but which can also be applied, or is related to, housebuilding. The section will show that even in the wider area of construction little research exists which analyses supply chains in their totality. This represents a gap in the literature which this dissertation seeks to fill– that of holistic supply chain management regarding housebuilding.

The construction industry represents, in total, around 10% of the UK's Gross Domestic Product (Gann and Senker 1998) and includes many, various types of building activity. Many authors believe construction is separate from all other industries because of its heterogeneous nature. Schonberger (1990) says "One industry, construction, is so fouled up as to be in a class by itself; delay, lack of coordination, and mishaps (especially return trips from the site to get something forgotten) are normal, everyday events for the average company".

A large amount of published work exists that relates to construction supply chains, much of it emanating from a few organisations or institutions. Several, UK Government led or assisted bodies have been involved in such publications. Examples here are CIRIA (1997); CPN (1999); CPN ((E9084) 1999); CRISP (1999); CIB (2000); Construction Confederation (2000); CPN ((MR1114) 2001); CRISP (2001) and Constructing Excellence (2003).

The UK Government has commissioned several reports to advise on improving construction including those of Latham (1994), Egan (1998 and 2002) and Fairclough (2002). The Egan Report Egan (1998) makes specific recommendations to the construction sector as a whole regarding the areas of partnering the supply chain, lean construction, design and standardisation – many aimed at improving efficiency in the industry and related closely to removing waste in the supply chain.

Although there is a great deal of literature to be found on construction logistics, looking at handling, operations and transport, there is little on the detailed analysis of overall supply chain improvements. There is, however, a tendency to concentrate on separate specific elements within the supply chain. An example of this is work by Horman and

Kenley (1998), who concluded from 'meta-analysis' of some 24 case studies that there is an average of 55% wasteful activities in construction processes. The studies, which were 'on-site based', including concrete work, carpentry, bricklaying and pipefitting activities, showed that there was a large amount of waste on average although this amount varied. Proverbs and Holt (2000b) assessed the situation of waste and inefficiency mainly by analysing concrete formwork and related activities, and proposed that construction contractors, as the vanguard of the supply chain, are best placed to meet increasing client demands for economic construction. The paper does suggest that contractors should gain early supplier involvement, and that suppliers should change their culture from 'product' to 'service' providers, a more value and customer related measurement. It concludes that although downstream alliances are common (contractor to client), there is a lack of upstream alliances i.e. mini-partnering arrangements with contractors and suppliers, which would increase the effectiveness of the whole supply chain. Other authors too take the view that construction is more focused on client relationships than those upstream to the suppliers (Gibb and Isack 2003). This is not to say that clients are not important, obviously as customers they are, and it is vital to understand the clients needs (Evans et al. 1997a; Smith et al. 1998; Barker et al. 2004).

A more holistic view is given by Agapiou et al. (1997), who studied construction supply chains from the builders' merchant perspective. This paper identified a trend towards consolidation in the sector; that JIT (Just-In-Time) principles in construction are not easily implemented; that collaboration is ad hoc and that there is a lack of overall perspective. It concludes that construction companies can only improve the supply chain through partnerships and long-term relationships with merchants.

Also, Vrijhoel and Koskela (1999) and Vrijhoel and Koskela (2000) in the process of defining the roles of construction supply chains, discuss at length the causes of overall waste. They conclude that most waste is due to a low level of partnership and non-co-ordination that they term 'obsolete myopic control'.

An authoritative holistic approach to improving supply chains is the use of modelling, where planning / modelling software such as IDEF0 may be used. Using this, Karhu and Lahdenpera (1999) present the possibility of systems modelling of the different stages of the contractor focused supply chain. This encompasses all stages, beginning with the initialisation of the project, the various design stages, build stages and possibly maintenance stages. Work done on simulation modelling (Sobatka 2000) in relation to the logistics of a total construction supply chain in Poland considered different strategies of material and information flow and showed that this holistic approach should reduce overall logistics costs. In general, much construction is make-to-order and therefore very project biased. Consequently, much time and effort is concerned with project definition, briefing, contractual arrangements, different design iterations, etc., prior to build. The impact and value of briefing on large construction projects is considerable, as shown by Barker et al. (2004) and Barrett (CPN(E9096C) 1999) Another modelling system, Process Protocol shown by Cooper (CPN 1999), is based on, but reportedly less cumbersome than, IDEF0. Once again, the modelling is aimed at the whole construction project with emphasis on initiation, design and project control, rather than supply chain functions and the improvement potential therein.

A useful survey of 40 large UK contractors by Akintoye et al. (2000) showed the construction industry to be relatively slow in adopting supply chain management (SCM). It revealed that contractors are, as previously mentioned, more oriented towards clients than suppliers and have more arrangements with clients than with suppliers. They tend to "regard suppliers on a par with employees and sub-contractors, i.e. as suppliers of a service they have the opportunity to dispense with largely as they please". This agrees with Proverbs and Holt (2000b) above, but goes against the growing trend in electronic, automotive and other manufacturing sector businesses where there is greater supplier involvement and suppliers are encouraged to improve 'value' and reduce total cost in the supply chain.

Many believe there are lessons to learn from manufacturing. Some believe, for example, Crowley (1998) that communication and the adoption of 'lean' philosophies will improve the industry. Others believe that construction should view the business as a 'system' (Naim 1999) with a process-focused rather than a functional-focused perspective and so gain a more holistic supply chain view and become more customer-centred. Others propose that lessons from the automotive industry would improve customisation and reduce cost by adopting a balanced use of standardised parts with flexible assembly (Gann 1996).

Work carried out in the Netherlands, by Pries (1995), as mentioned in Smook et al. (1996), states that about 40% of building production costs can be related to communication. There is also a shift of added value towards the preliminary stages of construction such as pre-assembly and prefabrication. This aligns with the fact that ancillary construction industry accounts for over 70% of all innovation (product and process) within the Dutch construction industry (Pries 1995).

Voordijik (2000) investigates the logistics system of the Dutch building supply chain using two case studies. Concerned with overall costs in the supply chain, this is considered to comprise of five elements – sourcing, production, inventory, transport, and service (the SPITS model) originating from TNO Into (1994) in (Voordijik 2000). The first case study described the decentralised production of highly customised pre-fabrication of concrete products and showed a reduction of on-site, inventory and transportation costs, but an increase in the factory production costs. The second case study analysed the ceramic tile supply chain, where it was found that due to deregulation and demand for increased variety, centralisation and cross docking was introduced, resulting in customisation earlier in the supply chain. This meant that with the use of IT, lower inventories could be held, service was improved but unfortunately transport cost increased. The impact this had on overall costs is not analysed or discussed.

As indicated earlier, the IGLC (International Group for Lean Construction) has contributed greatly to the published literature base surrounding lean construction, much of it relevant to supply chains in some form or other. Koskela (1992), Ballard and Howell (Ballard and Howell 1994b) and later Koskela (1996) introduce the concept of Lean Production Theory (LPT), derived from and related to JIT and Ohno (1988). This theory promotes the application of the 'lean concept' to construction and the idea of shielding production (Ballard and Howell 1998a and 1998b) from uncertainty (Toyota concept of 'level production' – heijunka) as a way of removing waste. This concept leads to the 'last planner' principle (Ballard 1993), a philosophy of allowing the final person in the planning hierarchy to choose to carry out work that will be most productive. Construction top level plans are continually being adjusted by external influences (late suppliers; weather; transportation uncertainties), and so it is really only the person at the end of the chain of command (site manager or equivalent) who can best decide activities and so shield production from disruption to achieve the highest PPC (Percentage Plan Complete). Such planning can take account of the best sequence of build, and the actual availability of all resources, including the analysis of why (root causes) the PPC was not 100% and implementation of corrective actions. A current discussion topic in this field (Ballard and Howell 2003) is whether commitment of work completion made from the existing top level plans should only be agreed at daily meetings by the 'last planner' i.e. the front line supervisors who speak for and are part of direct worker groups. This appreciation of overcoming uncertainties by using the last planner or site manager is an important issue within this dissertation as it shows the pivotal role of the site manager and forms a basis for later empirical work.

As shown in Johansen et al. (2004) the application of "Lean construction principles in the UK are not always easy or fruitful". Following the unsuccessful application of the 'last planner' concept on two UK construction projects, it is apparent that culture is a key barrier. Success really needs a proactive organisation/supply chain with mature strategic partnering relationships where cultural change is readily accepted.

Much opinion has been expressed on the subject of partnering within construction, with many supporting the adoption of partnering as proposed by UK Government initiatives (Burnes and Coram 1999; Akintoye et al. 2000; and Bresnen and Haslam 1991). Previously mentioned scoping, descriptions and definitions of partnering result in this to being a strategic decision because of the importance and resource implications such a relationship brings. However, within the construction sector the idea of 'project partnering' where contractor, sub-contractors and suppliers form a relationship but only for a specific project is becoming common (Larson 1997). This is understandable given the nature of most construction work as being individual, bespoke and unlikely to be repeated. Some authors Briscoe and Dainty (2005), Ireland (2004) believe that fully supply chain integration through partnering is limited.

This section has assessed the plethora of published work on general construction supply chains and has demonstrated that much of this concentrates on improvements in separate specific areas in isolation. This is despite the fact that it is recognised that the majority of inefficiency or waste occurs at interfaces between links in the supply chain (Christopher 1998, Lamming 1993 & 1996). Also, many improvements have been recommended which rely on better relationships, often adopting partnership to increase information, understanding and symbiosis within the supply chain. Such a change requirement is in contrast to the short term, adversarial and contractual culture of the construction industry which differs from many manufacturing scenarios where supply chain relationships are offered as the ideal for other industries to follow. If then, construction was more repetitive, high volume and stable could the culture change, and improved supply chain relationships and hence efficiency be achieved? This point is considered after the next section that describes and reviews the housebuilding industry in the UK.

2.4 UK Housebuilding Industry

This section of the literature review gives an outline of the UK housebuilding sector. Not only does this put the aim of the research into perspective and give context but also shows why the research is of importance, relevant and applicable. The dissertation argues that the housebuilding industry has been slow to change and adopt ideas from other industries. This will be achieved by firstly understanding the construction process, the size and shape of the housebuilding sector, and what problems exist in terms of not meeting demand and quality and customer dis-satisfaction issues. The section that follows this explores deeper into the supply chain issues of housebuilding, attempting to understand and explain why housebuilding has not greatly improved.

The housebuilding industry in the UK has changed little over many decades. The basic construction of most housing has remained the same, consisting of a concrete foundation, brick and block walls, timber beam floors and ceilings, timber frame roof with tiles or slates. Internally the floors are either concrete or floorboards on timber joists, walls and ceilings being plaster-boarded. Appendix 1 shows a 52 stage sequence of build for a typical privately built standard house. The process is highly labour intensive and carried out on site in whatever environmental conditions prevail.

Incremental improvements to this basic process of building have, and still are occurring, many of these based on using different materials. Fundamental alternatives to brick and block are timber or steel framing, use of modular foundations or piling and different flooring systems (Barlow 1999a). Many authors (Habraken 1991, Gann 1996, Gann

1998, Barlow 1998a and 1999a, Howell 1999, Roy and Cochrane 1999, Barker et al. 2000, Barlow et al. 2003, Naim and Barlow 2003, Barker and Naim 2004b, and Nakagawa and Shimizu 2004) have studied various aspects of the housebuilding process and have recommended different ways to make improvements. Many such innovations are seated in other industry sectors such as electronics, automotive and retail. Trial building work on steel framing and alternatives has been carried out (Roy et al. 2003). Pre-assembly and modularity has been investigated (CIRIA 1997; 1998; Fickling 1999; Gibb 2001; Gibb and Isack 2003) as such systems allow more in-factory control, quicker on-site assembly time and can gear the demand more closely making 'late-configuration' for customer choice easier to achieve (Barlow 1999a). Ideas and improvements from other countries such as from Japan (Gann and Senker 1993; Gann 1998; Barlow et al. 2003), and USA (Towill 1997a) have been discussed or investigated.

However, there has been little take-up within the industry as a whole with major housebuilding continuing with the traditional brick and block construction. Progress is slow and not all innovations are successful, as in the case of timber-frame housing (Aldrick 2001).

From the supply chain management perspective, the application of manufacturing best practice like pre-assembly, pre-fabrication, standardisation, lean and agile supply chains is a common theme in recommendations. A particularly relevant report aimed at housebuilding shows 20 success factors for 'Improving your Supply Chain' (Housing Forum 2001). From this report, (which is returned to later in the dissertation when describing how ideas were formed for empirical research), success points particularly noted were; early involvement of key suppliers, value driven procurement, shared goals and objectives, trust, good communication, measurement of performance, adoption of partnering and the embracing of continuous improvement.

The UK housebuilding industry is split into two parts; private and social sectors. Housebuilders that build for end consumers or the private market are termed 'private' housebuilders or speculative housebuilders (because building often starts with no known customer). Housebuilders who build for registered social landlords (RSL's) or for local authorities (LA's) are termed 'social' as they build for a customer who is not the end consumer. Some housebuilders have a foot in both camps, but as the majority of build in the UK is private, some 88.7% in 2002/2003 (ODPM 2003), most housebuilders do mainly private work.

Within the two classifications there is a huge range of companies in terms of their size, market sector, and abilities. (Parker 2001) reported using figures from the NHBC (1998), that 109 of the largest builders (less than 1% of all UK builders registered) collectively controlled three-quarters of the market. Also in 1997, the 10 largest housebuilders (Hooper and Nicol 2000) produced nearly 40% of the market output. The rank size distribution of British housebuilders is highly skewed with a few high volume producers, and many small businesses (Ball 2003). Economies of scale for larger housebuilders include risk-pooling, purchasing and financial economies, marketing and brand image, plus strategic benefits. Smaller housebuilders, in their thousands, survive through specialisation, taking risks and having cost, information or quality advantages. The major housebuilders tend to be regional; in 2002 the top 10 certainly were (Ball 2003).

Private housebuilding is said by many (Nicol and Hooper 1999, Hooper and Nicol 2000, Barlow 1999a and Barker et al. 2001), to replicate other more traditional manufacturing industries with a good amount of repetition in both materials and process.

The following listing highlights several key features of housing compared with general construction in the UK (Barker et al. 2001):

- Firm stable demand (relatively stable in that demand for UK housing is generally greater than the supply).
- Designs are stable – bespoke public housing still uses many common elements (materials and operations). Most private building is batch produced from a limited portfolio of designs (Hooper 1998; Nicol and Hooper 1999).
- Design is relatively firm, most are tried and tested – private housing customer choice is limited and controlled.
- Volume is relatively high.

- Relationships in supply chain can be stable with great potential for long term 'Strategic Partnering' as opposed to 'Project Partnering' now common is large construction projects.
- Processes within supply chain and on site are repetitive (can be likened to batch manufacturing with many improvement techniques applicable).
- Customer often naive and unknowing - especially for private housing.
- Build for private is mainly "make-to-schedule" and then "complete to order".
- Private housing has large investment (speculation) prior to order commitment.

This list indicates that housebuilding is not like general construction but has more similarities with manufacturing. The question, therefore, is why is innovation in business processes, materials and supply chain management not adopted by UK housebuilders as it has been in other manufacturing industries? And especially why not in the private housebuilding sector where the benefits of volume, standardisation are greatest?

Some argue it is a problem of tradition caused by cultural and structural barriers (Barlow 1999a). It is claimed that during the period from the 1960's to 1980's speculative housebuilders focused on capturing inflation gains from housing and land markets, but to-day, construction related costs account for the largest share of total housing development costs. Despite this there still remains resistance to change.

This complex situation is illustrated well in Figure 2.7 by Ball (1999) which describes the market context where, it is argued, housebuilders face a particularly difficult business environment. Firstly, the products are sold against existing housing stock as well as other housebuilders; secondly, that land availability and price are a separate market place; plus thirdly, that due to the subcontract nature of the industry plant hire, materials and labour must also be controlled. This complexity is a barrier to change and reduces adoption of innovation.

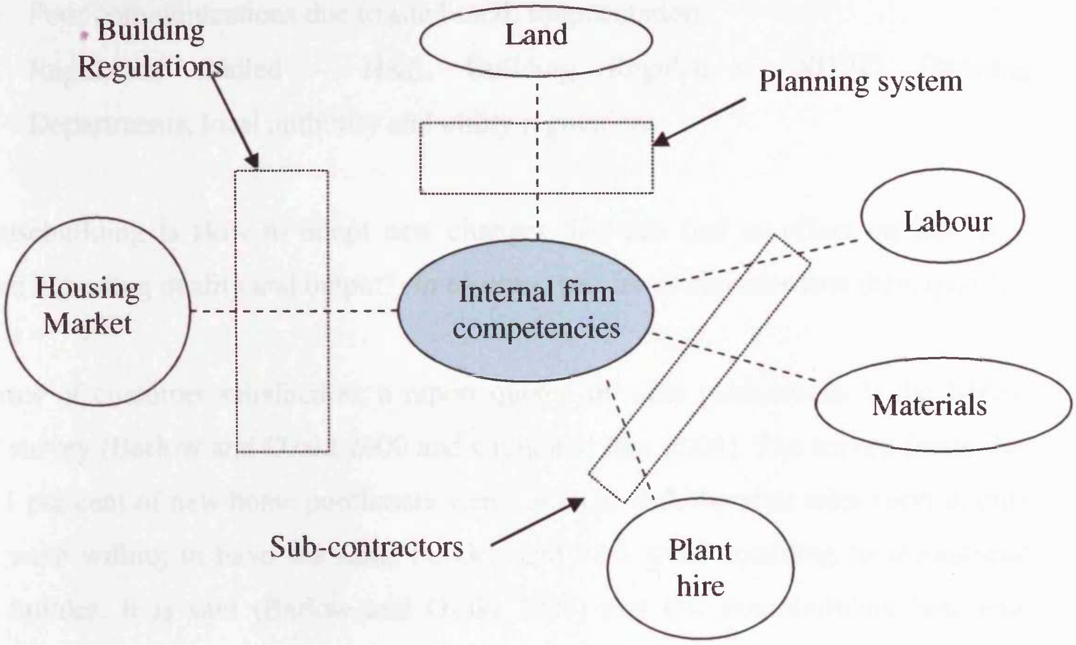

Figure 2.7 Housebuilders Market Context. Source - Ball (1999)

On the other hand, many authors agree that not all innovation is, in fact, applicable to housebuilding. There is much debate about the application of, for example, lean and agile philosophies (Barlow 1999a, Winch 2003). This topic, especially in respect to supply chains, is covered in the next section, but suffice to say here that there is agreement that housebuilding is more conducive to this approach than general construction based on the difference between the two sub sectors listed above. That said, it must be remembered that as a part of the construction industry, housebuilding does share some common problems that do make adoption of manufacturing philosophies difficult. These include:

- Environmental conditions – weather
- On-site work not factory so organisational difficulties
- Moving workplace with say 6 month duration
- Broad range of skills including wet trades, precision difficult
- Unskilled and unstable workforce
- Wide supply base
- Fragmented organisation with contractors; sub-contractors (virtual company)

- Adversarial, contractual supplier relationships
- Poor communications due to site based, fragmentation.
- Regulation riddled – H&S, Building Regulations, NHBC, Planning Departments, local authority and utility regulations

If housebuilding is slow to adopt new changes, has this had an effect on how it is viewed regarding quality and output? In essence, yes; let us consider first then, quality.

In terms of customer satisfaction, a report quoted in other publications is the NHBC 1997 survey (Barlow and Ozaki 2000 and Craig and Roy 2004). The survey found that only 1 per cent of new home purchasers were satisfied with the after sales service, only 24% were willing to have the same builder, and 58% were unwilling to recommend their builder. It is said (Barlow and Ozaki 2000) that UK housebuilding has, until recently, regarded customer service in terms of rectifying faults, and that the emphasis has been on reducing cost of defects rather than improving the customer service (Craig and Roy 2004). Other independent research (Ozaki 2003) into customer satisfaction concentrated more on customer focus, identifying three key issues: good service, customised house design and good information flow. The work is similar to other multi-dimensional measures of service or satisfaction such as HOMBSTAT (Torbica and Stroh 2001) and SERVQUAL (Parasuraman et al. 1985 and 1988). This work (Ozaki 2003), involved interviews with 6 housebuilders and questionnaires to over 200 customers or potential customers the results of which showed that customer satisfaction was low. Problems of poor quality finish of houses and poor after sales service were the key service problems, and specifically mentioned were quality defects that had been missed prior to hand-over. The work also highlighted the need to look at the whole business from a 'service' not a 'product' viewpoint and that communication with the customer was a main way to improve the relationship.

The National Customer Satisfaction (NCS) survey (Housing Forum 2003b), showed major housebuilders are not meeting customer requirements. The report measured, in a similar way to JD Power surveys in the automotive industry, the overall customer satisfaction of the major housebuilders in the UK according to three separate indicators: Quality of the home; Likelihood of housebuilder being recommended by consumer, and; Service from the housebuilder to the consumer.

The NCS survey showed that some 83% of customers were satisfied with their new home, a lower percentage than found in the previous surveys taken in 2000 and 2001. Regarding service provided by housebuilders, some 65% of customers were satisfied with 'their service from their housebuilder' but, again, this was lower than in 2001 and 2000. Survey results indicated that satisfaction with this service tends to decline over the purchasing process with satisfaction lower on the moving in day and at its worst with after-sales service. The experience of defects or snags (quality problems with the final product) had increased to some 90%, compared with 84% in 2001 and 81% in 2000. Overall, this indicated a decline in customer satisfaction over the last few years. In fact only 55% would want another newly built home if they were to move again. Surely this is a major indictment for the industry?

On the provision side of housebuilding, the need to increase the number of dwellings built has been reported on for several years. Amongst others, Nicol and Hooper (1999), Hooper and Nicol (2000) and Barlow and Venables (2000), have confirmed the gap between supply and demand. One of the latest reports is the Review of Housing Supply (Barker 2004), which states that there will need to be a 'concerted action on the part of the housebuilding industry. In the past, quality of service to customers and consideration on sustainability, design and innovation have been secondary to the desire to secure land'. The Barker Report also states that demand for housing is increasing due to demographic trends (more but smaller households), and rising incomes. In contrast, the housebuilding industry is not meeting this demand. In 2001 construction fell to its lowest level since the Second World War. Also, during the 10 years to 2002 output of new homes fell to 12.5% lower than the previous 10 years. Such a mismatch between supply and demand invariably results in spiralling house prices. A major government concern is that this lack of housing contributes to macroeconomic instability and has social implications as more and more people are finding home ownership unaffordable. New houses account for only 1% of the existing stock and therefore the report argues that building needs to increase substantially to give stability in the housing market.

The UK housing industry is still suffering from two major problems. First, insufficient numbers of dwellings are being completed; and secondly, already demonstrated above; there is insufficient progress in innovation and quality. There have been several government reports acting as wake-up calls in recent years. These include Constructing the Team (Latham 1994), Rethinking Construction (Egan 1998), Rethinking Construction Innovation and Research (Fairclough 2002) and Accelerating Change (Egan 2002). These papers and other guidelines have looked at improving the construction and the housebuilding process generally but also cover more specific areas such as supply chain improvements. Issues such as the cost of bidding, partnering, supplier involvement and general strategic supply chain management have been covered with reference made to key performance indicators (KPI's), Construction Best Practice Programme (cbpp), and Rethinking Construction. A particularly relevant section of the Accelerating Change report (Egan 2002) is Section 5.2, supply chain management and logistics:

> A considerable amount of waste is incurred in the industry as a result of poor logistics. There should be greater focus on supply chain management and logistics to facilitate integrated working and the elimination of waste. Supply chain management is the process by which one optimises the flow of goods and materials from supplier to the point of use and logistics is the process used to manage the flow of goods and materials, equipment, services and people through the supply chain.

Organisations such as The Housing Forum (now part of Construction Excellence) and the House Builders Federation exist to help and improve the housebuilding sector through information, events and general advice. Despite these initiatives supply levels and quality of the supply are still lacking, and innovation lags behind that of many other industries.

In summary then, the housebuilding sector consists of thousands of companies where something like the top 100 build the great majority of houses, which are private. These major housebuilders are regionally structured and numbers tend to be reducing as a result of consolidation. The construction process is traditional, with neither customer satisfaction nor level of supply meeting market expectations. It would appear that from the amount of advice given, much from the UK Government, that the housing industry should be aware of its shortcomings in these areas including that of need for better supply chain management. But is the industry moving forward and taking any of the advice offered? The research identified and presented in this literature review suggests that it is not. Although investigating the reason for this lethargy is not the aim of this research, the author's conclusion is that companies are content with their business situation (profit, turnover etc.) and no major threats currently exist.

2.5 Housebuilding Supply Chains

Despite an exhaustive literature search very little published work was found specifically concerning housebuilding logistics or supply chains, especially that regarding holistic efficiency improvements and the removal of waste. However, the author is of the strong opinion that housebuilders or developers are themselves doing some research in this area either solely within their own organisation, or in some form of partnership with Universities or other research institutions. This work includes rationalising the supply base, forming stronger partnerships, and looking at better information technology. The purpose of this is to gain competitive advantage and is therefore not in the public domain. This opinion is backed up by the views of other authors such as Leopold and Bishop (1983).

Despite the lack of work around whole systems, as indicated in earlier parts of the literature review, certain specific areas have been studied. However these are looked at mainly in isolation, such as on-site material and resource waste (CALIBRE 1999) standardisation and design (Hooper 1998, Hooper and Nicol 2000), pre-assembly (Fickling 1999, CIRIA 1998 and CIRIA 1997), customer-focus (Barlow 1999b and Ozaki 2003), and rework and its causes (Love et al. 1999a and 1999b). The Egan Report (Egan 1998) Chapter 5 recommended targets for improvement, demonstration projects, simplifying procurement, streamlining the supply chain and standardised component linkages as well as partnering. Since this report UK Government involvement in housebuilding innovation has increased with several organisations striving to improve the efficiency and effectiveness of housing industry (key ones being The Housing Forum and House Builders Federation as stated earlier). Also various research projects have taken place including the Meeting Customer Needs through Standardisation (MCNS) project referred to later in this dissertation (Barker et al. 1999). The project was funded by the Engineering and Physical Science Research Council (EPSRC) Innovative Manufacturing Initiative (IMI) and Department of the Environment, Transport and the Regions (DETR).

Partnering is an important element of success in housebuilding supply chains, more so than in construction supply chains. As previously shown there is an increase in the permanency of relationships within this section of construction and so great potential for benefit gain. Many authors advise adoption of partnering (Barlow 1998b, CPN(E1139) 2001, Packham et al. 2003, Barker et al. 2000 and Hong-Minh et al. 2001) for general improvements but the degree of take up is unclear. The main barriers to the success as shown in Akintoye et al. (2000) are the lack of top management commitment, poor understanding of the concept and lack of appropriate information technology.

A recent survey on partnering in the housebuilding supply chain referenced in Barker et al. (2001) contacted 30 top UK housebuilding companies of which 19 replied. Of these, 15 stated that they had partnering agreements with their suppliers. All 15 thought that partnering was working and all felt it was a key strategy, and yet on average they could increase partnering with suppliers by 40%. It also showed that, on average, 73% of partnership agreements involved contracts and 73% of partnered suppliers still had to tender for work, involving a very time and resource consuming process, often aimed at price targets as opposed to cost or value.

Published research into holistic improvement of housebuilding supply chains is limited, although several have allied the housebuilding process to that of 'lean' production from manufacturing. A focal point for such research has been the IGLC (International Group for Lean Construction founded in 1993) who through their annual conferences and networking have promoted improvements in housebuilding as well as general construction. Their sub-Group: IGLC the House Building Group specifically deals with housebuilding research and improvements.

Some authors initially allied to general construction research have seen the greater potential of applying 'lean' philosophies to the housebuilding process. Adoption of existing concepts such as lean construction principles (Koskela 1992) which promote construction to be viewed as 'flows'; shielding production from uncertainty (Ballard and Howell 1994b; Ballard and Howell 1998a); and the 'last planner' principles (Ballard 1994a) can and are being applied. Even flow production (Ballard 2001) applies these concepts and building on the PPC (percentage plan complete) monitoring and control system previously implemented, uses the innovation of multi-craft teams responsible for specific systems and components in the housebuilding process. The research claims success with a potential reduction in build cycle (though-put time) from the norm of 50 -70 days to 5-10 days, with a consequential reduction of WIP (work-in-progress) as the building site is analogous to balanced flow production assembly lines. This work is more concerned with the actual build process than the supply chain which is core to this dissertation.

A particularly relevant case study is the Texas (USA) based housebuilder Doyle Wilson initially quoted in Womack and Jones (1996:29) and subsequently by others (Towill 1997a; Dougherty 1998), and is a good example of reducing process time by identification and removal of unnecessary delays and adopting a process/flow attitude - in essence the principle of 'lean'. As shown by Womack and Jones (1996:51) the builder realised that five-sixths of the total build time was either *waiting* or *rework* due to poor planning and poor quality. Looking at the whole buying cycle for the home-owner the builder realised a similar situation existed, where the majority of time was wasted. After applying various innovative actions (Towill 1997a) (Towill 2001), the time from contract to completion was reduced from 6 months to fifteen days.

Other authors have looked at combining lean and agile philosophies. Childerhouse et al. (2000) applied the concepts to the whole of housebuilding supply chain by considering four positions on the continuum of customisation. That is, at one extreme is 'made to stock', then 'fit our to order', then 'shell and fit out to order' and finally 'made to order' with a consequential amount of 'lean' or 'agile' supply depending upon the positioning of the changeover or decoupling point for each supply chain type. This work is based on that of Fisher (Fisher 1997) where efficient and responsive supply chains are selected depending upon whether the goods are functional or are innovative. In the author's experience and shown in Hooper and Nicol (2000)) most major housebuilders already 'fit out to order'. That is they have a fixed external footprint, a fixed external and internal structure and allow a minimum of customisation through fit out of kitchens, bathrooms, floorings and such. Modification or removal of interior walls or re-allocation of room usage in not usually offered.

A similar idea for improvement also comes from the principles of lean and agile, but where the decoupling point between them is the builders' merchant (Naim and Barlow 2003). In this case, the builders' merchant is the consolidator of kits of parts, a suggestion promoted by others (Agapiou et al. 1998). The supplies coming into the merchant are many and various but in themselves can be classed as standardised and therefore be deemed a lean supply. From this point onwards though, because of the potential configuration options (and hence customer choice), selection, call-off and delivery activities of a 'just-in –time' nature, the process can be deemed agile. This is a very useful concept but is at odds with current housebuilding supply chains. It is the author's experience that although housebuilding supply chains have many standardised parts there are also several special/bespoke parts that could not be classed a lean supply chain because volumes are limited. However, taking the Fisher (1997) philosophy from the previous research, a possible option would be to create 'families' of goods each having a different degree of leanness or agility. This way, all components could be accommodated and the relevant supply chain management strategy determined for each.

Work, including pilot building has been carried out with major housebuilders (Roy et al. 2003), where materials used in terms of 'technology platforms' have been investigated. This is basically component based improvement, as already mentioned, but at a higher level. The aim is to reduce the materials complexity and so simplify and reduce build time, as well as ease the supply problem. The work revealed that no matter how simplistic the range and type of materials needed, effective supply chains are essential and therefore correct procedures and information flows between the housebuilder and the sub-contractors and suppliers are crucial.

Information flow can be improved with the application of the latest technology. Electronic Data Interchange (EDI) has existed since the 1980's in the form of dedicated bespoke linkages between business computers. With the advent of the Internet and World Wide Web the reduction in cost and ease of adoption has over the last few years been dramatic (Chaffey 2004:4). This changing technology is readily useable for improving information flows in supply chains and has been the subject of secondary research for this dissertation.

In San Francisco (USA) an internet company has created an internet-driven supply chain for large scale production home builders (Lurz 2001). The principle of operation is to create a direct link between housebuilders and the manufacturers, with key product items being electrical and plumbing products. Leveraging the information of demand via on-line orders which are aggregated then allows centralised bulk buying. This then leads to the use of trade packs that can then be delivered straight to site. The Chief Executive Officer George Mac Connell thinks that eventually the industry is going to learn how to connect with manufacturers better and so prevent waiting time. It is reported that evidence exists that highly skilled trades are prevented from work 10% to 30% of the time due to materials not arriving on programme. Quoting from a press release (Woodside 2000):

> "USBuild.com has created a business that moves products and information very efficiently. Their new e-Chain facilitates the flow of information and materials. It allows builders to easily place orders for each home's bill of materials directly with suppliers well in advance of scheduled installation. Suppliers will then build to order, rather than for inventory. USBuild.com then uses state-of-the-art logistics to accomplish reliable, just-in-time delivery to the job site. On the supply side, trade contractors, manufacturers and pro-dealers will benefit from reduced credit risk and improved cash flow, and improved customer relationships."

Other commentators on the USBuild innovation (Taylor and Bjornsson 2002) assess the internet driven supply chain, professing that the information hub based system reduces the lead-time lag by several weeks as compared to the traditional supply chain. Two important value drivers are the information flow improvements and material flow improvements. The former will reduce demand distortion, improve demand capture, and pool the demand. Material flow will improve by removing trade contractor links, adopting kitted material delivered just in time, and providing 'spare and repair' inventory in a forward position similar to VMI (vendor managed inventory).

2.6 Value and Waste in Housebuilding Supply Chains

This section explores the current definitions and perceptions of value and waste, commencing with value. These two topics are investigated and discussed together as the author believes it is necessary to understand value in order to understand waste which is at the root of the main research questions in this work.

Understanding and creating value is central to many disciplines, especially marketing and supply chain management. According to Porter (1980) "Superior value stems from offering lower prices than competitors for equivalent benefits, or providing unique benefits that more than offset a higher price". Many customers, including businesses, do not primarily aim to buy goods or services for their own sake but rather for the benefits or the end results that these goods or services bring.

There are many definitions of 'value', most relating to the customer, their perceptions (of value or satisfaction) and costs or the payment made. For example one definition Womack and Jones (1996:311) is "A capability provided to a customer at the right time at the appropriate price, as defined in each case by the customer". This, in fact, forms the basis for the first 'lean' principle (Womack and Jones 1996:32) that is to define value from the customer's perspective and encompass 'the whole product'. This concept has been extended further (Jones 1999) with suggestions for improvement to the construction industry by the application of manufacturing principles. Each of these principles (value, value stream, flow and pull), is in itself a potential spur to analysis and improvement. The concept presented can be summarised:

- specify **Value** by product
- identify the **Value Stream**
- make the product **Flow**
- at the **Pull** of the **customer**
- in pursuit of **Perfection**

Different authors define value in different ways. Lindfors (2000) defines value as "a quantity, which grows when customer satisfaction increases or expenses associated with a product decrease", thus echoing the views of Porter above. Christopher (1997) states that value "has long been the axiom of marketing and that 'customers' don't buy products, they buy benefits". Put another way, the product is purchased not for itself but for the promise of what it will 'deliver'. Gattorna and Walters (1996:99) suggest that "value may be: quality, exclusivity, convenience or possibly service response (an intrinsic value); the common denominator is cost to the customer".

Holbrook (1999) describes eight types of consumer value, concerned with different aspects of consumption. Here, consumer value definitions are based on those of Hilliard (1950), and are said to be interactive, relativistic, comparative, personal, situational and based on experience. Kotler (1991) says marketing is concerned with exchanges and transactions between two parties where something of value is given up for something of greater value.

A source which is more supply chain oriented Hughes et al. (1999:214), proposes that although focusing on delivering superior value to customers may well be an obvious activity, it is surprising how little this executive task of focusing on value is actually carried out. It goes on to say, "Customer value is a combination of functionality of product or service in terms of the benefits that are offered to the customer and the price that is charged". The price or the cost of exchange figures frequently in many definitions or understanding of value. "Since price forms a part of the total cost of ownership it follows that there has to be a relationship between the price charged and the customer's perception of value" (Christopher 1997).

From the literature reviewed by Payne and Holt (2001), nine core streams emerge around the concept of value - eight of which focus strongly on the customer or the end user. The general consensus is that Value Adding (VA) activities and processes, add value to a product or service as perceived by the customer. Non-value adding activities or processes have a cost but no perceived value – this may be termed as 'waste'. A Value Chain or Value Stream mentioned by many authors for example (Hines 1997), refer to the specific parts of the business process or organisation that actually add value. In other words, in a theoretically perfect value chain there are only value-adding activities. The inference here is that, to identify, evaluate and eliminate these 'non-value' adding activities will result in major improvements and move toward another well-versed paradigm, 'lean'. As stated by Lamming (1996) "The logic of lean production, leaving aside for the moment its implication for working practices and social impact, describes the value-adding processes unencumbered by waste (non-value adding activities)". Similarly 'lean supply' or a 'lean supply chain' is where inefficiencies and waste have been removed to the benefit of the whole supply chain. Lamming (1996) examples a 'progress chaser' (or in purchasing speak an 'expeditor') as an unneeded waste due to inefficiency between buyer and seller, which is a cost (non-value function) to the entire chain.

The removal of waste, either within an organisation, or at the interfaces between organisations, is a way to increase value and competitive advantage (Rummler and Brache 1995). However, in themselves, greater efficiencies may not be a primary competitive weapon, for as has just been reviewed, value is mainly in the eye of the beholder and consideration must be given to the delivery of total value to the customer. This means the delivery of not only greater cost reductions, but also the delivery of quality products at minimum lead-times and maximum service (Johansson et al. 1993). This latest definition can be expressed as a formula:

$$\text{Value} = \frac{\text{Quality} \times \text{Service}}{\text{Cost} \times \text{Lead-time}}$$

(Johansson et al. 1993)

Value, from a house-buyer's point of view, has been studied using quantitative analysis termed 'home-buyer satisfaction' (HOMBSAT) (Torbica and Stroh 2001), already presented in the previous 'UK Housing Industry' section. The system measures three areas: design, house quality and service quality, via 51 questions. The survey results showed that service was the most important of the three dimensions, but questions on overall cost (price), delivery time, and meeting promised delivery date, were not asked. This goes against basic definitions or constituents of value as mentioned earlier (Johansson 1993) and which may be defined as a function of quality, service, cost and delivery.

Lindfors (2000), referring to value chain management in construction, defines value as "a quantity, which grows when customer satisfaction increases or expenses associated with a product decreases". Work shown by Atkin (1998) in the use of IT (information technology) for speculative housebuilding not only showed a 50% reduction in design time (through use of CAD – computer aided design) but also a great reduction during the build process in "delays caused by errors and inconsistencies" when information was shared with manufacturers and major suppliers. Such use of IT can improve the efficiency of the building operation by reducing time and costs and hence increasing value.

Defining and understanding 'waste' in supply chains can be complex and confusing. The term 'waste' is often associated with environmental issues especially material or physical waste rather than the inefficiency of activities or operations. Understanding and avoiding waste has only recently become a focused issue in terms of categorising anything that does not add value as being a 'waste'. Generically businesses in all forms have tried to improve all operations and activities but it is only since the language of 'lean', 'value' and 'non-value' adding terms have arisen, has the realisation that 'waste' is multi factored.

However waste (muda), is defined by Ohno (1988:19) as follows: "we regard only work that is needed as real work and define the rest as waste". Another definition of waste, originating from Toyota, but quoted in Hay (1988:15) is "anything other than the minimum amount of equipment, materials, parts and working time absolutely essential to production". Ohno's 7 wastes, referred to widely in publications originate from the Toyota Production System. Ohno (1988:19) and Ohno and Mito (1988:2) give a detailed understanding of the philosophy and methods of improving a manufacturing system that are commonplace in many business sectors today. The 7 wastes being:

- Waste of overproduction
- Waste of time on hand (waiting)
- Waste of transportation
- Waste of processing itself
- Waste of stock on hand (inventory)
- Waste of movement
- Waste of making defective products

Categorising waste in housebuilding supply chains using these 7 definitions has been a subject of publication by the author (Barker and Naim 2004b) and showed that many wastes can be successfully classified. Following evaluation and comparison with relevant supply chain models and via a case study, improvements were offered towards a more efficient housebuilding supply chain. The work also presented a template for waste detection in housebuilding supply chains. It must be noted that these 7 definitions are based on the material flow within an automotive plant and therefore it is debatable as to whether they take into account the more human elements like waste due to poor communication, poor leadership and so on that occurs in organisations and projects. This is very relevant to construction as it consists of more than just material flow. Ohno's waste can therefore only be used to analyse to some extent waste within the housebuilding supply chain but there are other definite areas that are not covered.

Many authors have discussed and critiqued the principles of Ohno's definitions and work. Some authors suggest additions to these 7 classic wastes. Macomber and Howell (2004) proposing that 'not listening' and 'not speaking' are worthy of inclusion since a major potential of waste is the loss of human action and involvement, as exemplified by Henry Ford who saw people as a source of inventiveness in the firm. Another addition is that from Koskela (2004) where 'making-do' is proposed as an eighth waste. This proposal is underpinned by the work of Rohen (1992) on operations management which analysed causes and impacts of carrying out work when not fully prepared or ready. This allies with that of 'Last Planner' and of shielding production from uncertainty.

Many published articles link value or value-adding activities with waste. Koskela (1992) and Dulaimi and Tanamas (2001) are examples, and in discussing construction supply chains, describe non-value adding activities as taking up time, resource or space without adding value, but describe value adding activities as those converting materials and/or information as a benefit for the customer. The conclusion here is that it is useful to identify those operations that are wasteful and should be removed. An example of this is by reducing the number of different activities carried out by teams of workers (Ireland 1996). This research outlines waste elimination due to better organisation of the overall construction process where various activities associated with fit-out and M&E (mechanical and electrical) were re-organised by adopting multi-tasking. Initially there were 11 different contractors, but when reduced to 5 (each then having a wider brief of work), not only did the number of visits to the site fall but the amount of waste in waiting time, travelling and other non-value adding activities also significantly fell, as shown in Table 2.3.

	Traditional way of working	Single stage design and construction	Reduction as % of traditional way of working
Number of discrete activities to be managed	32	9	28 %
Number of Sub-contractors employed	11	5	45 %
Number of site visits required	25	9	36 %

Table 2.3 The Elimination of Waste from Multi-tasking. Source - Ireland (1996)

Another example of removing waste is in the saving of time due to the re-organisation of work processes. One example is a case study based on the US Navy Public Works Centre in San Francisco who control and carry out various construction projects (Ibbs 1994). Here, the adoption of the 'last planner' (section 2.3) principle was implemented which resulted in the planning activities being reduced to the lowest level and meant that planning and estimating function were consolidated with procurement activities as well as feedback of performance also being made part of the task. This meant a great change in job role but fewer people involved in each task. After these organisational changes the entire project management process was subject to a new information system. The result shown in Figure 2.8 was a reduction in project execution time of 60% which if these benefits were actually realised would make a huge improvement. Actual costs of savings and costs of implementation are not given. Personnel reassignment was apparently aided by use of a responsibility matrix. The work also showed that the people side of any change is important; "it has been said that 10% of any innovation is the research and development, and 90% is the implementation. Analogously, it could be said that 10% of any re-engineering effort is the work process study and redesign and 90% is smoothing the affect on people."

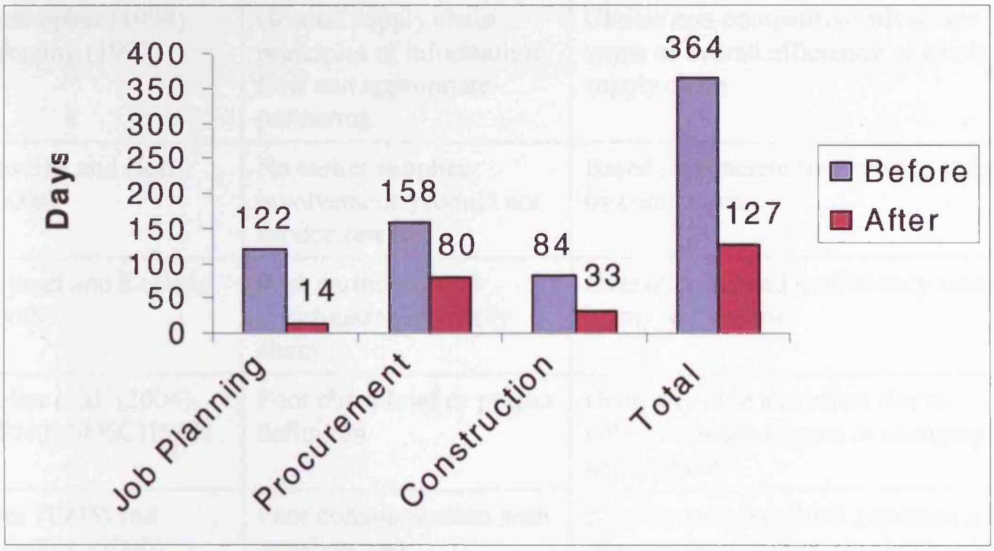

Figure 2.8 Time Saving Attributable to Re-engineering. Source - Ibbs (1994)

Bicheno. (2000) talks about waste and 'new waste' where waste can be untapped human potential, waste of resources like water and energy, the waste of inappropriate systems that add cost without adding any value, waste materials, wasted customer time, waste of losing a customer. Similarly, Alarcon (1994) after Ohno, as previously mentioned, defined a lean understanding of waste related to the construction site as "anything that is different from the minimum quantity of equipment, material, parts and labour time that is absolutely essential for production". Table 2.4 shows a summary of the key authors and classifications of waste.

Author	Issue	Waste Types
Ohno (1988)	Process activity related - manufacturing	Classic seven types - time on hand (waiting), transporting, processing itself, unnecessary stock on hand, unnecessary motion and producing defective products
Lamming (1996)	Progress chaser – expediting of orders	Mainly organisational due to poor supplier selection/relationship/trust
Atkin (1998)	Manual information transfer as opposed to use of IT – application of technology.	Excess time and cost of manual system and cost of errors
Koskela (1992)	Any non-value adding activities	Key wastes of – time, costs (resources and space)
Alarcon (1994)	Excess in any form	Materials, resources, time and energy

Christopher (1998) Lamming (1993)	General supply chain principles of information flow and appropriate partnering	Classic non-competitive advantage in terms of overall efficiency of whole supply chain
Proverbs and Holt (2000a)	No earlier supplier involvement, product not service oriented	Based on concrete formwork supply by contractors
Vrijhoel and Koskela (2000)	Poor partnering and coordination in supply chain	Overall waste and inefficiency caused by myopic control
Barker et al. (2004), (CPN(E9096C)1999)	Poor client brief or project definition	Generally time and effort due to unknown requirements or changing requirements
Pries (1995) and Voordijik (2000)	Poor communication with suppliers and manufacturers	A faulty process which generates a lot of waste by, for example changes in schedules, a strong variation on capacity, unnecessary delay, extra repair costs etc.
Voordijik (1999)	Improved communication with IT	Lower inventories can be held
Ballard and Howell (1998a)	Shielding production – last planner principle	Disruption causes extra time and effort
CALIBRE (1999)	On-site process monitoring	Material waste – due to damage and incorrect parts used
Love et al. (1999a and 1999b)	Rework up to 12% of total project cost, due to design and sequential nature in supply chain	Rework requires extra labour and materials, incurs delays. It is estimated that 85% of rework is from common causes and 15% from special causes
Bicheno (1991)	Poor quality	Requires rework, replacement etc.
Lurz (2001)	Poor communication, slow and inaccurate	Slow information caused delays and repetition
Towill (1993)	Demand amplification	On-costs due to excess delivery time and stock costs

Table 2.4 Authors Addressing Waste. Sources – see above.

The literature reviewed and presented in this section has demonstrated that value and waste are inextricably linked, that removal of waste will improve value and it is best to concentrate on what the customers really perceive as value to remove the worst waste. It has also shown that a lot of waste may result from un-necessary activities and poorly carried out activities leading to re-work. The author believes that from a supply chain perspective 'waste' can be defined as 'any excess of materials, resources, time and energy that are not really necessary in performing any activity or process throughout the supply chain'. Information, co-ordination and people/cultural issues really affect how well the processes involved, and the supply chain as a whole, work. Deciding what is value and so therefore what is waste are key to the process of improving the supply chain.

The next section looks at what techniques and methods can be adopted in improving housebuilding supply chains.

2.7 Improvement Techniques

Here secondary data relating to improvement methods and methodologies is presented and critically appraised. As shown in the literature review so far, supply chain management is a complex philosophy and encompasses many areas of business practice. Therefore the potential scope of this section is immense as any, all and every way of improving any business area could be covered. The overwhelming conclusion from reviewing the literature on supply chain performance and metrics is that the topic area is broad and vague.

In order to measure performance of supply chains it is first necessary to determine the measures of success for supply chains. This in itself appears un-answerable as each business and indeed each supply chain will have different business objectives. The literature identified therefore gives a broad range of answers rather than one answer or a single measure. The quest really leads back to what is value and what is waste for a particular business and the situation and environment that exists. Consequently this section will look first at generic methodologies and techniques that improve business processes and will then review supply chain success measures and how to gain improvement.

2.7.1 Generic Improvement Methods and Techniques

Most business process improvements are carried out either to reduce costs or to increase the quality, the service or the timescales involved (Johansson et al. 1993). The way an improvement exercise is organised is crucial for a successful outcome. While it may be thought of as common-sense to ensure that all the necessary activities are carried out in the correct sequence, in reality this is far from what happens and therefore several 'approaches' exist to help achieve this. Most of these approaches are based on recognised stages of investigation, measurement, analysis, evaluation and implementation of the improvement with many ideas emanating from an operations management, work study or quality origin.

The Deming cycle (Deming 1986) is universally known: Plan Do Check Act (PDCA) with many variations on this such as to DRIVE (Define Review Investigate Verify Execute), the Six Sigma methodology that uses the slightly different approach DMAIC (Define Measure Analyse Improve Control).

The Ford 8D cycle where D stands for discipline is another approach adopting the following: (1) Use the team (2) Describe the problem (3) Contain the symptom (4) Find the root cause (5) Choose and verify the corrective action (6) Implement permanent corrective action (7) Prevent reoccurrence (8) Congratulate and celebrate (Bicheno 2002).

Similarly, there is the UDSO (Understand Document Simplify Optimise) approach (Watson 1994) adopted by LSDG (Logistics Systems Dynamics Group) at Cardiff University Business School. This has a systems perspective and as will be shown in the next chapter is simple but effective to apply, the author having used this approach when carrying out previous research work whilst at LSDG.

Finally, another methodology is the OODA (Observation Orientation Decision and Action) model that can be applied in aiming for time compression (Stalk and Hout 1990:181).

The author initially planned to categorise methods and techniques for improvement under measure, analyse and evaluate. However following an evaluation of the literature it is apparent that many of the different methods fit into more than one of these categories. However, to give a flavour of the vast array of methods and tools that do exist, common methods for 'measure' include: Pareto; process mapping; tally charts; string diagrams; histograms; run diagrams; scatter diagrams; statistical process control (including x-r charts, p-charts and capability charts); flow charts; and cause and effect diagrams (Bicheno and Catherwood 2005).

Analysis and evaluation tools include: the five whys and root cause analysis; five W's and H (what, why, when, where, who, and how); affinity diagrams; interrelationship and network diagrams; tree diagrams; contingency diagrams; matrix analysis; critical path analysis; failure mode and effect analysis (FMEA); force field analysis; importance performance matrix; service gaps (SERVQUAL); and quality function deployment (QFD - House of Quality); Design of Experiments - Taguchi (Bicheno 2002).

There are also more broad business measures and improvement methodologies that include; mathematical modelling; Value stream mapping (Bicheno. 2000); Balanced score card (Kaplan and Norton 1993); EFQM (European Foundation for Quality Management) Excellence Model (CPN(E9078) 1999; CPN(E9089) 1999); ISO 9001: 2000; Costs of Quality concept (Oakland 1989); Theory of Constraints (TOC which considers throughput, inventory and operating expense as the key measures (Goldratt and Cox 1993); Benchmarking (Hines 1998); KPI (Key Performance Indicators); Business Process Re-engineering (BPR).

Many of these are applicable to most areas of business but some are specific to particular industries i.e. manufacturing or service industries. The important issue with all such methods and techniques is knowing which one is the most appropriate for a given situation and what impact it will have. How improvement or success is measured is therefore most important and will be dealt with next.

2.7.2 Supply Chain Success Measures

What makes a successful supply chain, as alluded to earlier, is more complex than what makes a successful individual company. Also, the success of a particular business is determined largely by its strategic goals and the measures in place to meet them. From the literature reviewed it is clear it also depends upon the perspective taken on what constitutes a supply chain, because different people view supply chains differently and therefore look at different measures of success to suit their view.

These issues of measurement and performance are directly related to all four research questions. In order to understand current best practice and where waste or inefficiencies in supply chains may exist, it is necessary to review existing practice especially from those regarded as exemplars. In addition to identify the potential for improvement it is necessary to comprehend suitable measures of supply chain performance for, if you cannot measure it, how do you know it has improved?

Another important factor is whether a supply chain or network can agree, as an entity, on what amounts to success, necessary as a precursor to determining the measures for success. Many supply chains include a range of business sectors with differing attitudes, organisational and information systems and cultures that can make integration problematic.

What drives the definitions of success may well be the authority of a few or even a single organisation depending upon market position or power (Cox et al. 2004). Neely (1995 in Bititci and Nudurupati 2002) defines performance measurement as "the process of quantifying effectiveness and efficiency of actions". Unfortunately there is limited literature regarding holistic supply chain performance measures, but what exists is reviewed here against the key direction of this dissertation.

The literature leaves no doubt that supply chain measures of performance are important (Latham 1994; Harland 1997). What is difficult to ascertain is what constitutes an accepted measure of performance (O'Brien 1995). In fact, some authors argue that there is no evidence that meaningful performance measures that span the supply chain actually exist (Hoek 1998; Lambert and Pohlen 2001). Many authors look at a single element of performance like time (Towill 1996) (Proverbs and Holt 2000b) or quality (Love et al. 1999a; Bicheno 2002) but these do not address the whole supply chain.

Although a single numerical measure for performance is often preferred to more vague qualitative ones, this would not be appropriate with supply chains because of the complexity of such systems (Beamon 1999). Not only is there the matter of correct context, but also of scope, since a supply chain consists of many echelons or businesses each having a number of facilities. This does seem logical as individual company metrics such as lead-time, on-time performance, inventory levels are not multi-firm measures (Lambert and Pohlen 2001) and just because one firm is performing well this does not mean the whole chain is too.

Because supply chain performance measures are complex some authors propose a framework approach as opposed to a single metric. One example is based on strategic goals related to 'resource', 'output' and 'flexibility' (Beamon 1999). Beneath each category of measurement lie more specific criteria. For example under 'resource' we find total resource cost, distribution cost, manufacturing cost, inventory cost, and return on investment (ROI). Another example of a framework is one that classes criteria against strategic, tactical and operational categories (Gunasekaran et al. 2001). Here performance measures deal with suppliers, delivery performance, customer service, inventory, and logistics costs. These measures are also mapped against key business elements of plan, source, make/assemble and deliver. When considering a single business this seems plausible, but if considered for a large supply chain or network this becomes an immense task and concern is raised on usability.

Using a survey research tool to determine impact of three supply chain management elements (Tan et al. 1999), it was shown that although these elements 'TQM', 'supply base management' and 'customer service' are important it is also necessary to have both the quality and procurement, in terms of their strategies, tactics and measurements, aligned with the corporate view if competitive advantage is to be gained. The work also showed that supplier involvement had the greatest impact on growth and return on assets (ROA) and that managing the supply chain as an integrated entity of suppliers, manufacturers and customers was key to achieving financial and growth objectives. Tan's work is based on 313 respondents, (21% return rate) from a broad range of industries (mainly manufacturing), all members of American Society of Quality Control. The questions (70 in total) were Likert scale opinion based where the firm's proficiency against the three elements was compared to their overall business performance measured by 9 scaled criteria. The criteria included four marketing related measures, ROA, production cost, customer service levels, quality and overall competitive position. The findings are useful in setting out a measure of performance and in confirming that managing the chain is important and that suppliers greatly affect this.

From a review of some 17 authors concerned with supply chain models and performance, Beamon (1999) proposes that there are predominantly two different kinds of measure - 'cost' and a combination of 'cost and customer responsiveness'.

As far as construction and housebuilding are concerned common measures of supply chain performance exist in the form of KPI (Key Performance Indicators) and the cbpp (Construction Best Practice Programme). Because construction is a project based activity that incorporates several players, a supply chain or network is naturally formed with the objective of completing the bridge, road, building or whatever. Government organisations (see Section 2.3) such as Construction Excellence maintain and encourage the use of KPI throughout UK construction through workshops and seminars (CPN(E9098)1999) and websites (http://www.constructingexcellence.org.uk/ resourcecentre/kpizone/default.jsp). Such KPI's include various measures for economic performance, respect for people and environmental considerations. All information including training via CD is free to members. Because of its nature, construction regards environmental and health and safety issues as important and focuses on these along with general business measures. Most literature regarding construction-specific performance measures relates to the standard metrics of time, cost and quality although there are moves in the industry to adopt more sophisticated measures such as the Balanced Scorecard and the European Foundation for Quality Management Excellence Model (EFQM) (Bassioni et al. 2004). Housebuilding is supported mainly by the Housing Forum (part of Construction Excellence) and House Builders Federation, the former also having KPI's through their benchmarking club. There is little secondary data on performance measures used by housebuilders.

2.7.3 Supply Chain Performance Improvement

As with the section on supply chain measures of success, little literature was identified on the holistic view of how to improve supply chains. This is understandable due to the complexity of this multi-faceted situation and that improvement in a single element is unlikely to give an overall benefit (Tan et al. 1999). However this does not contribute to providing information for Research Q4 of this research. Many authors have looked at single element improvements or particular issues such as quality (Langford et al. 2000) (Love et al. 1999a), business process improvement (Ballard and Howell 1994b; Towill

1997a), logistics activities (Evans et al. 1997b), time compression theory (Thomas and Martin 1990; Towill 1995; Barker et al. 2004), and relationships (Ellram 1990; Burnes and New 1996) (Wagner et al. 2002).

A particularly useful publication which highlights the pitfalls and opportunities in managing inventory in supply chains is (Lee and Billington 1992). The list (see below) is based mainly on experiences of companies in a logistic setting rather than any specific empirical study; however they do act as a useful summary of relevant issues and 'prompts' for investigating waste in housebuilding supply chains:

Pitfalls identified are:

1. No supply chain and metrics
2. Inadequate definition of the customer-service
3. Inaccurate delivery status and data
4. Inefficient information systems
5. Ignoring the impact of uncertainties
6. Simplistic inventory stocking policies
7. Discrimination against internal customers
8. Poor coordination
9. Incomplete shipment methods analysis
10. Incorrect assessment of inventory costs
11. Organisational barriers
12. Product-process design without supply chain considerations
13. Separation of supply chain design from operational decisions
14. Incomplete supply chain

Opportunities identified are:

1. Design for supply chain and management
2. Integrate databases throughout the supply chain
3. Integrate control and planning support systems
4. Redesign organisational incentives
5. Institute supply chain performance measurement
6. Expand view of supply chain

More holistic views on how to improve businesses and the supply chain include those regarding modelling supply chains and framework or change model approaches. These are covered briefly below.

There are several publications which refer to modelling of the supply chain, most with the aim of improving some element, if not overall performance. An early work (Hakansson 1992) modelled an area of the construction industry and looked at the demand for rebar (reinforcing bar for concrete) and the effect of different delays and stock levels. The work showed the need for flexibility in production to meet customer requirements and low inventory levels. Other work on materials management (Lee and Billington 1993) proved useful in supporting strategies for inventory levels at Hewlett Packard for inkjet printer manufacturing. Systems dynamic modelling based on the work of Forrester and Burbridge quoted in (Towill et al. 1992) looks at the effects of information integration, demand amplification (known also as bullwhip) on the inventory levels and response to orders. This area of work concludes that benefits in the supply chain overall are best made through removing an echelon (if possible) or improving the collaboration between players for true information which would reduce distortion, the cause of uncertainty in demand. Other work (Disney and Naim 1999; Hong-Minh et al. 2000) builds on these principles looking at more specific areas. Other modelling is that based on a propriety software system IDEF0 (Atkin 1998; Karhu and Lahdenpera 1999) where, in a similar way to in-put out-put diagrams, the complexity of the supply chain can be mapped to aid better understanding. The author of this dissertation regards this as not really an improvement methodology but more a tool for representation.

There are several framework or change model approaches to improving supply chains. One such model is a business systems engineering (BSE) change model (Berry et al. 1999) using systems thinking and is based on business process re-engineering (BPR) principles, expanded so as to ensure coverage in all relevant dimensions. Termed a SCOPE paradigm, the idea is that sufficient depth, breadth and width of the supply chain elements are covered, for as previously argued (Tan et al. 1999), success may not be achieved through improving only some issues. The work describes logically the different levels of process elements in degrees of complexity – first, work processes, then business processes, then supply chains and finally holonic networks. Unfortunately the work was either purely theoretical or any useful findings were confidential so no reliable conclusions could be drawn.

Another model for supply chain improvement is the Cardiff Business Process Change Model (Towill 1997a) based on a Business Systems Engineering (BSE) approach to supply chain management which draws theories from both soft systems methodology (Checkland 1990) and systems engineering philosophies (Parnaby 1994). The model has four elements: 'Technology', 'Culture', 'Finance' and 'Organisation' which inter-relate where no element can be ignored but relative importance varies depending upon the situation at hand. A good description of the theories is given in Towill (1990) and Evans et al. (1995). The model has been used to analyse the primary change drivers in the Doyle Wilson housebuilder success (Towill 1997a) based on the description given in Womack and Jones (1996) already discussed in Section 2.5.

A further model or approach is that from 'Lean Thinking' as shown by Dulaimi and Tanamas (2001). There are 5 key principles to emerge from 'Lean' (Womack and Jones 1996) that can be applied to improving construction:

1. Specify value – ultimately the customers' need
2. Identify and map the value stream – assessing the activities needed as part of a process across all boundaries and barriers
3. Flows – considers the process of activities holistically and rejects fragmentation and helps identify waste
4. Pull – strategically identifies true customer need, all else is waste; assisting in customising and delivering this need.
5. Perfection – implies constant improvement against customer need (kaisen).

Other methodologies to improving supply chains are those related more to how organisations approach the task. An example of this is the 'Quick Scan' methodology (LSDG 1999) a specific approach to gaining relevant information about a company or a supply chain so as to analyse and propose improvement. It is a comprehensive methodology adopted by the LSDG and used on several research projects (Lewis and Naim 1998; Childerhouse et al. 1999; Disney et al. 1999).

In summary, this final section covers methodologies and approaches specifically targeting construction or housebuilding processes or supply chains. There are many examples of 'Lean thinking' being applied to construction (Ballard and Howell 1994a; Howell and Ballard 1994; Tommelein 1998) by just concentrating on a chosen area without use of a selection methodology. Originating from 'Lean Thinking' is the culmination of 'shielding' and 'heijunka' (level scheduling) and multi-skilled teams into what is termed 'Even Flow Production' (Ballard 2001). This innovation is aimed at cycle time reduction through an even and repeatable cycle of activities and hence stability to the planning of work. Here, all house types are initially assumed to have the same workload and are therefore scheduled equally; this then allows an even flow of work. If there is a large variation in workload between say large houses and small ones then an average duration is used. This concept can be said to follow the lean construction rule to first improve work flow reliability and then to increase the speed. This is very much linked to the principles of 'last planner' which requires identification and action on the root causes of not meeting performance. To measure performance the percentage plan completion (PPC) per day or per week is used. Key to achieving cycle time reduction is that once the work flow is stable, waiting and queuing times are reduced by having multi-skilled teams. For example, to build a complete house the paper shows only five different teams, each team member carrying out all the various team tasks. When compared to the way the UK housebuilding industry works with around 12/15 different trades and something like 52 different stages of build (see Appendix 1) the potential for removal of non-value adding time and waiting time appears vast.

Other related work regarding the 'Last Planner' (Ballard and Howell 1994b) shows that the main reasons why construction did not meet the targets (PPC) was divided equally between lack of materials and lack of drawings.

2.8 Best Practice in Housebuilding Supply Chains

This section of the literature review relates most directly to the aims of this dissertation. So far a background of understanding has emerged from the review on the current status of knowledge regarding supply chains, their complexity and what is taken as a measurement of performance. Also many examples of research related to construction and housebuilding supply chains have been discussed and reviewed. From this underpinning understanding key issues will now be drawn out in an attempt to determine what pertains as best practice for housebuilding supply chains and thus begin to address the first two research question of this dissertation.

The first point is that supply chains are complex and there is no easy answer to their measurement and hence improvement. Secondly, from the literature, there are many conditions which apply that aid effective supply chains. Those identified are;

- Housebuilding is allied much more to manufacturing than general construction and therefore principles that have worked in production environment could well be used.
- Partnering or good relationships prove to be beneficial.
- To avoid waste, lean production principles can often be applied – this included methods such as Last Planner; even flow; shielding; JIT, and heijunka.
- To give customisation in housing, agile principles may be applied.
- Information flow between players can avoid demand amplification and reduce uncertainty (this related back to relationships).
- Information technology can improve the above mentioned communications, maximising the potential of internet and related technologies.
- The use of multi-skilled labour/teams can reduce the waiting time and confusion on site so improving the total cycle time. This point is particularly apt in a climate of construction and housebuilding with many trades and a sub-contractual culture.
- Reducing the complexity of parts needed on site through pre-assembly. Pre-fabrication, standardisation, rationalisation, unitisation can reduce the dependence on the supply chain and reduce the on-site time of build.

2.9 Summary of Literature Review Findings

The literature review has demonstrated that the number of houses built, their quality and customer satisfaction is not satisfactory, nor is it improving. There have been many examples of where waste has been identified within the literature review, so providing partial answers to research question 3. These include: time for design that was shortened using IT, material waste due to poor design and procedures (CALIBRE 1999), too much demarcation of job roles leading to waiting time, poor relationships within the supply chain, functions and businesses working in silos rather than as part of the supply chain, poor supplier and client involvement, poor communication between supply chain players, poor on site planning and scheduling, rework, a 'product' not a 'service' mentality, poor house quality finishes, and poor after sales and service to the house buyer.

The review has shown there is a great deal of research on construction supply chains, much promoted by support bodies/institutions such as IGLC, CIRIA, and DETR etc. However, the main emphasis is on short term bespoke work and projects rather than long term construction with a strategic perspective. The forming of fixed links and relationships in supply chains is therefore more difficult and of less perceived value. There is evidence that in many instances a 'network' situation exists rather than the theoretically simple 'chain' for supply, giving a more complex and uncertain situation. Literature relating to overall supply chain improvement was limited compared with specific related topic areas where the main areas of research have been centred on:-

- Partnering
- Material and building waste
- Design/Project management (protocols)
- Sustainability

Literature relating specifically to housebuilding supply chains was sparse. Much published work is already known and related to the work done, or being carried out, by LSDG at Cardiff University. Examples of publications most allied to the work of this dissertation, that is housebuilding supply chains, include Davies (1996); Agapiou et al. (1998); Atkin (1998); Barlow (1998b); Barlow and Ball (1999); Childerhouse et al. (2000); CBPP (2001) and Barlow et al. (2003). However few are concerned actively with 'supply chain' assessment and improvement. From previous research work the author believes that there is research being carried out in this area but because of its competitive nature it is not being published. Main areas of published research in housebuilding are:-

- Partnering and relationships
- Customisation and agile principles
- Material and building waste (sustainability)

- Standardisation, rationalisation, off-site assemble and pre-assembly initiatives
- Lean production and production scheduling improvement.

The literature review supports the opinion that there is much scope for the application of manufacturing principles to the housebuilding industry in the UK. This is especially so for the majority of private housebuilding that is carried out by a few (less than 100) major builders. However, like construction, there is a reluctance to adopt new ideas and improvements. The traditional, adversarial, transactional and contractual culture remains and as demonstrated, this prevents the collaboration necessary for good communication and symbiosis within the supply chain. Improved communication between buyers and suppliers offers great potential for improvement in supply chain management, as do the adoption of a better quality culture amongst the site workers and the use of manufacturing expertise for housebuilding planners and schedulers.

In conclusion, the literature has been valuable in adding to the author's personal knowledge and understanding, in defining the context and scope of main themes – supply chain management, waste, and housebuilding supply chain improvements. It has also been very useful in refining the research questions, especially in defining questions one and two regarding current best practice (see section 1.4), because although section 2.2 has provided an overall understanding of supply chain management, both section 2.5 covering housebuilding supply chain management and section 2.7 describing what could be part of best practice indicate a definite lack of knowledge on what is actually regarded as current best practice and existing levels of competence within the industry. Also the last two research questions have not been adequately answered by the literature review. Section 2.5 showed various definitions of value and whilst causes of waste have had some coverage this was fragmented especially in relation to housebuilding supply chains waste. The author categorised waste in supply chains but there is very little published on what the situation is regarding UK housebuilding supply chains. Even greater gaps in the literature exist for improvement methods and techniques where it was found that coverage of general process improvements abounds but research into their application to housebuilding supply chains is very limited. This conclusion confirms the relevance and importance of the work in-hand for expanding knowledge in this area and the validity of the research questions.

CHAPTER 3
RESEARCH METHODOLOGY

Nothing has such power to broaden the mind as the ability to investigate systematically and truly all that comes under thy observation in life.

Marcus Aurelius

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Chapter Overview

This chapter begins by reviewing research philosophy in general to discuss and understand the basis and underpinning paradigms of the research for this dissertation. The chapter then examines contrasts and summarises various research methodologies to assess the most relevant methods for adoption in the case of this dissertation. It discusses why particular research methods were not appropriate and so were excluded. Finally, in relation to the aims and objectives of the dissertation, it justifies why a three stage approach was adopted for the empirical research and why the chosen methods have been employed.

Figure 3.1 shows the work as a simple flow chart with the three stages of empirical research identified.

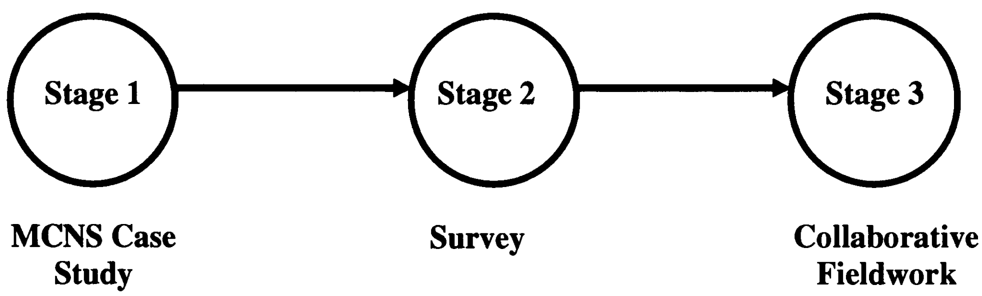

Figure 3.1 Flow chart of research stages. Source – author.

Although this chapter follows the Chapter 2 Literature Review in the setting out of this dissertation, it should be recognised that the literature review was an essential and early activity and included research into, and the understanding of research methodology. This meant that work for the previous chapter and for this one was sometimes carried out in parallel, in order to arrive at a cohesive and well-structured research methodology framework for the dissertation.

Research is not just about *"finding out something you don't know"* but also *"finding that you don't know something"* (Phillips and Pugh 1998)

3.2 Research Theory - the Philosophies

This section looks at the theories of research philosophy in general terms, compares and contrasts different views of research philosophy including the categorisation of research types and reasons why these exist.

3.2.1 Definitions

Before looking in depth at the various aspects of research philosophy, a few definitions and perceptions of just what research is are presented below.

The Oxford Concise Dictionary (Sykes 1982:884) defines research as: "careful search or inquiry *after* or *for* or *into*; endeavour to discover new or collate old facts etc. by scientific study of a subject, course of critical investigation."

Research has acquired different meanings depending upon the circumstances, environment and ways in which it is conducted although there is a common theme running through much of the literature - trying to understand more! According to Drew: (Drew 1980:4) "research is conducted to solve problems and to expand knowledge" and also that "research is a systematic way of asking questions, a systematic method of enquiry". It is argued by Howard and Sharp (1983:6) that most people with reasonable ability could undertake research "Most people associate the word 'research' with activities which are substantially removed from day-to-day life and which are pursued by outstandingly gifted persons with an unusual level of commitment. There is of course some element of truth in this viewpoint, but we would argue that the pursuit is not restricted to this type of person and indeed can prove to be a stimulating and satisfying experience for any people with a trained and enquiring mind".

Hussey and Hussey (1997:1) agree that research means different things to different people and say that there is no consensus in the literature on a common definition.

However there is agreement that: research is a process of enquiry and investigation; it is systematic and methodical; research increases knowledge.

Bell (1999:2) uses the terms “research”, “investigation”, “inquiry” and “study” interchangeably and stresses it is not the title but the systematic approach that is important, and that orderly record keeping and thorough planning are essential. Others for example Jankowicz (2000:109) define research in a roundabout way: “And used loosely, the term (research) is fairly appropriate. After all, you’re setting out to investigate in a systematic way, in order to increase knowledge”.

The research process, as described by many authors, is complex and has different levels or depths. Research philosophy is often shown as the first or higher level before issues of research strategy and research methodology are encountered and dealt with.

"Although we might not be immediately aware of it, our everyday lives are fundamentally interwoven with theory" (Gill and Johnson 2002:28). These theories are a way that individuals generate predictions about the world and are often based on past experiences which in turn influence future dealings with the world. They can also emphasise that people experiencing the same event will often perceive it differently from others in the group. Research investigations are therefore never completely free from prior assumptions. This is because people act in accordance with their expectations or prejudices as to what will happen in particular circumstances. Understanding this situation and its impact on what research philosophy is about is important for a researcher. Easterby-Smith et al. (2002:31) present the different philosophical terms associated with research and define the relationship between ontology, epistemology and methodology, see Table 3.1:

Ontology	Assumptions that we make about the nature of reality
Epistemology	General set of assumptions about the best ways of inquiring into the nature of the world
Methodology	Combination of techniques used to enquire into a specific situation
Methods	Individual techniques for data collection, analysis, etc.

Table 3.1 Research Philosophy. Source - Easterby-Smith et al. (2002:31)

From the review of research methodologies it is apparent that the first two terms in the above table are important to understand and that researchers need to be aware of their epistemological stance before and whilst undertaking research. The following section explores both ontology and epistemology so as to understand the author's approach to the research.

3.2.2 Ontology and Epistemology

Ontology, according to Jankowicz (2000:109), relates to personal opinion, beliefs, bias, motives and assumptions in the way people understand and gather information. Personal values affect this – are we a person who sees the world more in terms of people, of process or of numbers? This personal view affects and determines a person's "ontological position", which in turn affects the way their research is carried out. For example different people will notice different events; different people will notice the same event but not in the same way; different people will gather different evidence from the same events allocating different degrees of importance. This all sounds very theoretical and many people may attach little importance to it. However, when undertaking serious research it is necessary to recognise one's own 'position' so that when deciding on research strategies and methods, and gathering and analysing data we are aware of the implications of our actions.

Hussey and Hussey (1997:49) take a similar view that ontology is about how a person views the nature of reality, which in turn is influenced by a person's opinions and beliefs.

This is explained by reference to their position within the research paradigm continuum, which stretches between the extremes of positivist and phenomenological assumptions, sometimes termed quantitative and qualitative paradigms. These two main paradigms are said to be key in understanding the conceptual issues within research philosophy. Cresswell (1994) in (Hussey and Hussey 1997:48) relates different research assumptions to these two main paradigms – illustrated in Table 3.2

Assumption	*Question*	*Quantitative*	*Qualitative*
Ontological	What is the nature of reality?	Reality is objective and singular, apart from the researcher	Reality is subjective and multiple as seen by participants in a study
Epistemological	What is the relationship of the researcher to that researched?	Researcher is independent from that being researched	Researcher interacts with that being researched
Axiological	What is the role of values?	Value-free and unbiased	Value-laden and biased
Rhetorical	What is the language of research?	Formal Based on set definitions Impersonal voice Use of accepted quantitative words	Informal Evolving decision Personal voice Use of accepted qualitative words
Methodological	What is the process of research?	Deductive process Cause and effect Static design – categories isolated before study Context-free Generalisations leading to prediction, explanation and understanding Accurate and reliable through validity and reliability	Inductive process Mutual simultaneous shaping of factors Emerging design – categories identified during research process Context-bound Patterns, theories developed for understanding Accurate and reliable through verification

Table 3.2 Assumptions of the Two Main Paradigms.

Source - Cresswell (1994) in Hussey and Hussey (1997:48)

Easterby-Smith et al. (2002:33) views ontology slightly differently and explains the apparent debate between science and social science on what is reality and truth. The 'science' perspective has three views; traditional realism, internal realism and relativism, as shown in Table 3.3. Traditional realism is the view that the world is solid and unshakeable and that through observation we understand what is happening. On the other hand internal realism maintains that we can observe what is happening but that we are likely to affect the evidence because of the observation. Finally relativism recognises truth and facts as having some standing but still need confirmation from a number of different viewpoints before complete acceptance.

Ontology of Science	***Traditional Realism***	***Internal Realism***	***Relativism***	
Ontology of Science		**Representationalism**	**Relativism**	**Nominalism**
Truth	is established by correspondence between observations and phenomena	is determined through verification of predictions	requires consensus between different viewpoints	depends on who establishes it
Facts	are concrete	are concrete, but cannot be accessed directly	depends on viewpoint of observer	are all human creation
Epistemology of Science	**Positivism**		**Relativism**	
Epistemology of Social Science		**Positivism**	**Relativism**	**Social Constructionism**

Table 3.3 Ontologies and Epistemologies in Science and Social Science.
Source - Easterby-Smith et al. (2002:33)

A person's ontology then, affects the way they see the world, whereas the second term in the above table, a person's "epistemology", affects what is thought of as knowledge, evidence and events. Jankowicz (2000) says "epistemology is to do with your personal theory of knowing: what you feel counts as knowledge, and what doesn't; and related to this, what counts as evidence, and proof, and what doesn't." It is in essence, an examination of the relationship between the researcher and what is being researched (Hussey and Hussey 1997:49). Table 3.3, from Easterby-Smith et al. (2002:33), shows an outline of the different ways science and social science look at ontology and epistemology. Here, science's view of knowledge has two variants; positivism and relativism, whereas 'social science' views add another variant, social constructionism.

A particularly useful illustration showing the fusion of most research elements is that put forward by Saunders et al. (2003:83) using the analogy of layers on an onion as shown in Figure 3.2.

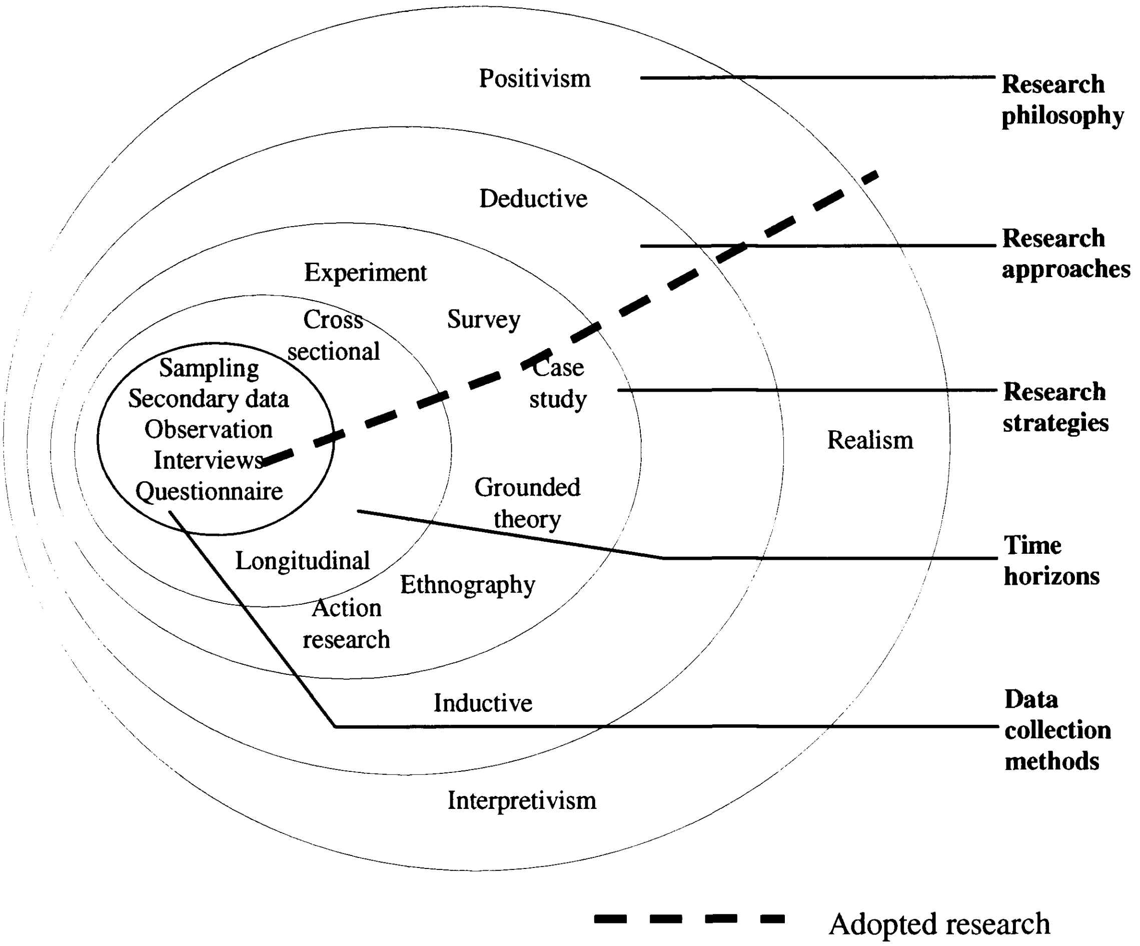

Figure 3.2 The Research Process Onion. Source - Saunders et al. (2003:83)

This analogy helps understand research by linking the various philosophies, approaches, strategies and methods together, even though there is some disagreement on terms and meanings within the research literature. The only important missing element is the impact of ontology and epistemology on the philosophies presented, although this is partially covered by Saunders under the outer layer called research philosophy. Using this illustration as a reference datum, different layers of the research undertaken in this dissertation as represented by the dotted line on Figure 3.2, will be explained.

3.2.3 Positivism vs. Constructivism/Interpretivism/Phenomenalism.

The argument about what represents an acceptable view of research, sometimes termed philosophy or paradigm or even research assumptions, has been raging for many years. As shown in the Figure 3.2 Saunders describes 'research philosophies' as a continuum of positivism, realism and interpretivism. (Jankowicz 2000:112) describes this continuum of basic assumptions with the words positivism and constructivism. Hussey and Hussey (1997:48), use the phrase "assumptions of the main paradigms" with positivist and phenomenological descriptors as alternatives for quantitative and qualitative respectively. Although this represents a mêlée of theory to be comprehended a good understanding is necessary before a research process can be decided upon. As reference to Figure 3.2 shows, there are several layers to peel before the full process of research can be understood.

Most views expressed about, and descriptions given, in relation to, research philosophy agree about positivism. It is a scientific approach to understanding complex issues; a sceptical approach which tests hypothesis with reference to relationships between variables. Positivism is very similar to a scientific experiment, in that it searches for the truth through scientific methods commonly known as hypothetic deductive methods (Jankowicz 2000:113). Researchers who are inclined towards quantitative data (facts and numbers) will prefer this philosophy. Such researchers tend towards objective analysis, taking a scientist's natural perspective and producing law-like generalisations from observable social reality (Saunders et al. 2003:83)

The opposite of positivism is described by slightly different definitions. Some call it constructivism, (Jankowicz 2000:113 and Easterby-Smith et al. 2002:39), some interpretivism (Saunders et al. 2003:84), and some phenomenolism (Hussey and Hussey 1997:47). It is argued (Saunders et al. 2003:84) by many that the business world is more complex and so is less amenable to accept law-like generalisms that can apply to say, physics; that because so many variables come into play that business situations are unique; that because of the effect of people and their subjectivity what is reality is a matter of interpretation. Within this same paradigm of philosophy is also a slightly different interpretation of reality (see Figure 3.2). The underlying premise is that reality exists independent of human thought and beliefs, but that human interpretation affects the meaning and this must be taken into consideration. Others (Hussey and Hussey 1997:49) believe that researchers have values and these affect the acceptance of facts, determine the interpretations and so everything is related to phenomena. A similar view (Jankowicz 2000:113) is that what we all see is really a construction determined from our own personal and social experience. Table 3.4 summarises the differences between positivism and constructivism. Summing up, these different views do agree on several fronts – the world is complex, people look at things differently and this should be taken into account when doing research.

Positivism	Constructivism
Knowledge is something we develop by gradually discovering more and more about what's out there.	Knowledge is what we construct to make sense of our personal and social experience.
Phenomena can be analysed in terms of variables.	Phenomena can be analysed in terms of issues.
Data can be collected by a dispassionate outside observer.	Data are collected by participants and by observers, all of whom have varying degrees of involvement and detachment.
Given evidence, we are always capable of distinguishing what is true from what is untrue, and are therefore enabled to agree on the real reasons for things if we wish to do so.	Truth can't be determined in any absolute way; we are capable of using evidence to work towards a consensus, but must sometimes agree to differ, and sometimes conclude that the truth is undecidable.
The purpose of enquiry is to build theories; these are general statements which validly explain phenomena.	The purpose of enquiry is to gain sufficient understanding to predict future outcomes.
Once such theories have been developed sufficiently, we should seek to apply them for productive purposes.	There is no need to seek to apply theories; understanding and prediction are already theory-in-action, being theories-from action.

Table 3.4 The Basic Assumptions of Positivism vs. Constructivism.
Source - Jankowicz (2000:113).

3.2.4 Research Approach - the Link to Deductive and Inductive Investigations

It can be recognised that deductive and inductive approaches to research also link into the positivist versus constructivist argument. Deductive investigations are often termed 'the scientific approach' (Saunders et al. 2003:86) and happen when theories or hypotheses are formalised initially and then data is collected to test the hypothesis. This approach equates closely to the 'positivist' approach where laws provide the basis of explanation, permit the anticipation of phenomena, predict their occurrence and therefore allow them to be controlled (Hussey and Hussey 1997). Trochim (2001:17) summarises the deductive approach in Figure 3.3.

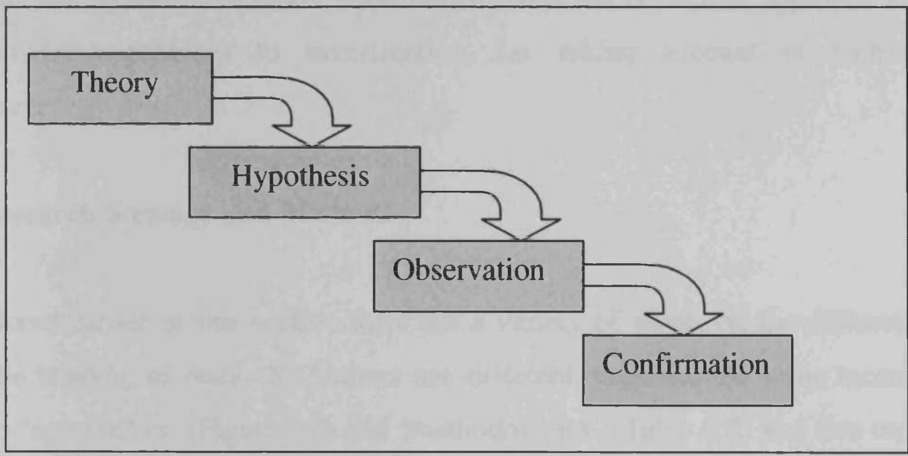

Figure 3.3 Stages in the Process of Deduction. Source – Trochim (2000:17)

This approach clearly relates back to the positivist approach, in terms of the hypothetico-deduction method mentioned earlier, which relates to theory, hypothesis, operational definition, measurement, testing and verification.

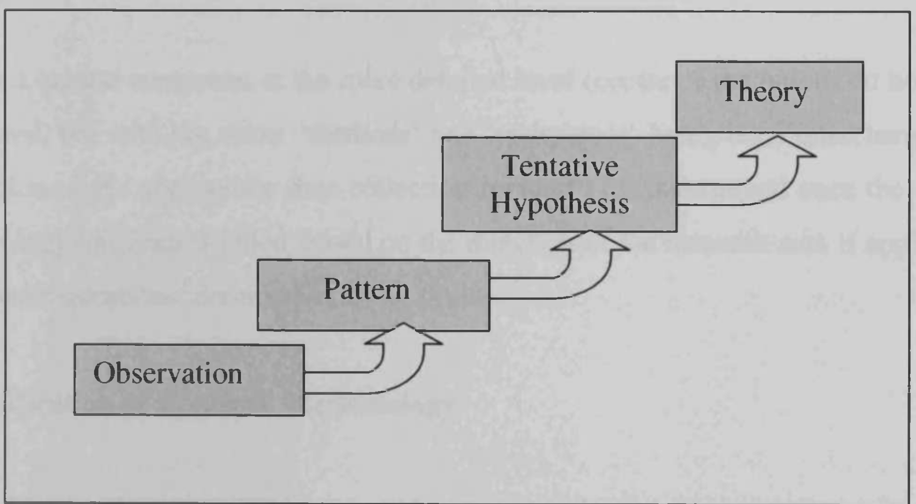

Figure 3.4 Stages in the Process of Induction. Source - Trochim (2000:18)

The other approach to investigations is inductive, which is the reverse of deductive, as demonstrated once again by Trochim (2000:18) and shown in Figure 3.4.

The inductive approach is more 'open ended' than the deductive approach and uses constructivist approaches to investigation, i.e. taking account of feelings and experiences.

3.2.5 Research Strategy and Methods

As explored earlier in this section there are a variety of views on the different topics under the heading of research. Authors use different terms for the same meaning, for example 'approaches' (Figure 3.2) and 'methodologies' (Table 3.2) and few create any kind of framework within which all these various definitions and understandings fit together. Figure 3.2 from Saunders et al. (2003:83) is the exception to this. The next layer is termed 'research strategies' by Saunders et al. (2003:85) or 'methodologies' by Hussey and Hussey (1997:59), or 'methods' by Jankowicz (2000:210) and is often allied to the positivist view or its alternative paradigm or philosophy. Included here are experiment; survey; case study; grounded theory; ethnography; action research; cross-sectional and longitudinal studies; exploratory, descriptive and explanatory studies (Saunders et al. 2003:93).

There is a greater consensus at the more detailed level (centre of the onion) on how data is gathered, but with the terms 'methods' and 'techniques' being used interchangeably. The choice of the appropriate data collection method(s) is determined once the overall methodology has been decided, based on the direction of the research and, if applicable, the research questions identified.

3.3 Justification of Research Methodology

Having reviewed the various philosophies and theories of what constitutes research, what are those most appropriate to adopt for this research in this dissertation? Firstly, it is clear that the paradigms and philosophies reviewed so far often show opposite ends of the spectrum and although this helps to clarify the theories it does little to make sense of the specific situation within a particular research project. What must be understood is that such paradigms and philosophies actually form a continuum (Hussey and Hussey 1997:54) and are not simply a choice of two extremes. So, for example, individuals are rarely pure positivist by nature. Also, not only is it possible to have a combined research approach (inductive/deductive) it is often an advantage to do so (Saunders et al. 2003:88). The adoption of multi-methodologies and multi-methods is recommended as this leads to triangulation which helps give credibility to any findings (Hussey and Hussey 1997:72).

A person's ontological and epistemological stances are related to the research in hand, so before looking at the specific aims of this research and the research questions, the author's own ontological and epistemological characteristics need to be considered. The author's background and experience as an ex-work study engineer, a chartered engineer, an ex-engineering and manufacturing manager with aerospace, electronics and automotive industry reflects and indeed has led to the further development of a more positivist and quantitative attitude. This stance is underpinned by having a 'can do' and 'must do' attitude to both work and life, which affects his understanding of, and relationship with the world around him. However, despite this positivist stance the author is aware that the intentions, knowledge and background of the people involved in any research, including those of the researcher, affect the findings. Having dealt with people at different levels and situations within many business environments the author adopts the position of a 'realist', taking into account that peoples' perceptions can indeed sometimes be reality!

The reasons for adopting a particular methodology and subsequent data collection methods can best be described by relating the flow of the author's ideas for the research, with reference to the research questions and the 'research process' previously set out in Chapter 1.

The research began with an exploratory phase which compared and contrasted construction industry with manufacturing, and included the initial literature review and the first of the three data collection exercises. This helped elucidate the degree of sophistication within construction and housebuilding relating to supply chain management. This can be termed a quasi-deductive and positivist methodology that led to an underpinning hypothesis that housebuilding supply chains would permit an improvement in efficiency and effectiveness. Whether this condition and its causes were generic was unknown. This understanding led to a more focused direction that of the UK private housebuilding sector; and resulted in the adoption of a positivist, deductive, survey approach focusing on major housebuilders. Here, previous knowledge and experience in similar research as well as results of the literature review helped define the methods to be used and design the tools.

Once a picture of the position regarding housebuilding supply chain awareness (and associated problem areas) in the UK had been established through a national survey, it was then decided to validate (triangulate) and explore this further via in depth interviews. Evidence emerging from the literature review showed site managers of housebuilding sites to be the key group of staff and thus they were chosen for interview. In order to gain access to these key individuals, this phase required a collaborative partnering agreement with a major UK housebuilder, who because of confidentiality will remain unknown to the reader.

The author deduced that it was necessary in order to meet the aims of the research that the housebuilder selected was a major private UK housebuilder, within the top 25 (Anon 2005a) and with a regional presence (Hooper and Nicol 2000 see section 2.4). They would then be representative of key players within UK housebuilding and so the identification of waste within the supply chain and the application of improvement techniques would be more applicable to a major part of the industry. From personal contacts the author approached this particular major housebuilder in late 2002 and a collaborative agreement was made.

The methodology used here can be described as mainly a positivist, deductive, case-study approach but includes some qualitative and interpretive aspects as applied in the opinion based interactive questioning.

The final phase of research was again case-study based having not only a confirmatory purpose but also entailed experimental research. This used various analytical tools, never used before by practitioner experts, to determine the causes of problems.

The research process can also be illustrated in terms of depth and breadth of data collected. Figure 3.5 shows the three stages of research. The initial exploratory research, 'MCNS case study' is shown to be of mid depth and breadth; the following stage of research the 'survey' is shown as broader and more generic involving UK major housebuilders. Finally, the 'collaborative fieldwork' work consisting of site manager interviews and an improvement workshop with a single major housebuilder appears as in-depth, and a more focused area of research. This combination of approaches was not fixed at the beginning of the work but was explored and decided upon at the completion of stage 1. At this time it was clear that the MCNS initial work was a suitable basis for the dissertation and that it should be followed up by means of a generic survey, leading on to in-depth collaborative work. This would result in a logical and sequential research process giving clear direction for this thesis supported by an appropriate and robust overall methodology.

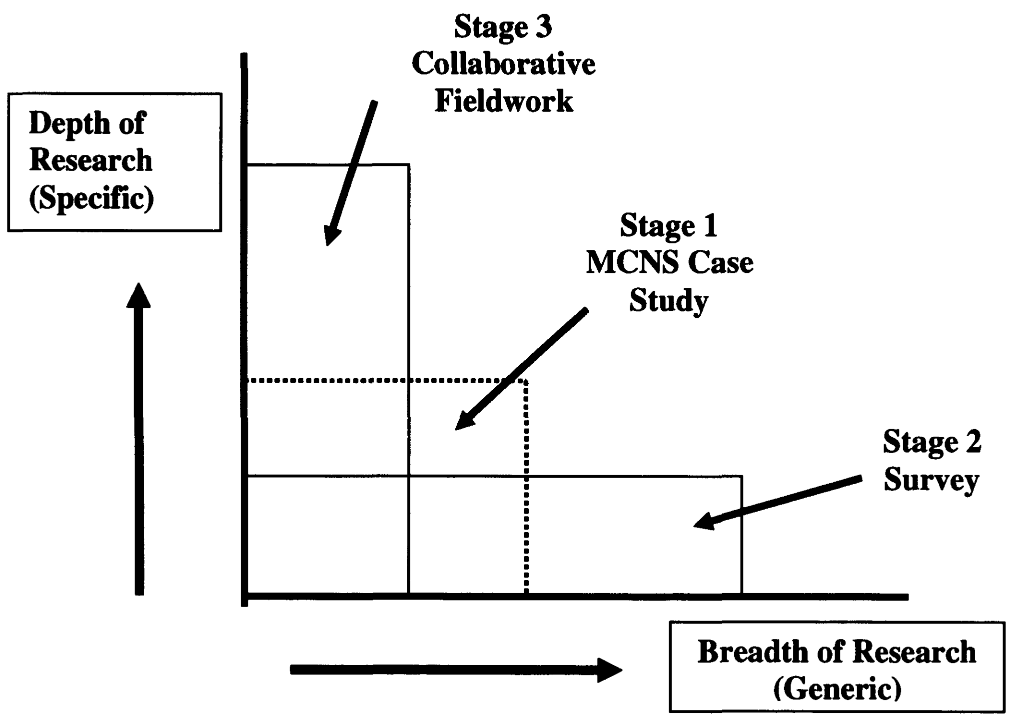

Figure 3.5 The Three Stages of Research. Source – author.

In summary, the research process combines mixed strategies and approaches. The use of multi-method data collection techniques provides triangulation of the data collected wherever possible so as to ensure credible research findings.

The underlying research stances above and the actual research methodologies adopted and described in the remainder of this chapter should all be seen in the context of the research questions repeated here for reference:

1. What is supply chain management in housebuilding and what is accepted as current best practice?
2. What is the current level of supply chain management competence, including the adoption of best practice?
3. Which are the significant causes of waste for major UK private housebuilders?
4. What are the key methods and techniques that can be adopted for improvements?

The next three sections of this chapter relate to the research methodology for the three areas of research and include the justification for the methodology and data collection tools adopted.

3.4 Stage 1 - MCNS Research Methodology

3.4.1 Introduction

This Section 3.4 outlines the early research that initiated the concept for the subject area covered by this dissertation. The work, which was a major UK government funded project 'Meeting Customer Needs through Standardisation (MCNS)', was carried out when the author was a Research Associate at Cardiff University Business School's Logistics Systems Dynamics Group (LSDG) between September 1998 and December 1999. The research project was a joint academic exercise with LSDG, the University of Sussex's Science and Technology Policy Research Group (SPRU), and nine industrial partners from the housebuilding sector. The research methodology was centred on the Terrain Scanning Methodology (TSM) developed by the author (Barker et al 1999) for this particular research project in order to gain an understanding of the working of housebuilding supply chains. Much of the work from the original research has already been published by the author and others in conference proceedings and academic journal articles; these will be referenced during the narrative accordingly.

3.4.2 Background to the Research

Although much can be understood about housebuilding supply chains from carrying out a critical appraisal of the literature, it was considered to be of additional benefit to elicit some primary data on the overall functioning of a housebuilding supply chain by investigating the industrial partners themselves so as to provide a foundation of knowledge.

This section describes the methodology used to aid understanding and assess the business processes and supply chains in housebuilding. The methodology was devised as a means of understanding the relationship, function and business processes of a number of industrial partners at the start of a large house building research programme. Terrain Scanning Methodology (TSM) is based firmly on Watson's (Watson 1994) adage of Understand, Document, Simplify and Optimise (UDSO) and is an adaptation of a 'Quick Scan' methodology developed initially for the automotive sector (Lewis and Naim 1998 and Childerhouse et al. 1999).

The TSM contributes to existing knowledge by offering a methodology that uses the minimum amount of resources and time, is flexible in its scope, and gives direction for potential improvements to the supply chain studied. As will be presented later, the TSM comprises a number of investigative and assessment tools, each covered in the literature review, Chapter 2. The TSM consolidates such tools and applies them to housebuilding supply chains.

3.4.3 The MCNS Research Programme

As part of the UK Government's initiative to improve the construction industry, research funding was made available for a collaborative project between centres of academic expertise and construction companies. The work was co-funded by the UK Government's Engineering and Physical Science Research Council (EPSRC) Innovative Manufacturing Initiative (IMI) and Department of Environment, Transport and Regions (DETR). The specific research project, 'Meeting Customers Needs through Standardisation (MCNS)', was a joint research exercise with Cardiff University

Business School (LSDG), the University of Sussex's Science and Technology Policy Research Group (SPRU), and nine industrial partners from the housebuilding sector. These nine industrial partners (see Table 3.5) were different echelons of the UK housebuilding industry and represented a good cross-section of the established supply chain. Many of these organisations were, at that time, working on a housebuilding project or had previously done so and were keen to be involved in research that could improve the industry.

Company	Role	Number of employees	Turnover £M	Construction sector	Customer type
A	Manufacturer	700	80	Social/ Private	Contractors
B	Manufacturer	340	30	Social/ Private	Contractors /Housing Association
C	Main Contractor	300	90	Social	Housing Association
D	Developer	1,012	312	Private	Individual Customers
E	Architects	130	5	Social	Housing Association /Contractor
F	Housing Association	370	45 (only for rental)	Social	Social Tenants
G	System Integrator	20	1.4	Social/ Private	Individual Customers/ Developers
H	Manufacturer	1,000	171	Social/ Private	Merchant
I	Consultant	1	0.05	Social/ Private	Developer/ Contractor

Table 3.5 MCNS Industrial Partner Profiles. Source - Barker et al.(2000)

The aim of the whole research project was approached from three separate directions:

1. Component technology
2. Supply chain research
3. Customer focus research

The involvement of LSDG centred on the second aspect of the wider research study. The aim of the second aspect was ultimately to define suitably robust supply chain structures to support the delivery of standardised and/or pre-assembled components in house building. The author's role was to identify and understand the principal supply chain trends and conditions within the construction/housebuilding industry. This was carried out by analysing secondary data and by investigating the industrial partners and their supply chains (see section 3.4.4 that follows) and comparing them with other industries including automotive, aerospace, and electronics.

As stated in the literature review, in an ideal scenario the supply chain acts as a single entity, focused on end customer requirements and ensuring the product that is delivered is of the highest quality, with good service, 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) and implies that it is no longer possible to be competitive using just a single measurable criterion. In addition to these metrics there is also a need to consider the health, safety and environmental issues that govern the end customers' needs (Evans et al. 1997a).

It is evident from many areas of research, as illustrated in the literature chapter (Chapter 2) that the improvement in business processes (and supply chains themselves) equates, to a large extent, to the elimination of waste, which exists in various forms. Material wastage or delay is really the 'symptom', whereas the 'cause' is the inefficiency in, or the poor control over, the various processes concerned. In other words poor planning, poor organisation, poor methods/procedures, poor relationships are the reasons why there is wastage in time and resources and this in turn determines the effectiveness of the overall supply chain. In elucidating and understanding the business processes and interaction at the interfaces between the industrial partners, the research provided an initial assessment of waste within a housebuilding supply chain.

3.4.4 Research Partners

As part of the research project the nine industrial partners were assessed using the TSM. They each represented different components of a house building supply chain. These included 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. See Figure 3.6 for an outline map of the industrial partners' position in the housing sector, which should be read in conjunction with Table 3.5.

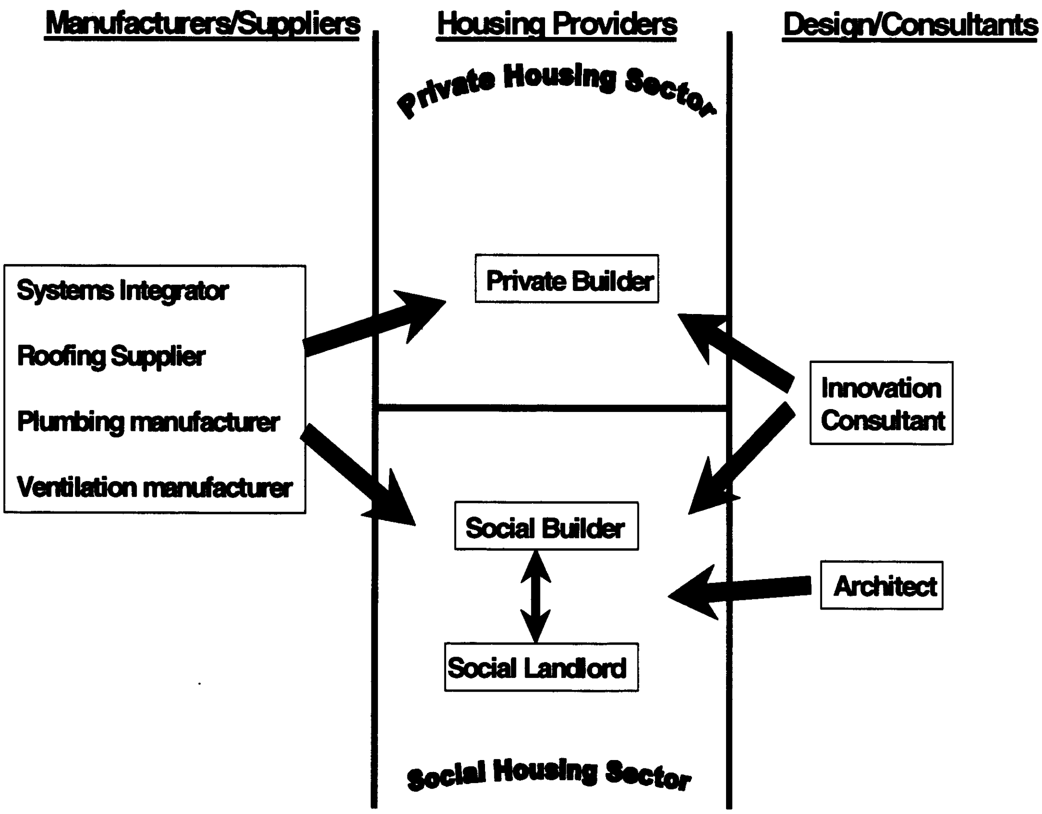

Figure 3.6 Industrial Partner's Position in Housing Sector. Source – Barker et al. (2000)

3.4.5 Description of Methodology

The TSM was designed with the needs of the construction industry in mind, to obtain and analyse information regarding the key internal processes and overall external processes related to the housebuilding supply chain. The data collection tools were configured for companies working in both the public and private sectors of the housing industry, reflecting the position of the industrial partners.

TSM is an adaptation of a 'Quick Scan' methodology developed by the author's research team in the automotive sector (Barker 2000 – adapted from Lewis et al, 1998, and Childerhouse et al., 1999). The TSM also built on the systems engineering expertise from 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 (FMCG) and aerospace. The methods, tools and techniques have also been documented in Berry et al. (1998 and 1999).

An overview of the TSM process is shown in Figure 3.7 which provides an illustration of the following narrative which describes the process:-

Preliminary visits/presentations: The initial visits to the project's industrial partners occurred over a two week period in October and November 1998. These visits were to introduce the TSM philosophy, establish the key contacts for questionnaires and interviews. The visits were also used to identify two representative products/services and for each of these, a representative supplier and customer. These two products/services were used as a means of guiding the interviewees through the questionnaire, process mapping and general information gathering stages, as participants could relate more easily to specifics than to generalities when providing data.

Understanding their business processes and how their supply chains worked was also extracted in the form of process flow charts frequently produced as a joint effort between the researchers and the industrialists. The location and timing for the main data collection visits was also agreed at these initial visits. These were especially useful in the case of building site visits where several other individuals would be involved. Assurances of confidentiality and anonymity were discussed and given as necessary.

In order to obtain the necessary information regarding activities and business processes of the industrialists, three different questionnaires were created. One questionnaire was aimed at gathering internal operational information, while the other two were aimed at the supplier and customer interfaces respectively. As a result of the different nature and business discipline of the industrial partners it was also necessary to tailor the three questionnaires and interview forms used accordingly. This resulted in there being three versions of each of the three questionnaires: one set for manufacturers; one for service businesses; and also one specifically for architects leading to a total of nine distinct questionnaires. As agreed at the preliminary presentations, three different questionnaires (one set) were sent to appropriate named personnel, a week prior to the main visits.

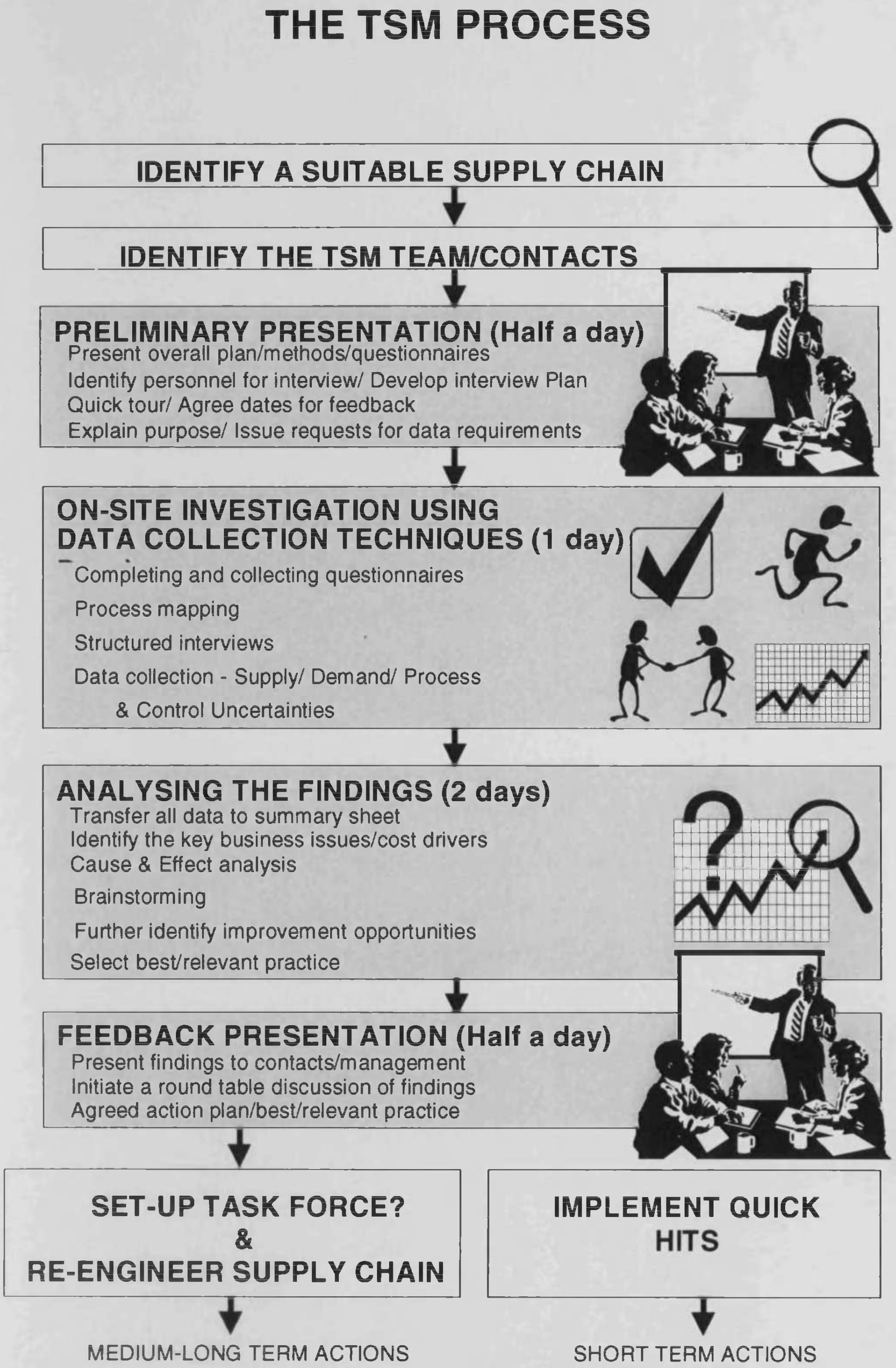

Figure 3.7 Process Outline of TSM. Source - Barker et al (2000) Adapted from the Quick Scan Methodology, Childerhouse, P., et al (1999)

Appendix 2 gives an example of the 'customer interface' questionnaire which was one of the three formats used.

On-site investigation visits: All nine partners were visited over a four month period starting in May 1999. The venue depended upon the nature of the partner concerned. In the case of manufacturers a visit to their production premises was necessary. Architects, consultants, systems integrators and housing association required a visit to their main offices. The main contractor and developer required a visit to actual housebuilding sites as well as main offices. Following consultation with the housebuilders, four building sites were selected; two private/speculative and two social. These four were considered to be typical and representative of the general mode of operation of each sector at the time. The two social sites consisted of one with 69 dwellings (42 houses and 27 flats) and the other with 130 dwellings (all houses - mixed semi-detached and linked) and all of conventional brick and block construction. The two private sites were comprised of one with 41 houses (detached and linked), and the other with 26 (all detached houses or bungalows). One particular 'private' site which was extra to the selected two was also visited, as this was using a 'timber-frame' approach for the construction of the internal walls. This approach to construction was a quicker method than the conventional method and had been used previously for 'show houses' but was subsequently used across this particular site.

As part of the research remit to understand the housebuilding sector, various other building sites were visited. This included a visit to a major national housebuilder who was linked to the research project but not as a full participating member. Also, several non related major housebuilders were visited, where the researchers posed as potential buyers in order to obtain a better understanding of customer perspective and to view the site operations and processes. Sites where building was still in progress were most useful. Also visits were made to some major car manufacturers' salesrooms to gain an understanding of the service, warranty and delivery aspects of a high value consumer product.

Confirmation that the questionnaires had been received prior to the main visit was obtained via telephone and this also provided an opportunity to clarify any queries that had arisen.

The main visit consisted of:

(a) Firstly, checking through questionnaires and where necessary clarifying information obtained.

(b) Walking through and mapping the business and supply chain processes, obtaining material flow and information flow data. In the first instance these were usually hand drawn onsite for expediency.

(c) Carrying out semi-structured interviews, where a pre-scripted data collection sheet was used to prompt the most useful data required (See Appendix 3 for example)

(d) Obtaining relevant archival and analytical information. This was often recorded during questionnaire completion or during the semi-structured interview.

The TSM aimed to triangulate data as much as possible and thus the data collection utilised four main sources 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, results from questionnaires

Triangulation, including repeat and reverse questioning, aimed to verify the 'as is' rather than the 'as stated' or 'as believed' situation regarding business and supply chain processes. The main topic areas covered were: material flows, information flows, measures of performance (MOPs), customer interfaces, and supplier interfaces.

Analysing the findings: Data assimilation and initial analysis took place immediately following the TSM visit. This ensured that accurate recall and recording of data occurred. This was followed by a more in-depth analysis where all key data collected was transposed onto a single sheet of A3 paper to ease understanding and analysis.

Informally termed a 'mind dump' by the team, this data rich summary sheet contained all the relevant names, metrics, measures of performance (MOP's) and other useful information. At this stage, reference was made as necessary to the research group's business process, supply chain knowledge and early literature review to seek potential improvements. It was often the case that further contact (usually by telephone) with the industrialist was required to resolve queries or obtain more data. The analysis ended with a brainstorming session amongst the immediate research team with support from other LSDG members to identify 'poor practices'/'good practices' and 'potential improvements' for the companies concerned. The analysis was then systematically scrutinised and relevant outputs determined. Techniques including the '5 Whys', 'cause and effect' and 'influence diagram' were used in this part of the analysis.

It was considered at the outset of TSM that it would be useful to understand the method of communication between supply chain members. Therefore 'information technology' (IT) and the 'relationship' between members (or customers and suppliers) was an important metric for gauging supply chain performance. This also provided a comparator between partners. Relationship was evaluated via questions on: trust, commitment, joint R&D programme, and open book. Information Technology usage was determined from the method of transfer: paper, telephone, fax, e-mail, EDI, or other. These measures are described more in Table 3.6, in the narrative content and language used in the questionnaires.

<u>'Relationship' was evaluated via questions on:</u> **Trust**: An expectation that your trading partner will behave in a predictable and mutually acceptable manner. [Sako (1992:37)] **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 or 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]
<u>Degree of IT is determined by ascertaining</u>: 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.

Table 3.6 Summary of TSM Terms for Relationships and Degree of IT Utilisation.
Source – Barker et al. (1999)

Based on a 'rating scale' output from the questionnaires, a simple 2-by-2 matrix was constructed as shown in Figure 3.8 The four descriptors used in the 2-by-2 matrix emphasise the nature of the organisation. 'Stone Age' refers to a lack of proficiency in both relationships and in IT. 'Techie' describes those organisations that are accomplished in IT but lack the ability or aim of forming good/close relationships with customers and suppliers. 'Humanist' implies the ability and aim to form good/close relationships but not employing current IT. Finally 'Modernist' combines the best of both worlds and indicates proficiency in both criteria. Both the idea of measuring companies this way, as well as the measures themselves were useful at this stage of the research and were adopted again in the survey methodology section later.

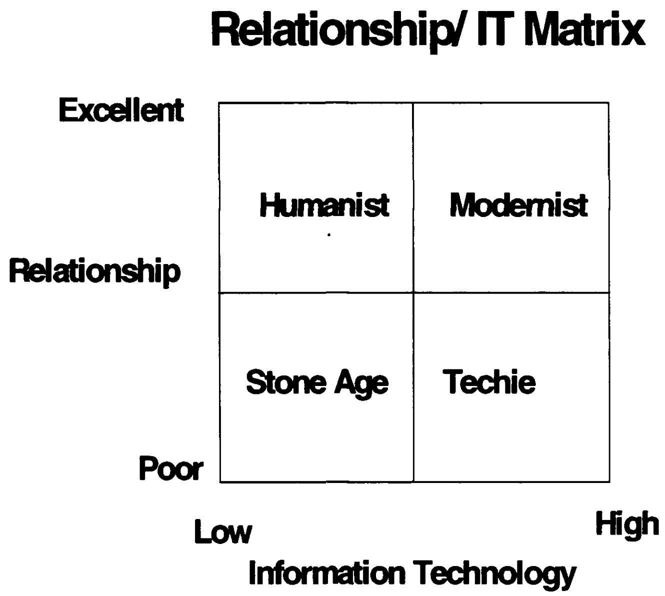

Figure 3.8 Partner Comparison Matrix. Source – adapted from Barker et al. (2000)

Feedback presentations: It was important that each company received individual feedback presentations outlining poor practices, good practices, potential areas for improvements and overall conclusions. Discussion and comments ensued regarding the presentations and the underlying supportive reasoning. Permission was also sought to share 'relevant/best practices' with other companies in the same supply chain who had also participated in the TSM exercise. A group feedback presentation and discussion was then held where key issues and 'relevant/best practices' were raised and debated. All industrialists participated and a greater understanding of each other's business processes and the supply chain was achieved by sharing information, viewing different process maps, identifying and acknowledging information technology problems and discussing interface problems.

The TSM research process can be presented using an input-output diagram as shown in Figure 3.9. This diagram was actually used in the early introductory presentation to the industrial partners to show benefits and outputs that were planned. As can be seen, 'relevant practices' and 'evaluation framework' outputs were particularly relevant for this author's dissertation. The researchers involved then set-up various task forces to address opportunities raised by the TSM process resulting in recommendation to re-engineer the supply chain. These activities go beyond the remit of this dissertation and so are included here.

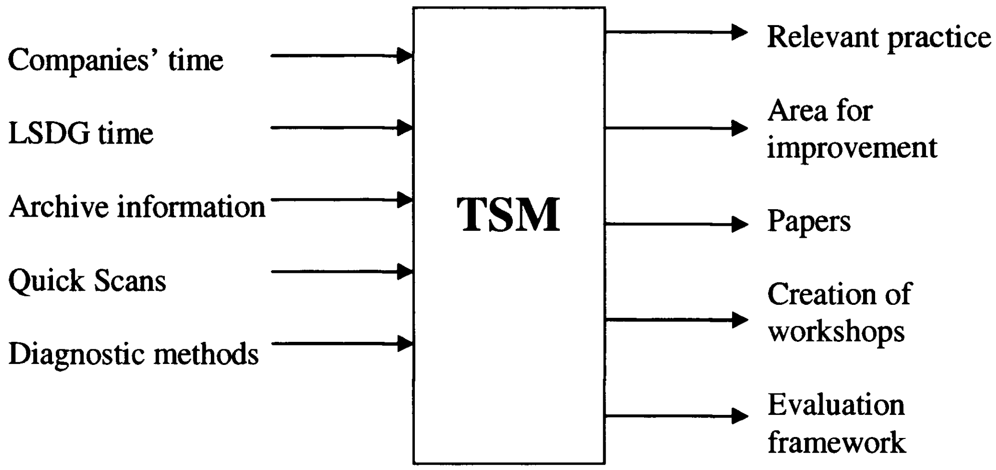

Figure 3.9 The TSM Input-Output Diagram.
Source – Barker et al (1999) MCNS Project presentation OHT's.

The TSM was completed in as short an activity time as possible so as to maximise the diagnostic opportunity. The timings were approximately a total of four days per company; see Figure 3.7, with less than two days of actual personnel contact time per visit. During the study the TSM team consisted of the author and another full-time researcher, with the aid of off-line support from the rest of the academic team when required, plus part-time involvement of company personnel.

The findings from this area of research are shown in Chapter 4 and provided the author with an initial understanding of the housebuilding process from which to progress further.

3.5 Stage 2 - Survey Research Methodology

3.5.1 Overview of Survey

This part of the chapter presents and discusses the research methodology used, namely a survey, to understand current supply chain awareness of private UK housebuilders. It justifies the research approach and the data collection tool used by reference to the literature and the situation prevailing. This was necessary so as to produce a platform from which to progress into more focused case study research. The conclusion of the literature review (section 2.9) revealed a gap of knowledge in the current best practice and level of competence in UK housebuilding supply chains and in the causes of waste and the application of improvement techniques. This survey was aimed at addressing this gap. The final questionnaire, the instrument used for the survey, and which may be useful for reference for this section, is shown in Appendix 4.

3.5.2 Theory related to Questionnaires

Oppenheim (1996:Preface) states that "the world is full of well meaning people who believe that anyone who can write plain English and has a modicum of common sense can produce a good questionnaire". However, many surveys are carried out with insufficient design and planning, and weaknesses are only discovered once the results are being analysed. Correctly planned and organised surveys take a great amount of fore-thought and the continual re-assessment of the key aims and objectives of the research.

There are several important advantages and disadvantages of postal questionnaires as shown in Table 3.7.

Advantages	**Disadvantages**
• Low cost of data collection • Low cost of processing • Avoidance of interviewer bias • Ability to reach respondents who live at widely dispersed addresses or abroad	• Generally low response rates, and consequent biases • Unsuitability for respondents of poor literacy; for the visually handicapped, the very old or for children below the age of, say, ten; often unsuitable for people with language difficulties • No opportunity to correct misunderstandings or to probe, or to offer explanations or help • No control over the order in which questions are answered, no check on incomplete responses, incomplete questionnaires or the passing on of questionnaires to others • No opportunity to collect ratings or assessments based on observation

Table 3.7 Advantages and Disadvantages of Postal Questionnaires.

Source - Oppenheim, A. N. (1996:102)

Key stages in carrying out a survey are firstly concerned with the research design, and then the research techniques (adapted from Oppenheim 1996:7):-

1. Determination of the general and then the specific aims of the research. Here a hypothesis may be formed which leads to the identification of what variables need to be measured, and in turn lead to the formulation of actual questions, scales and indicators to be adopted. Justification of the research should be central to this stage.
2. The review of the literature, and discussion with relevant informed personnel and organisations
3. Preliminary interrogation and analysis of the research design, review of aims and objectives, and practicality in terms of time, resource and costs. The finalisation of the research instrument and techniques so as to incorporate all the previous work, including how the returns will be analysed, codified, and findings presented.
4. Piloting of the questionnaire, inclusion of corresponding improvements and re-piloting if necessary
5. Consideration of the sample – i.e. representative, list or sampling frames. Assessment of effect of no-response on the research e.g. difference between planned sample and achieved sample. Decision on final sample frame.
6. Execution of the field-work – e.g. sending out the actual questionnaire, control of related issues like queries, collection and checking of returns. This field-work stage is often shorter than the preparation stage.
7. Processing the data, selecting and using appropriate methods and tools. e.g. Computer software such as Excel spreadsheet, Mini-tab or SPSS.
8. Processing (and analysing) of the data, selecting and using if necessary appropriate methods and tools. E.g. computer software such as Excel spreadsheet, Mini-tab or SPSS.
9. Statistical analysis of the data so as to verify the accuracy of the finding that will emerge, i.e. testing for statistical significance. It is absolutely crucial to realise and record that association is not proof of causation.
10. Presentation of the results and issue of the report, testing of the hypothesis, drawing conclusions and making recommendations from the results obtained.

Easterby-Smith et al. (2002:135), explains the different between surveys and questionnaires: "The main purpose of a survey is to obtain information from, or about, a defined set of people or population. This population might be defined to include: all the people in one country; all women aged between 30 and 40 who live in Paris; all managers of Grade 7 or above who work for the Mage Corporation; or all supervisors in a company who have attended course Y during the last 3 years". When the population is small (say less than 500) it is usual to send the questionnaire to, or to have interviews with, all members; this 100% sampling is called a census. If it is not possible to contact the whole population then sampling can be used. Indeed by using statistical techniques it is not necessary to hold a census, as the whole population can be represented by a smaller number. Sampling techniques can be used to define a sub-set of the population that will represent, within certain bounds, the whole population. Different sampling techniques include random sampling, stratified sampling and cluster sampling. Whenever these techniques are used it is usual to carry out some statistical testing to prove representation. Information can be obtained in a survey by different means, but all respondents must be asked the same questions. One of the tools available for conducting a survey and asking the same questions is a questionnaire. According to Bell (1999:14) 'surveys can provide answers to the questions What? Where? When and How, but it is not so easy to find out Why? Causal relationships can rarely if ever be proved by survey methods'. The main emphasis here is on fact findings and that is why this dissertation uses a third stage with a qualitative approach employing cause and effect techniques to determine the root cause for problems of waste in housebuilding supply chains.

As will be shown later in this chapter the 'housebuilders', that is, the population relevant to this research was relatively small (some 131) and so a 'census' approach was the most appropriate and was employed.

Bell (1999:118) gives advice on questionnaire development, the question type, the question wording, including the dangers of posing leading questions, presuming questions, hypothetical questions, and potentially offensive or sensitive questions. There is also a basic insight into sampling and representation. Piloting is strongly recommended even if only with friends or relatives (Bell 1999:128). Although the text is mainly aimed at the undergraduate student it includes much useful advice for all levels of research, and thus has been adopted here.

A major concern in survey results is that of bias. Seltzer and Bass's study (1990) in Alvesson and Deetz (2001:56) shows that the natural inclination of respondents is to give positive answers, at least in some cultures, and to behave according to existing social norms. In addition, the fixed leader-follower structure of questionnaires with limited potential for social reality being applied (and therefore, encouraging the researcher to re-think the basic ideas and categories) is a potential problem.

Easterby-Smith et al. (2002:132) – talks about first distinguishing between factual and opinion questions, so in forming the questions it is important to be aware of this difference in order to phrase the questions correctly. This is closely related to the issue of qualitative versus quantitative methodology as discussed earlier in this chapter. The author also states that there are two other key distinguishers - open and closed questions. Open questions allow for more information, but take time to complete and it is often more difficult to assimilate and aggregate the results. Closed questions are quicker for respondents and results are easier to analyse but have the potential to produce superficial answers. The author also sets out some general principles in forming questions, as follows:

- Make sure the question is clear;
- Avoid any jargon or specialist language;
- Avoid negatives (e.g. *Q:* do you dislike your work? *A:* Yes/No);
- Avoid personal questions;
- Don't ask two questions in one item;
- Avoid leading questions, which suggest indirectly what the right answer might be.

A very relevant point is how closed questions can be used to determine more than just a Yes/No response. As the speed of completing a questionnaire affects the response rate, closed questions tend to be used more frequently. Closed questions can also be termed close-ended questions as the respondent chooses from a set of pre-determined answers. In other texts these are termed multiple choice questions (Hussey and Hussey 1997:168) where one or more choices are allowed. There are several types of closed question such as scale (including Likert), rating, ranking, list and category types. All of these give more detail and potentially more useful information than the simple Yes/No question (Saunders 2003:292). Jankowicz (2000:275) also gives advice on devising closed questions including some of those above and free-choice and multiple choice.

Some general advice on the overall format of the questionnaire is found in Easterby-Smith et al. (2002:134) as follows:

- Provide a short covering letter explaining the purpose of the research and why/how the respondents were selected;
- Start the questionnaire with brief instructions about how to complete it;
- Vary the type of question occasionally, but keep similar types of questions together in bunches; and
- Start with simpler factual questions, moving on later to items of opinion or values.

A similar but more comprehensive set of advice is found in Hussey and Hussey (1997:165). Here, an outline of how to design questions is given from the perspective of a positivist or a phenomenalist point of view. When conducting a positivist study the designer needs to have a substantial amount of subject knowledge in order to develop the correct questions. With a phenomenological study an open mind is needed and therefore the need to specify and detail 'subject' expert questions is not as great, because 'open questions' are mainly used. Also, when designing questions the potential respondents' knowledge and understanding of the topics must be borne in mind. It is key to ensure that the question design is right because once the questionnaires have been returned there is little that can be done to correct things, either in respect of changing the questions or improving the response rate or response quality. The authors carry on to say it is useful to qualify the questions by referring to a specific topic areas or timescale; this helps the respondents to be clearer about what is being asked and therefore to give a more relevant and or accurate answer.

General rules for designing questions are given by (Hussey 1997:165):

- Explain the purpose of the interview or questionnaire to all participants
- Keep your questions as simple as possible
- Do not use jargon or specialist language

- Phrase each question so that only one meaning is possible
- Avoid vague, descriptive words such as 'large' and 'small'
- Avoid asking negative questions as these are easy to misinterpret
- Only ask one question at a time
- Include relevant questions only (do not be tempted to include every question you can think of)
- Include questions which serve as cross checks on the answers to all the questions
- Avoid questions which require the participant to perform calculations
- Avoid leading to value-laden questions which imply what the required answer might be
- Avoid offensive questions or insensitive questions which could cause embarrassment
- Avoid questions which are nothing more than a memory test
- Keep your interview schedule or questionnaire as short as possible, but include all the questions required to cover your purposes

Saunders et al (2003: 281) say that questionnaires are not best for exploratory research where many open-ended questions would be useful. Questionnaires work best with standardised questions, which hopefully will be interpreted the same way by all the respondents. Questionnaires are therefore best for descriptive and explanatory research, which relates to the previous points raised about 'factual or opinion' questions. Descriptive research looks at opinions, attitudes and behaviour, and allows an understanding of the variability that exists, e.g. how organisations work. In contrast explanatory or analytical research examines and tries to explain the relationships between variables, such as cause and effect relationships, e.g. why organisations work the way they do.

The survey method (Saunders et al 2003:281) can measure managers' attitudes about certain issues, gather subjective appraisals of manufacturing processes, or obtain expectations of various outcomes. Also, surveys can be used as strategic tools to drive and measure organisational change and in studies of improvements in manufacturing businesses. Thus survey method draws on data that exist at present and is useful to establish peoples' views of what they think, believe, value or feel. This can help support or oppose any changes that have been or may be planned. The survey method is deemed particularly useful in contacting a relatively large group of people to gain data on particular issues or questions. Surveys can assist the researcher not only to describe but also to compare, to relate one characteristic to another and to demonstrate that certain features exist in certain categories (Bell 1999):14). If well constructed and piloted, surveys can be a relatively quick and economical way of obtaining a lot of information.

For these various reasons a survey was selected as the most appropriate tool to determine the general situation in the UK for housebuilders' awareness of supply chain management and allied knowledge. As will be seen later the question formulation for the survey related directly to the research questions outlined above, and to understand the situation regarding improvement tools and techniques.

3.5.3 Validity, Reliability and Generalisability

'Whatever procedure for collecting data is selected, it should always be examined critically to assess to what extent it is likely to be reliable and valid.' (Bell 1999:103).

Reliability concerns the repeatability of results under the same circumstances. In other words, in the case of the questionnaire in this study, if this was repeated to the same housebuilders, would the same results be obtained? Reliability of responses is an important issue in positivist studies (Hussey (1997:173) and questions that contain errors, are ambiguous, are boring, or create bias are a problem here. 'Self-administered' questionnaires that do not rely on any human interaction are more likely to repeat the same results. However, ensuring the clarity of questions by careful fore-thought and piloting is important. Although much is written on the theory of reliability, and some on testing for such, it is clear that keys ways of ensuring reliability are by repeat or check questions, and follow-up questions. In theory, as purported by Bell (1999:104) and Saunders (2003:309) there are three ways to reduce the likelihood of reliability problems at design stage:

- Test-re-test: repeating the same test sometime after the first.
- Internal consistency: checking for correlation between questions and so measuring the consistency of response.

- Alternative form: similar to above but repeating the same question in a different form elsewhere in the questionnaire, commonly called a check question.

The practice of repeating the same question was employed in the questionnaire used in this study (Q8 & Q20 are very similar). Also during the chasing of returns, several housebuilders were asked their views on the questionnaire itself. Those asked felt that the questions were understandable. Some however said that the diagram in question 17 was complex and not easily understood. A discussion of this problem is covered in the Chapter 5.

Validity is concerned with whether the questionnaire discovers or measures what it is supposed to discover or measure. If the questionnaire was not reliable then it would also mean that it was not valid. It could reproduce the same results time and again but those results could be erroneous (Bell 1999:104). This would result from the fact that the questions used did not elicit what was really needed. One of the main ways of ensuring 'validity' is to involve subject experts during the question formulation stage (Saunders 2003:308). Piloting is recommended, so that a number of people can check that the questions actually ask what is required.

Generalisability is about whether the findings would be applicable to other external situations (Saunders et al. 2003:102). In the case of this research, could the results be representative of say other builders or in fact other parts of the housebuilder population? As the following section will show, the sample selected was restricted to major housebuilders. Chapter 2, the literature review revealed that the 'housebuilder' population is extremely large with just a few major players, and so results are not generalisable in this case, nor indeed was it the intention that they would be generalisable.

3.5.4 Survey Process

The following sections explain the overall process used in carrying out the survey of UK housebuilders in this study to gain an understanding of their supply chain awareness. As previously stated the survey methodology was based on knowledge gained from previous 'case study' research and was undertaken in order to underpin the proposed action research with a particular major UK private housebuilder.

Although the survey process (including the sample frame, formation of the questions, piloting, and administration) is explained in a clear fixed order, in practice several activities were developed concurrently.

3.5.5 Sample Frame

As discussed earlier in the chapter, in order to ensure results are representative of a chosen population it is necessary either, to obtain information from the whole population, or from a sufficiently large sample. "Sampling can be defined as the deliberate choice of a number of people, the sample, who are to provide you with data from which you will draw conclusions about some larger group, the population, whom these people represent" (Jankowicz 2000:192).

It is therefore crucial to:

a) Define and ensure the 'sample frame'. This must create adequate representation but be achievable in meeting the aims and objectives of the research methodology
b) Ensure sufficient returns

A checklist for selecting a sample frame is shown below (Saunders 2003:154)

- Are cases listed in the sampling frame relevant to your research topic, for example are they current?
- Does the sampling frame include all cases, in other words is it complete?
- Does the sampling frame exclude irrelevant cases, in other words is it precise?
- (For purchased lists) can you establish precisely how the sample will be selected?

The population for this particular survey is defined by the author as all major private housebuilders in the UK. In determining the actual identity (names) of these housebuilders various sources were used:

- Government/DTI websites
- Building Magazine
- House Builders Federation
- National House-Building Council (NHBC)
- The Housing Forum
- University of Sussex Science and Technology Policy Research (SPRU)

During the research it was discovered that a commercial organisation, Credit Lyonnais Laing, produce a top 200 UK housebuilders listing but the cost of purchase prevented its acquisition. NHBC was contacted and although their web-site provides a free housebuilder search facility to check whether a particular builder is NHBC registered, the fee to obtain a full listing of registered housebuilders was again prohibitive. The National Housebuilders Federation was contacted and they agreed that the survey was useful and that they were happy to have their name used as an endorsement to encourage a better response rate.

Company	Units	Company	Units	Company	Units
Wimpey	11437	Cala	841	David McLean	277
Barratt	10636	Haslam	827	Roland Bardsley	247
Beazer	8223	Stewart Milne	820	Connolly	241
Persimmon	7035	Linden	764	William Davis	223
Bellway	5714	Gleeson	720	Britannia	218
Westbury	4435	Henry Boot	651	Matthew	
Wilcon	4215	Galliard	639	Jennings	211
McAlpine	4007	Willmott Dixon	616	Swan Hill	208
Bryant	3961	Morrison	604	Chartdale	200
David Wilson	3604	Kier	573	Walton	200
Redrow	3330	Robert Hitchins		Allison	185
Berkeley	3210	Croudace	566	Hopkins	159
Bovis	2360	Bett	556	Weston	151
Countryside	2173	Allen	523	Banner	143
Taywood	1919	Morris	520	Michael Shanly	
Miler	1844	Abbey	496	Saxon	140
Lovell	1815	Frogmore	479	Bewley	137
Crest	1731	Martin Grant		Hillreed	129
Fairclough	1707	Shepherd	425	Sunley Estates	118
Bloor	1700	Jones	407	Scotia	109
Prowting	1579	Jelson	386	Cavanna	105
McCarthy & Stone	1539	NorthCountry	385	Country & Metropolitan	82
Fairview	1459	Ben Bailey	350	Arncliffe	76
Wain	1371	Rialto	342	Octagon	74
Laing	1235	Ward	333	Wates	63
Tay	931	Yuill	289	Leach	59
Stamford	904	Crowther		J A Pye	58
Rydon	899	Gladedale	277	Goldcrest	52
				Total Units in 2000	112,227

Table 3.8 Top Housebuilders in 2000. Source – Sussex University (SPRU)

The author compiled an initial list of housebuilders from the National Housebuilders Federation "Major Housebuilders List 2003" which contained 73 of the major UK housebuilders. These 73 alone account for 80% of all UK homes according to (Housing Forum Annual Report 2002/3). This list was supplemented by reference to a listing of 84 top housebuilders in 2000 from Sussex University (SPRU) shown in Table 3.8, and the 'Building Magazine' top 25 housebuilders listings for 2003, Appendix 5. By merging these, a final listing of some 94 separately 'named' housebuilders was produced, but this did not contain contact names or current addresses. (Note: Table 3.8 does have some volumes of build missing, but this was as received from the source and was not a major factor as the real objective was to determine housebuilder names).

In order to meet the requirements of the survey and to improve the response rate it was felt necessary to contact each housebuilder so as to identify appropriate named contacts and to verify addresses. Where possible individuals involved in supply chain management (Supply Chain Manager) were identified and contacted. Alternatively, if this was not applicable, then Procurement Managers, Quantity Surveyors, Senior Buyers or Buyers, were sought as appropriate. The individual designated depended upon the company's size and complexity or sophistication. Following several days of telephoning and online reference to company web-sites etc. a more complete and detailed listing of housebuilders was produced. In some instances companies were represented by individual regional offices and in others by their Group Head Office. Several of the 'named' housebuilders had been subject to a take-over or merger. This process of speaking with housebuilders resulted in a better understanding of the relationships and consolidation that had recently occurred amongst them and this is shown in Table 3.9. Such consolidation is still on-going and the table merely represents the author's best assessment of the situation as at November 2003.

The final listing contained 131 contacts and is shown in Appendix 6. This reflects that in some instances more than one and sometimes several, regional contacts were used for the same 'named' housebuilder. For example, Charles Church had five separate operational regions, which worked independently, so all five were sent a questionnaire. Each housebuilder was identified by a unique random number so as to ensure confidentiality during any recording and analysis of results.

Berkeley Group has 9 regions and owns The Crosby Group, St. Georges plc., and St. James Homes
Bloor Homes now has 8 regions
Country and Metropolitan now owns North Country Homes
David Wilson now owns Henry Boot Homes
Fairclough Homes have become CDC2020 RTC.
Furlong Group now owns CastleGaite Homes
Galliford Try Group now includes Try Homes, Stamford Homes, Midas Homes and Gerald Wood Homes
KeepMoat Holdings plc now owns Haslam Homes
Keir Group owns Allison Homes, Bellwinch Homes and Twigden Homes
Lovell Partnerships now own Morgan Sidal and Britannia Construction
Morrison Homes have become AWG Construction
Persimmon now have 23 regions and include Charles Church, and Beazer Homes
Westbury now own Prowting plc.
Wilson Connolly now own the merged Wainhomes and Wilcon Homes

Table 3.9 Housebuilder Relationships and Consolidation. Source - author

The sample frame selected (i.e. the total of 94 separate companies or 131 contacts) represented the major proportion of private housebuilding in the United Kingdom. This resulted from the fact that the sample included 10 more companies than that of the SPRU listing (Table 3.8) of 84 builders who in 2000 had built of over 112000 dwellings, the majority of which were private. This figure compares well with a total in the UK of actual completions during the period of April 2002 to April 2003 of 163,756 (ODPM 2003), i.e. more than 70% of all private dwellings in the UK would be covered by the survey if there was a 100% response rate.

This number of 131 contacts therefore represents 'the' majority of housebuilding in the UK, and it is argued that it is precisely these housebuilders that the survey wished to cover.

3.5.6 Formation of Questions

It is crucial to be fully aware of the research objectives and type of research being carried out prior to formulating any question in a survey (Saunders 2003:290). Indeed, it is recommended that some form of plan or 'data requirements table' be constructed whereby the aims of the survey and the means by which these will be met are critically analysed before any questions are formed. The author adopted this strategy to produce Table 3.10 which shows the 'investigative question' of what was being sought; the respective 'variable' and 'detail' that helped determine the final question; and finally the 'check' for its presence and location.

Investigative Questions	Variable (s) Required	Detail in which data is measured	Check it's in
General Information			
Do companies respond different depending on size?	Number employees; T/O; houses built	Factual number for employees, T/O & completions in 2002	Q1-3
Are companies in the Private housebuilding sector?	Number of private houses built	Proportion of private/social built	Q4
What proportion is part of large national company?	Whether or not part of a Group	Yes/no part of a Group	Q5
What awareness of general supply chain management?	Knowledge of business	Degree of familiarity with – KPI's; cbpp; Rethinking Construction	Q6 & Q8
What commitment to SCM?	Activities and resource allocated	Number of dedicated personnel currently involved in SCM	Q7
Relationship Issues			
What kinds of relationships exist with key suppliers and sub-contractors?	Existence of partnership/ collaborative relationships for top 3 suppliers / subcontractors	Likert scale: trust, commitment, cost transparency, joint R&D, ESI, length of relationship also strategic or project partnership	Q10
What progression in relationships?	Attitude to improve relationships	Reducing number of suppliers / subcontractors; move to more partnering - more partners	Q9 & Q11c
Are there procedures for selecting partners/key suppliers?	Behaviour regarding selection	Yes/no	Q11a
Importance of partnering?	Whether partnering is strategic	Is partnering classed as short term of strategic?	Q11b
Supply Chain Issues			
What awareness of supply chain issues?	Knowledge on various SCM principles	Grade of awareness on: JIT; Demand amplification, lean, value stream mapping,	Q12
Level of Sophistication of current SCM?	Behaviour regarding SCM, cost or quality/service oriented	How choose top 3 supplier & subcontractors on price/cost/TAC	Q13
Level of Sophistication of current SCM?	How measure supply chain performance?	Open question	Q14
How sophisticated is current communications in SC?	What comm. methods currently used for top 3 suppliers / subcontractors	Ranking of methods – post, fax, telephone, e-mail, web, EDI, web-based, meetings	Q15
What organisation of supply chain?	Related to key partners, how integrated is SC?	0-100% scale of sharing goals / objectives; meetings to agree; agreements on resolving problems; shared understanding	Q16
Supply Chain Improvements			
What are 5 greatest areas of wastes in their supply chain?	Name the five worst areas	Name in order of importance - open question	Q17 & Q18
What are possible areas of waste/inefficiency?	Communications, re-quotes, mat'l waiting, late deliveries, stock levels on site, etc.	Current activity is waste? i.e. 0% -10% 100%	Q19
What is creating waste/ inefficiency?	Greatest problems or areas of uncertainty affecting the SC	Open question	Q21
Level of awareness of improvement techniques?	Familiarisation with KPI's, process mapping, FMEA's, TQM, benchmarking, balanced score card	Rated degree of familiarity	Q20

Table 3.10 Questionnaire Data Requirements.

Source - author - based on Saunders et al. (2003:290)

This strategy outlined the aim of the survey, which meant re-visiting the overall research objectives, which in turn helped re-assess the type of research to be done. Next, the detail of what was being sought, how this was defined (variables) and the type of qualitative or quantitative data to be measured was considered.

The work to produce the framework of data requirements involved considering the various types of information required and then sub-dividing and categorising under different headings to clarify the structure. All this re-assessment contributed greatly to defining the outline of the questionnaire and helped ensure the questions would obtain the required data.

During the question formulation process academic publications and previous questionnaires used at both Cardiff and Glamorgan Universities were studied.

The Housing Forum (Construction Excellence) survey of 2001 (The Housing Forum 2001), was particularly useful and relevant question areas were identified. These were specifically:

- the use of KPI as an indicator of supply chain awareness (Q8)
- level of commitment and trust (Q10)
- selection criteria for suppliers and sub-contractors (Q13)
- is supply chain performance being measured? (Q14)
- adoption of technology/IT within supply chain (Q15)
- does the supply chain share goals and objectives? (Q16)
- understand key partners businesses (Q16)

Also in constructing Q17 in the survey, which asked respondents to identify key problems within their supply chain, it was felt appropriate to illustrate the structure of typical supply chain for major housebuilders. To this end the 'rich picture' Figure 3.10 previously used during the author's research whilst at Cardiff University LSDG was adopted (Naim and Barlow 2003). The picture shows a presentation of the housebuilding supply chain for a major housebuilder. The representation is a simplified one compared to the actual situation but helps clarify the key linkages, relationships and issues concerned in the supply chain. It concentrates mainly on the final phases of the supply chain that are close to the actual building. As can be seen the central figure in the rich picture is the 'site manager' who is surrounded by the various elements that are required for the housebuilding activity. The 'HQ' is the headquarters that arranges main/national supply agreements with contractors and suppliers, although the regional buyers are involved in the placing of orders. Some information from the regional buyers is given to the manufacturers in terms of likely requirements but this is later confirmed to the manufacturers or the merchants depending upon the products concerned. The 'stock yard' is the place on site where required materials are held prior to use. This can be a central secure area for more valuable items (such as plant, bespoke lintels, reserve materials) as well as being various places specific for one or several plots (houses) where general materials often go straight to the build (such as bricks, roof joints). The site manager controls the day to day 'call-offs' of materials and contractors so as to meet the build plan. Depending upon the organisation the site manager can also be responsible for organising and ordering any ancillary plant and equipment for site. The site manager organises all labour, often through contractor foremen. Depending on the size of site there may be a finishing foreman who helps progress chase the building including the final checking of the house (termed snagging). Many housebuilders use a large wall chart and plot/site plan to control and monitor progress. Some major builders are now starting to use EDI/internet IT for call-offs, and for reporting build-status to HQ. Following the work undertaken in the next stage of research using interviews with site managers (outlined in next section) this rich picture was modified to be more accurate in its representation.

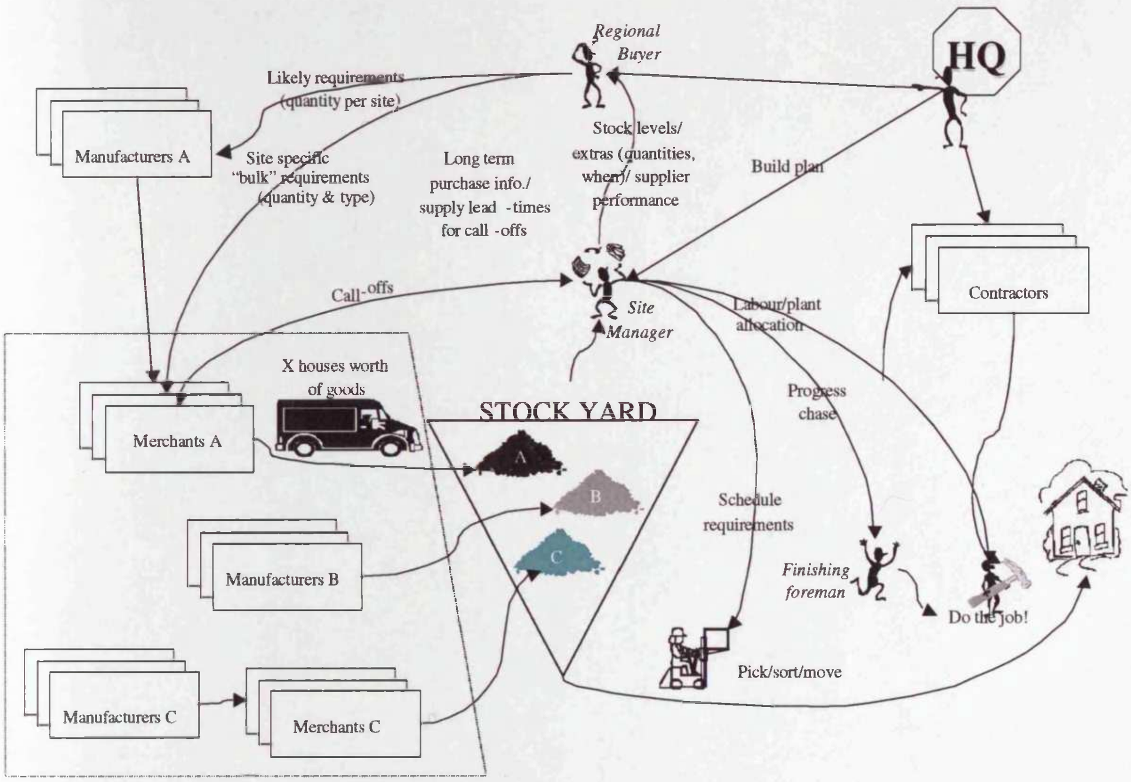

Figure 3.10 Rich Picture Representation of Housebuilding Supply Chain.
Source – adapted from Naim and Barlow (2003)

Following the assimilation of the relevant research and critical consideration of the aims of the research (reference to above table) a draft questionnaire and covering letter was produced.

It is reported that frequently too many questions are included in the initial attempt at producing a questionnaire to collect original data (Hussey and Hussey 1997:175). It is therefore useful to examine each question in turn, not only for their individual usefulness and clarity but also to eliminate any superfluous questions. To this end in this particular case, the questionnaire was analysed using the checklist shown in Table 3.11.

1. Does the question measure some aspect of one of the research questions?
2. Does the question provide information needed in conjunction with some other variable?
   (If NO to both 1 and 2, drop the question; if YES to one or both, retain)
3. Will most respondents understand the question and in the same way?
   (If NO, revise or drop; if YES, retain)
4. Will most respondents have the information to answer it?
   (If NO, drop; if YES, retain)
5. Will most respondents be willing to answer it?
   (If NO, drop; if YES, retain)
6. Is other information needed to analyse this question?
   (If NO, retain; if YES, retain only if the other information is available or can be obtained)
7. Should the question be asked of all respondents or only a subset?
   (If ALL, retain; If ONLY A SUBSET, retain only if the subset is identifiable beforehand or through questions in the interview)

Table 3.11 Question Checklist.
Source - from Czaja and Blair (1996:62) in Hussey and Hussey (1997:175)

3.5.7 Piloting of the Questionnaire

Both the covering letter and questionnaire were piloted with Cardiff University and Glamorgan University work colleagues involved in supply chain and quantitative analysis. Other individuals improved certain areas, especially language and grammatical issues. A prospective final version was then sent to a particular major housebuilder for consideration and this resulted in comments from key supply chain personnel being received and adaptation made as appropriate.

As well as testing that the correct questions were being asked, it was decided beforehand to test how the questions would later be analysed. To this end, a draft spreadsheet was created, questions/answers were coded for data entry and dummy data was entered to check that it could be successfully analysed. Some dummy analysis was carried out and some results tables and charts were created.

In all there were some six iterations of the questionnaire content and format prior to completion ready for posting out. The covering letter also had several changes resulting from the piloting exercise.

3.5.8 Administration of the Questionnaire

Prior to questionnaire distribution an attempt was made to contact all recipients by telephone (see above section – Sample Frame), to explain the aims and objectives of the survey. Recipients were also informed that the research was supported by the House Builders Federation (the contact there was Alex Mitchell); confidentiality of individual responses was guaranteed; the work was independent; that the academic research was not part of any business or company investigations; and that a summary of results would be supplied to participating housebuilders on request. All of these were intended to build trust and interest so as to improve the return rate.

Based on published material on best practice for ensuring a maximum return rate the following actions were taken:

- The covering letter and envelope included the personal details of the recipient (name and job title)
- The cover letter included a target return date.
- The cover letter was printed on Glamorgan University Business School coloured and headed paper and included the author's full title, telephone-mail, and internet home page details and was individually signed in a contrasting coloured ink.
- The fact that completion of the questionnaire should only take a limited amount of time was included (20 minutes was stated).
- A stamped addressed, University of Glamorgan embossed envelope was included for the reply.
- Confidentiality was guaranteed, and reassurance given that although the questionnaire had an individual 'Form No.' this was only to progress the returns.

Questionnaires were posted in University of Glamorgan embossed envelopes. See Appendix 4 for examples of the final questionnaire and cover letter that were used.

3.6 Stage 3 - Collaborative Fieldwork - Research Methodology

3.6.1 Overview

This section of the research methodology covers the final part of the three data collection methodologies. This involved a collaborative relationship with a major UK national private housebuilder (some times termed developer) who will remain anonymous due to confidentiality of the information gathered but will be referred to in this dissertation as 'Goodbuild'.

The methodology employed in the collaborative fieldwork was in two parts. The first, involved interviews with site managers to identify and evaluate supply chain problems and the second took the form of an improvement workshop with experts from regional headquarters that analysed the interview data in the light of the national survey with the aim of determining root causes of the problems. This involved the use of cause and effect analysis and then allowed opportunities for prevention and improvement via a Failure Mode and Effect Analysis (FMEA) tool. Both areas of this methodology will now be explained and justified. Although the research might have been supplemented and supported by inclusion of measurements of some waste parameters i.e. hard data in the supply chain, this additional option was not feasible due to the sensitivities associated with obtaining this data from Goodbuild. In any case, the research concentrated on the opinions and perceptions of staff regarding waste, and a more holistic view of the supply chain which more accurately reflects the focus for this work.

3.6.2 Site Manager Interview Methodology

This section explains the rationale for interviewing housebuilding site managers, and relates this work to that of the dissertation as a whole. It justifies the research methodology, the research tool used, and describes the data collection process.

Following on from the results and findings in the National Survey (as presented in Chapter 5) more detailed information on the key problem areas was required. As has already been discussed there is evidence that Site Managers play a pivotal and crucial role in the housebuilding supply chain. In fact, their position at the centre of operations means that their perspective and understanding is of great value when assessing any improvements in the efficiency and effectiveness of the supply chain. According to other authors, foremen or site managers at the 'coal face' are a good source of information on how to improve things (Christian and Hachey 1995; Zhao and Chua 2003). Figure 3.11 illustrates the key activities and responsibilities of a housebuilding site manager by considering the 'sources' of information and the 'receivers'.

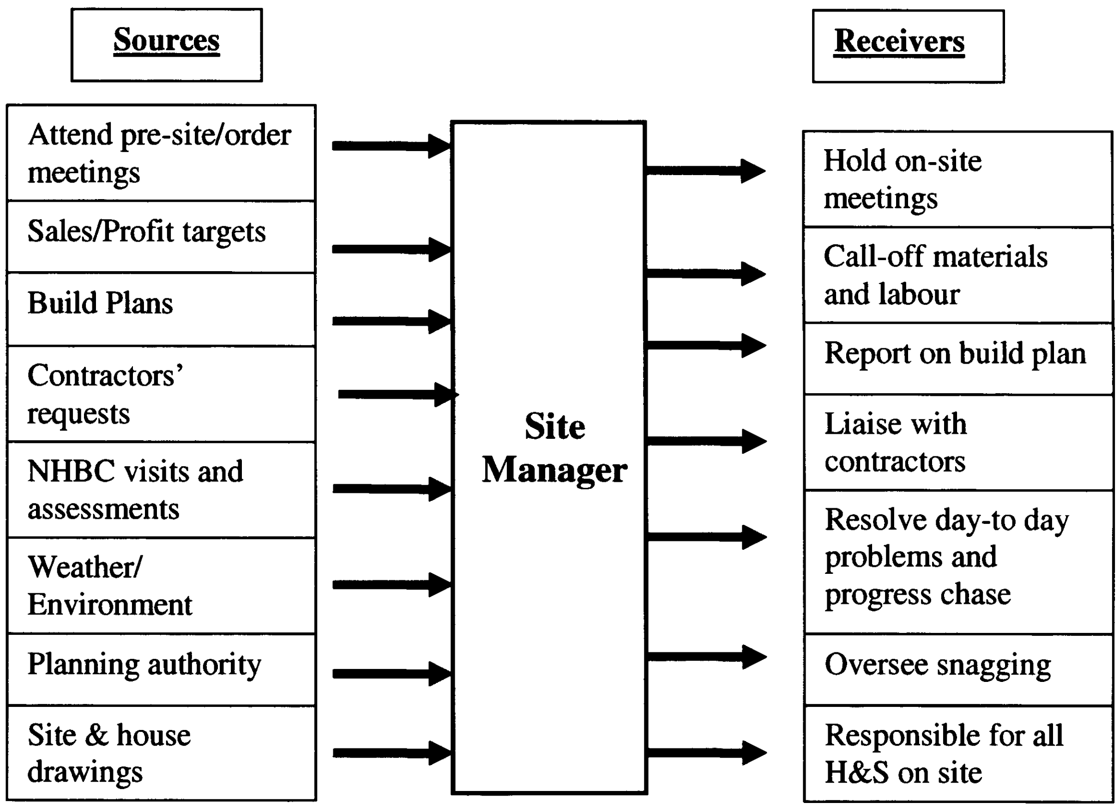

Figure 3.11 Site Manager Input-Output Diagram. Source – author.

A data collection exercise from site managers is justified so as to investigate and analyse in more the depth the key problems in the housebuilding supply chain using an appropriate data collection tool and methodology. Such work would also triangulate the data from the survey if similar questions were employed and also would confirm findings.

Several potential options were available to collect data from site managers including, questionnaires (postal or via e-mail), focus groups, observation, interviews (on-line, telephone or face to face; individual or group; structured, semi-structured or in-depth). However, in order to relate this area of the work back to the aims of the overall research a more qualitative and richer type of data was needed and so a different type of method was needed. While being qualitative in nature any method must still allow some consistency and comparability with the survey regarding key problems, if previous finding were to be triangulated. It was therefore decided that a form of interview which would give depth, but with some pre-fixed questions be adopted. Bearing in mind that contact time would be restricted the author decided on a semi-structured interview format rather than on the more 'open' unstructured design (Saunders 2003:246).

Permission was obtained from the senior management of 'Goodbuild' to interview a number of site managers in their region. During these discussions it was made clear by the author that in order to gain accurate responses it was best to use a high degree of confidentiality and shield the source of all information and opinions from other company staff including the senior management team. This principle was agreed at director level by Goodbuild.

3.6.3 Design of Interview Form

The initial design of the semi-structured interview form was based on the question analysis framework found in Saunders (2003:290). The aims and objectives of this area of primary data collection were:-

- To delve deeper into the key areas of supply chain problems (or areas of greatest potential improvement)
- To gain the site managers' perceptions of such problems
- To triangulate what had already been found from the survey.

A major restriction to this part of the research was that of contact time with the primary data source. Only a limited amount of time was available with site managers because of the likely disruption to their very busy schedule and to the crucial contribution such key controlling personnel make at the housebuilding sites. The company senior management agreed with the author a time allocation of around half an hour at each site.

As a result the semi-structured questionnaire had to be short and concise without compromising the necessary information collection. The completed question analysis framework is shown in Table 3.12.

Research question/objective: To obtain opinions of key supply chain problems from a building site perspective and to compare/contrast existing findings from survey.			
Type of Research: Mainly of descriptive nature with some explanatory research i.e. quantify severity of likely problem areas.			
Investigative Questions	**Variable (s) Required**	**Detail in which data is measured**	**Check it's in**
What are the main supply chain problems for housebuilding sites; their causes and likely solutions	Name the three worst areas and corresponding causes and possible solutions	Name in order of importance – open unprompted question	Q1
Compare/contrast possible areas of waste as used in survey – allows comparison of findings	Opinion on 9 stated likely areas of inefficiency: Poor information to suppliers, re-quotes, time waiting for materials, number late materials deliveries, time waiting for subcontractors, stock levels on site, others	Rate on a scale of 0-100% situation regarding 9 likely inefficiency areas	Q2
Evaluate the key problem areas found in survey – allows comment on survey findings	Opinion on 8 stated key problems areas found from survey	Rate on a scale of 0-100% situation regarding 8 problem areas	Q3
Have the major problem areas been covered?	Any comments on supply chain management and general improvement	Open question	Q4

Table 3.12 Interview Question - Design Framework.

Source – author , based on Saunders (2003:290)

The interviews commenced with an explanation of the background to the research and the overall aims. The rich picture (Figure 3.10) was used to present the author's understanding of the current supply chain for this particular housebuilder, together with the principles that would underpin an ideal supply chain. In the case of the ideal supply chain that the flow of material and resources would occur with a minimum of inefficiency and waste, that people would not make mistakes, that everything would be perfect, and that high quality houses would be built to the build plan with no delays. This introduction was designed to set the scene for the questions that would follow and give the respondents a common baseline understanding and approach.

The sequence of the questions was vital, as it was necessary to gain an unbiased and fresh opinion of the problems before informing them of what had been previously found. It was therefore decided that that the open question seeking their three major problem areas would be asked prior to any closed (prompted) questions which included known potential problems.

It was also felt beneficial to have a mixed style of presentation and questioning with the site manager, that is to actually explain the reasons for the interviews and ask the questions verbally but also to show the questions written down as it would help understanding and create an environment of trust and cooperation.

3.6.4 Sample

With consultation and agreement from senior management of Goodbuild a sample of 13 sites out of a total of 21 within a particular region was chosen. The sites were spread geographically, some were traditional brick and block, one was timber frame dwellings, and some had a mixture of traditional and timber frame. All were supported by a combination of national and regional buying and supply chain management activities with the business working on a number of kits of parts per dwelling. The site managers themselves had a mix of different backgrounds. That is, some site managers only had experience with this housebuilder but others had worked for other companies previously. Information on site managers' names, site locations and contact details were provided by Goodbuild but because of confidentiality have not been included here.

It was agreed with Goodbuild that the selected site managers would be informed internally that interviews would be taking place, but that the researcher would be contacting them directly to arrange appointments in due course. This gave the exercise more credence and encouraged site managers to give it priority as it was clearly endorsed by the company. It also allowed the researcher to control arrangements and plan a visit schedule compatible with the researcher's and the site managers' commitments.

The author contacted all site managers via telephone, where a brief explanation and reason for the interview was given, dates and times were arranged and where necessary directions to the building site obtained. The 'Multi-map' web site was used initially with the known building site post code, but direction of site access in some cases was not obvious. The author stated that around half an hour would be required for the interview.

3.6.5 Pilot

Piloting of the interview form was carried out with colleagues at University of Glamorgan and at Cardiff University. A copy was sent to the regional supply chain specialist of Goodbuild and a practice interview was carried out on one of their sites with an assistant site manager (who would not be involved later).

The piloting process resulted in the following changes being made:

- Problems areas to be identifies in the first question were reduced from five to just three. This was mainly due to restricted time available with the site managers, but also to allow the respondents to focus on the major problem areas in more depth rather than on more areas but to a superficial degree.
- Additional areas for comments and examples for both Q2 and Q3 were added to allow richer qualitative answers to be captured.
- A full A4 page representation of the 'rich picture' was used to make the initial explanation of the research as it was easier to visualise and point out the detail than on the smaller version included in the interview form.

The final interview form as used is shown in Appendix 7.

3.6.6 Improvement Workshop Methodology

This section explains the reasons and methodology used in carrying out a workshop with a major housebuilder that considered and analysed in depth the findings from the previous site manager interviews.

3.6.7 Workshop Overview

It had been agreed at the time of carrying out the site manager interviews (July 2004) that it would be very useful, once all the site manager data had been collected and analysed, to look in depth at the causes of such problems and the potential improvements. The author had stated clearly that in order to gain useful information via a workshop a multi-disciplinary team from the regional office would be needed. Also, for the workshop to work at a useful depth it would need to be of a full day's duration. This would mean a major commitment by Goodbuild.

However, once the data had been collated, analysed and understood it was a very busy time for the Goodbuild and the end of year business pressure meant there had to be a delay. Eventually, after discussions with senior management about the timing, venue, and attendees, a workshop was agreed for some months later (February 2005). The venue was a specific regional office and the proposed attend were: Regional Commercial Manager; Senior Production Manager; Regional Technical Manager; Senior Regional Buyer and the Regional Supply Chain Manager.

During discussion, in preparation for the workshop, the author expressed the importance of representing the key areas of the supply chain, including if not an actual 'site manager' then someone who would be their representative and defend their position. Table 3.13 shows key responsibilities of planned attendees against job titles.

Attendee Job Title	Responsibility regarding Supply Chain
Regional Commercial Manager	Overall costing plans and monitoring; Quantity Surveyors; sub-contractor selection and monitoring
Senior Production Manager	Buildability, meeting build schedule, cost and quality, including - site managers,
Regional Technical Manager	Preplanning and preparation, including specifications and design
Senior Regional Buyer	All material and equipment procurement for site-build
Regional Supply Chain Manager	Co-ordination of supply chain, especially between national and regional aspects of all sourcing and supply.

Table 3.13 Workshop: Attendee Job Titles v Responsibilities. Source – author.

Prior to the workshop, a summary of the 'findings' from the site manager interviews was provided to the attendees. This consisted of summary graphs and charts on the answers to the three questions. It was also agreed that a colleague from Cardiff University would also attend and give support to the author in running the workshop.

A plan of 'expected outcomes' from the workshop was drawn; and it was decided due to the time restriction to consider and analyse the only two key problems which were determined from the site managers' interview results (section 6.3.3, Table 6.1) described below. This meant considering:

- Materials quality/quantity/incorrect (this was split into two areas - quality and quantity)
- Technical information/support

Drawing on the author's research into problem solving and improvement techniques and by discussion with other researcher colleagues the methodology for the workshop was created, and included the use of two specific tools; the Cause and Effect (fishbone or Ishikawa) Diagram (Bicheno and Catherwood 2005) and elements of the Failure Mode and Effect Analysis (FMEA) (Ford 1984). The reason for this choice is that, as shown earlier in the literature review, 'cause and effect' diagrams are a very useful and effective way of eliciting the potential causes of problems. For the situation concerned here i.e. having site managers' information of major problems, it is appropriate that a small team of 'experts' should discuss and analyse this information. This, combined with their knowledge and understanding of the specific housebuilding supply chain, leads to the determination of the most likely causes. The identification of likely causes for key problems could then lead logically to, and underpin, the formulation of improvement or prevention measures. Figure 3.12 shows the format of the cause and effect/fishbone diagram used in the improvement workshop. This is based on that used previously by the author in the automotive industry and is termed four M's and an E, representing five categories of methods; machines; materials; manpower and environment. In Figure 3.12 manpower is replaced with people. Other categories that can be used as the 'bones' of the fishbone diagram to help generate potential causes for the problem include 4 P's (Places, Procedures, People, Policies) and 4 S's (Surroundings, Suppliers, Systems, Skills (Bicheno and Catherwood 2005).

There are few tools that can be used to reduce the risk of problems or failures in systems or processes. However one methodology which is available is FMEA, with which the author was familiar, and had used, in the automotive industry ((Ford 1984)). Described as a Pareto type of analysis (Bicheno 2002), FMEA can be used in conjunction with tools such as Quality Function Deployment (QFD), flowcharting, cause and effect diagrams and others as appropriate. Once the likely causes have been identified then undertaking a FMEA can determine the major risks and recommended improvements.

3.6.8 Planned Workshop Process

The planned process for the improvement workshop was:

1. **Set the Scene** – author planned to give background and reasons for the workshop to the attendees, including brief reference to previously issued site manager 'findings'.
2. **Stressing a Team Culture** – the idea was to express the view that the attendees were the experts and it was essential to have a pro-active, collaborative, open, honest, and confidential, no-blame environment during the workshop. It was planned to allow the team themselves to decide the 'rules' as this would assist greatly in this activity.
3. **General Discussion of Information** - gained from the site managers' interviews. Raw data of site manager's problems, root causes and potential solutions was provided

so as to allow the workshop team to accept the findings to-date. The author planned to explain the process used in the site-managers interviews and refer to the semi-structured interview form used. This included how the use of a 'rich picture' (Figure 3.10) was used to ensure the site managers understood the overall supply chain and that processes, people, relationships, communication etc. would be considered in answering the questions. This would be a 'moment of truth' in ensuring the team bought into the information that formed the basis for the workshop; if it was felt that the data was unrealistic, biased, or not in sufficient detail the whole exercise would collapse. It must be recognised that the team members were (collectively) ultimately responsible for total support of the site managers and that any problems and blame would unarguably rest with someone within the workshop team.

4. **Brainstorming for Causes** - of these key problems. This was planned to concentrate on one problem at a time, and by using 'post-its' to allow each attendee to give a cause against a particular element of the fishbone diagram which would be drawn on a large wall chart (Figure 3.12 for typical illustration). This method is more useful than writing down collective comments, as more data is obtained via individual comments and ensure everyone has an input. This process would allow a large number of possible causes to be stated before any discussion or critique.

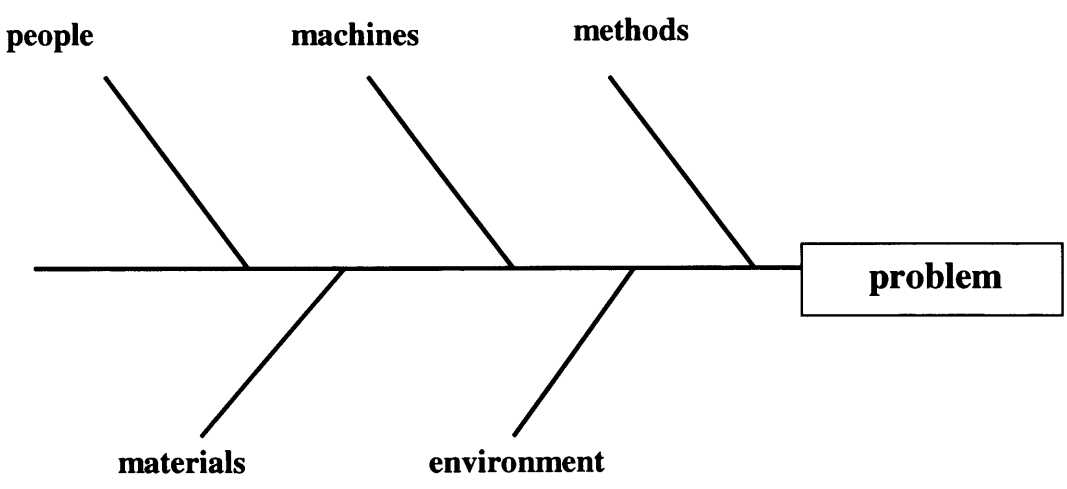

Figure 3.12 Fishbone or Ishikawa Diagram. Source - Bicheno and Catherwood (2005)

5. **Discussion and Critique** - to determine the most likely and important causes from a collective team approach; here each attendee's particular expertise would be useful. The main causes found would form the basis for the FMEA.

6. **Use of Agreed Causes in FMEA** - once the 2 key problems had been analysed for causes, the main causes found for each problem would be used in an FMEA style technique. This would involve assessing the occurrence, severity and detection probabilities to determine the risk priority number (RPN). Corrective actions for improvement of each cause could then be discussed and formed. Again, a large wall chart of the FMEA format was planned so as to create team involvement. The format decided is an abridged version of the most popular FMEA designs and is illustrated in Figure 3.13. It was likely that the term 'problem' would be substituted for 'failure' during the workshop itself.

Failure Mode	Effects of Failure	Causes of Failure	Occ.	Sev.	Det.	RPN	Corrective Actions

Figure 3.13 FMEA Format. Source - adapted from Ford (1984)
Note: Occ. means occurrence; Sev. means severity, Det means detection and RPN means risk priority number.

7. **General Discussion** - the final phase of the workshop would be a general discussion on the day and the outcomes found including what future work would be appropriate.

3.7 Summary of Methodology

This chapter began by presenting and discussing general research philosophy and research strategies. Following this exploration of theoretical and potential research methodologies it goes on to explain and describe in detail the mixed methodology and data collection approach, in chronological order, adopted in this work and outlined in Figure 1.2, Chapter 1. The chapter then leads the reader logically through the evolution and content of the main stages of the research beginning with an exploration of the general situation of housebuilding supply chains (an inductive approach) using an extensive literature review and the MCNS case study. Then, a survey is undertaken which used ideas and knowledge gained earlier to identify the common issues and problems (again, mainly an inductive approach). This is followed by a more focused (deductive) approach using interviews with site managers to evaluate and measure major problems regarding waste and value in the supply chain. Finally, working with practitioners from the industry in an improvement workshop these major problems are investigated to find solutions and methods of preventing waste occurring (inductive).

CHAPTER 4
STAGE 1 - MCNS CASE STUDIES FINDINGS

True genius resides in the capacity for evaluation of uncertain, hazardous and conflicting information.

Sir Winston Churchill

CHAPTER 4 STAGE 1 - MCNS CASE STUDIES FINDINGS

4.1 Chapter Overview

This chapter presents and analyses the results from the first in a series of three data collections. This first data collection comprises the initial investigation work carried out by the author as part of a major research project MCNS (Meeting Customer Needs through Standardisation) as described in the Chapter 3. Not all the findings from the original research work have been included here, but rather, a selection of those most relevant to the theme of this dissertation. The chapter concentrates on the application of improvement tools and techniques as described and discussed in the literature review chapter that can be applied to the housebuilding business process. Specific findings on housebuilding processes are presented, mainly in the form of process maps and recommendations for improvement for industrial partners. More general findings about broad supply chain issues are also included.

4.2 Application of Tools and Techniques

The TSM (Terrain Scanning Methodology, an adaptation of the Cardiff 'QuickScan' methodology) data collection and analysis methodology was conducted over a four month period starting in May 1999. The overall methodology is previously described in Chapter 3 Section 3, and supply chain partners involved in the research are summarised in Table 4.1

Company	Role
A	Manufacturer
B	Manufacturer
C	Main Contractor
D	Developer
E	Architects
F	Housing Association
G	System Integrator
H	Manufacturer
I	Consultant

Table 4.1 MCNS Partner Roles. Source – adapted from Barker et al (2000)

Table 4.2 shows the various tools and techniques used throughout the MCNS Project by the author.

Type of Tools	**Shown in**	**Purpose**
Questionnaires	Appendix 2	Initial data collection from all practitioners
Interviews	Appendix 3	Follow-up and confirmation of data
Process mapping	Figures 4.1/4.2/4.3 Appendices 8, 9 & 10	Understand and document business processes
Cause and Effect/5 Why's	Appendices 11 & 12	Analysis of root causes
Brainstorming	Figure 4.5 and Appendix 13	Analysis of findings for feedback presentations and recommendations
Input-output Diagram	Figure 3.11 (in previous chapter)	Project introduction and justification

Table 4.2 Tools and Techniques Used. Source – author

Examples of some of the tools in action are given in Figures 4.1, 4.2 and 4.3. An important feature of the TSM used in the study was the ability to transfer between high-level supply chain process maps as given in Figure 4.1 and lower level work processes as given in Figures 4.2 and 4.3.

Figure 4.1 highlights the hand-over and timings associated with the social housebuilding supply chain and provide an overall view of the MCNS supply chain situation. This top-level map includes all industrial partners except the private housebuilder and the consultant, as these are not normally involved in a typical social housing build.

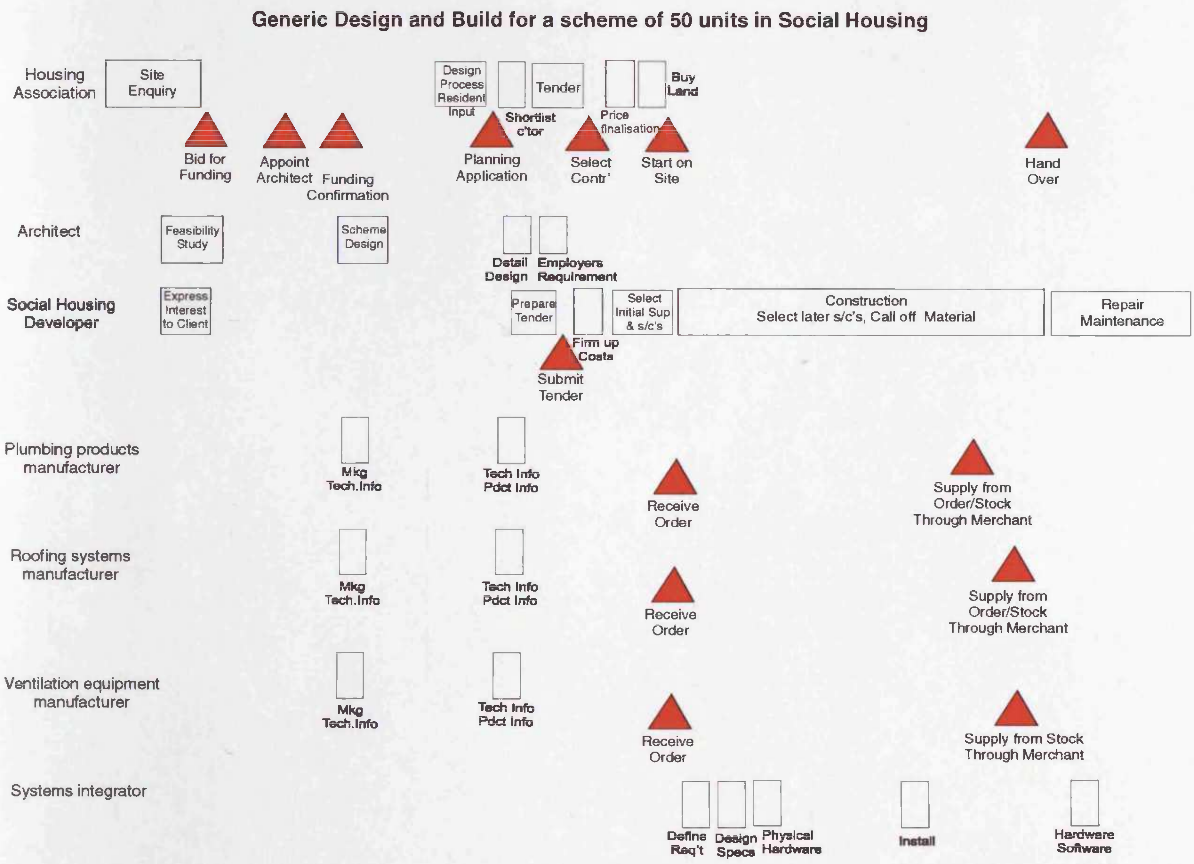

Figure 4.1 Top Level Supply Chain Process Map. Source (Barker et al. 2000)

Please note ▲ indicates a major trigger or activity point not inventory.

The process maps were drawn for all partners and these helped them understand their own and each others' processes. This understanding enabled questioning of activities: their existence, sequencing, value and the transformations undertaken in the supply chain's constituent flows. Other data including timings, stock levels, methods used etc.

helped to identify a route to potential improvement and elimination of wastes. Process maps also supported the project by facilitating dialogue between the research team (facing in) and the industrial participants (facing out).

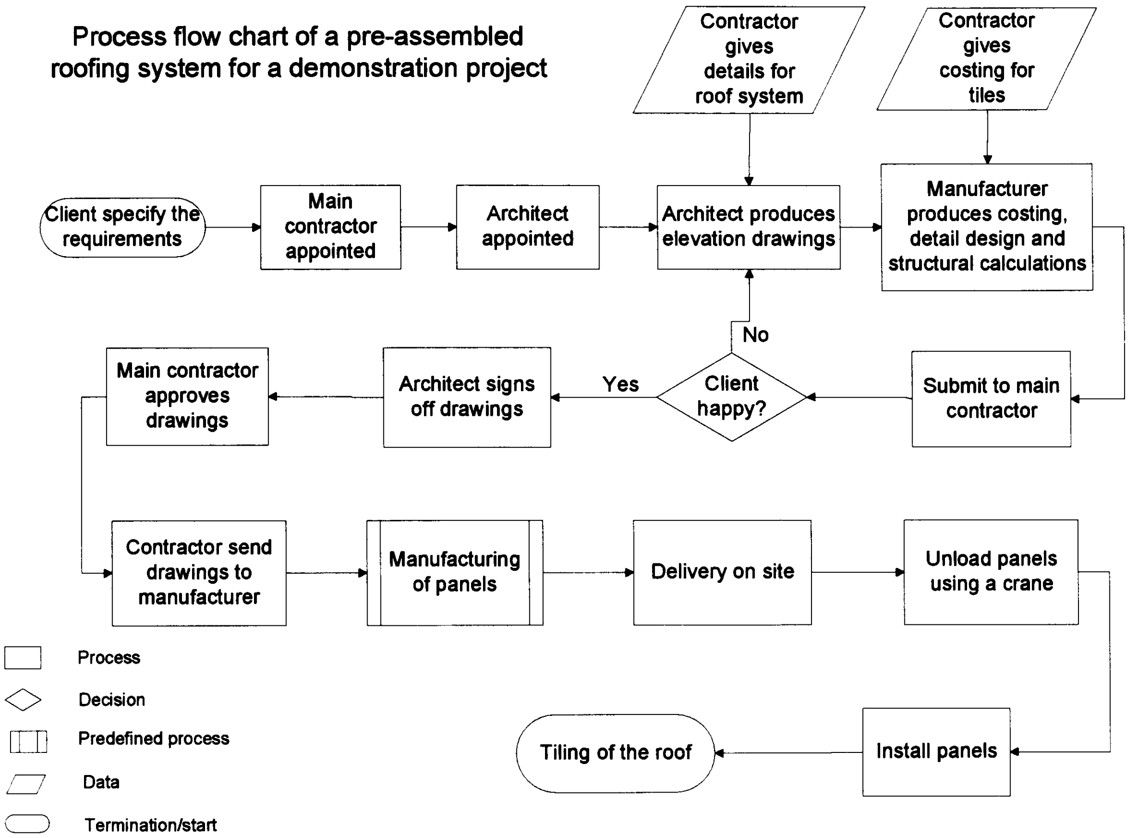

Figure 4.2 Lower Level Business Process Map - roofing. Source - Barker et al 2000

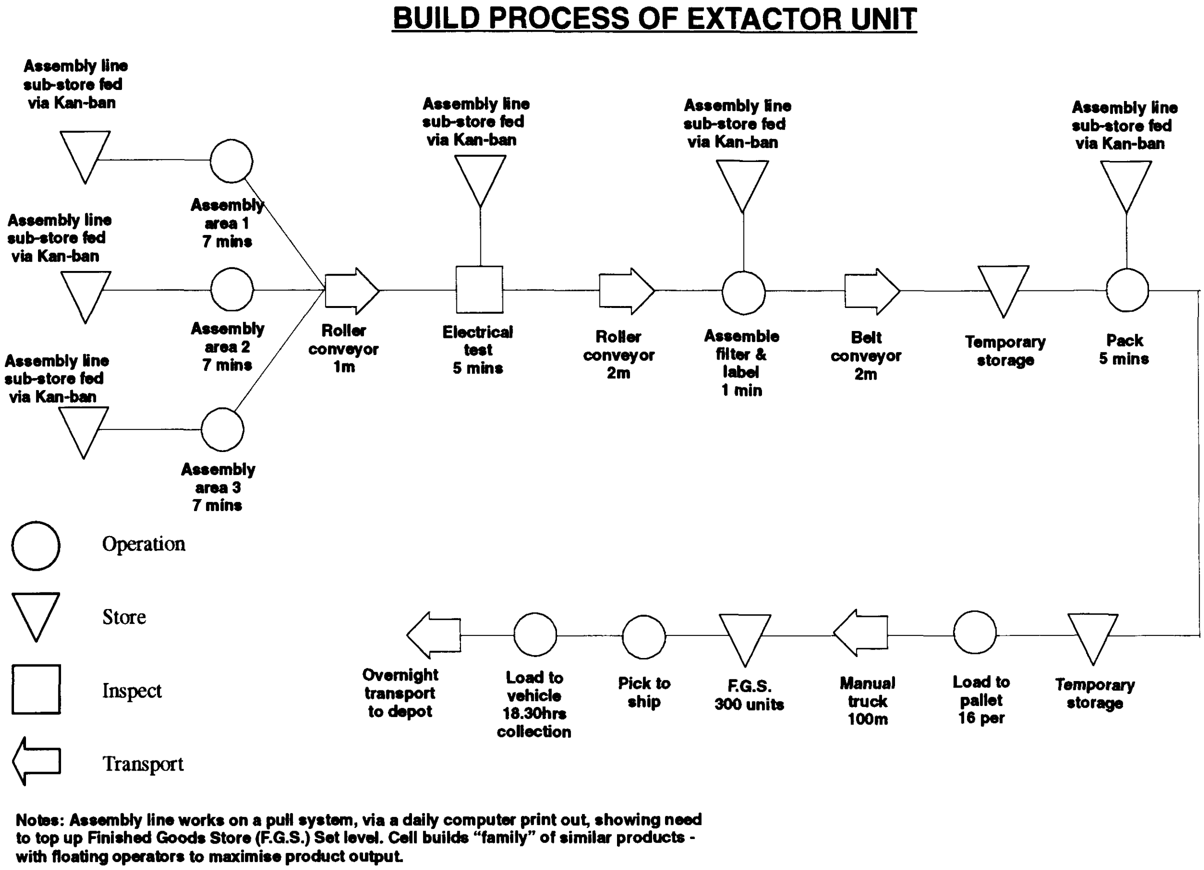

Figure 4.3 Lower Level Business Process Map - extractor fan.

Source - Barker et al 2000

4.3 Presentations to Partners

As set out in the previous Chapter Section 3.4, presentations of both the data collected and the analysis were made to each of the individual supply chain partners and also, in many cases (depending on the requirement for confidentiality), to the group as a whole. This openness and involvement was regarded as vital by the research team so as to gain confirmation and validation of the work carried out and to elicit further in-sights into potential improvement areas. An example of an individual feedback presentation is shown in Appendix 13; the name of the company has been removed to ensure confidentiality.

4.4 Findings

By employing subsequent recursive analysis, involving follow up interviews with the industrial partners for further information and clarification on the business processes, it was possible to determine cause and effect relationships for the problems highlighted during discussions and feedback presentations. Examples of two '5 Why's' analyses are shown in Appendices 11 and 12. The benefit of applying such techniques in this way is that independent and unbiased analysis can determine root causes which are crucial for implementing improvements.

Appendix 11 shows an analysis of why, in a Housing Association, "adversarial relationships with the main contractor" existed. Here, concerns about loss of power, lack of trust, previous experiences and management philosophy were intermediate causes, but it also shows that attitudinal and cultural issues were deeper causes.

Appendix 12 indicates that the symptom of "a non-partnership relationship" is due to "thinking it's not worth it" or "there is no need". However, the root causes are the "culture" of the industry and being "not aware of the benefits". No particular single player in the supply chain was responsible for the symptom, "nobody asked for partnership", but it was attributable to the interaction and dynamics between players and the culture in the total supply chain – very similar to that in Appendix 11.

These cultural situations or problems have been known to academics and industrialists for many years; but such an analysis indicated they still existed. The aim of the analysis was to raise awareness of the problems that needed to be tackled. Industrialists (it was considered) were more likely to believe and act upon information they know to be true as it was derived directly from them (their data that was collected) and their own opinions and experiences.

All the individual partners' TSM analyses were collated and a joint feedback session for all partners undertaken. A number of relevant practices were highlighted from each of the partners that indicated potential learning opportunities between them. The relevant or best practices identified were:

(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, as shown in Figure 4.4 was also presented for most partners. The matrix illustrates that those companies occupying the top-right are those with best practices in terms of fostering better relationships with customers and suppliers, and in maximising the opportunities of transferring information with their trading partners through the use of IT (although this may be more appropriate for some than others). The actual identity of each partner has been concealed to ensure confidentiality, although reference can be made to Table 4.1 for an indication of their role or business type. During individual feed back presentations each company was identified to itself, so it could see its own position relative to the other, non-identified, partners.

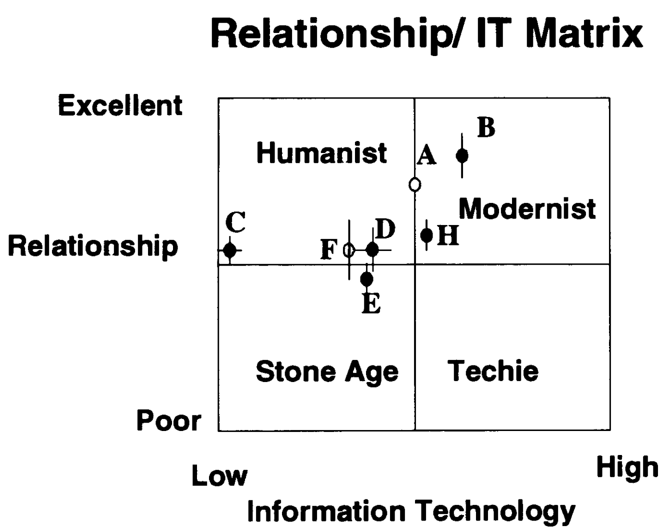

Figure 4.4 Partners Positions Regarding IT & Relationships.

Source – Barker et al (2000)

4.5 Housebuilding Specific Data

Data collected from all partners was useful in understanding the individual and overall business process of housebuilding. Specific data from the two actual housebuilders were particularly relevant to the aims of this dissertation. Visits to the private housebuilder included four different building sites, a regional office and head office. Visits to the social housebuilder included two different building sites, plus regional and head offices. Data were gathered from various supply chain management personnel, buyers, site managers and assistants.

The information from the housebuilders, resulting from the application of the various tools and techniques outlined above was very broad ranging and detailed and is not all presented in this dissertation, mainly because there is too much information and data and not all information obtained from this initial housebuilding investigation was directly relevant to inform the next phases of the research in this dissertation.
However, a summary of the type of data obtained is listed below so as to indicate the level of understanding gained during this initial research work:

- Demand knowledge and planning policies
- Material lists – BOQ (Bill of quantities)
- Site Build programmes – See Appendix 1for an example
- Supply base; sourcing strategies
- Vendor rating information
- Supplier lead-times and variability
- Group/Regional purchasing policies
- Top level cost breakdown of housebuilding sites
- Overall housebuilding process (via process charting) with durations
- Insight into key problem areas of build and supply

This information enabled the author and other researchers to compare and contrast the business processes within the MCNS supply chain with those of other businesses, including some construction, previously investigated (by the LSDG and the researchers themselves). It also allowed detailed feedback to the two housebuilding partners presenting their 'own' good and bad practices; with a comparison between the different approaches in building 'social' and 'private' housing. There were two specific areas of study that were relevant in the conduct of this dissertation: one was the mapping of the supply chains to compare 'brick and block build' with a 'timber frame approach', and the other was the analysis of the overall housebuilding supply chain in terms of probable waste areas. These two specific areas are now covered before moving on to more generic findings in the Stage 1 research (MCNS project).

4.5.1 'Brick and Block' and 'Timber Frame' Comparison

By agreement with the private housebuilding partner (D in Table 4.1), the author and other researchers were allowed to make on-site observations and data collection including taking photographs of their traditional 'brick and block' process and the 'combination timber and brick' construction technique. The team observed the building of a standard small detached two storey house where the frame consisted of pre-assembled internal load bearing timber walls and floors, together with the roof frame structure. This was assembled on the foundation slab, with strengthening joints fitted as appropriate for the first lift walls, and then the first floor assembled followed by the second lift walls and finally the pre-assembled roof structure. Subsequently the roof was felted and tiled giving a weather-proof shell in a shorter time scale than normal. Later the outer facing brick walls were built concurrently with the interior work. Even in wet weather the direction of rain would still allow one or two of the outer facing brick walls to be bricked.

On-site 'supply chain' diagrams for both construction methods were drawn, see Appendices 8 and 9. After discussions with the housebuilder and other research staff the author created an improved timber frame supply chain, see Appendix 10. The 'improved' or 'dream' timber frame supply chain consolidates much sub-contracted work (replacing plastering with dry-lining, bricklaying carried out by supplier), and allows a tradesman with a broader skill base to reduce the variability, complexity and uncertainty common with traditional housebuilding. Many of the ideas emanating from the literature review.

As can be seen from these diagrams the timber frame technique used by this particular housebuilder potentially reduces the overall construction duration by:

1. Having the timber frame walls pre-assembled in factory not on site.
2. Having a shorter time to construct the walls and roof (for traditional build both inner block skin and outer brick skin are completed before roof is constructed)
3. Allowing internal work to begin earlier because the roof is in place sooner.

As part of the MCNS Project and for individual research, further work was carried out on the comparisons between various alternative house shell systems and traditional brick and block; these alternatives included larger timber frame, stick built steel frame and light steel frame (Hong-Minh 2002).

4.5.2 Housebuilding Supply Chain Waste Areas

As outlined in the previous chapter (Section 3.4.5) the conclusions reached about the general processes employed and the principle methodologies that underpinned the various business processes and supply chains were validated by presentations and discussions with the partners involved. This process included the identification of waste/improvement areas for each participant or relevant area of the supply chain. Of particular use here was the participation of the private housebuilder, who was a national company operating on a regional level. Figure 4.5 based on Naim and Barlow (2003) depicts a 'rich picture' representation of the building site generic supply chain state, with the Site Manager playing a key role in the tactical running and day-to-day operations of all aspects of the build. The figure focuses on the major issues concerning the planning and control of the supply chain and its associated operational logistics.

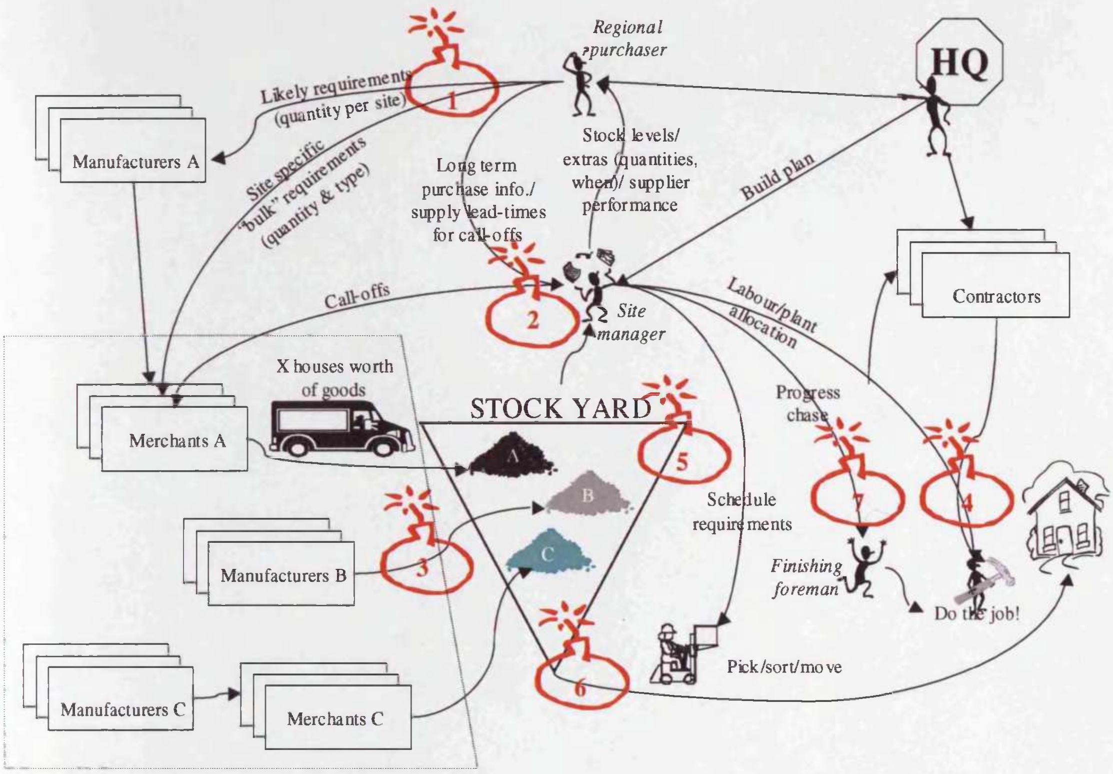

Figure 4.5 Rich Picture Representation of Housebuilding Supply Chain. Source Naim and Barlow (2003)

Whilst the picture is not meant to be comprehensive it does highlight seven critical 'waste spots' identified during research team brainstorming sessions where a pictorial summary of data gathered from participants and data about the relevant supply chain was amassed. These problem areas were validated by consensus with participants as already discussed in the previous chapter. This supply chain representation is realistic and using Harland's (Harland 1997) definitions of different supply chain configurations can be described as a hybrid encompassing a combination of dyadic, raw material to the final customer and network types, and includes information flows between the site and regional/national headquarters and the interface with suppliers, manufacturers, merchants and contractors.

The figure and its 'waste spots' provide a basis to illustrate the traditional problems of waste in housebuilding supply chains. These spots are now defined and discussed one by one. Table 4.3 shows a description of each of these seven waste spots.

Waste Spot	Description
#1	Little supplier management /involvement
#2	Lack of supply chain integration
#3	No time compression strategy
#4	Inability to rapidly re-configure. Need more collaboration between various sites and activities for each key supplier or sub-contractor
#5	Stock – excess cost
#6	Stock – material wastage
#7	Poor quality - waste should be prevented by better supplier management, quality operating systems, quality circle approach, need more collaborative team approach not blame culture

Table 4.3 Waste Spot Analysis. Source - Barker and Naim (2004b)

- Waste spot #1 (*little supplier management /involvement*) – At a regional and site level, loose purchasing agreements are made with manufacturers, suppliers and builders merchants but these are based primarily on price. There are no guaranteed time scales for actually buying and calling off the material. Involvement and collaboration is low, hence the suppliers have little vision of long-term market requirements.
- Waste spot #2 (*lack of supply chain integration*) – The site manager has the unenviable task of "juggling a number of balls" at the same time. He obtains a considerable amount of information but, without a clear strategy of how best to utilise the information, this becomes more of a detriment to the supply chain than a benefit. This finding concurs with theoretical studies about information transfer in the supply chain (Hong-Minh et al. 2000). Information transfer to the supply base is merely in terms of call-offs. To ensure supply chain integration trust needs to be developed in the supply chain and appropriate information needs to be shared (Edum-Fotwe and Thorpe 2001).
- Waste spot #3 (*no time compression strategy*) – Manufacture and supply lead-times are protracted. Supplier delivery performance is poor. A lack of partnership, and supplier development combined with an environment of confrontation yield a vicious circle of blame. Some suppliers get volatile short-

term call-off information from the site but no medium term demand requirements. They are therefore unable to respond adequately to site needs. Both the regional purchaser and the site are uncertain about the suppliers' abilities and impose unrealistic requirements. Late changes in site requirements occur and the supplier is unable to quickly respond. This is a common phenomenon in the supply chain, and has a detrimental effect upon the business's competitive advantage (Stalk and Hout 1990; Taylor and Bjornsson 2002).

- Waste spot #4 (*inability to rapidly re-configure*) – Similar to Waste spot #3, sub-contractors are selected by headquarters (again based on price rather than value) but are called as and when required by the site without medium term planning horizons. Due to the associated uncertainty (material delays, weather, or change of plan) sub-contractors commit themselves to a number of different sites without actually having capacity available to meet those commitments so the waste of waiting for materials or sequence to start is high - 10% to 30% of the time skilled trades can be waiting (Bicheno 1991). There can therefore be a poor response from the contractors when they are required on site.
- Waste spot #5 (*stock – excess cost*) – A clear symptom of the uncertainty in the supply chain is 'muda' (waste), in the more obvious forms of excess stock. It is necessary to build a stockyard of material due to the uncertainties or mura (inconsistency) mentioned in the previously described waste spots. This is merely a 'comfort' stock and has little strategic value. Sometimes material that is required will not be available from the stockyard, at other times it may be available. As the stockyard is often not properly engineered into the site layout or controlled it becomes merely a dumping ground for material. Material from the stockyard may or may not arrive to the right house, at the right time, in the right quantity. More than likely it will not be synchronised with staff availability.
- Waste spot #6 (*stock – material wastage)* – Because of having a store of unscheduled material, losses occur through damage, deterioration, being mislaid or theft and hence waste is high. The picking, sorting and moving of material is ad-hoc and due to poor material identification leads to waste time.

- Waste spot #7 (*poor quality*) – The ultimate symptom of the traditional and inefficient supply chain is the need for finishing foremen (snagging). The role is simply to ensure that corrections are carried out and hence the very task is a waste. The role progress chases contractors and materials. The finishing foremen identify faults and assigns re-work programmes (some sites even have pre-snagging checks). They often interact with the new homeowners and attempt to address the snag list and yet all the waste spots indicated previously, still exist. They are an indication that total customer value is poor and in particular, the in-process quality is at a very low level. The emphasis here could wrongly be on 'correct and cure' and not pro-active continuous improvement and 'prevention'.

Each of these waste spots is analysed in generic terms in Chapter 7 prior to an overall discussion section.

4.6 Generic Research Outputs

At the end of the MCNS research project, after major presentations, discussions and workshops had been held, a resume of individual findings was used to formulate generic outputs. These outputs, given below, tended to relate to the interaction of partners and the functioning of a supply chain as a whole.

Visits were also made to housebuilders in the USA whilst attending and presenting at the 7th annual IGLC conference in San Francisco (Barker et al 1999). These visits allowed the comparison of the build process as observed in the USA with that in the UK. The benefits of the visits were that different techniques of housebuilding were observed and discussions held regarding supply chain management and the use of internet for information technology in the USA.

4.6.1 Relationship/Trust/Culture - Changing the 'Mind –set'

Relationship/trust/culture was the way that the partners considered their working situation within the industry and the general attitude to change and improvement. The initial data gathered showed that there was a difference between manufacturing and non-manufacturing organisations. In Housing Associations, Architects, Contractors and

Sub-contractors, relationships were generally contractually based and thus indicate little trust. Reference to, or legal use of, contracts with penalty clauses was common. This adversarial state of affairs, although understandably, the result of previous bad experience, perpetuates poor cooperation and leads to un-competitiveness. However, change was happening in the industry and many companies were seeing the benefits of, and had started moving towards, better relationships or partnerships (Construction Productivity Network (CPN(819B)1998). The speed of this transition was slow in housebuilding due to several factors such as the market structure, intense competition, price dominance and the simplistic and repetitive nature of the process (Barlow 1999a). However considerable benefits, such as improved quality, meeting completion dates and reducing overall cost can be gained from a more open, pro-active culture (Hong-Minh et al. 2001) where continuous improvement is the norm. This was demonstrated by those companies in the top-right hand corner of the matrix (modernist) in Figure 4.4.

4.6.2 Process Orientation - Total Value Perspective

Several of the companies visited appeared to be working within a functional silo environment. In this situation, 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 meet customers' requirements more easily (customer focus). This emanates from the concept of 'value' being created throughout the product or service delivery process and allows the business to recognise what activities contribute added value in their total supply chain.

4.6.3 Communication and Learning

The final opportunity resulted from the ability to communicate with others in the industry so as to share experiences and expertise in a proactive way for common learning. Exchanging knowledge, working practices and even exchanging personnel was seen as a positive way to improve individually as organisations, and collectively as an industry. Several partners in the study had relevant or good practices and, as outlined by Hong-Minh et al. (2001), much benefit can be derived from sharing of best practice (gains), and the understanding of customers/suppliers' problems (pains).

The specific problems revealed during the examination of the industrialist supply chain and business process is outlined in Table 4.4. Here a selection of problems is shown to demonstrate the different categories of issues raised. As can be seen, specific hard process quantitative data as well as softer organisational findings were identified.

Problems	Category
1. Supplier delivery lead time is 20 times that of own final product to customer	Supply Chain
2. No formal customer satisfaction monitoring to allow continuous improvement	Organisational
3. Stock level of finished goods too high – 7 stock turns p.a.	Inventory
4. Four separate internal departments working in a "silo" (compartmentalised) way not "process oriented".	Organisational
5. No formal supplier selection and performance monitoring.	Supply Chain
6. High allowances (approximately 10%) for wastage – damage, theft and scrap.	Process
7. No electronic information medium employed	Process

Table 4.4 Examples of Typical Problems Revealed by TSM.
Source - Barker et al (2000)

Whether the issues uncovered during this research were considered of any importance to the organisations themselves was very much indicated by the nature of their response during the feedback presentation. Even more so, the importance attributed can be demonstrated by the actions taken, or indeed not, to implement the 'Quick Hits'. In addition this is indicated by the willingness (or lack of) to consider the potential for a longer term 'change programme'. Part of the core activities and aims of the research project was the participation of all the industrialists towards the goal of creating a supply chain, providing increased standardisation and off-site assembly for housebuilding. Even while en route towards this innovation, much preparation and improvement can be accomplished. Table 4.5 outlines some of the improvements recommended, and the reaction and subsequent action of the industrialists.

Company	Quick Hit Opportunities & Recommendations	Action Taken	Change Programme Recommendations	Action Taken
A	Increase number of standardised parts. Need to prove acceptable product performance over weather conditions	Agreed - currently on-going Agreed - wind tests already carried out, rain/leak at next installation	Control or own the higher echelon in supply chain Use CAD and EDI with next tier supplier. Reduce delivery lead time to 1 week	Partial-agreement awaiting strategic decision Agreed – work on-going Agreed - part of strategic plan
B	Improve operator involvement in reject analysis/quality circles Increase assembly aids – assy jigs/auto drivers	Agreed – this now occurs Agreed will be done for new modified product range	Use EDI for major suppliers and customers	Partial-agreement, plan to detail a benefits/cost study
C	Have a feedback mechanism for continuous improvement Complete employees training on partnering	Agreed – now instigated monthly reviews with Key Performance Indicators Agreed – now on-going	Reduce supply chain echelons, and supply base Consider use of IT for major suppliers for orders, scheduling and monitoring etc.	Reduce supply base, already in progress, was 300 now 60. Echelon reduction still on-going Now IT manager appointed – work on-going
D	Need generic material handling procedure and storage location Earlier involvement of Site Manager	Agreed – procedure and compound plan near completion Agreed – "pre-start meeting" now on site with Site Manager in attendance	Extend Show House opening times Increase customer choice: prepared list of options with extra costs Fix an achievable completion date	Considering - further trials planned Agreed to study – looking to introduce but long term policy Agreed to study – but long term policy
E	Need to introduce continuous improvement meetings Change workload measurement method from known man-hours	Agreed – planned to action Agreed - planning to have different method	Partnership culture must be improved, need better relationships with key customers and contacts	Agreed – real problem with day to day work but a possibility with housing sector
F	Form cross-discipline teams i.e. management-development Use IT for monitoring progress and severity of repair activities	Agreed – being carried out through "Best Value" programme Agreed – now using system acquired form Employers Agent	Create long term partnerships with contractors and Architects Change from a departmental approach to a Project approach of working	Partial-agreement, only Project partnership not Strategic Partial-agreement, already partial team approach of working

Table 4.5 The Main findings and Actions from the TSM. Note: To maintain confidentiality, names of organisations have not given and the description of benefits have been deliberately generalised. Source - Barker et al (2000.)

Subsequent to the involvement of the author with the MCNS research project several task forces and initiatives were set up and workshops held where issues raised by the research were discussed and analysed. Many of these culminated in a change of approach and policy by the industrialist involved.

4.7 Resume of Chapter

In summary this initial MCNS research was an integral part of the inductive and grounded theory approach adopted by the author in understanding housebuilding processes and supply chains. It would be difficult to provide an exhaustive list of the many and various sources, methods and issues that contributed to a greater knowledge base on which to move forward but an attempt to list key outcomes is provided here:

- Business processes: by observing, collecting much data and mapping the processes of the industrial partners a greater understanding of the housebuilding processes was acquired.
- Understanding the MCNS partners, including their awareness of supply chains and cultural standing, helped form the basis for the subsequent two stages of research. Figure 4.4 was especially useful in understanding relationship issues that are fundamental to supply chain integration and effectiveness.
- The rich picture representation of the housebuilding supply chain Figure 4.5 (Naim and Barlow 2003) and the corresponding identification of 'waste spots' compared with the literature review and the value and waste definitions have provided an understanding of the key issues for this dissertation.
- Particular supply chain improvement opportunities, as shown in Table 4.5, have been recognised and presented to the industrial partners. More generic and higher level improvements to relationships, culture and value perspectives were recommended. An important issue in Table 4.5 is that in the case of Company D, the private housebuilder, the importance and involvement of 'site managers' was recognised, as was early site meetings at which site managers were present. The importance of the foreman or last planner was stressed in the literature review chapter and this appears again during the next two stages of this research.

- Following this initial research Company D, the private housebuilder, was subsequently subjected to mergers and consolidation with other housebuilders. This meant that this company actually became part of a larger company which was included in the survey covered in the next chapter. This larger company is also the housebuilder which was used in collaborative fieldwork in the final phase of this dissertation research (Goodbuild). There is therefore a continuity and logical link between this initial exploratory phase and the final research outcomes achieved by this work.

CHAPTER 5

STAGE 2 - NATIONAL UK HOUSEBUILDERS SURVEY

Particulars are not to be examined till the whole has been surveyed.

Dr Samuel Johnson, Preface to Shakespeare

CHAPTER 5 STAGE 2 - NATIONAL UK HOUSEBUILDERS SURVEY

5.1 Chapter Overview

This chapter shows the results obtained from the UK national housebuilding survey conducted in 2003. The research methodology and data collection tool design is presented and justified in Chapter 3 Section 3.5.

In the text below a description is given of the administration process, the response rate and then the results are presented in the order in which the questions appear in the survey questionnaire itself. Some explanatory discussion of results is included here, along with some critique and justification of the questions used. The main critical analysis and discussion appears in Chapter 7. Refer to Appendix 4 for the final questionnaire and cover letter used.

5.2 Summary of the Administration Process

The key activities and events surrounding the development and administration of the survey are presented below in chronological order:

- Drafting of the survey questionnaire took place between June and July 2003.
- Comments from work and academic colleagues were sought and appropriate amendments made to the draft questionnaire. The draft was submitted to the research supervisor in early July 2003.
- Pilot testing of the questionnaire with a major national housebuilder took place in July 2003. The company undertaking the pilot testing of the questionnaire was the same company participating in the collaborative fieldwork described in Chapter 6.
- Initial telephone calling to those companies identified in the final listing took place in early July 2003. This is described in detail in Chapter 3 Section 3.5.5; See Appendix 6 for final listing of companies.
- The survey questionnaire initial posting took place on 21st & 22nd July 2003, with target return date of 8th August 2003.
- Progress chasing of replies via telephone was conducted between mid-August and mid-September 2003.

- In response to the telephone follow up an additional posting of questionnaires (38 in total) followed between mid-August and mid-September 2003, with a amended target dates to improve response rates.
- Questionnaire replies were received at University of Glamorgan where they were opened, checked for readability and completeness and the data entered into an Excel spreadsheet.
- Where necessary respondents were contacted over the telephone to complete any missing data.

5.3 Response Rate

The response rate at the initial target date was 39 from the 131 questionnaires initially sent, that is, only 30%. This was considered to be unacceptable and that it could be improved. Consequently an attempt was made to contact all potential respondents by the telephone to ensure that they had received the questionnaire and to remind them about it in order to give them the opportunity to respond and thus improve the rate of return. The coding system employed to identify potential respondents was invaluable here, being used to inform the follow up telephone exercise over a period of approximately three weeks. The result of the progress chasing was that many said they had returned the questionnaire but they had not arrived. Many more said that they had never received the questionnaire and cover letter in the first instance. In response five further batches of questionnaires were re-posted to housebuilders and in some instances e-mail was used. In total, a further 38 questionnaires with individually and appropriately worded cover letters were sent out. Of these 38 re-sent surveys, eight were returned. In addition, during this period of progress chasing a further five replies to the original posting were also received.

Overall then, the final return rate was 52 out of 131 i.e. 40%, with 33 separately named housebuilders being represented. Thirty-six respondents requested and were sent, a copy of the overall results.

5.4 Results

The results for each question are presented below, in the order they appear in the questionnaire. A summary of the question or the actual question itself is included for clarity. The survey raw data is presented in two Excel spreadsheets included as Appendix 14 and 15. Appendix 14 covers the general questions, whereas Appendix 15 is designed specifically for questions 17 and 18. This separation was required due to the complexity of questions 17 and 18 and need for interpretation, categorisation and comparison with previous work in understanding the likely/potential problems and solutions relating to the housebuilding process. The findings were analysed using the Excel software and the graphs and charts generated from this analysis.

Within this results section reference is made mainly to the general data obtained and all results are summarised in Appendix 16. Reference is also frequently made to the specific results of the 'Top 10' housebuilders who replied, (i.e. those who built the greatest number of dwellings in 2002) and as appropriate to the 'Remainder' (i.e. the 42 respondents who built the remaining dwellings). This has been done to provide a contrast between results and allow analysis of any trends and tendencies. All results for the 'Top 10' respondents are shown in Appendix 17.

5.4.1 Section 1 – General Information

Q1 – Please state approximate Turnover in £'s for 2002

A1 - Of the 52 replies five did not answer this question. Total turnover from the 47 who did respond was £7,850 millions. This compares with £16,171 millions total for the top named 25 housebuilders (Anon 2005a) i.e. the survey represented 49% of top 25 housebuilders total turnover. Out of these top named 25 housebuilders 12 are represented in the survey responses. Average turnover for the 47 replies was £167 million. The 'Top 10' respondents represented 74% (some £5774 millions) of the total survey turnover, with an average of £577 million. The 'Remainder' of the respondents represented only 26% of total turnover with an average turnover of £56 million. This question along with the next two provided an indication of the size of the company, so as to allow deeper analysis.

Q2 – Maximum number employees in total for 2002

A2 – Only one returned questionnaire failed to give an answer to this question. Analysis of the results revealed an average staff level of 475 with a range of 7150 maximum and 15 minimum. The 'Top 10' respondents represented 54% of the total survey staff numbers with average staff level of 1312; with the 'Remainder' having 271 on average.

Q3 – Number of houses completed 2002

A3 – Only one questionnaire did not provide a reply to this question. The average number of house builds for those who did reply was 964, with a maximum of 12,850 and a minimum of 70. Total build by the sample, 49,170 in all, represents some 56% of total built by top 25 housebuilders and over 27% of all private dwellings built in the UK in 2002/2003 (ODPM 2003). The 'Top 10' respondents represented 77% of the total survey built in 2002 with an average build of 3773; with the 'Remainder' having average of build of 272.

Q4 – In what housing sector does your company work.

A4 – Responses to this two part question showed that the respondents built mainly in the private sector. Some 33% were pure private builders, with 67% doing both private and social. Of the 67% respondents doing both, the level of private building was of 84% and the level of social building was 26%. The results showed that no builders who responded undertook only social building. Overall the housebuilders that replied built 87% private dwellings. Regarding the 'Top 10', only two were purely private builders with the other eight building both types: whilst the 'Remainder' had 15 purely private builders and 27 who built both types.

The purpose of this question to check that all those participating in the survey were actually 'private' housebuilders and that no purely 'social' builders had inadvertently been included. The industry does have many 'mixed' housebuilders and this gives validity to the percentage results obtained here.

Q5 – Is your company part of a larger housebuilding group?

A5 – The results of this two part question showed that 73% were part of a larger group but of these 32% bought regionally, only 5% bought by head office, with 63% buying by both means. It should be noted here that when the 'Top 10' housebuilders are considered then only one is not part of a larger group, and buying both regionally and by head office is the most common method (see Appendix 17). With the 'Remainder' 69% were part of a larger group, and of those that were, 38% bought regionally, 7% by head office and 55% both.

Responses to this question, along with Table 3.9 (in Chapter 3 Section 3.5.5) show that there is considerable merging and consolidation within the industry with an overall move to fewer, but larger, companies.

Q6 – Does your company have a Supply Chain Management Strategy?

A6 – This question was one of the core questions at the heart of the survey and the results showed that very few had a definite strategy. The results are shown as a pie chart Figure 5.1. Here the majority (67%) admitted to have some form of strategy (definitely or in some ways), meaning that the rest, some 33%, had no known strategy (i.e.4+19+10%) – demonstrating an area of great potential improvement. The 'Top 10' respondents showed slightly better results in all aspects, with more (percentage) definitely having a strategy, with more 'not yet' answers, and fewer 'no' answers. However, only 2 of the 'Top 10' had a definite strategy; consequently the 'Remainder' showed an even lower likelihood of having a supply chain strategy.

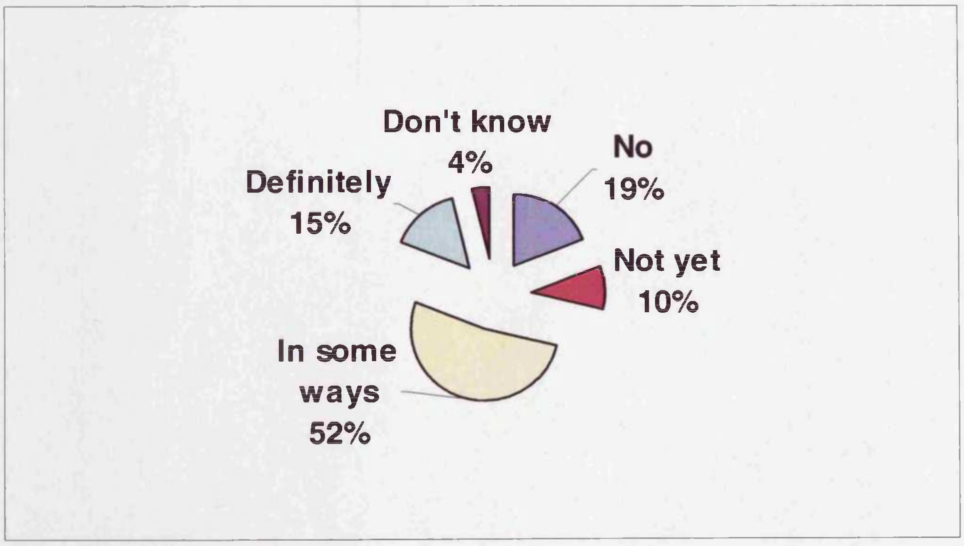

Figure 5.1 Q6 - Existence of a Supply Chain Strategy. Source - author.

However in analysing this answer it could be that there are different perceptions and interpretations of Supply Chain Management definitions amongst respondents which could affect the way in which they answered. It would have been possible to include a definition in the questionnaire but this would have made the question very long and so possibly reduce the likelihood of response. It must also be said that in this and other similar questions respondents may wish to avoid showing their company in a poor light and so this may result in a positive bias in their response; answering 'In some ways' is an obvious way of accommodating this stance. The 'Top 10' respondents had a 20% 'not yet' answer which was twice that of the total respondents indicating a possible move towards having a supply chain strategy.

Q7 – Please state number of dedicated people involved in controlling and managing your supply chain (not just buying/purchasing)

A7 – While results of this question indicate an average of 13 dedicated staff there is a great variation, between 1 and 60. On reflection during the analysis stage, the author has concluded that this question was not phrased adequately to elicit what was actually required. The aim of the question was to identify numbers of specific supply chain staff – not buying staff. However the wording could be, and probably was, interpreted to mean both supply chain and purchasing staff! The replies do not show any results of value. However answers to Q1-Q8, Q12 and Q14 give a good indication of how companies valued supply chain management which was the essence of what sought by Q7.

Q8 – Please indicate general awareness of supply chain.

A8 – Answers to this question revealed an overall lack of awareness of what was considered to be three key aspects of supply chain awareness and improvement. The construction industry media and related publications refer extensively to Key Performance Indicators (KPI's) as both a stand alone means of improvement and also as a means of benchmarking companies. The same can be said for Construction Best Practice Programme (cbpp) and Rethinking Construction, both of which are high profile government initiatives aimed at improving construction. The author was convinced that proactive, supply chain aware companies would be familiar with these concepts to some degree and would understand the abbreviations. In fact, not knowing the abbreviations was actually an indication of not being aware. The results, in Figure 5.2 show that 30%

of respondents had not heard of KPI's and in the case of 'cbpp' this figure was 70%. This demonstrated an important gap of knowledge in the industry.

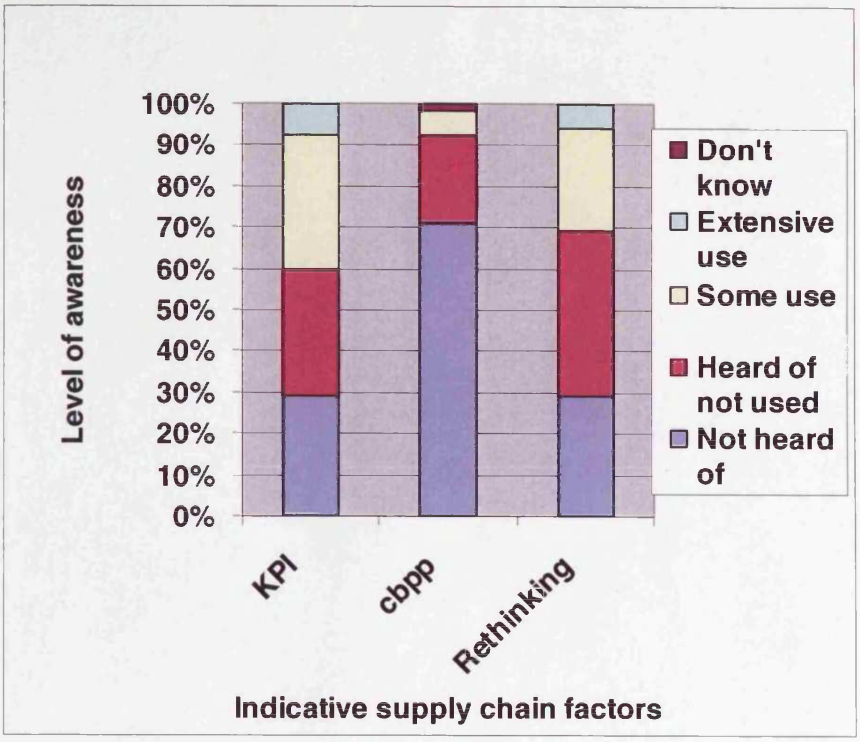

Figure 5.2 Q8 Awareness of Supply Chains. Source – Barker and Naim (2004a)

Again when considering the 'Top 10' replies to the survey, the overall awareness is better, with all of the 10 having at least 'heard of' KPI's. The 'Top 10' also had a smaller proportion of the 'not heard of' answers with the other two measures, but the percentages are very similar to the overall results. The 'Remainder' is slightly worse.

5.4.2 Section 2 – Relationship Related Issues

Q9 - Please indicate the approximate total number of suppliers and sub-contractors used in: 1997 & 2002.

A9 – The reason for the inclusion of this question was to determine if housebuilders were, like many other industry sectors, rationalising their supply base. This could mean a reduction in the number of relationships with suppliers and sub-contractors (subcontractors) but those becoming deeper relationships. The results showed that over the 5 year period (1997-2002), the average number of suppliers changed from 309 (31 responses) to 395 (42 responses). Overall this shows that the supply bases have actually increased. This could be due to a number of reasons including the consolidation within the industry.

The results also showed that a few housebuilders, and these were larger national ones, have a very large number of suppliers and sub-contractors, i.e. over 2000. One explanation why respondents did not answer this question may be that they do not know the number of suppliers, showing a lack of knowledge about their supply chain. There may well be a valid reason in some cases (for example, mergers and acquisitions) for not knowing numbers in 1997, but current supply base figures should be known. The 'Top 10' respondents had considerably more suppliers and sub-contractors in both 1997 and 2002 (averages were 839 and 1429 respectively) than the total sample shown above. There is also a very large increase over this period, which indicates too large a supply base and a potential area for improvement. Again mergers and acquisitions could well be the reason for this situation. The 'Remainder' had averages of 155 in 1997 and 151 in 2002 showing a small decrease in supplier numbers.

Q10 - Please describe the kind of relationships you have with your most important 3 suppliers and top 3 sub-contractors as a whole.

A10 – A fundamental requirement of successful supply chain management is to have a good working relationship or a partnership with the most important suppliers and subcontractors. This question was aimed at assessing these relationships by using nine different measures derived from the literature review, and previous research by the author, including the MCNS Case Study Project into supply chain relationships, as well as reference to other similar work.

The results for relationship descriptors as in Figure 5.3 (the first 7 parts of this question, 10a – 10g) show that the perception of trust and commitment is high, which theoretically is a good basis for a useful working relationship. However, cost transparency, research and development (R&D) and earlier supplier involvement (ESI) are low. A concern with the posing of this question was the possible lack of or variation in, respondents' understanding of some definitions and meanings. This was especially relevant in the case of cost transparency, where although a two way cost openness strategy is most desirable, the question could have been interpreted as applying to one way activity (only the buyer sees the supplier's costs). This latter form is often more prevalent in traditional adversarial relationships (Baily et al. 2005). The 'Top 10 respondents' show a better result than the total sample. The 'Remainder' was very similar to the overall results with the levels of trust appearing good but the application of this trust, low.

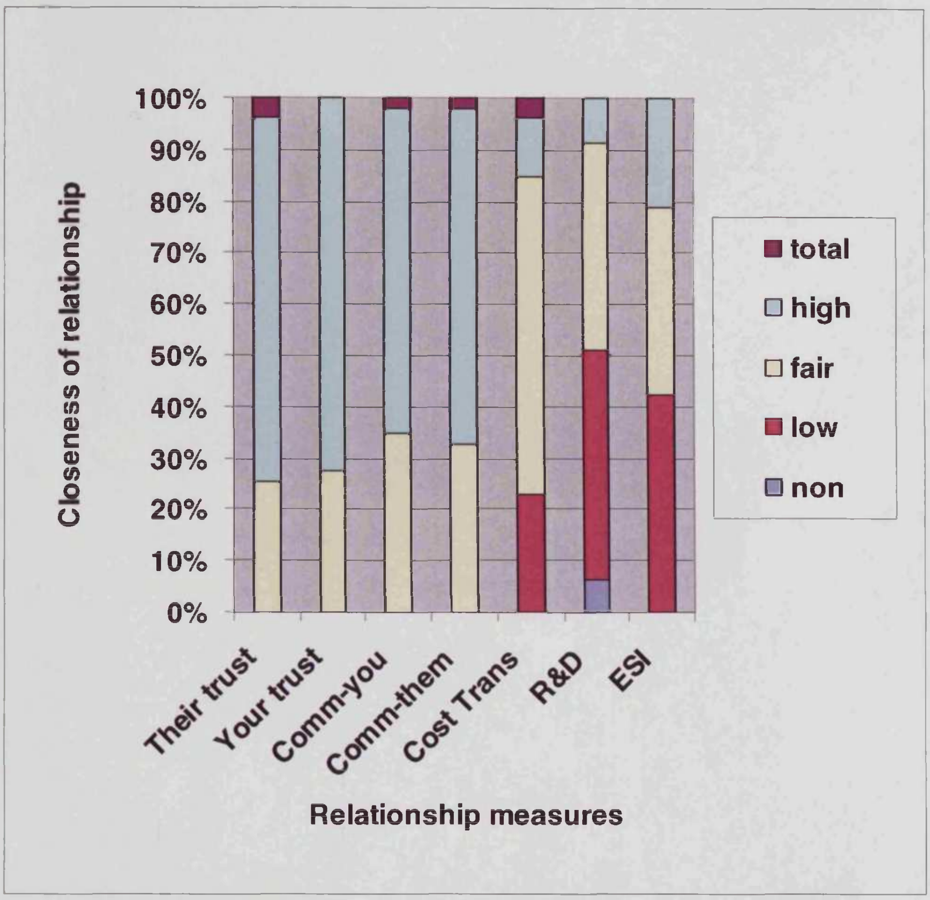

Figure 5.3 Q10 (a-g) Relationship Issues. Source – author.

The eighth part of this question (10h) sought to understand the degree of formality of the relationships. The premise here is that the industry could benefit from a move away from a purely traditional and contractual culture. The results in Figure 5.4, show very few totally contractual relationships but reflect that the majority are of a 'mix' which will include contractual ones. It must be stressed here, that this question is aimed at only the top three suppliers and top three sub-contractors where it was thought the best most intimate relationships would exist but the results appear to show that this is only partially the case. The 'Top 10' respondents showed no 'contractual' relationships, an improvement on the total sample, but showed only 20% 'informal' relationships (i.e.

80% were mixed) which reflects strongly the existence of the traditional culture for some contractual and possibly litigational agreements.

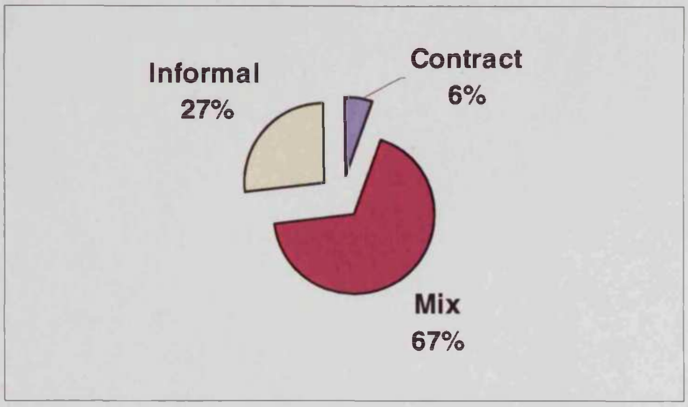

Figure 5.4 Q10 (h) Types of Relationships. Source – author.

The final parts of this question (10i & 10j) aimed to measure the supplier/sub-contractor relationships by the duration of their existence. The results showed a reasonable duration of the relationships, on average some 7 years, median value (mid range) around 5 years. The author believes this can reflect healthy relationships so long as performance is being measured. There is, however, a wide spread with some relationships having been in existence as short a time as 6 months while others were up to 12 years. Again changes in supply base due to consolidation of the industry must be considered as a possible factor in this. Six respondents did not answer this question fully. The 'Top 10' exhibited a longer duration of relationship, with an average and a median of over 8 and half years. The 'Remainder' had slightly lower figures of around 6 years and 5 years respectively.

Q11 - Please describe the general situation regarding "partnering" in your company.

A11- This question, as Q10, is also concerned with partnership, in this case by asking about three separate aspects. A definition of partnership was included in the question to aid respondents' common understanding and thus aid validity and reliability. The first part (11a) aimed to measure whether the companies were seriously in favour of partnership working. If this was the case, then the author believed that there would be an overall policy for partnerships which should be executed via procedures. The premise is that the more the industry perceived 'partnerships' as useful then the more procedures for them would exist and be used.

The results, as shown in Figure 5.5, show that more housebuilders 'definitely did not use' procedures (14%) than those that 'definitely did' (12%). As expected, the majority indicated 'sometimes' to reflect their situation. This leads logically to consider if a partnership is so important why use procedures only sometimes? This may be indicative that the true understanding of partnering and its benefits are not fully appreciated. Interestingly, the 'Top 10' showed a lower tendency to use partnering procedures, with a 'never' figure of 22%, whilst the 'Remainder' aligned more closely with the overall results.

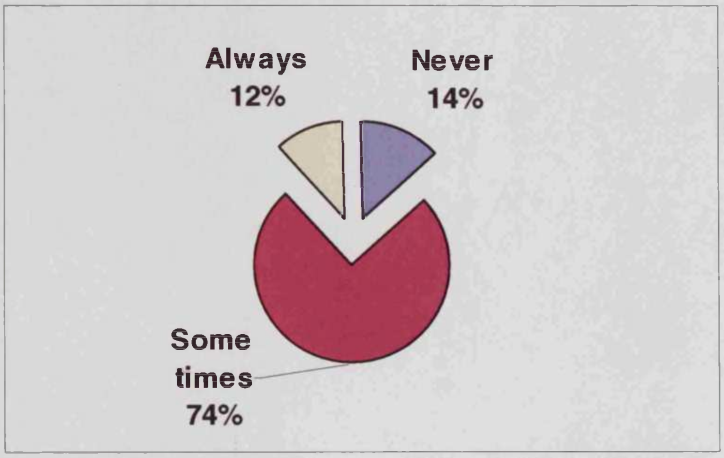

Figure 5.5 Q11 (a) Use of Procedures for Partnering. Source – author.

The second part of this question (11b) asked the respondents to class partnering as being strategic, or a mix, or short term. This is an important question as the concept of 'Strategic' versus 'Project' partnering is very topical and highly debated within the construction industry, with leading theorists recommending strategic long term relationships, especially for housebuilding. The results, Figure 5.6, show that the sample contacted perceives partnering as only partially strategic. Just over a third (36%) felt it warranted being termed strategic and this is quite different to many exemplar manufacturing industries. The question gave an interesting result in that the 'Top 10' results appears worse than the 'Remainder', in that the 'Top 10' respondents results showed that 0% felt partnering was short term, but nevertheless only 13% felt it was definitely strategic. In contrast, 17% of the 'Remainder' felt it was short term and 41% strategic. This anomaly may be due to only 8 out of the Top 10 answering this question but even if these two had felt it was strategic it would mean only 3 out of 10 agreed (30%) which is still lower than the 'Remainder'. This then shows a lack of clarity and presents an opportunity for further work.

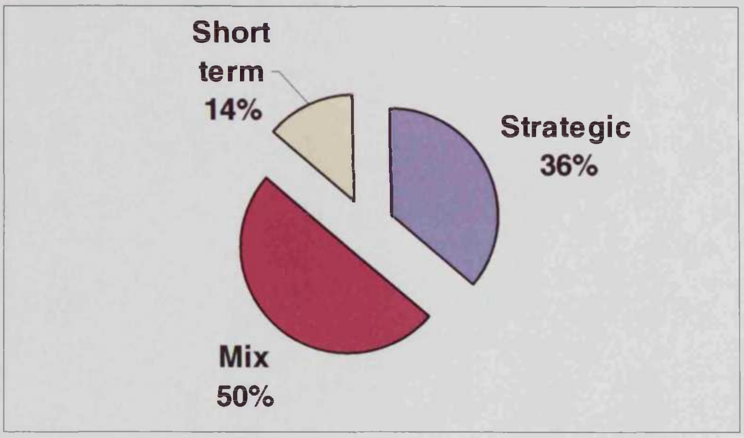

Figure 5.6 Q11 (b) Classification of Partnering. Source – author.

The final part of Question 11 (11c) "state number of partners you had in 1997 and 2002" measured the progress, or otherwise, in moving towards a partnership policy. The greater the increase in numbers of partners during this 5 year period the more partnership was being accepted. This question reflects the fact that many theorist and Government initiatives recommend a general move towards partnering.

The results showed that on average the number of partners had increased from 9 (based on 36 replies) to 19 (based on 40 replies) over the 5 year period. Interestingly, for 1997 there were 16 entries of 0 indicating that there was no partnering in place at that time for those respondents. Overall results show that there has been a definite move towards partnering in the sample questioned. The meaning of the low number of replies in uncertain, but could mean respondents are again not as aware of their supply chain situation as they should be. The 'Top 10' respondents showed average number of partners had increased from 13 (7 replies) to 33 (7 replies), an even better set of results than the overall results. A concern with the responses to this question was that some respondents could have understood 'Partnering' to mean a relationship with the client rather than what was intended, the relationship with a supplier or sub-contractors. However, the author believes that private sector housebuilding, is not as familiar with client partnering as, for example, the general construction industry or social housebuilding and so this probably did not have affected responses.

5.4.3 Section 3 – Supply Chain Related Issues

Q12 - Please indicate your company's general awareness of supply chain issues (tick as appropriate):

A12 – This question was similar to question 8, and together they measure general supply chain awareness. The factors listed here represent important supply chain management principles and the tick boxes indicate the level of knowledge and use of these principles. The results in Figure 5.7 below show that on average the respondents have a low level of knowledge and use of these principles. Of particular concern is that about half of the replies indicate no knowledge at all of three of the four principles. It is clear that the respondents are not involved with supply chain management to any level of sophistication. Just in Time (JIT) was the most widely known and used principle, with some 20% indicating 'extensive use' and 50%, 'some use'. All respondents answered this question. The 'Top 10' respondents exhibited no higher usage overall, see Appendix 17.

There is here some potential for misinterpretation of the terms – but this misinterpretation itself is an indicator of the respondent's level knowledge and understanding. An example of this is what is meant by JIT? How much is known of the Toyota full supply chain theories and applied, compared with a more shallow understanding that is exemplified by "we only order things when we need them".

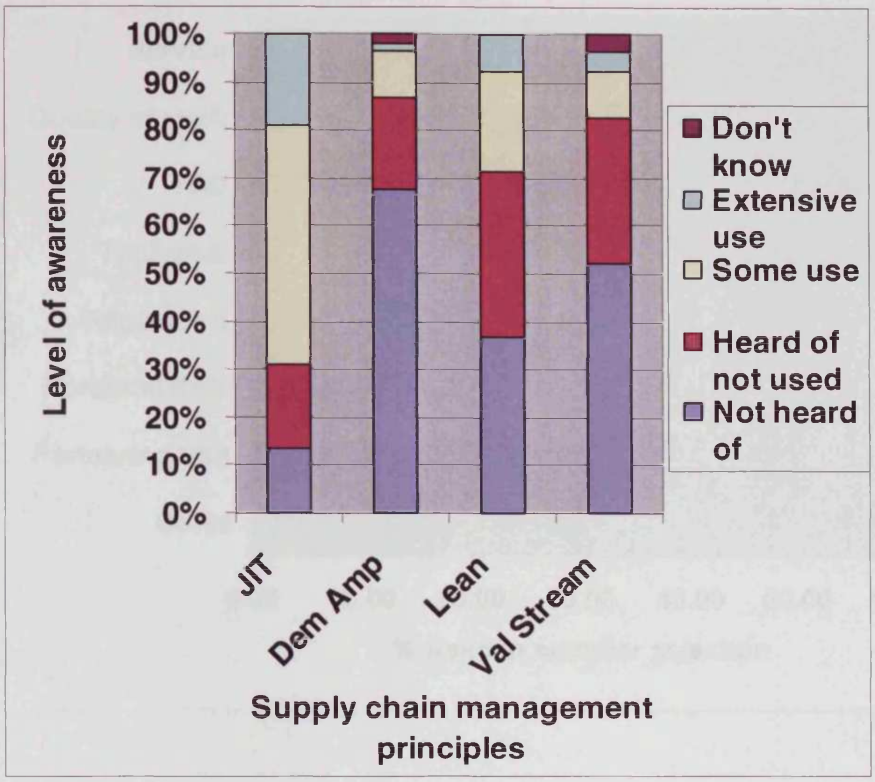

Figure 5.7 Q12 Awareness of Supply Chain Issues. Source – author.

Q13 - Please rank the following criteria for choosing your key suppliers (1 most important; 8 least important)

A13 – This question assessed the importance respondents attributed to a number of different factors for supplier selection. The Housing Forum Report (Housing Forum 2001) stresses that price does not equal cost, and neither does cost equal value. This question was designed to see the relative importance of these selection factors to survey participants. The results in Figure 5.8 show that the respondent housebuilders have not chosen cost as their prime selector, but indicated that 'service' and 'quality of work' were more important. This compares favourably with the findings from the Housing Forum see Figure 5.9, where price was most critical. The results for the 'Top 10' respondents and consequently the 'Remainder' do not differ from the overall response.

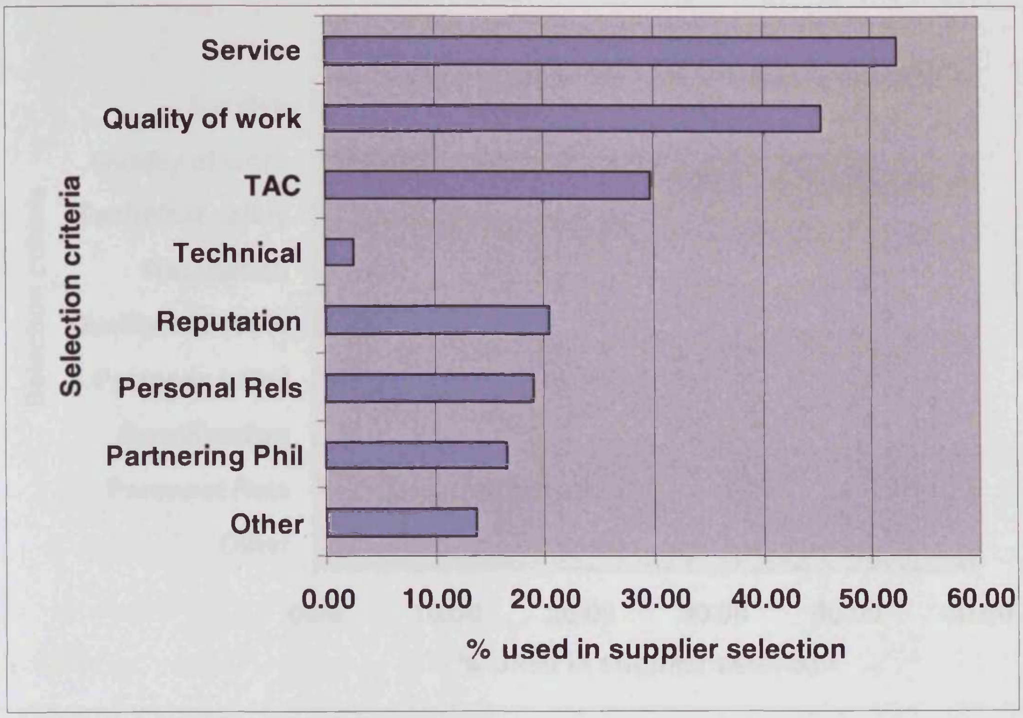

Figure 5.8 Q13 Supplier Selection Factors. Source – author.

On reflection, including 'price' as one of the factors in the question would have improved the question because it would have enabled a direct comparison to be made with Housing Forum (Housing Forum 2001) results. This would have indicated that the housebuilders in this survey were more enlightened than those taking part in the Housing Forum survey of 2001.

Figure 5.9 Supplier Selection Factors from Housing Forum 2001.

Source – Housing Forum (2001).

The data from this question was analysed making the assumption that ranked values had an equal and linear scale amongst the replies. This approach has some statistical flaws (Oppenheim 1996:155) as the gaps between each will vary; however it does have the benefit of allowing an average opinion to be presented. Values of importance were reversed to show the most important factor having the largest (not smallest) value, so allowing the above comparison with results from the Housing Forum. Of the 52 survey returns 44 provided an answer to this question. A problem with this question which emerged when responses were received was that 11 respondents did not 'rank' the factors but actually 'rated' them. On these occasions the results were converted into rankings by the author. Seven respondents also felt there were 'other' criteria not specified in the question. Only two of these went on to identify these; one being 'geographical' and other 'national recognition'.

Q14 - Does your company have formal procedures on measuring your supply chain performance?

A14 – This question returns to the issue of whether the company manages its supply chain, and as such is similar to Q6 although asked in a different way. It was possible that many respondents would want to reply in a positive way (possibly falsely) and so an open question followed asking for a description of the procedures which would really check the situation with specific examples.

The results in Figure 5.10 show that in over half of the replies companies do not measure their supply chain performance and only some 37% (i.e.19 replies) definitively do. The 'Top 10' display better results with only 40% (4 replies) not measuring performance and half 50% (5 replies) doing so. Although these 'Top 10' are much better than the total sample their replies still show a lack of supply chain management sophistication bearing in mind these are amongst the largest housebuilders in the UK. What is more revealing and disconcerting is the analysis of the description of the procedures used. Within the 19 'definitely do measure performance' replies most refer to general meetings and reports as the basis for the performance measurement. Very few mention key supply chain performance indicators such as overall delivery performance, delivery and on-site defect rates, overall inventory level and total acquisition cost or supply chain cost. The 'Remainder' of 42 replies were worse than the total and the 'Top 10' with 57% and 33% respectively.

Considering the eight respondents who indicated they had a definite supply chain strategy (Q6), six of these did say they measured their supply chain performance in Q14.

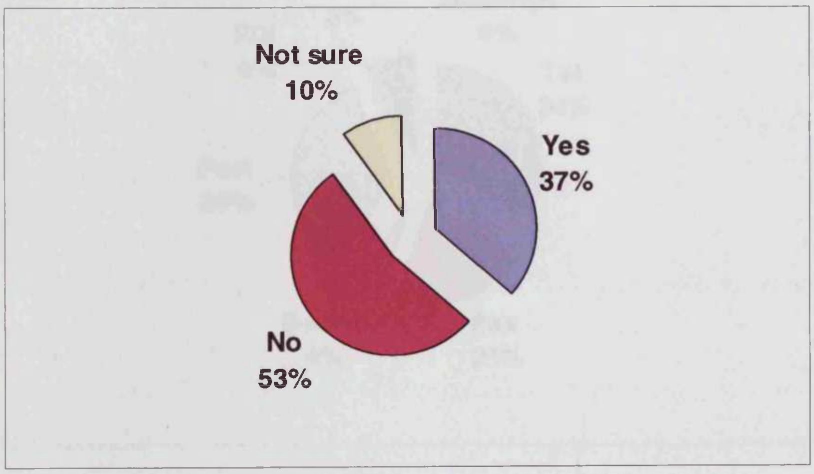

Figure 5.10 Q14 Procedures on Measuring your Supply Chain Performance.
Source - author.

Q15 - Please indicate how you communicate with your 3 most important suppliers/subbies. Please give approximate percent for each category.

A15 – This question was aimed at understanding the level of sophistication used in communication, and relates back to the work in the MCNS Project (Chapter 4, Section 4.4, Figure 4.4) where use of technology was assessed by considering various means of communication. Most manufacturing sectors make some use of the technology of e-commerce, be it with e-mail or complex internet systems. The question assumed that there could well be a range of different communication scenarios from just placing orders or similar transactions to more information rich collaborative type communication. The question therefore asked about two different environments, offering the same choice of communication method ranging from the more conventional methods of post and telephone to leading edge internet and e-mail. Rather than using tick boxes, percentage allocation was used, so as to enable an indication of the relative usage of these different communication methods.

The results (Figures 5.11 and 5.12) yield several interesting points. Firstly, that not only are traditional methods of post and telephone by far the most popular, but also that leading edge e-commerce methods of EDI and internet are not used at all. E-mail, now very popular in many industry and manufacturing sectors, was used very little by the housebuilders.

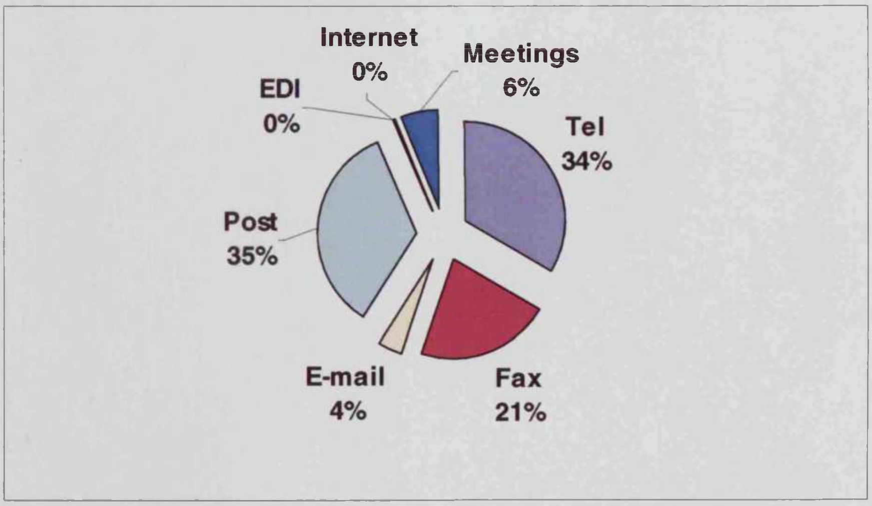

Figure 5.11 Q15 Technology Adoptions via Communication (Orders, invoices & payments). Source - author.

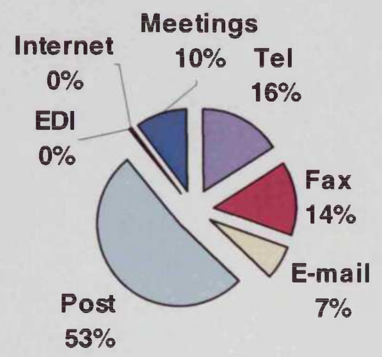

Figure 5.12 Q15 Technology Adoptions via Communication (General information, drawings, tenders & quotes). Source - author.

A major area of improvement in the supply chain is in the more efficient transfer of information and data. Larger and complex amounts of data such as drawings and specifications can be sent via e-commerce almost instantaneously with less likelihood of errors. The results here indicate that the housebuilders are some way behind most other industry sectors in this respect.

Completion rate for this question was quite high with 48 responses to the first part and 46 the second. Four respondents used ticks and rather than actual % as requested. These were ignored in overall results shown. The 'Top 10' showed no greater use of e-mail, internet or EDI than the overall replies. This was unexpected as in the MCNS project (see previous chapter, Section 4.4 Figure 4.4) there was a significant difference in the use of communication technology between industrial partners.

Q16 - As an indication of supply chain integration, please indicate your company's situation regarding the following:

A16 – This question sought to establish the level of integration within the housebuilders supply chain. As explored and expanded in the literature review good integration is vital for good supply chain performance. Figure 5.13 below, shows that in regard to the companies in this survey integration is around half of what could be achieved; a 0% means no integration and 100% would be total. The best score is achieved in the area concerning respondents understanding their key suppliers or sub-contractors. Considering that these are crucial to the housebuilders' supply chain, a result of just over 60% is a very poor result. The overall view of the results for this question shows that there is only about half the integration there could be and that there is great room for potential improvement (the red areas). The 'Top 10' showed no better integration being only just over 1% more integrated on average. It is possible that respondents have tried to portray their company in a good light in their responses to this question. If it is the case that their abilities have been exaggerated then the situation may be even worse than it appears.

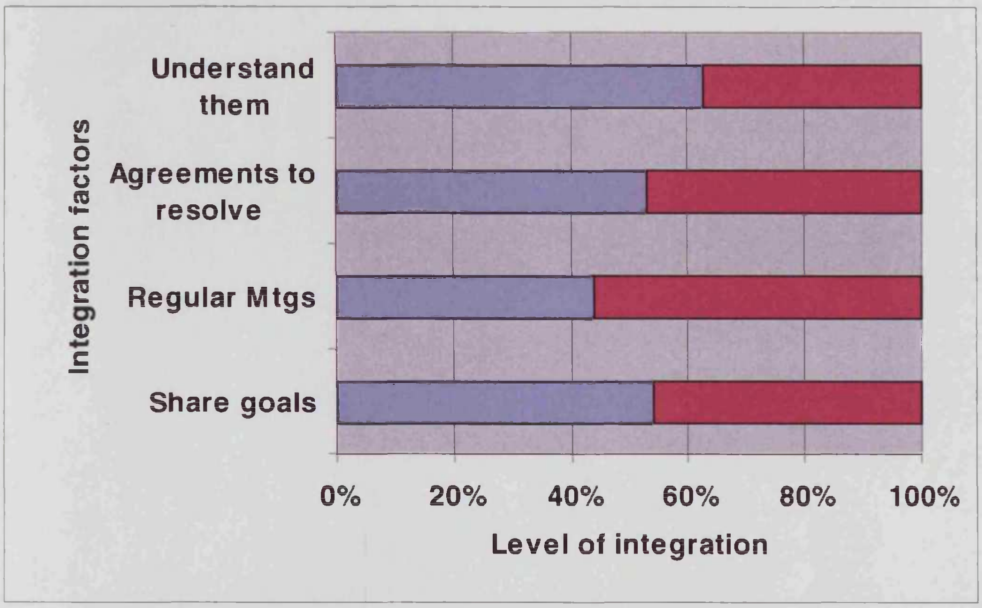

Figure 5.13 Q16 Indication of Supply Chain Integration. Source - author.

5.4.4 Section 4 – Supply Chain Improvement

Q17 Please consider the following "rich picture" and identify these 5 areas by annotating the diagram with 1 – for the greatest, through to 5 for the least significant.

A17 – This question was the one whose contribution and value proved to be of greatest concern. Only 24 out of 51 respondents answered the question by annotating the rich picture with the locations of where they thought the greatest problem areas for their supply chain were. The idea for this question emanated from work done in MCNS Project, Chapter 4, Section 4.5.2, relating to the identification of 'waste spots' (Barker and Naim 2004b). Although asked to indicate the severity of the problem with 1 to 5, many did not do this, and for those that did their meaning was not clear. Table 5.1 below summarises the responses which were provided and while it may give some indication of the location and severity of supply chain problems the author is convinced that to draw any useful findings from this data would be unreliable. Note that raw data for Q17 & 18 are in Appendix 15.

Areas of Rich Picture - annotated	1	2	3	4	5	Total	Rank
Note: only 24 out of 51 annotated the diagram!							
Head Quarters (HQ)/Regional buyer		2	2	2		6	
Contractors	4	4	3	2	3	16	1
Labour and Plant	1	2		1	2	6	
Site Manager	6	1	1	1	2	11	3
Call offs	3	1	1	1		6	
Manufacturers/Merchants		3	2	1	1	7	
Stockyard & stock levels	2	2	2	6	3	15	2
Build plan	3			2	3	8	
Long term purchase information, supply lead-times for call offs	2	1	2		2	7	
Schedule requirements		3	1	1		5	
Likely requirements/site requirements	2	1	2	3		8	
Miscellaneous	1	2	5		3	11	
Totals	24	22	21	20	19	106	

Table 5.1 Q17 Indication of Supply Chain Problems on 'rich picture'. Source - author.

Q 18 Improvement of supply chain – please describe below these 5 problem areas and how you are currently try to improve them.

A18 – Here open questions were used to try and gain an unbiased account of the major supply chain problems and what improvements were being tried. The results were descriptive and initially meant some 62 different problems were listed. Using the author's previous experience and knowledge from this and other research projects in housebuilding these were reduced to 8 problem categories by clustering similar problems together plus a miscellaneous category, as shown in Table 5.2.

Rationalised Problem Categories	1	2	3	4	5	Total	Rank
Stock level, late/poor deliveries	8	11	7	10	7	43	1
Scheduling and build plan related	7	2	5	5	4	23	2
Call offs and Site Manager related	6	3	5	5	3	22	3
Supplier/subcontractor problems	4	6	2	0	5	17	4
Communications	4	3	2	2	2	13	5
Design/Specification/buildability	3	4	3	0	1	11	6
Labour	3	3	2	2	1	11	7
Group/Regional buyers/purchasing information	1	0	1	2	6	10	8
Miscellaneous categories (Finance, equipment, pre-start mtg.)	0	0	2	0	2	4	9
Totals	**36**	**32**	**29**	**26**	**31**	**154**	

Table 5.2 Q18 Supply Chain Major Problems and Improvements.

Source - Barker and Naim (2004a)

This particular exercise of rationalisation was potentially subject to, and could have been affected by, the author's epistemological stance. The process and outcomes were discussed with colleagues and researchers in this field who endorsed the approach and outcomes as valid.

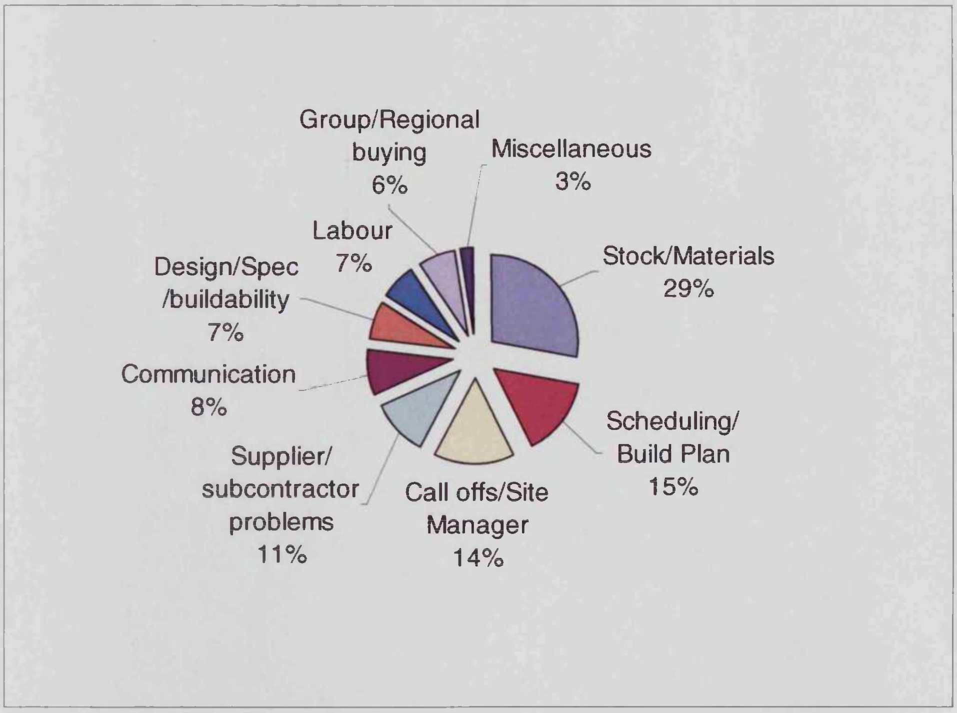

Figure 5.14 Q18 Supply Chain Major Problems. Source - author.

When the results of the totals from Table 5.2 are compared by converting scores to percentages, as shown in Figure 5.14, then 'Stock levels and late/poor deliveries' (i.e. material problems), accounted for 29% of problems cited by the respondents and was hence ranked as the highest problem category area. This was followed by 'scheduling and build plan issues' (15% of problems cited) and 'call off and site manager issues' (14% of problems cited). This provides a strong indication that stock levels and poor/late material deliveries are a major problem in the supply chains. What is also significant is that from the Table 5.2 this category had the highest rating across all the severity classes. The 'Top 10' results given in Figure 5.15 demonstrate greater problems with 'Call offs/Site manager' but fewer with 'Scheduling/Build' plans and with 'Stock/Materials'.

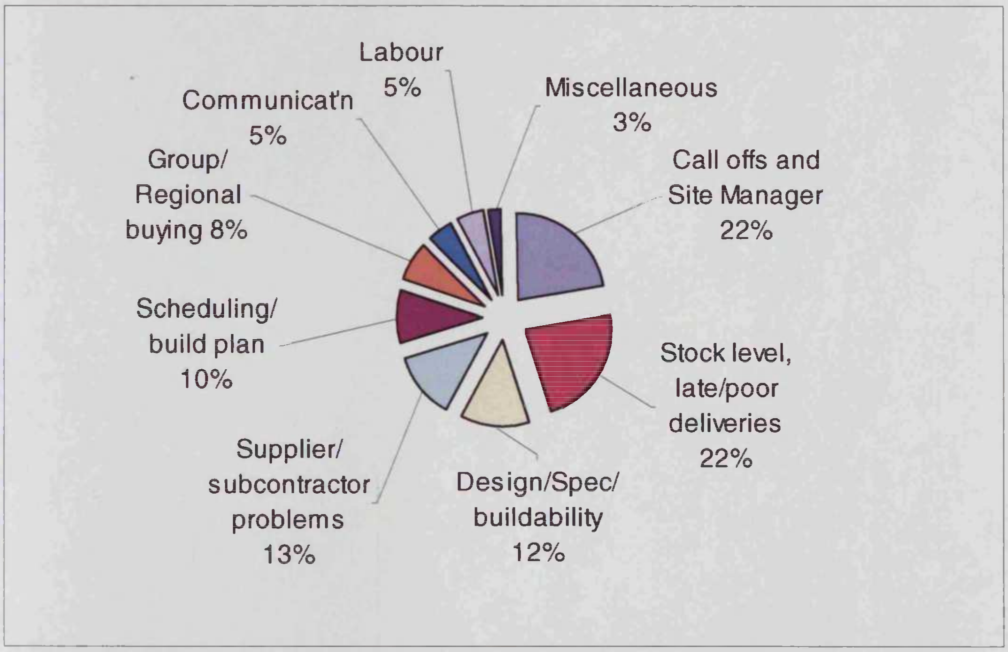

Figure 5.15 Q18 Supply Chain Major Problems – Top 10. Source - author.

When asked about current improvement methods, respondents gave 93 answers compared with 154 for the problems. These responses were all categorised irrespective of the severity rating of the corresponding problem. The results in Figure 5.16, show that 'supplier relationships and purchasing' was the main target area for improvement (37%) followed by 'planning and organising' (29%) aligning with the problem categories identified in Figure 3.15.

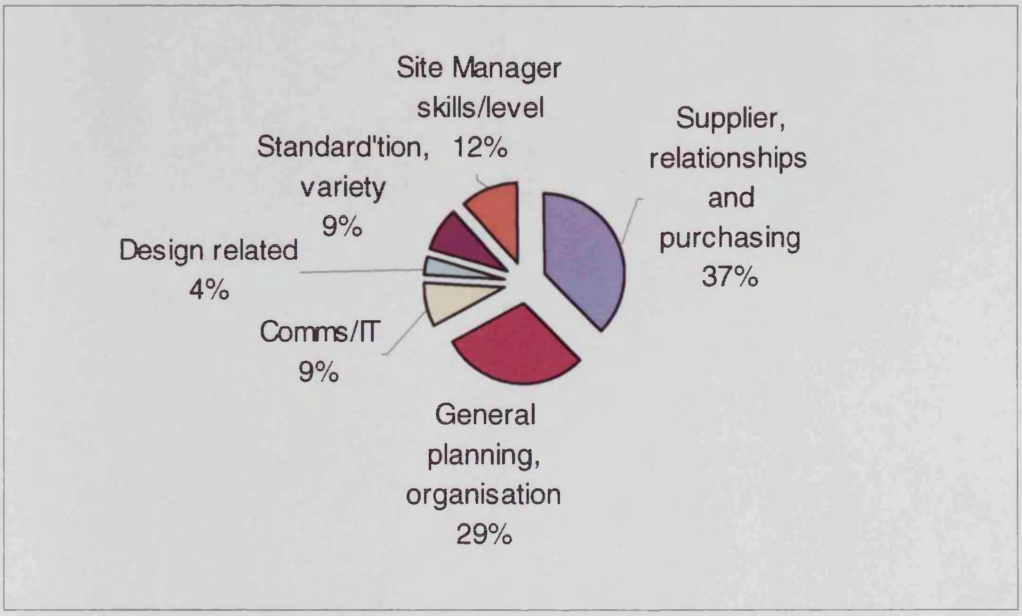

Figure 5.16 Q18 Supply Chain Major Improvement Areas. Source - author.

When considering the 'Top 10' respondents, see Figure 5.17, there is a reversal of the two main areas for improvement with 'general planning, organisation' leading 'supplier relationships'. Other categories are similar to the overall results except for communications/IT where this is not being seen an area for improvement. This finding conflicts with the answers to given for Q15 where the 'Top 10' were very similar to the overall responses and showed little use of current technology in communications.

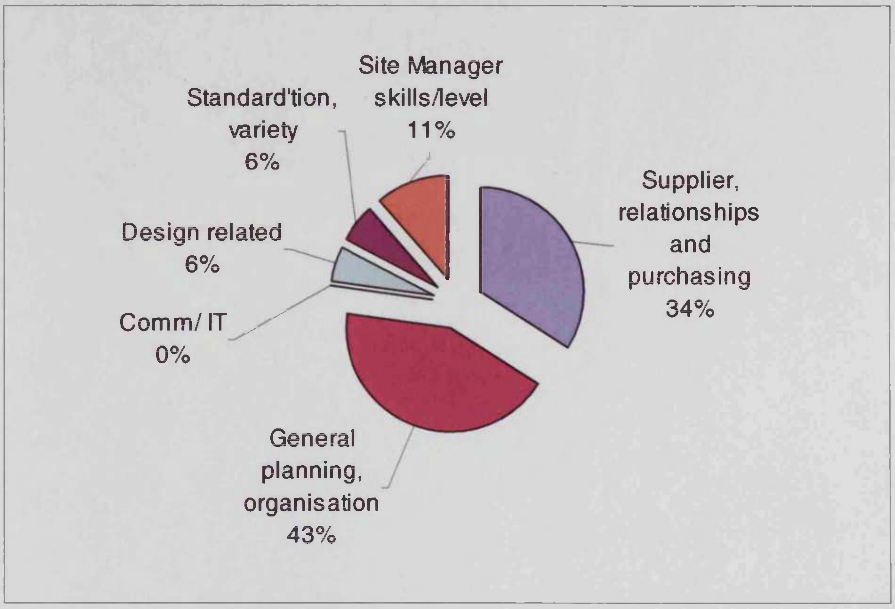

Figure 5.17 Q18 Supply Chain Major Improvement Areas – Top 10. Source - author.

As in Q16 there is the risk that respondents might exaggerate their company's abilities and current situation. In addition the question may have been improved by asking for root causes as some respondents gave other more general problems i.e. reported the effects rather than causes of problems.

Q19 Please indicate how good your company is regarding the following activities. i.e. 100% means very poor - the worst, and 0% means ideal perfect situation – cannot be improved upon!

A19 – This question was a closed prompted question asking participants to rate the severity of particular problem areas. It was crucial that this question followed the open questions Q 17 & 18. This was because Q19 listed problem areas which risked 'leading' the respondents if it had been asked before to Q 17 & 18. The question was framed in such a way that the respondents aligned the 100% as being very poor with a high amount of waste in the supply chain and conversely that 0% would mean little or no waste. Figure 5.18 shows that snagging costs and poor communication were ranked the poorest activities (only 60% or less of the ideal performance). That is, there was gap of around 40%, being the potential for improvement. The important issue here is understanding the underlying causes for the problems. For example, snagging is really caused by many other activities including poor materials, poor workmanship and a poor quality culture. An overall view of the results for Q19 shows that there is nearly a 40% (the red areas) lack of performance and therefore there is great potential improvement in all the supply chain activities mentioned. This is of great concern and importance for the industry.

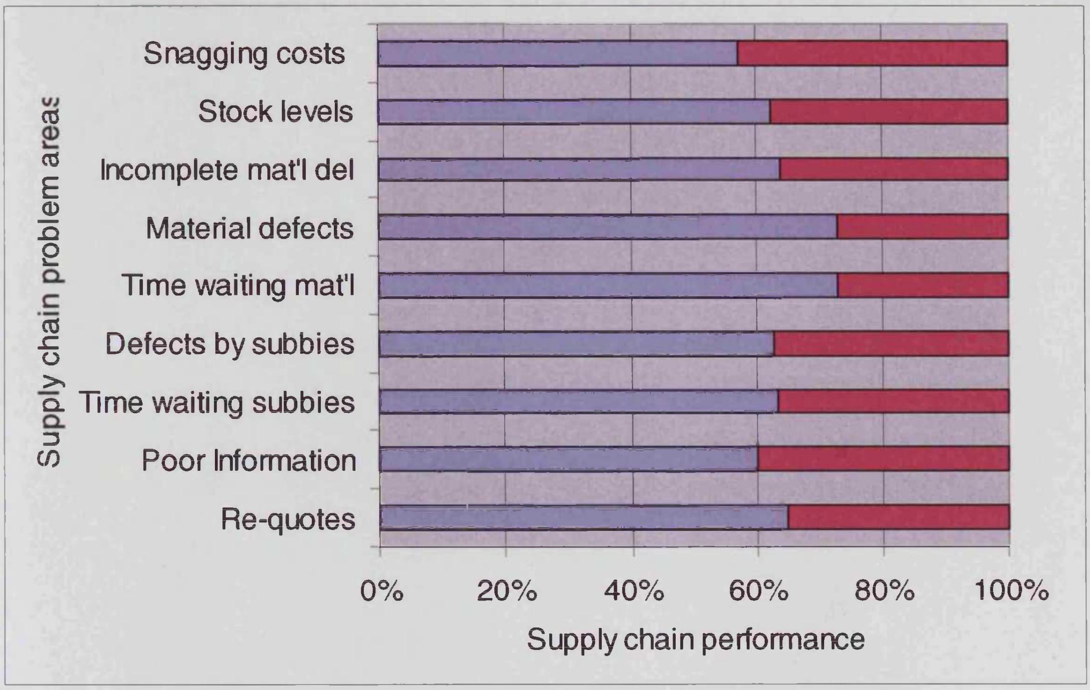

Figure 5.18 Q19 Severity of Prompted Supply Chain Problem Areas. Source - author.

The 'Top 10' respondents showed nearly identical results with snagging, stock levels and poor information being equal worst place at only 56% i.e. 44% improvement required. Clearly the supply chain and purchasing staff respondents for these 'Top 10' see these high quantity housebuilders as having much room for improvement.

Q20 Please indicate your company's general awareness of improvement techniques

A20 - This question triangulates with Q8 and, as shown in the Figure 5.19 reveals a low awareness and use of supply chain improvement tools / techniques which are widely used in other manufacturing industries. Benchmarking and KPI's were most used by housebuilders in the survey but still showed less than a 50% adoption; balanced scorecard, FMEA's and process mapping were very little used and in fact, mainly unheard of. Nine of the 'Top 10' respondents answered this question, but the results were very similar to the overall position and indicated the same lack of awareness.

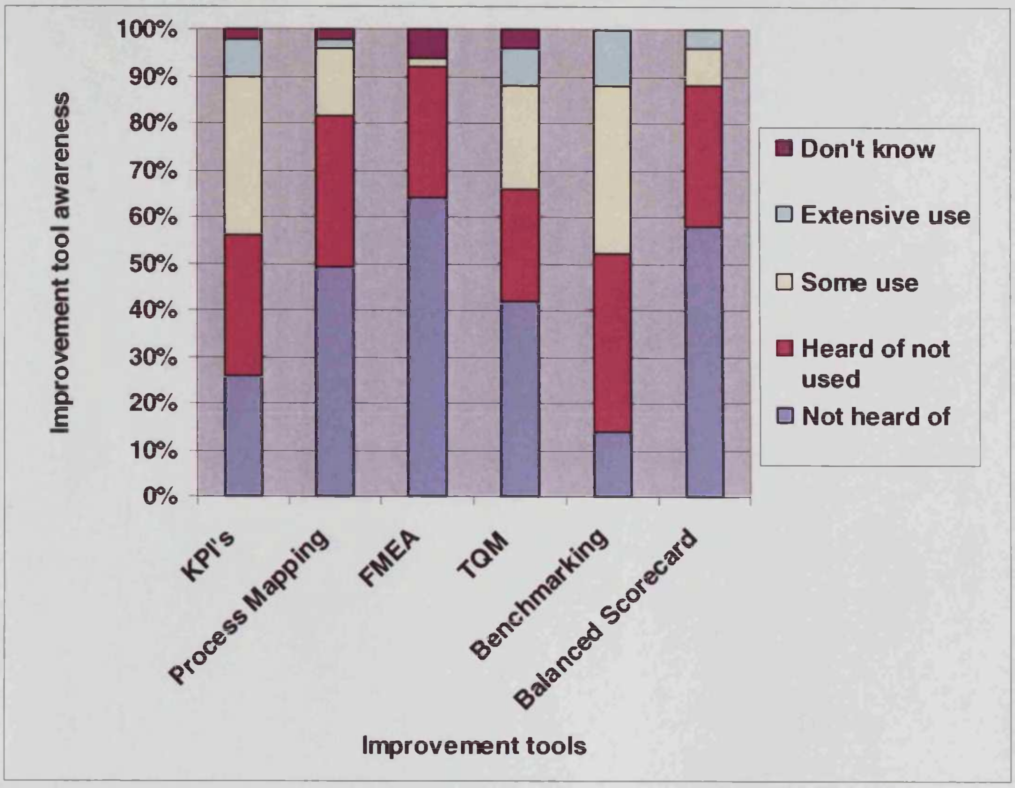

Figure 5.19 Q20 Awareness of Improvement Techniques. Source - author.

Q21 If you wish please give any general comments regarding supply chain management and overall improvement, or about this survey:

A21 – This was a 'catch all' open question allowing respondents to give general comments and any points of view they had not been able to express up to that point. All 15 answers are presented verbatim as they appeared on the returned questionnaire (Appendix 14):

1. Company very set in its ways. p.s. most people here think "Latham" was a cricketer. (Author's note: this implies that although the respondent is aware of the Latham Report (Latham 1994) most people in the company were unaware).
2. Didn't like Q17/18!
3. The industry is generally under resourced
4. Just appointed Group Managing Buyer to address these problems. Would you like to do a talk on Supply Chain management and the results?

5. SCM must be bought into at top then down. Must be benefit to all, KPI's must be inward & outward looking
6. SCM not structured but developed with group purchasing/partnering strategy as company grown
7. To be honest had no experience of SC management solutions
8. Suppliers aware of need for SCM, suggest subbies need education as does construction industry
9. In process of changing way of working, becoming far more pro-active in SC relationships - give more planned responses
10. Region only 3 years old, & respondent only there 1 year not sure info OK
11. SCM means trust openness & honesty - something our industry is slowly learning
12. Believe construction industry behind in SCM compared to auto and many others
13. We use same subbies and suppliers and build same/similar type houses - so have relatively few problems
14. SCM good concept if all conditions perfect-maybe 1 element at a time, then progress. Difficult to administer
15. Difficult to give accurate report on every aspect because so many different areas - SCM may be too reliant on Utopia

5.5 Summary of Results

This chapter has set out the results from a UK national housebuilders survey conducted by the author during 2003. All respondents built private dwellings; the majority were part of a larger group; and of these most bought both regionally and from their head office.

The key issues emerging from this stage of the research relate to the housebuilders' overall supply chain awareness and the application and use of improvement tools and techniques. Prior to discussion of the results in Chapter 7 it is worthwhile to summarise some of the key results which emerged. From the original 21 major questions posed (comprising a total of 63 individual question elements), six questions or parts of questions have been identified as providing a useful measure of these key issues. Figure 5.20 summarises the findings associated with these issues, presenting the data so as to allow comparison between the three groups analysed that is, total respondents, the 'Top 10' respondents, and the 'Remainder'.

The key criteria selected are described and justified below:

1. **Supply Chain Strategy.** The first criterion is derived from Q6 and regards the company having a supply chain strategy. This is a vital question and provides a useful indicator of whether the companies that replied are 'serious' about supply chain management. For each of the 3 groups (total, 'Top 10' and 'Remainder') the degree in percentage of the existence of some strategy is the measure. Consequently, responses of 'definitely' and 'in some way' have been added and used as the measure. It is important to note that the majority of the values presented are from the 'in some way' category and not from the 'definitely' category, 52%/15%, respectively for the total responses.
2. **Level of Supply Chain Awareness – Supply Chain Initiatives**. The second criterion emanates from Q8 where both 'some use' and 'extensive use' have been summated for each of the three categories and then averaged for each of the three groups. This gives an average indication of the companies' awareness and use of UK Government initiatives.
3. **Use of Partnering Procedures**. From Q11a the percentage of 'always using' procedures for partnering has been used as a criterion as this measures the seriousness or commitment attached to this key supply chain philosophy of partnering.
4. **Partnering is Seen as Strategic**. From Q11b and related to Q11a, this measure determines the companies' perceptions of partnering as either strategic or short term. The literature review provided evidence that if companies are serious about supply chain management then they should view partnering as a strategic activity and not short term. What is very interesting with the results shown in Figure 5.20 is that the 'Top 10' show lower agreement that partnering is strategic. This may be because only 8 out of 10 answered this section of question 11. However even if these two had agreed it would still only lead to a 30% agreement which is still lower than the total and 'Remainder' score.
5. **Level of Supply Chain Awareness – Supply Chain Management Principles**. From Q 12 both 'some use' and 'extensive use' have been summated for each of the four categories of supply chain awareness and then averaged for each of the

three groups. This gives a measure of supply chain awareness against exemplar industries as described in the literature review.

6. **Use of Improvement Techniques**. From Q20 the measure is 'use of' improvement techniques. As in criterion 5 above this measure has been applied to give an average for the awareness of improvement techniques. This analysis triangulates with criterion 2 above.

It should be noted that the vertical axis i.e. % Score/performance, in Figure 5.20 for criteria 2 to 6 shows an average of less than 40%. This indicates a potential improvement of greater than 60% for these criteria.

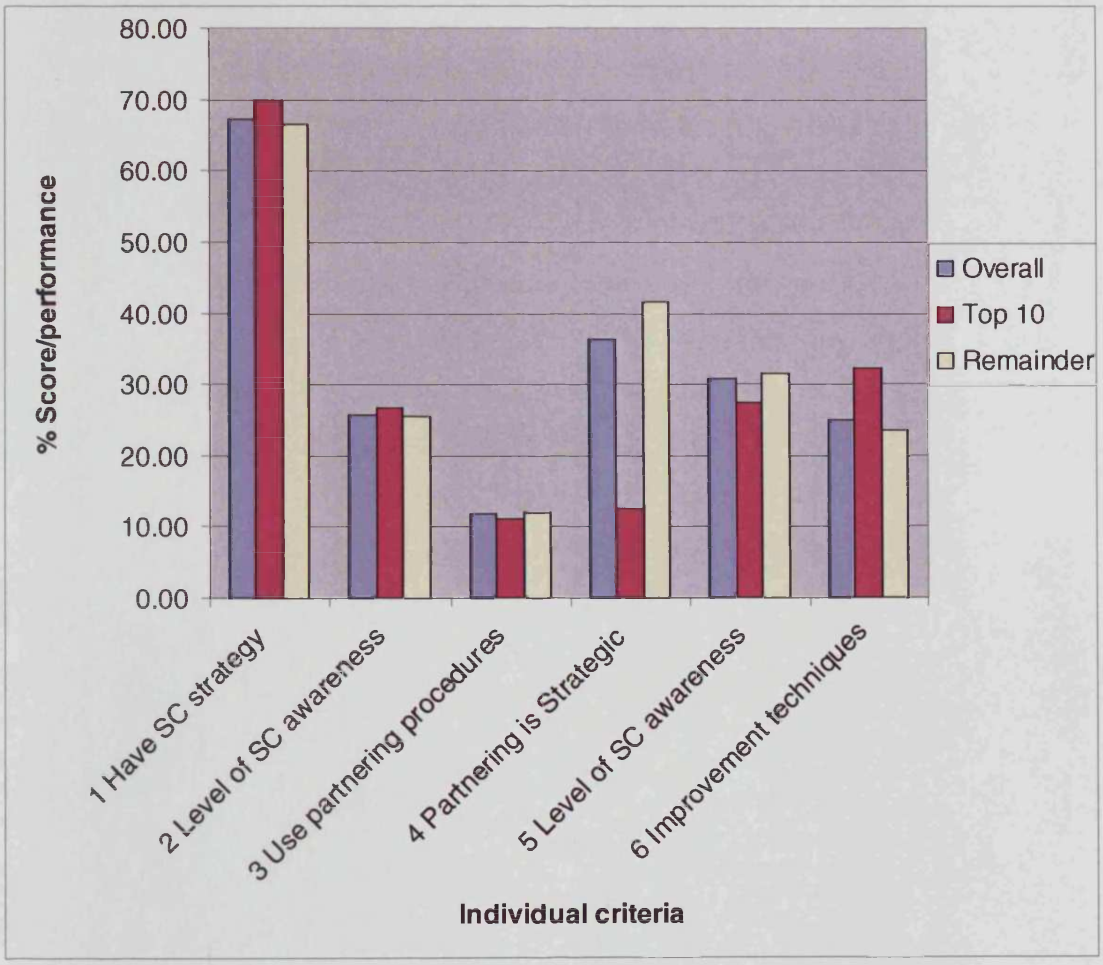

Figure 5.20 Summary and Comparison of Key Survey Results. Source – author.

CHAPTER 6
STAGE 3 - COLLABORATIVE FIELDWORK RESULTS

Our lives improve only when we take chances - and the first and most difficult risk we can take is to be honest with ourselves.

Walter Anderson

CHAPTER 6 STAGE 3 - COLLABORATIVE FIELDWORK RESULTS

6.1 Overview

This chapter reports the results from the two stages of research undertaken as collaborative fieldwork in a mutual relationship with a major housebuilder/developer. In order to maintain anonymity and ensure confidentiality the major housebuilder/ developer is referred to by the pseudonym, 'Goodbuild'. The first set of results is the data collected from the thirteen Site Manager interviews using semi-structured interviews. The second sets out the outcome from the improvement workshop facilitated by the author with experts from Goodbuild, that analysed the site manager interview findings using a cause and effect methodology and then by applied a Failure Mode and Effect Analysis (FMEA) technique for improvement.

6.2 Collaborative Partner Profile

During the early stage of this research work the author formed a collaborative framework agreement with a major UK housebuilder and developer. This agreement included a confidentiality contract and an understanding for mutual benefit. The author presented and discussed with the senior supply chain personnel at the company's national headquarters, the overall direction and aim of the research, which was accepted. Following this, a working relationship was formed with the MD (Managing Director) for a specific region where the majority of the actual research work and data collection was based.

It is necessary for the reader to know that this same company (referred to as Goodbuild) was, due to a merger and acquisition changes, the resultant company derived from one of the companies researched in the MCNS project, Chapter 3 Section 4 for methodology and Chapter 4 for results. This same company, Goodbuild, also assisted with, and was one of the respondents in, the survey research element, covered in Chapter 5.

Visits were subsequently made by the author to the particular regional office and to headquarters so as to understand some of the key business processes and how the supply chain was controlled and managed. Interviews, observations, and mapping of processes were carried out and copies of various documents and procedures obtained so as to understand the modus operandi. Documents obtained included organisational structure both at national and at regional level; top level procedural documents for land, technical, production and commercial activities; national supplier and subcontractor framework agreements; national partnering agreements; nationally used subcontractor selection questionnaires; health and safety questionnaires; invitation to tender forms; approved tender lists; regionally used site evaluation sheets; investment appraisals; site material budgets; typical build schedules and programmes; and building site and plot layout drawings. To clarify the key processes used by the company the author mapped the top level process used from 'land acquisition' to 'start on site'. Appendix 18 shows this process map which helped in the formation of survey and site manager interview questions.

The information from investigating and understanding the systems and business processes at Goodbuild together with that from the literature review led to the decision that site managers were an ideal source of measuring the 'as is' situation regarding housebuilding supply chains and their performance levels.

6.3 Site Manager Interview Results

6.3.1 Interview Introduction

Thirteen identified site managers, see Chapter 3 Section 3.6, were successfully interviewed using semi-structured interviews, see Appendix 7. The original plan was to complete these in three days of visits. However, after making contact with the site managers this was amended to take account of their work commitments, availability and holidays. The interviews were completed in five days of visits between the 16th June 2004 and 6th July 2004.

6.3.2 Interview Process

At the beginning of the interview, the author explained the background to the work; the fact that it was an academic study related to PhD research; that it was independent from Goodbuild's management; and that individual responses would not be revealed. This last point had been previously agreed with the senior management of Goodbuild. The author also told interviewees that he had carried out a national survey of major private housebuilders the previous year and that it was important to obtain the opinion of site managers who are at the 'sharp end' of the housebuilding process and control the day-to-day activities on site.

The 'semi-structured interview form' was shown to participants and the interview process explained. It was stressed that the author needed the site manager to answer all questions from the perspective of their experience at 'Goodbuild' and the site they were currently managing, or alternatively where necessary the previous site, e.g. if the current site was very new. By specifying this condition the data collected would be more specific, unbiased and more accurate as the respondents could relate more readily to a definite situation with which they were familiar. It would also be more useful for 'Goodbuild' themselves.

Using an adaptation of the rich picture diagram, as shown in Figure 4.5 in Chapter 4 but having removed the seven waste spots, the overall supply chain concept and the various elements involved were explained. This explanation was important so that the site managers could take an overall or holistic view of their situation in managing the building site, relating to the 'ideal' situation of an efficient and effective supply chain. Where possible the author sat alongside the site managers during the interviews, but if this was not possible then they were allowed to see the interview form and the questions it contained. However, the author wrote down the answers himself in the presence of, and with the agreement of, the interviewee to ensure readability at a later date. With Questions 2 and 3 which contained a scaling element, the site managers were often asked to circle the most appropriate answer themselves, and provide comments and example, which were recorded by the author. Respondents actively verified these written comments as an accurate reflection of their opinions.

6.3.3 Results

All the data collected from the site manager interviews is given in an Excel spreadsheet Appendix 19. In the spreadsheet the comments section represents an abbreviated version of text. However the sense and meaning have been recorded accurately, with the actual forms retained for evidence.

During the interview process it became apparent that although the rich picture was a very close representation of the housebuilder's supply chain there were a few elements missing. Discussions with the site managers resulted in three changes:

- Headquarters (HQ) made national agreements with manufacturers and suppliers as well as with contractors
- The site 'build plan' was issued to the site managers by the Regional Office.
- The site managers 'call-off' work from sub-contractors as well as suppliers.

The final version of the 'rich picture' incorporating these amendments is shown as Figure 6.1.

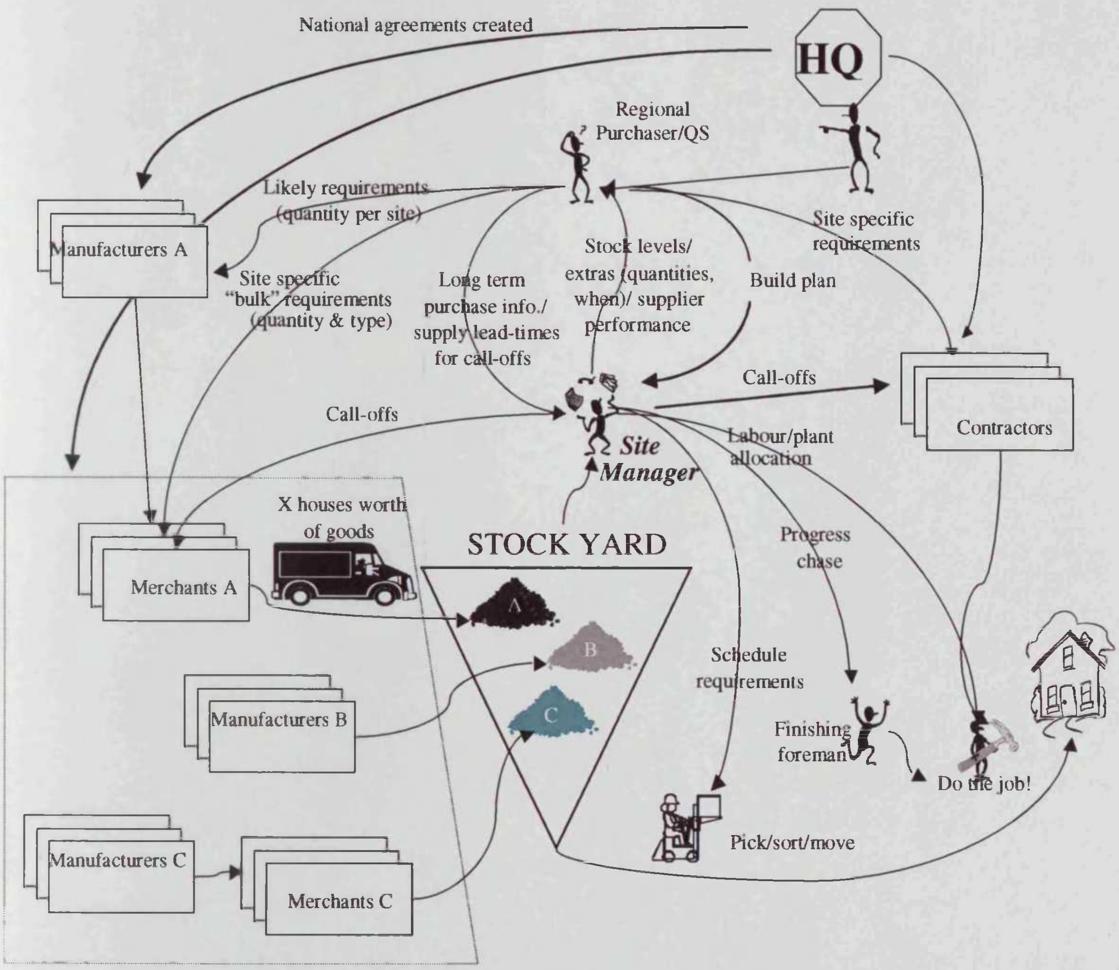

Figure 6.1 Rich Picture Representation of Housebuilding Supply Chain.
Source – author modified from Naim and Barlow (2003)

Each question and answer from the interviews will now be presented in turn, with a limited amount of discussion and critique, the main analysis and discussion being in Chapter 7. The questions posed in this methodology are more qualitative in nature, as is the approach taken, and the data collected are therefore presented as more descriptive text than the results from the survey questionnaire in the previous chapter (5).

Q1 – Major 3 problem areas

A1 – When asked to name three problem areas within the housebuilding supply chain all but one site manager were able to do so. The author was confident that the respondents understood the question and were thinking of the overall situation regarding the supply chain as represented by the 'rich picture' illustration. The site managers were asked to consider the problems in order of importance. That is, to first consider what they thought was their greatest problem, its root causes and its possible solutions before moving on to the second greatest problem and so on. During the questioning the author described major problems in a number of ways so as to aid clarification such as:

- The greatest problem
- The greatest opportunity for improvement or
- The issue(s) that had greatest variability that could not be controlled and that adversely affected their main aim of building quality houses to programme without overall waste and inefficiency.

The results contain descriptions of 38 problems, their root causes and potential solutions put forward by the site managers. Using knowledge of the housebuilding process from previous research, specifically Chapter 4 Section 4.5.1 building site observations and mapping and Section 4.5.2 identification of waste spots, and Chapter 5 Section 5.4.4 survey Q 17 & 18, the author has categorised these 38 individual responses into eight problem types which are shown Table 6.1.

Site Manager major problems	1	2	3	Total
Technical information/support	1	4	5	10
Materials quality/quant/incorrect	4	8	3	15
Communications/IT/PC	1			1
Controlling utilities	1			1
Initial start up/no site start meeting	2			2
Poor labour/skills/quality	2		3	5
Start late on site/build programme	2			2
Lack build continuity/planning/organisation		1	1	2
No comment			1	1
	13	13	13	39

Table 6.1 Site Manager – Open Question Major Problems.

Source – Barker and Naim 2005)

These categorised problem types can be illustrated better using a pie chart. Figure 6.2 shows the categories directly from Table 6.1 using a simple summation of all three problem severity classes irrespective of importance.

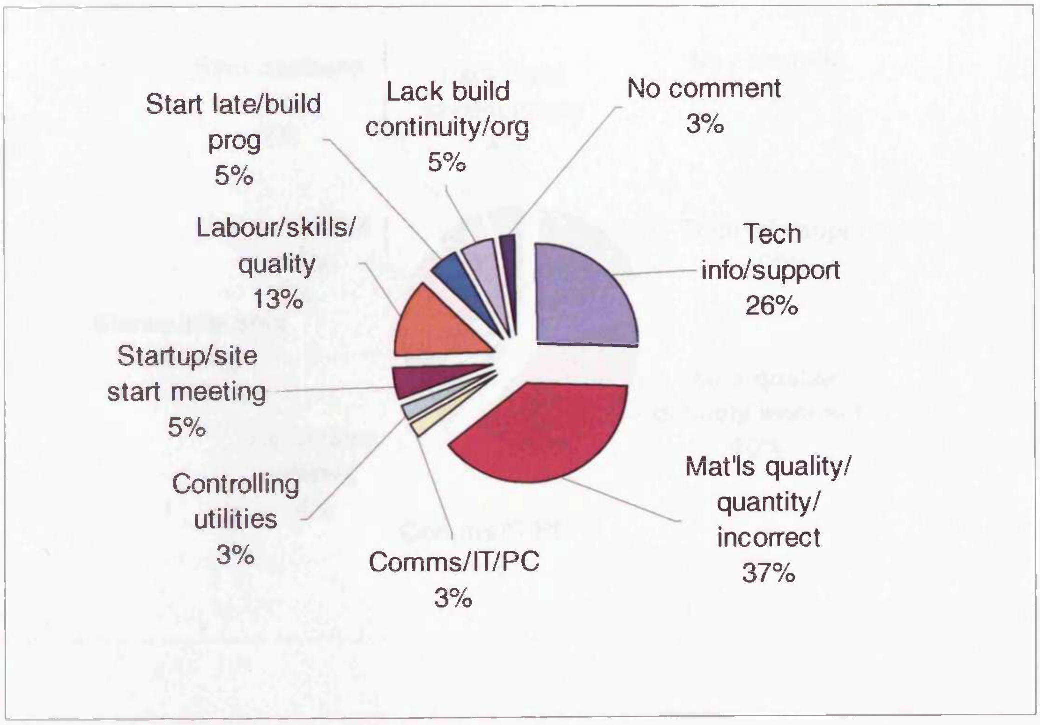

Figure 6.2 Site Manager – Open Question Major Problems. Source - author

It could be argued that a simple summation of the problems does not take into account the importance factor of the problems and that class 1 problems should be valued more than the classes 2 or 3. It is not statistically possible (Oppenheim 1996:156) to apply definite weightings to the three classes as there will be a variation between problems and between site managers' perspectives of the actual 'absolute' level of importance. However, the author believes that presenting the results with some allocation of weighting will give a better opportunity for comparison. To this end Figure 6.2 shows the same major problems but with a weighting system applied. Problem class 1 (the greatest problem) was given a weighting of 3; a problem class 2 given a weighting of 2 and a problem class 3 a weighting of 1. The scores were then normalised by using percentages. Although, as explained, this is not strictly statistically correct this weighting system does take better account of the problem importance, than a straight addition of all classes together giving an overall view. When the two charts are compared there is very little difference between them and the relative importance of all problems is the same, and therefore the overall result is not affected by applying the weighting.

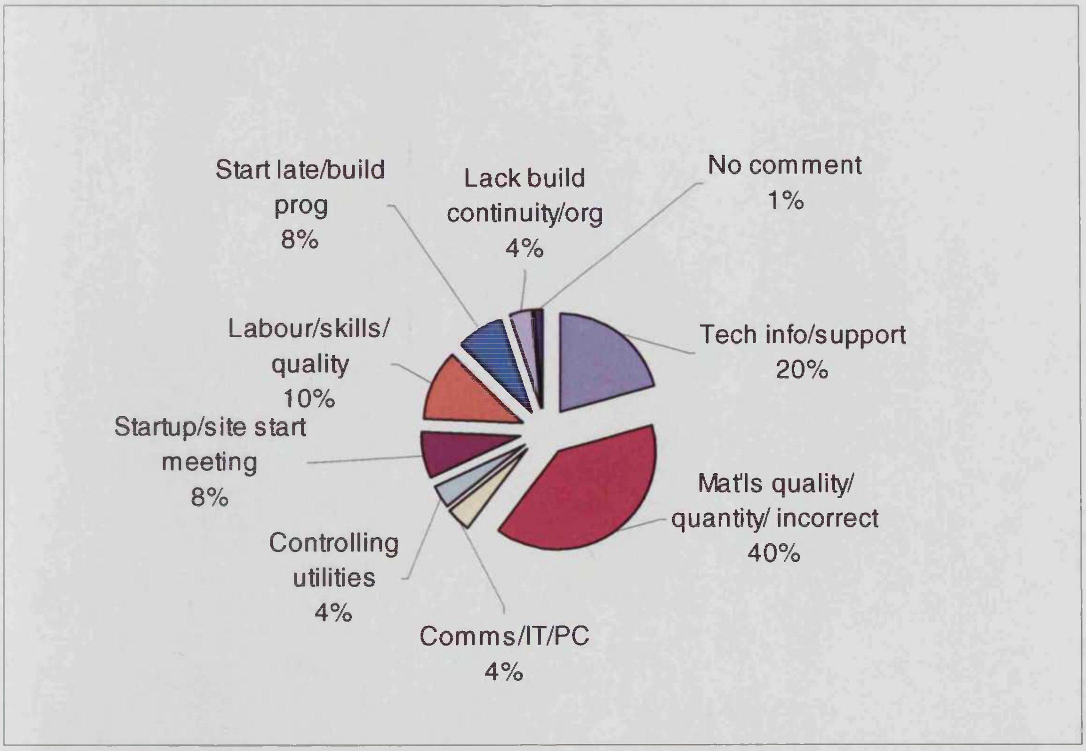

Figure 6.3 Site Manager – Open Question Major Problems (weighted). Source - author

The table and both charts clearly show that 'material related' issues are the greatest problem identified by site managers, followed by 'technical information and support', and thirdly, 'labour and skills' issues. Each of these three will now be described in more detail.

Material related issues - Referring to Appendix 19, the materials problems range from poor quality to incorrect specification but the most frequent problem was identified as poor or late delivery. At the time of the interviews six out of the thirteen sites were using a different kitting, delivery and control system for materials. The site numbers for these are highlighted in yellow in Appendix 19. Out of these six sites, four had some material related issues, three of which were due to the build packs being incomplete. The four problems were:

Class 1 - Build packs short
Class 2 - Incomplete delivery of materials
Class 3 - Not ordering in time (sub-contractor & materials)
Class 4 – Material system control - poor not complete

This means that the six sites (46% of the 13) having a different material and control system only experienced 4 material problems (27%) whilst the remainder (7 sites – 54%) using the traditional material control system experienced 11 (73%) material problems. This indicates a lower occurrence of material problems at these particular sites, than those being supplied materials by the traditional means. Nevertheless overall, material supply remains the main problem.

Technical information and support - This problem area concerned mainly the help from the regional office where the engineers, quantity surveyors and buyers are based. The problems here included incorrect or missing drawings, BOQ.s (Bill of Quantities) and related information from the beginning of work on site, and the lack of response or support to related problems. The importance of gaining the perspective of the site managers clearly shows itself here as they are responsible for the build, meeting schedules and programmes and overcoming all related problems.

Labour and skills issues – The third most important problem area was identified as labour and skills issues. Poor skill levels were a commonly stated problem as was site managers' perceptions that many sub-contractors are more concerned with speed than the quality of work. Lack of commitment by the subcontractors' companies and their labour plus a lack of basic skills across many disciplines was a major concern.

The basic data on site manager problems can also be categorised using the same descriptions for major problems as were used in the national survey. The corresponding results from the survey were presented in Chapter 5, Section 5.4.4 (Question 18). Figure 6.4 shows a comparison of the site managers' problems with those from the survey using the same problem categories and applying the same weighting principle as described earlier. In comparing the results in Figure 6.4 it must be noted that the survey responses were mainly from purchasing and supply chain personnel, and on a few occasions from quantity surveyors. These people were 'situated' at the planning, preparation and ordering stage of the supply chain, whereas the site manager problems are concerned with the execution of the systems or processes and with meeting the build programme.

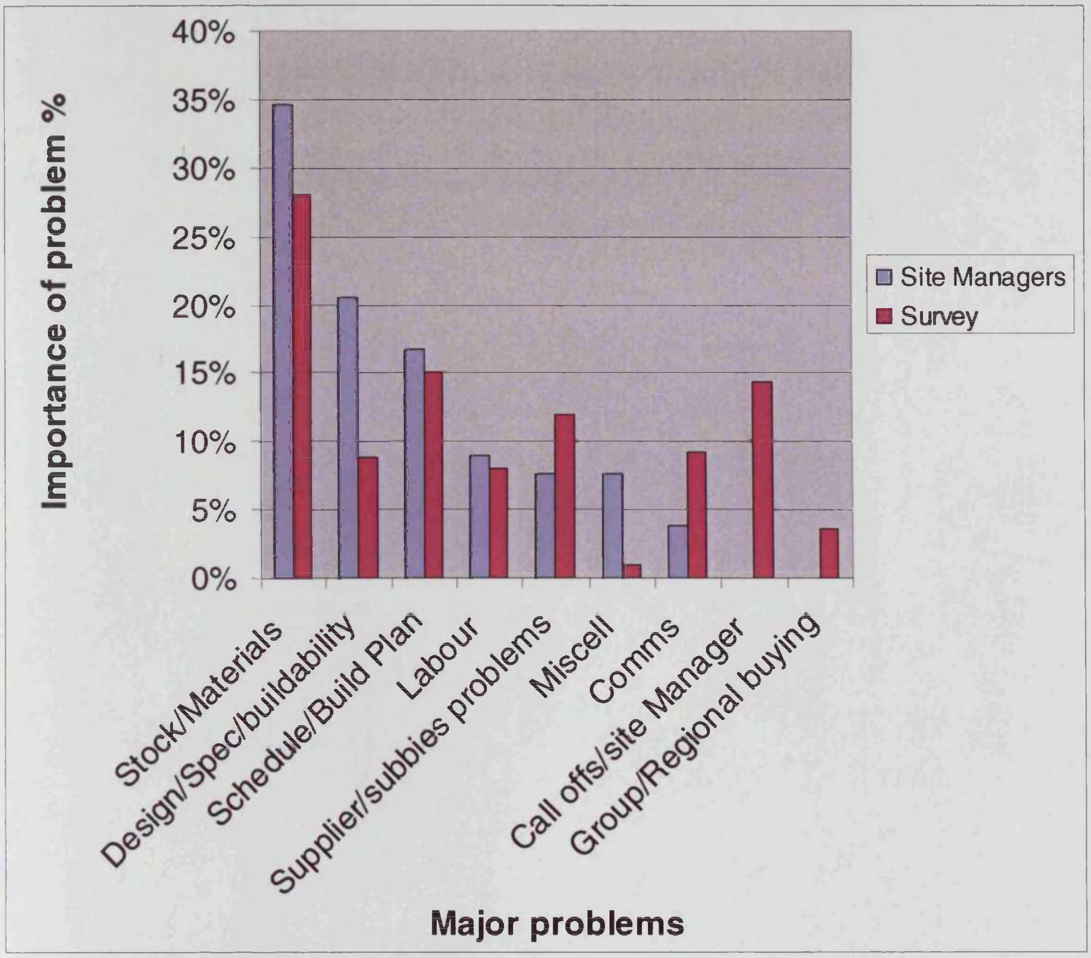

Figure 6.4 Comparison of Site Manager and Survey Open Question Major Problems (weighted). Source – Barker and Naim (2005)

This comparison shows that:

1. Site managers identified the same greatest problem as purchasing or supply chain personnel, i.e. stock levels and material issues.
2. The second most important issue for site managers is design/spec/buildability, which is different from the survey results. A likely explanation for this difference is that because site managers are responsible for completions they felt that buildability is more of a concern.
3. Schedules and build plans is the third major problem in both site manager interviews and in the survey. It is likely that both the purchasing process and the building process in the supply chain are under the same completion pressures.

4. Next, labour problems and supplier/subcontractors problems are roughly equal for a joint fourth place in both the interview and the survey.

Q2 – How good is the supply chain

A2 - This question asked site managers to rate how good their company's supply chain performed against specified potential problem areas using a scale. As was explained to respondents during the interviews, each particular potential problem within the supply chain was rated between the ideal (0%) and the unacceptable or worst scenario (100%). This description allowed the site manager to view the supply chain from an 'amount of waste' perspective and so results could be related back to the research question 3 (section 1.4). Here then, a 0% rating indicated no waste and so represented a very efficient and effective supply chain, whereas 100% indicated maximum waste and thus a very inefficient and ineffective supply chain. See Appendix 7 for the question posed and section 3.6.3 Table 3.12 for methodology.

In order to represent the results of this question more clearly then the description was actually reversed in order to show how good the supply chain was on the scale of 0 to 100%. By way of example, a 20% answer would actually mean a potential for a 20% improvement (i.e 20% waste level) and consequently an 80% performance level.

As shown in Figure 6.5, using this reverse technique, where red represents the gap between actual and desirable, there is a great deal of potential for improvement - approximately 30% in all areas. The greatest problem area is that of 'snagging' where there is only a 55% performance level, i.e. a 45% potential for improvement. The next greatest problem area is 'poor information' followed by 'defects by subcontractors'.

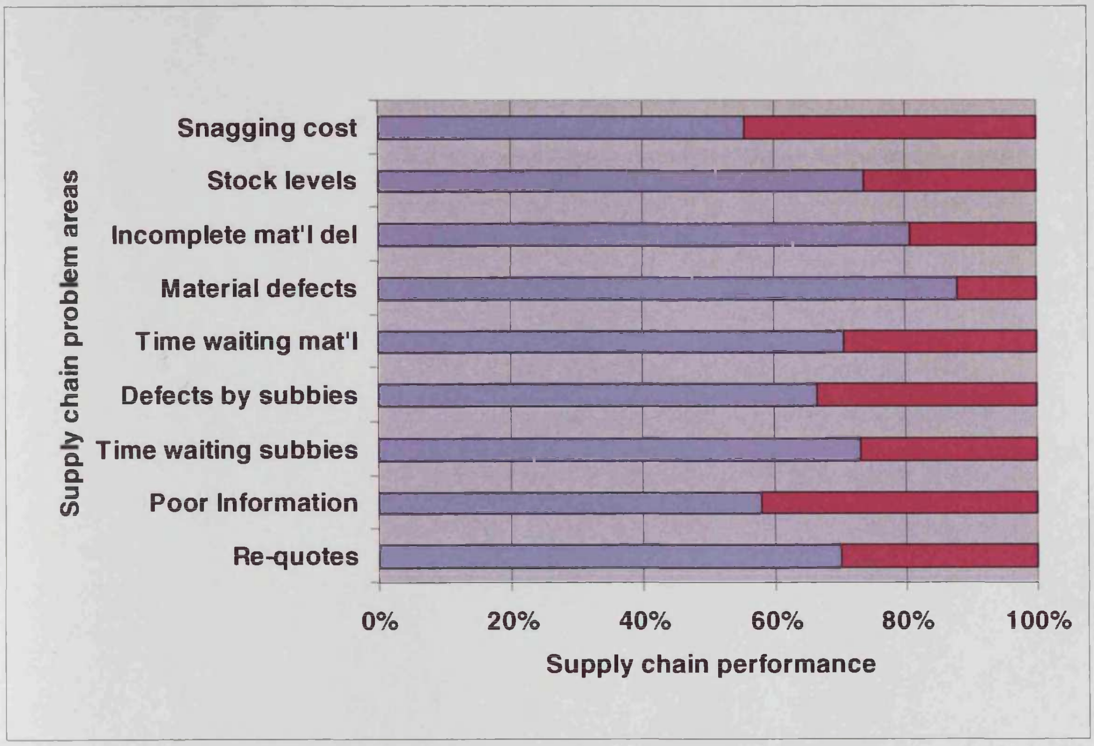

Figure 6.5 How Good is the Supply Chain. Source – author.

At the end of Q2 there was a specific blank space 'Any Other' category, so that site managers could add any particular problems they felt had not be mentioned. Those added by the site managers during interview were:

- Poor site set-up, had to move office
- Lack of site planning & organisation
- Lack of technical information - only 50% at start up.
- Communication with subcontractors and Site Manager
- Cheap materials and subcontractors
- Too much chasing progress and corrections
- Key dates unrealistic
- Too many site visitors
- Technical information wrong/late

The results from Q2 of the site managers' interviews can be compared with exactly the same question used in the survey from the previous chapter i.e. Q19, Section 5.4.4 Figure 5.18. Figure 6.6 shows this comparison in the form of potential for improvement.

As can be seen, there is agreement on the top two problem areas, snagging and poor information in that they offer the greatest potential for improvement.

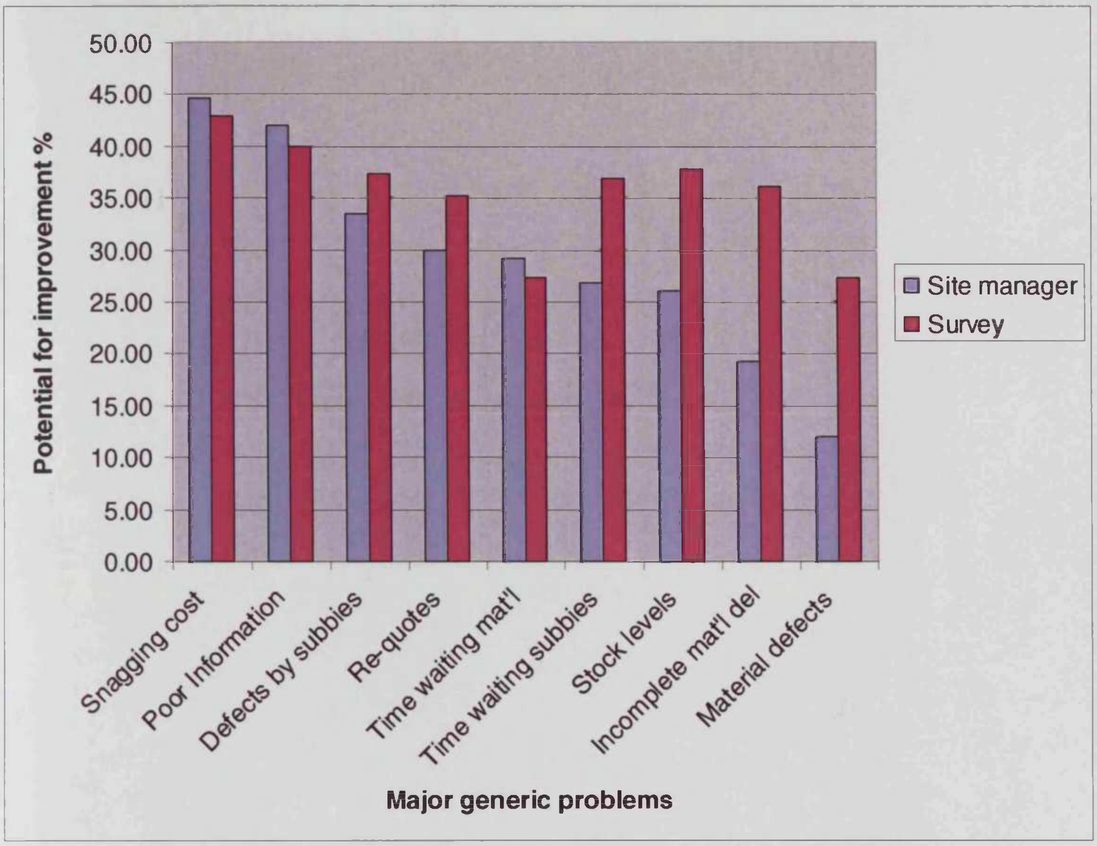

Figure 6.6 Comparison of Site Manager and Survey for Major Generic Problems.
Source – Barker and Naim (2005)

Q3 – How good is the supply chain – Survey problems

A3 - This question used the same type of scaling as Q2, once more using the reversing technique. In this case the site managers were asked to rate the severity of eight problem areas that had emerged from an open question in the survey, shown in Chapter 5, Section 5.4.4, Q18, excluding the miscellaneous category. These eight areas were arrived at by the categorisation of 154 responses in the survey given by senior purchasing personnel or those responsible for the supply side. The responses to Q3 are shown in Figure 6.7 and indicate, as in Q2 in the opinion of site managers, a poor level of overall performance with therefore a potential room for improvement of around 30% in most factors that are affecting the supply chain.

On analysis, the results show that the greatest problem (or potential for improvement) was 'design and buildability', followed by 'communication', and then 'schedules and build plans'. This outcome could be explained because site managers were very concerned with build targets as this was their key measurable. Buildability, build plans and the labour problems are also closely interrelated to this priority task. Poor delivery and stock levels do affect site managers but it is possible, if not probable, that the more important day-to-day control of site progress relegated this factor to fifth place. In contrast, buyers and supply staff responding in the survey saw their function as ensuring that good quality materials were available and may have deemed this (delivery and stock levels) to be a more important problem.

Figure 6.7 Severity of Survey Raised Problems. Source - author

Whilst carrying out the interview it was necessary, in some instances, to elaborate and explain the question in more detail. The third part of this question concerned how well 'call offs' were made and how well the 'site manager' did their job. Obviously this was quite contentious as it was the site managers themselves that being interviewed. However because it was a problem highlighted in the survey (see Table 5.1) it was considered by the author to be relevant and appropriate. During the explanation of the question the respondents were asked not to think of themselves personally in this context but to consider the overall function of 'call offs' and how well site managers within Goodbuild carried out that function. Even with this re-phrasing it is possible that bias prevailed. The fifth part of the question was about 'Communications' and additional explanation was given to clarify that overall or general business communications was the focus.

Q4 – Open question – 'Any Comments'

A4 - Several comments were made in response to this question and when added to others throughout the interviews contributed to a comprehensive list that added a qualitative element to the data derived directly from the questions themselves. Additional comments made are presented here:

- No supplier vendor rating or feedback - especially national suppliers
- IT system - no confirmation received from supplier; sometimes call-offs not converted at HQ to faxes and so not sent
- Sometimes the system unreliable - crashes; difficult to use for group discussions in office; need initial training/check competence
- Snagging and corrections take up large amounts of time - 50%; always having to check work; 2/3 hrs per day
- Start date at site has become shorter - was 14 wks now six after planning permission
- Business generally numbers and profit oriented not concerned with process of building
- Suppliers sometimes lengthen lead-time but don't inform us
- Poor national suppliers, especially service element, appear they are chosen on price
- Some suppliers and subcontractors are good, but Goodbuild gives them too much work, should we do a resource check? (authors interpretation of several comments)
- Lack of continuity of work (one site to the next) can be a problem as this means can lose good labour

- Major problem mentioned is correctness of technical information and response to problems by regional office. Some site managers feel insufficient or lack of technical skills (authors interpretation of several comments)
- An example of above is that once there used to be one quantity surveyor for each site and now one quantity surveyor for ten sites.
- H&S (health and safety) can take up lots of time, possible have H&S specialist for few/several sites
- Build packs/design don't allow for wastage could use 'as built' surveys for BOQ.
- Overall lack of planning and organisation especially at pre-start
- Consider smaller but more build packs - i.e. instead of 5 use say 10
- Schedules/BOQ are not designed for timber frame houses - tend to use brick/block designs

At the end of Question 3 respondents were asked whether the questions asked and the problems raised were relevant and valid. All the site managers responded that they felt that the questions were important and pertinent and had addressed the key issues regarding their supply chain.

6.3.4 Summary of Interview Results

The results show clearly that the site managers interviewed consider that 'materials' in terms of availability and stock levels was the major constraint in housebuilding supply chains. This is shown in Figures 6.2, and 6.3. This finding is substantiated by the previous findings from Chapter 5, the national survey, which questioned buying and supply related staff, see Figure 6.4.

Site managers also identified problems with design/specifications and buildability which had not been recognised as a problem by the buying and supply chain personnel in the survey.

There is however consistency of findings with the survey for 'scheduling and build plan' issues. Although the sample size of site managers interviewed was too small (thirteen) to ascertain a national picture, it does represent the majority within a region of a major housebuilder.

The other major issue identified from the interview results is that of quality and the culture of quality. Snagging emerged, as shown in Figures 6.5 and 6.6, not only as having the greatest potential for improvement but was also highlighted by comments from site managers as the biggest time user for them. This correlates with government customer satisfaction data on quality issues, in that rework i.e. snagging costs, are unacceptably high - see Chapter 2 Section 2.4, (The National Customer Satisfaction (NCS) survey by the Housing Forum (2003b).

Poor information was also a major problem for site managers, as per Figure 6.5 and 6.6, and this was reflected in the survey too. This problem area also appears under the heading of 'technical information/support' in Figure 6.2 and 6.3 and possibly in Figure 6.4 as design/specification and buildability.

Further detailed analysis of these findings continues in the next chapter, after the work and findings from the improvement workshop have been presented.

6.4 Improvement Workshop

6.4.1 Pre-amble

The workshop took place as planned and as outlined in the earlier research methodology Chapter 3, with all intended personnel participating. The following section gives a chronological outline of activities that occurred during the workshop together with the results found. This is followed by discussion of the results and some analysis relating to the overall aims of the dissertation.

It must be stated that although the workshop was well planned in advance, the reactions and views of the participants were unknown and unpredicted and so a true situation of grounded theory prevailed with slight changes being made to the activities. This was necessary so that all members of the workshop 'bought into' the overall aim and so contributed to making it a success. In order to maintain confidentiality no individual responses are attributed.

As background it should be noted that the company concerned had lately 'taken over' another housebuilder and that the site manager data had been collected from some of these 'acquired' sites. These sites used a different method of material delivery where 'kit packs' were assembled by the sub-division of the company and then delivered to sites, as previously mentioned in Section 6.2.3 under Q1. Materials for each house consisted of some six 'kit packs'. These sites were identified by the author during site manager data collection and results showed that material problems were less than those experienced at traditional sites. This point is made because the company was in a state of transition, in the process of evaluating the adoption of this method across the company and so materials organisation and control was in a state of change.

The aim of the workshop was to analyse in depth the problems which had been identified from the site manager interviews, to determine potential causes and then to determine corrective actions that would prevent re-occurrence. This activity would then answer one of the research questions of this work, that of recommending improvements to the housebuilding supply chain and recognising improvement tools that are suitable for this purpose.

As the time available at the improvement workshop was limited it was necessary to select carefully the areas on which to focus. It was previously explained in Chapter 3 Section 3.6.6, that the two major problems as shown in Table 6.1, should be considered and that the materials problem should be split into two parts for ease of analysis and subsequent improvement. This meant that there were three key problem areas to concentrate on at the workshop:

1. Materials quality
2. Materials quantity
3. Technical information/support.

6.4.2 Workshop

The actual agenda used at the workshop is shown below:

- Introduction - reason for workshop – set the scene
- Discussion of information from site managers
- Brainstorming for causes of key problems – on chart
- List and discuss priority of causes

--------------------LUNCH-------------------------

- Do failure mode and effect analysis – determine corrective actions – on chart
- Discussion and wrap-up

Setting the Scene – Prior to the start of the workshop, 3 large wall charts with outline fishbone diagrams and outline formats for the FMEA's (Failure Mode and Effect Analysis) were attached to the walls around the meeting room. Following introductions, the author thanked the attendees for their time and explained the overall purpose of the workshop, which was to illicit confirmation and qualitative feedback on the site manager findings and to:

- Identify the key causes for these problems by using a 'cause and effect' brainstorming technique
- Assess the size/importance of the problem and what could be done to prevent occurrence by using the FMEA tool.

It was stressed by the author that an explanation of how the tools worked and would be used, would be given as the workshop proceeded.

Stressing a Team Culture – The author introduced the concept of 'team rules' which were then discussed and agreed. The team actively participated in creating the rules and, as had been hoped, key words offered by them included honesty; confidentiality; being positive; openness; being pro-active. This was immensely useful as it set the scene for positive participation and ensured that the attendees understood the reason behind this part of the exercise.

General Discussion of Information - Copies of the site managers' raw data (problem areas) were given to the attendees. This was in addition to the summary of the results issued prior to the workshop as mentioned in Chapter 3 Section 3.6.6. This additional information was discussed for a time in an open and constructive way and several points emerged:

- At the time of the site managers' interviews the company was in a period of transformation due to a merger and therefore there were problems with information/IT packages and skills.
- There was surprise by one particular attendee that the site manager findings showed that 'kit pack' sites were better on materials problems than traditional sites. It was reported by the attendee that there had been many phone calls and issues raised by the sites using these kits.
- It was difficult for members of the workshop to understand what was meant by the site managers' comment on a 'lack of technical support' without having more detail on specific problems.
- Clarification was given as to whether the site managers' opinions were a generalist company view or site specific. The author stated that site specific views had been sought as these would be more current, relevant and valid.
- One attendee stated that communications were very important.
- One attendee questioned whether 'call-off's' were actually too late or was it the delivery time once material had been called off. The author said that reference to particular data was needed and this would be addressed during the workshop.
- It was stated that there was a labour skills problem in the industry.
- Some attendees felt it would have been useful to have had three or four site managers together to share opinions on problems and causes and gain a more common view of problems. The author agreed and had previously offered to present individual site manager findings to a regular site manager meeting and thereby gain consensus.
- Some attendees wanted more detail on which items were late e.g. bricks or blocks, which suppliers were involved and so on. The author agreed that it would have been useful to have more detail from the interviews but time constraints prevented this.

Drawing the discussion to an end, the workshop attendees reach a consensus that the information presented did represent the site managers' views, that it had been obtained in a fair and reasonable way and that it was a useful platform to look into causes and potential improvements during the workshop.

At this point a major 'moment of truth' had passed and it was clear that attendees were satisfied and happy to continue.

Brainstorming for causes - An explanation was given as to how the cause and effect technique worked, and that one problem at a time would be addressed, starting with 'poor or late delivery of materials' as this was the greatest problem. The next to be considered would be 'low quality/wrong spec materials' and finally 'technical /information support'. It was also explained that it was best to use 'post-its' so as to increase the number of 'potential' causes and also to gain individual and unique opinions that had not been influenced by peer pressure. Using a large wall chart for each problem, potential causes were then 'posted' in the relevant position on three different cause and effect fishbone diagrams. It was explained that the positioning of the 'post-it' to the correct category on the fishbone diagram was not crucial as all comments would be reviewed before proceeding. Participants reported that no-one had used this technique previously. See Appendix 20 for photographs of completed wall charts and Appendix 21 for a listing of all the individual potential causes made against each category for each of the three problem areas.

Discussion and critique - Once all three wall charts (cause and effect diagrams) had been completed then, again in turn, all the potential causes were scrutinised for their likelihood. This involved a good deal of discussion, grouping of individual comments, and eventually a consensus was reached of the main likely causes for each of the 3 problem areas, i.e. the 'causes of failure' were identified. The following description lists the scope of discussion and the issues arising from each problem area in turn.

6.4.3 Major Problem Areas

Problem 1 - Poor or late delivery of materials (43 comments) – Through consensus poor management planning emerged as a generic cause for many of the issues related to this problem. This first discussion area was interesting and crucial to ensure the 'team rules' of a no-blame culture and a positive and proactive atmosphere for the meeting worked; however were still some cultural difficulties with openness and some defending of 'one's corner' took place.

1. Initial discussion about causes included issues on general management; flaws in planning; lack of system understanding; supply chain not responsive enough; poor suppliers.
2. If suppliers are late there were no means to identify this before this became a serious problem – this agreed with some site manager comments that some suppliers change lead-times without prior notification.
3. It was stated that the company did not share forecasts with key suppliers due to confidentiality. This matter was discussed and the opinion that specific sites and quantities need not be given but it would have been useful to give overall requirements in a reasonable time frame would be useful, i.e. the idea of booking ahead supplier capacity
4. It was felt that although site managers call-off or order materials mainly electronically, there was limited introductory training. Also training was not done on site and back up and support for both the training and the system itself was lacking.
5. A major cause identified was that of orders being cancelled prior to delivery completion. Participants reported that the IT system for transaction processing could close an order when only partially complete so cancelling remaining deliveries.

Ultimately the discussion on this problem resulted in six major 'causes of failure' to be taken forward to the FMEA.

Problem 2 - Low quality/wrong specification materials (37 comments) - Not all areas discussed under this heading have been included here, but the major issues regarding low quality or wrong specification can be summarised into three key causes.

1. On reviewing the comments made, many related to poor specifications.
2. During the discussion a key issue was 'quality versus cost'. It was felt that materials used were not poor quality but rather that they were of low specification although adequate for the job. It was felt that despite the existence of low quality this was not affecting house sales. Therefore why bother improving the quality of materials when demand was still very high and the level of customer dis-satisfaction was acceptable. There was then a debate as to whether this attitude was right or wrong.
3. Due to different market forces and different planning requirements different regions require different materials. However the company wide standardised approach did not allow the versatility necessary.

The discussion on this problem resulted in two 'causes of failure' to be taken forward to the FMEA.

Problem 3 - Technical/information support (38 comments) – Again not all areas discussed under this heading have been included here, but the major issues were:

1. Drawings received were not correct, e.g. doors were hinged on the wrong side, garage/house adjoining wall was studded not brick. All these cost to repair.
2. Some people did not understand drawings – maybe cannot read them properly
3. Current system used was that only one person checked the drawings and some errors get through – was one person enough?
4. Some lack of or late information was due to third party involvement i.e. utilities and planning departments, technical approval issues
5. It is hard to track changes to drawings in the system
6. Some felt the schedules agreed were impossible and this created a poor attitude and work environment
7. There was a need for a high level of co-ordination in the whole process from beginning to completion – even if there was a reasonable land bank there was still need to control and allow for planning.

The discussion on this problem resulted in four 'causes of failure' to be taken forward to the FMEA.

During the discussion and critique it had been planned that the author would collate and cluster individual comments, but this was eventually done by the 'experts' themselves. On the first 'cause and effect' chart (for materials delivery), each comment was given a tick or a cross (shown as a V or a X) to signify whether this really was a valid and likely cause or not, before they were grouped into the likely major potential causes, see Appendix 21. On subsequent problem discussions this method was not used as the attendees were more closely in agreement as to what was a likely cause and what was not. It was felt this was due to 'learner curve' effects of them understanding the process more. In these cases comments were just grouped into major potential causes by the experts themselves without the author managing this process. This change in 'group dynamics' was willingly accepted by the author as it indicated the group themselves were functioning as a team and coming to agreement on the most likely causes.

6.4.4 Failure Mode and Effect Analysis Overview

Before the next stage of the workshop proceeded, copies of FMEA instruction booklets were given out and the basic process of undertaking a FMEA explained. On the wall charts adjacent to each of the three fishbone diagrams three FMEA tables had previously been drawn. As a result the author could act as the enabling facilitator and complete the tables for the team. Due to time restraints the explanation of the process of carrying out an FMEA was shortened with only the key activities of allocating the problem ('failure modes') and the potential causes determined from the cause and effect brainstorming ('causes of failure') being described. The description and use of the 'effects of failure' were omitted in the explanation. None of the delegates had heard of or had used the FMEA technique previously.

All the likely 'causes of failure' for the first problem (i.e. poor or late delivery of materials) were placed in a FMEA table by the author and then by consensus, the probabilities of occurrence (Occ), severity (Sev) and detection (Det) were decided so as to form a judgement of relative importance by the risk priority number (RPN). In carrying out the scoring it was assumed that the 'end product' was actually the 'process' of housebuilding. Such an assumption does affect the scoring especially that for severity as usually process FMEA's are completed from the perspective of the finished product being used by the end consumer. After determining the RPN, corrective actions were discussed and eventually added to the chart. This was not a quick or easy activity and the attendees were all enthusiastically involved in the discussion until an agreement was reached.

6.4.5 Failure Mode and Effect Analysis Results

When applying the FMEA methodology to the three major problem areas they are termed 'failure modes' and are subjected to interrogation in order to determine their 'causes of failure'. Each FMEA is shown in a Table 6.2, 6.3 and 6.4 with the causes of failure, the RPN, and the corrective actions. They are not listed in any order of importance but represent the sequence that they were identified and discussed during the workshop. Below each table is a discussion of the results.

Failure mode 1 - Poor/late delivery materials

Failure Mode	Effects of Failure	Causes of Failure	Occ	Sev	Det	RPN	Corrective Actions
Poor/ late delivery		Not providing accurate information/specification	4	5	4	80	Closure of hand-over meeting, need detailed agreement
		Suppliers not set-up (80% National)	5	6	10	300	Improve supplier relationships, supplier selection /feedback
		Our staff/site managers not trained sufficiently	4	7	9	252	Specific on site trainer (use buyer?) and follow-up
		System not identifying when non/poor delivery	4	8	5	160	Audit processes (identification number)
		No feedback process to supplier	3	6	7	126	Need feedback process product specific
		Transaction processing (currently by HQ)	8	7	7	392	Accounts functional move to regional control

Table 6.2 FMEA for Poor/Late Delivery Materials. Source- author

Each of the 'causes of failure' and corresponding scores and corrective actions are now discussed in order:

1. Not providing accurate information or clear specifications was felt to be a major cause of problems. Occurrence and severity rated fairly high, but because the people involved were usually aware that information was missing the RPN was low, at score of 80. It was felt that the hand-over meetings prior to site-start could be greatly improved if there had been a more detailed analysis and agreement of the documents involved. The author had met this issue previously and one way of overcoming such a problem is a checklist to

ensure all issues and documents are correct and discrepancies are noted at hand-over.

2. The next major cause identified was thought to be much more important (RPN 300) and reflected the concerns of the team that many suppliers were performing poorly. The key issue here was that if suppliers did not notify the buyers or the site itself prior to late deliveries it was not then possible to make alternative arrangements in time and meant the site having to wait. The impact of delayed deliveries can severely affect the build programme with often little possibility of catch-up. During the discussion examples of this effect were mentioned. The majority of suppliers used were national suppliers (around 80% of items bought) which were selected by HQ and were imposed on regions with little process of redress (see point 5 below).

3. The next cause was felt to be quite high (RPN 252) because if site staff could not use the IT system correctly it could make a great difference to the deliveries. This was the case because regional buyers and quantity surveyors place blanket orders for materials and services but the site calls off the orders as and when required (determined by the schedule and the progress of build). Detection of problems was also felt to be a great concern as only site staff used the IT system for contacting the suppliers, and so may not have the necessary skills and knowledge to detect and resolve problems. It was felt that due to pressure of build many site managers did have a problem in fully understanding and using the IT system. It was suggested that the regional buyers should give extra assistance and training on site following the initial induction of any newly recruited site staff. Such training would also promote knowledge and teamwork within the region.

4. The fourth cause discussed was that of the system not identifying when there was poor or no delivery, which was felt to be related to poor supplier feedback. The ordering system did not proactively show delivery performance and so reduced the possibility of giving supplier feedback. This cause had the greatest severity rating in this table and needed a corrective action to be

included in the system, namely, an auditing feature to capture the problems of non/poor delivery.

5. There was no feedback system in place that allowed the site staff or regional buying staff to specifically rate the performance of suppliers. This was particularly so for national suppliers. The current system only allows comments against suppliers generally but not against particular products that are delivered. This cause had a low occurrence but the team felt it was important to feed back to suppliers that performed badly. A corrective action of a product specific supplier feedback and monitoring system was suggested.

6. The final cause for this problem was the most significant (with highest RPN of 392). It was that the accounting function would sometimes close a blanket order when it was only partially completed, i.e. prior to all the call-offs being made. This action would prevent the supplier from completing the order and meant that deliveries would cease. This cause had the highest occurrence rating and was also of high severity and was undetectable until site staff realised that parts were not being delivered. The participants identified a lack of co-ordination in the housebuilding supply chain, i.e. between site, region and the HQ accounts function. The regional team felt a 'big brother' attitude existed and that regions should have accounts authority if accounts responsibility was given them. The author felt, and the team agreed, that there should be some system indication to both buyers and site managers when orders were cancelled.

Failure mode 2 - Low quality/wrong specification materials

Failure Mode	Effects of Failure	Causes of Failure	Occ	Sev	Det	RPN	Corrective Actions
Low quality/wrong specification		Rigid specifications	5	2	1	10	More open specifications regional authority
		Profit driven not customer driven	10	2	1	20	Change company culture. Do we need to? CSR?

Table 6.3 FMEA for Low Quality/Wrong Specification Materials. Source - author

As shown earlier in this section, there was a good deal of discussion regarding this problem of low quality and wrong specifications, mainly centred on just what quality was really required. There are just two 'causes of failure' and related discussion was as follows:

1. It was felt that the national buying system was very prescriptive in specifying materials and was too rigid, often preventing more suitable materials from being used. Occurrence of this was fairly high but the team felt the severity was low as rigid specifications only meant using lower quality material and not a poor quality material. Detection was very high, thus a low score, because the buyers/quantity surveyors concerned were quite aware of the materials specified by HQ. The RPN was very low (ten) especially when compared with the previous table on materials delivery. The team still felt that more regional control over specifications was needed and this would allow a higher quality of materials to be used.

2. This cause was a very interesting one, with an occurrence of ten (i.e. definitely occurring) but with low severity and everyone aware it existed. The team was adamant that low specifications in the company were due to the cultural effect of the supply demand non-equilibrium that existed in the housing market. There were obviously insufficient houses on the market and insufficient being

built to fulfil this need. Why make houses better when the company was selling every one they built anyway? The team felt quality was not poor but just low and in a profit driven business there was no incentive to change. The corporate social responsibility (CSR) of the business was discussed, as was shareholder dividends.

Failure mode 3 - Technical Information/Support

Failure Mode	Effects of Failure	Causes of Failure	Occ	Sev	Det	RPN	Corrective Actions
Technical Information/ Support		Lack of resource	7	8	1	56	Merging of companies (now past!)
		Late information	9	10	1	90	Buy land sooner, quicker planning permission
		Too many changes	7	8	5	280	Planning permission late – third parties. More reaction from HQ on standard product design Human error Hand over meeting
		Site manager – skills and abilities	2	8	1	16	Recruitment process No blame environment

Table 6.4 FMEA for Technical Information and Support. Source - author.

1. The team stressed that at the time the site manager interviews took place the company was going through great change and overcoming a merger which meant a particularly high workload for the resource available. Although the occurrence and severity was high, it was stated that all staff were aware and so a low RPN was allocated. Late information was felt to have the greatest occurrence and severity and although because everyone knew this and a low RPN resulted – it still meant it was a major problem. The business cycle pressure of converting bought land into sellable housing appeared to be the

key root cause and although systems and procedures seemed to be in place information on the build process was often late. There was a fair amount of discussion on how this could be avoided with some members of the team 'defending their corner' once more.

2. The major cause for lack of technical information and support was felt to be 'too many changes'. Here both occurrence and severity were high but unlike other causes in this table the team felt there was a poor detection rate; the score of a five resulted from changes occurring that were so late that they caused much rework in the form of re-planning, re-quoting, repeat ordering etc. As the table shows planning permission and third parties such as utilities were major causes (although it must be said here that this is really due to the above cause of business pressure not allowing such issues to be resolved before the design/purchasing process was initiated). Having to use standard HQ material specifications or trying to have them amended was also a delaying factor. There was consensus that a way of overcoming the 'rush before we're ready' syndrome would be achieved by having a more detailed and complete hand over meeting prior to site start; this also being an action from the first FMEA table (Table 6.2).
3. Site manager skills and abilities was the final cause identified by the team for this problem category. This is quite perverse in that it is the site-managers who have the problem – but the team felt that if site managers were more aware of the system and procedures and were better acquainted with the IT ordering system they would not need to rely so much on the regional office. Such a change would also allow the necessary information more efficiently. An issue here was the lack of openness and existence of an internal blame culture approach to resolving problems. This cause is linked with cause three in the first table (Table 6.2).

6.4.6 Resume of FMEA Outcomes – Conclusion and Wrap up

When the FMEA charts were all completed the author went through a quick resume of all that had been done and prompted the question "what does all this mean and what could Goodbuild do now to improve?" Areas of improvement that were put forward for further discussion by the company and possible action were:

- Better hand over meetings with detailed agreement – this appeared on two occasions
- Need for active supplier feedback mechanisms specific to products/services (not an overall supplier rating)
- Improvement on supplier selection and relationships – it appears as if suppliers are not bothered
- Site manager awareness of the IT ordering system – seems insufficient training here. Idea of buyers involved in training would promote knowledge and teamwork
- Need some fail safe modification to the IT ordering system to prevent incorrect cancelling of blanket orders when delivery is only partially complete
- Over coming or working around planning permission and fixed standard specifications from HQ – needs discussion.
- Is the culture really right for quality and no blame? Are site managers views really sought? What improvement techniques are regularly used?

At the end of the workshop an internal survey at the regional office was requested by the author to determine the awareness of improvement techniques. Based on work in the survey and site manager interviews a simple questionnaire was designed, checked by the author's colleagues and piloted with the regional supply chain manager. This was then distributed by the regional supply chain manager to various staff in the regional office. The questionnaire form is shown in Appendix 22.

Unfortunately only six responses were received, two from administration staff and four from management/technical/production staff. The results in Figure 6.8 show a major lack of awareness of the staff, with most improvement techniques not having been heard of and consequently having little use.

Following the workshop the author produced a résumé of the activities and findings and forwarded these to Goodbuild's regional supply chain manager, see Appendix 23.

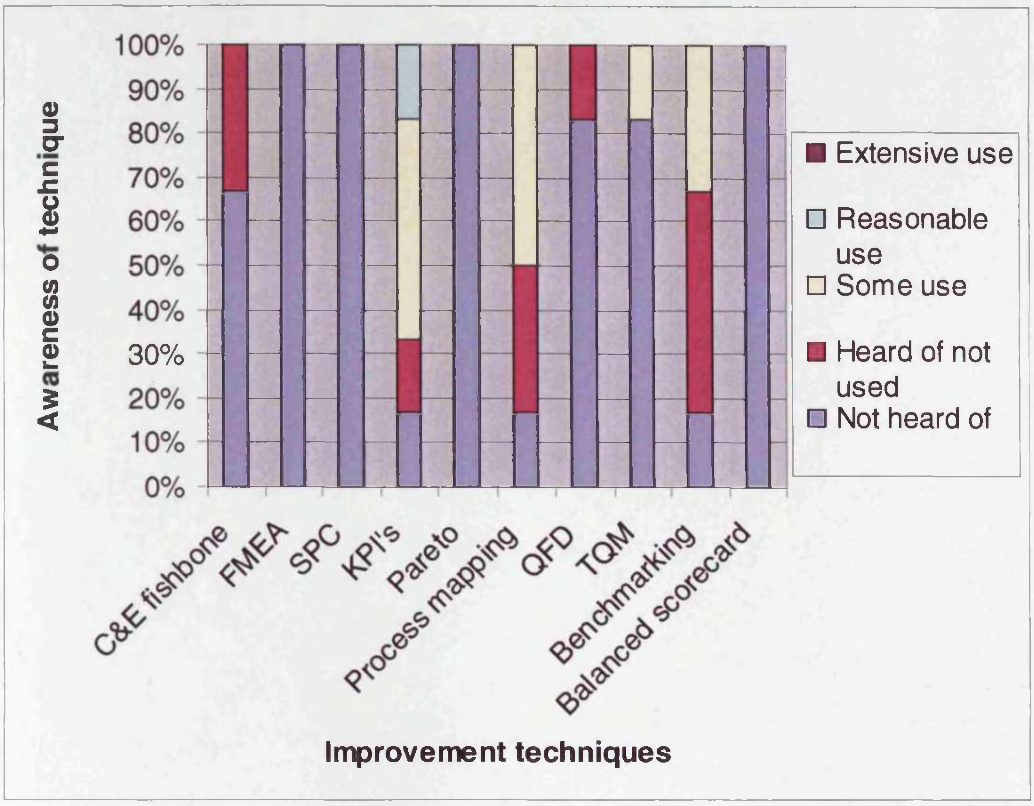

Figure 6.8 Staff Improvement Techniques Awareness. Source – author.

CHAPTER 7
DISCUSSION

The aim of argument, or of discussion, should not be victory, but progress.

Joseph Joubert 1842

CHAPTER 7 DISCUSSION

7.1 Overview

This chapter is comprised of four main areas. The first three discuss the three stages or individual research findings which have been presented in the preceding three chapters, Chapters 4, 5 and 6. The fourth and final area discusses the results as a whole and how they link with one another. The main purpose of the discussion is to consider the relevance of the work in relation to existing knowledge, that it the secondary data covered in Chapter 2 Literature Review, and to examine the merits and limitations of each area of research in turn. It also initiates the exploration of the arguments about how the work contributes to new knowledge.

7.2 Stage 1 - MCNS Discussion

This section discusses the use and validity of the Terrain Scanning Methodology (TSM), the identification of 'waste spots', and the MCNS generic and overall findings.

The initial area of research described, was mainly based upon an investigative and assessment methodology known as Terrain Scanning Methodology (TSM). It encompasses various diagnostic tools, but is based firmly on Watson's (1994) adage of Understand, Document, Simplify and Optimise (UDSO). It has much in common with other systems engineering methods (Berry et al. 1998) and also work carried out at Ingersoll Engineers utilising an Analyse, Simplify, Integrate and Automate methodology (ASIA), (Small 1983). Simplification is a fundamental aspect of lean thinking, manufacturing strategy and Business Process Re-engineering (BPR) methodologies. As Skinner (1985) has highlighted, good managers cope with complexity, the best managers simplify. Senge (1990) has said "simulations with thousands of variables and complex arrays of detail can actually distract us from seeing patterns and major interrelationships". Simplification is synonymous with many improvement techniques including Total Quality Management (Oakland 1989). Simplification leads to time compression of activities, the elimination of 'non-value adding' activities and the undertaking of activities concurrently (Towill 1996). Before, during and after the TSM application the limitations of the methodology and its associated tools and techniques were discussed by the research team and a strengths and weaknesses analysis undertaken as shown in Table 7.1.

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	

Table 7.1 A Strengths and Weaknesses Analysis of the TSM.

Source - Barker et al. (2000).

The weaknesses were recognised at the outset of the TSM application and although there was a feeling by some of the industrialists taking part that the TSM is only "skin deep", others, in particular those at the top-right hand corner of Figure 4.4, Chapter 4 Section 4.4, felt that the TSM is an important pre-requisite to change. It should be recognised that the TSM is, as the name implies, a 'terrain scan' and therefore has limitations in that it is a relatively shallow analysis tool. However, it can be invaluable as a means of efficient identification of areas of potential improvement, and a prerequisite to a deeper study using, say a Quick Scan or process re-engineering study, that can lead to a full change programme. The TSM literally 'scans' the terrain of the supply chain. It does not burrow deeply under the surface, but merely provides pointers to the possibilities for improvement. Despite its limitations several improvement opportunities were identified and implemented for each partner involved, so proving the usefulness of this technique.

The analysis undertaken of the housebuilding supply chain and the identification of 'waste spots' proved to be a useful activity and a basis for further identification and analysis of waste in the housebuilding supply chain. These 'waste spots' initially presented in Chapter 4 Section 4.5.2, are now analysed in generic terms for primary improvement opportunities using the engineering change model proposed by Towill (1990), illustrated in Figure 7.1.

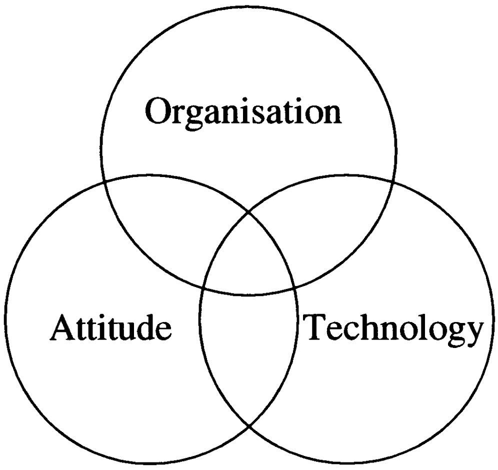

Figure 7.1 Engineering Change Model. Source Towill (1990)

This model categorises the focus of any change programme according to technological, organisational structure and attitudinal factors. Table 7.2 presents these opportunities in relation to other potential improvements based on these waste spots previously discussed in Chapter 4.

Waste Spot	Technological	Organisational	Attitudinal
#1	EDI, e-commerce	Information and material flow structured	Share information, trust, relationships
#2	CPFR - collaboration, planning, forecasting, & replenishment. Site based e-commerce	Co-ordination of strategies, planning and operations	Share information, trust, relationships
#3		Process orientation, Supply chain integration	Awareness and adoption of time compression strategies
#4		Buy/reserve capacity, reduce supply base, supply & fit	
#5 & #6	Pre-assembly, pre-fabrication, house kits quick assembly, standardisation, JIT	Supplier relationships, supplier development	Continuous improvement
#7		Training, accountability,	TQM – ownership & commitment

Table 7.2 Primary Change Opportunities. Source - Barker and Naim (2004b)

Waste spot #1 – Here the introduction of closer relationships with key suppliers plus use of new information and communication technologies will enable improved information and material flow. The metrics of total costs and value rather than price will focus better on improvement. 'Overproduction' by the suppliers due to demand amplification (Forrester 1961 in Mason-Jones and Naim (Mason-Jones et al. 1997)) is highly likely. Also 'waiting time' at site occurs due to irregular demand causing uncoordinated deliveries, which can be resolved with better relationships.

Waste spot #2 – To increase integration of the supply chain good information flow is essential. As highlighted by Taylor and Bjornsson (2002) new Internet systems offer great opportunities for value creation. Collaborative Planning Forecasting and Replenishment (CPFR) is usually associated with a technological solution in which e-Business enables a more holistic perspective of the supply chain. Again, adequate trusting relationships need to be put into place so as to ensure that the supply chain as a whole has an agreed and shared understanding of the strategic intent, its operational activities and that the processes are co-ordinated to provide optimum value. Without such improvement there will continue to be waste in Ohno's terms of; waiting, due to late materials arrival; transportation, due to excessive movement and double handling; and also stock on hand, due to early material arrival.

Waste spot #3 – The drive towards business process orientation is well recognised not only in the Business Process Re-engineering literature but also lean thinking and agile production. Codification of putative business processes (i.e. process mapping) enables the dismantling of functional barriers within and between businesses in the supply chain and ensures orientation towards delivering total value. This waste spot is related to poor supply chain integration, poor supplier relationship management and non-realisation of time compression benefits. The results shown here are mainly slow and erratic delivery, not actually an Ohno waste; however excessive or under delivery of materials give waiting-time wastes and stock-on-hand wastes that are only too prevalent in most industries.

Waste spot #4 – The ability to offer customer choice requires a supply chain infrastructure with sufficient capacity to respond quickly and flexibly. The current attitude in the house building industry requires a focus on total value and not just cost. Buying dedicated capacity from fewer but preferred contractors (partners?) ensures that resource is readily available when required and in fact will reduce total costs. The move to supply and fit within the industry reduces the supply base, improves commitment/accountability and gives control on materials (moves from a product to a service provision). Analysis of the wastes here shows they are similar to #3 but related to sub-contractors and not suppliers. However, the inability to plan the work sufficiently leads sub-contractors to a 'wait and rush' situation and thus to potential quality problems. In relation to Ohno there are 'waiting' and 'defective products' wastes and the potential for wastes from 'transportation'.

Waste spots #5 and #6 – Classic tools and techniques recently branded as the Lean Toolkit (Bicheno and Catherwood 2005) including 5S (mainly housekeeping), pokayoke (or fool proofing) and small group working (kaisen) enables the process operators to own the solutions to eliminating waste and delivering greater efficiencies. For these two areas, reductions in stock and improvements in process are necessary.

Technological enablers such as modular open systems, pre-assembly, timber frame systems that allow quick assembly of housing elements and reduce the volume of materials required, need to be implemented. A major principle for Ohno and JIT is the reduction of unnecessary stocks that hide inefficiencies and quality problems. Such a reduction promotes the elimination of the root causes which can be achieved by a more responsive supply of quality goods, resulting from good supplier management.

Waste spot #7 – Total Quality Management (TQM) as advocated by Deming (1986) and Oakland (1989) is mainly a philosophical approach in which everybody in the organisation, and the supply chain, takes ownership of quality. They are responsible for ensuring their activities do not impact detrimentally on subsequent operations in the supply chain. Quality is therefore everybody's responsibility and built into the process, with post-inspection, if any, kept to a minimum. This concept is problematic in housebuilding primarily due to the multi-disciplinary, transient, and in some operations, low skilled nature of labour. Ohno preaches involvement and empowerment – "teamwork is everything". A zero-defect (ZD) philosophy originated by Shewhart, and developed by Deming was well accepted by Toyota (Ohno 1988) and has been a key to the world class standing held by the Japanese manufacturing industry.

The analysis of these waste spots leads on to the three generic research outputs i.e. root causes of waste in the MCNS supply chain: relationship/trust/culture - changing the 'mind–set'; process orientation - total value perspective; and communication and learning. These major causes have been researched thoroughly and confirmed in terms of both their academic/theoretical and industrial/practical standing and confirm previous research. Such work included in industry targeted publications, (Bennett and Jayes, 1995/1998; Saad and Jones. 1998; and Flanagan, Ingram and Marshall 1998), and academic papers (Ellram and Krause 1994; Evans et al 1997, and Ibbs 1994) stress the need for improved relationships/partnering, customer focus and process orientation. It is clear that the supply chain assessed in the MCNS project has room for improvement by adopting best practice evident in other industry sectors.

The final area for discussion in this section is related to the main findings from the MCNS project shown in Table 4.5 Chapter 4. On consideration of these outcomes, although several improvements listed were not unique to housebuilding, they were proved relevant by the fact of their adoption and corresponding action taken by the partners concerned. It is clear that most of the waste identified was in the form of time and resource. The research team also recognised during the study that a specific area for improvement was through "Earlier involvement of the site manager" (Company D – private housebuilder) and having this person involved in pre-start meetings would have saved excess work and material wastage on a particular building site. This point is explored further in the overall discussion.

7.3 Stage 2 – National UK Housebuilders Survey Discussion

This section initially discusses the findings presented in Chapter 5 the reader should refer to the research tool itself in Appendix 4.

The response rate and hence the sample size equates to an acceptable representation of major private housebuilders in the UK, based on total annual build. The survey indicates that all respondents built private dwellings and many were part of a large national housebuilding company. The responses lead to a concern that there was a lack of any supply chain strategy, Q6 and lack of supply chain awareness in Q7. Also, most respondents increased their supply base in recent years (Q9) which conflicts with the trend in most other industries. As stated earlier, government initiatives, especially Building the Team (Latham 1994), encourages involvement with major suppliers (Q10), but the survey showed that although trust was felt to be good, in reality actual close working was found to be low.

Partnering was also found to be lacking (Q11a) with only 12% saying they definitely partnered formally, and only 36% felt it was a strategic activity. When considering general construction there is an on-going debate of 'project' versus 'strategic' partnering due to the variable nature of the work. However in the case of housebuilding where repetition of materials and processes is very high, partnering is a viable principle. A positive point is that there was an increase in the number of partners (Q11c) over the last 5 years; the survey indicated almost a doubling of partners. Also positive, is that respondents chose suppliers and sub-contractors not merely on cost but on service and quality of work (Q13). However, from previous case-study work by the author in the MCNS project, feedback and encouragement to suppliers and sub-contractors was rare.

An indicator of on-going supply chain management is supply chain performance measurement (Q14). 37% of respondents said they had some measure, but many descriptions included generalities like meetings, monitoring suppliers and other appraisals systems. Very few included recognised measures such as supplier delivery performance (time/quality), on-site defect rates, total inventory levels/costs, total acquisition cost, on-time completion performance and customer satisfaction as mentioned by other authors referred to in the literature review (Torbica and Stroh 2001; Craig and Roy 2004). Linked to lack of supply chain management capability was that very few respondents used information technology for communication (Q15). The internet and e-mail have become major media employed by most businesses but this is not the case in housebuilding. Also supply chain integration is low (Q15), even though, this has be actively promoted by government initiatives.

Within the arena of supply chain improvement (open question Q18), 'material delivery' emerged from the survey as the major problem, being nearly twice as important as the next problem 'schedules and build plans'. This conforms well to many other findings in this survey, such as overall lack of supplier involvement, communication and general integration of the supply side and verifies that the supply chain integration is low. Both the total returns and the 'Top 10' returns confirmed this. The analysis of responses to Q18 regarding the problems, showed that some respondents provided the causal nature of the major problems, (e.g. lack of subcontractor resource) whereas others just gave a description of the problem itself (e.g. not meeting the build programme).

The survey also showed (Q19) that as far as the overall supply chain performance was concerned there was a 30% room for improvement with 'snagging' having 45% potential. This result is a strong indicator that the quality and the culture for quality are very poor. This point is emphasised again when response to (Q20) indicated that there was a low awareness of and use of any popular improvement techniques.

A very useful output from the survey was Figure 5.20 and the corresponding discussion Chapter 5, Section 5.5 which evaluates many measures of supply chain awareness and compares the overall response with the 'Top 10' and with the 'Remainder'. The author is of the opinion that the result of 67% for the first measure, having a supply chain strategy, is too positive as most of the responses fall in the 'in some way' category, with only around 15% overall having a 'definite' supply chain strategy. The results for the rest of the measures confirm a serious lack of awareness of both supply chain management and improvement techniques, which is currently unpublished. Even the 'Top 10' respondents, amongst them several well known major national housebuilders, on average faired no better than the remainder. In fact, in the case of whether partnering is strategic, the 'Top 10' results were worse than the overall respondents. This finding is particularly damning considering the many government initiatives previously mentioned (Egan 2002; Housing Forum 2000; Fairclough 2002). These initiatives strongly recommend the avoidance of traditional adversarial relationships that have existed in the construction industry for so long and promote the adoption of more partnering. This is an area of great interest to the author and is re-visited in the final chapter as a consideration of possible further work.

There are several possible drawbacks and limitations of the survey work, however none of these are considered to be major or to detract from the key findings. An important consideration is that of whether only those companies that were proficient at supply chain management and pro-active for improvement might have responded. Also it was possible that only those with sufficient resource, that is, better organised companies, would be the ones that responded. These issues have the potential to influence the results. In answer to these concerns the results highlighted that the majority of respondents were shown to be poor at supply chain management and indeed at improvement techniques. This overwhelming negative result indicated that any positive bias by the respondents was minimal or nonexistent. In fact the results of the 'Top 10' compared with 'overall' and 'remainder' did not show any association between having greater resource and being more proficient at supply chain management and improvement techniques.

A converse argument would be that those companies that were very good at supply chain management and improvement techniques would not have replied as this may compromised their commercial advantage. This may have occurred to some extent, but those that did respond (whose identity was known by the author) included many famous names. Although some major housebuilders did not respond, however half of the Top 50 (Anon 2005a) did, and so it safe to assume the validity to the findings.

In dealing with a complex topic like this there is always a concern that recipients my not have understood the terms used in the questionnaire. An example is the definition of 'supply chain management' which is the subject of ongoing debate even by academics. The conflict here is that explanations make the questionnaire long and more complex and this could have reduced the response rate. Maintaining a balance between ease of use and comprehensive explanation is difficult. In order to test this balance and to avoid confusing terminology the questionnaire was proof read and piloted several times. The possibility of misinterpretation of responses, especially question 18 (an open question) was also a concern. Some comments given in answer to this question indicate the causal nature of the issues whereas others simply described the problem.

Another factor that might have affected the survey results was that of companies being in a state of merger or take-over at that time, and therefore not being in their normal state of control regarding processes and personnel. This situation was definitely the case with some respondents and was also evident in the collaborative fieldwork research element. Chapter 3 Section 3.5.5 Table 3.9 shows that is an on-going situation and therefore the findings from the survey are representative of the industry at any time that is this state of change is normal.

7.4 Stage 3 - Collaborative Fieldwork Discussion

The interviews with the site managers proved to be a very enlightening and information rich exercise and provided a qualitative approach from that of the more quantitative survey. Nearly all the interviewees were very positive about trying to improve the housebuilding supply chain and were quite open in their attitude and in their comments in response to the questions. They freely admitted, as can be seen from the results, that there was much room for improvement in many of the key areas raised. A particularly important point was their agreement and endorsement that the major factors affecting the housebuilding supply chain had been covered during the interviews. A concern expressed by senior management at Goodbuild was that these interviews would be a good vehicle for the site manager to 'moan'. However they did accepted the author's argument that, if there was consensus on problems this should be noted and taken forward for discussion at the improvement workshop to test for validity and further investigation.

The author became more adept at expressing the aims of the research and asking questions as the interviews progressed. The rich picture (see Q1 - Appendix 7) was found by the site managers to be a good representation of their overall processes and proved useful for the author in explaining the theoretical ideal of a no-waste supply chain. During the questioning many examples of problems and issues arose – too many to include in the final write up, but all copies of completed forms have been retained as evidence so support the list of comments included in the results Chapter 6.

The results from the interviews shown in Chapter 6 Section 6.2.3, closely align with the major findings of the survey and show that materials are the major problem in housebuilding supply chains. Allied to this, was that of schedules and build plans being incorrect or not agreed was also a major problem. An important outcome from the interviews, again supported by results from the survey, is the scale of the potential for improvement on major issues affecting the supply chain. Questions 2 and 3 indicated that around a 30% improvement was possible, with snagging (again in agreement with survey findings) having a 45% potential for improvement. When compared with other manufacturing industries such poor quality indications are very significant. Snagging emerged as not only having the greatest potential improvement but was also commented upon as a major time user for site managers themselves. This correlates with government customer satisfaction data on quality issues in that rework (snagging costs) are unacceptably high.

On reflection there were few concerns about the questions asked during the interviews. However during posing of the first question (open question) and subsequent responses, it became clear that the author needed to control the sequence of answers and ensure that the site managers first considered the greatest problem, its root causes and potential solutions before moving on to the next problem area. This was necessary to avoid confusion and a mixing of problems and causes. Also, as the number of interviews continued, it became apparent that the site managers' understanding of what constituted a 'root cause' varied. The other three questions proved to be uncomplicated and generated useful data, even though, due to various interruptions, most interviews lasted over an hour rather than the 30 to 40 minutes agreed with Goodbuild's management.

From all the data collected it became evident that as shown in the literature review and the research methodology, Chapter 3 Section 3.6.2, site managers are indeed in a key position to understand and evaluate the problems and performance of housebuilding supply chains. They were aware of many issued concerned with the supply chain and had definite answers for all the questions posed during the interviews.

Following the analysis of results from the interviews the author offered to give a presentation to Goodbuild's site managers (for the region concerned) but this was never taken up. Such a meeting would have proved an ideal opportunity to increase validation by use of a short supplementary survey.

One limitation of the interview method was that the number of interviews was small (thirteen) it does represent the majority within a region of a major housebuilder. Also in terms of gaining qualitative data of an 'explanatory' nature (Saunders et al. 2003:248) they were very successful. In any interview process the quality of the data obtained can be affected by the reliability of reporting and potential for bias. However, great care was exercised to present a non-threatening, friendly approach with confidentiality being assured to facilitate honest and open responses. The author also provided some assurance of his identification, status and competence via a business card and university web site details. Site managers often stated that this was not necessary but the author was convinced that it did assist the collection of valid data. Pre-printed interview forms (Appendix 7) used, enabled easier and more accurate recording of responses together with a consistent approach for all site managers.

The improvement workshop proved to be a real testing ground for the research questions raised in this dissertation. It was surprising that none of the participants who represented a regional group of experts from a major UK housebuilder (therefore likely to be one of the best in class) were familiar with process or quality improvement tools. As the workshop progressed, however, it became clear that the despite their lack of familiarity with the tools the majority of the experts were enthusiastic and interested in the purpose of the workshop and this greatly assisted in achieving its aim. The improvement workshop was a successful culmination of the previous stages of research and provided evidence and justification the research as a whole. Firstly, it confirmed the findings from the site manager interviews in that after some initial discussion they were accepted as valid. More importantly the in-depth analysis employing causes and effect methodology followed by discussion and formation of corrective actions, led to the useful conclusions that are central to the aims of this dissertation.

It was unfortunate that the time available for the workshop was restricted which meant that a more detailed analysis and completion of more factors within the FMEA table could not be achieved. It would have been beneficial if participants had been able to view the video of the FMEA process which was sent to Goodbuild prior to the workshop.

7.5 Cross Methodology Synthesis

The overall methodology employed within this work is a mixture of approaches and data collection techniques formed so as to meet the aim of the research and the four research questions. The progression of research has been from the generalist towards the more specific and more focused areas of waste in housebuilding supply chains. This final discussion section links together the three stages of the research and looks at the work as a whole.

There are potentially many ways to identify 'waste' in housebuilding supply chains. This research first assessed housebuilding supply chains by understanding exemplars from other industries and then took data from the supply chain management and procurement personnel of major UK housebuilders to identify the main areas of waste (potential improvement). Based on these findings, a deeper study to confirm and identify specific areas of waste for a particular major housebuilder was carried out. This was done from the perspective of the site manager who is the 'last planner' and controls the operations. These findings were in turn accepted by 'experts' during an improvement workshop. This acceptance validated the outcomes of the earlier research, and took the work forward into the identification of potential corrective actions and their proposed implementation. Reaching this stage successfully justifies the overall methodological approach taken and within this, the sequential application of the individual research phases.

A key factor in this research has been that the same private housebuilding company was involved in all three stages of empirical research. This fact added credibility to the findings, by ensuring consistency and aided the author in understanding the housebuilding supply chains, form a general level towards a more specific level, and hence the ability to categorise and analyse the empirical data, especially in the last two stages.

There are many areas with the potential for even greater depth of analysis using the findings of this work, than are presented here. Although such analysis falls outside the scope of this work some which are worthy of note, that are particularly pertinent and link the cross methodology approach are now presented.

- As shown in section 6.3.3, the survey and the site manager interview findings via the open questions of major problems concur that materials and stock levels constitute the greatest problem (Figure 6.4). This point was emphasised during stage 3 collaborative improvement workshop where material problems accrued the highest RPN (see Table 6.2)
- Similarly Figure 6.6 shows agreement from both these sources on what the author puts forward here as generic supply chain problems, i.e. both felt that 'snagging costs' followed by 'poor information' were greatest problem areas. What is interesting to note here is that on this question (Q19 survey and Q2 site manager interviews) the author had separated 'stock levels' and 'incomplete delivery'. If these two problem categories had been combined (see Figure 6.6) this could well have emerged as greatest problem and so would support the above deduction. However, this is could not be substantiated from the actual results.
- Another key point coming from stages 2 and 3 is the level of overall performance on many of the measures. When considering the survey results on supply chain awareness, for example Figure 5.20, the results show a potential room for improvement of around 75% on key measures of awareness and good supply chain practice. This is a massive potential (or gap) and although a generalisation, based on anecdotal opinion it does highlight an area of concern for the industry. Taking 'scaling' questions for both the survey and the site managers' interviews, i.e. Q19 survey and Q2 interviews see Figure 6.6, the overall potential for improvement is between 45 to 15%, once more indicating

a poor overall performance. This is also borne out by Figure 6.7 where site managers gave opinions on the severity of problems raised by the survey, and where performance levels of only around 70% were felt to exist.

- An outcome from this cross methodology research is that there is consistency of results regarding awareness levels and application of improvement techniques. Comparing Q20 in the survey (see Figure 5.19) with the Goodbuild staff survey (see Figure 6.8) there is great similarity, both showing a low level of familiarity. Techniques which the author considered that the housebuilding industry would be aware of, for example KPI's, benchmarking and TQM, were reported on as having little awareness. This too, should be of concern to the industry.

CHAPTER 8
CONCLUSIONS

A conclusion is the place where you get tired of thinking.

Arthur Bloch

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I tell this tale which is strictly true
Just by way of convincing you
How very little since things were made
Things have altered in the building trade

Rudyard Kipling C. 1900

8.0 CONCLUSIONS

8.1 Research Process and Outcomes

This chapter assesses the research as a whole and refers back to the research questions presented in the introductory Chapter 1, exploring how well, and in what respect, those questions have been answered. The Chapter also looks at what contributions the work makes to existing knowledge, reflects how the work could have been improved and outlines areas for further research.

This thesis began by summarising and critiquing the current state of secondary information regarding supply chain management in housebuilding. This was followed by three distinct but sequential stages of empirical research designed to address the four research questions that constituted the core thread and direction of the work. The 'total' research process encompassed the adoption of many tools and techniques. These included process mapping, observation, brainstorming, interviews, questionnaires, focus group work, cause and effect analysis, and finally failure mode and effect analysis (FMEA). Initial techniques used were the main basis of the Quick Scan and Terrain Scanning Methodology which made up the first research stage, but others were added as the research progressed and evolved. The process employed, and the consequent research outcomes, have built upon existing information and expertise on housebuilding supply chains and has moved forward the boundaries of knowledge by increasing the understanding and the application of tools and techniques to new areas. This chapter will now contextualise the work carried out as well as review and reflect upon its implications and importance.

8.2 Key Findings and the Research Questions

Each of the four research questions are presented and discussed in the light of the work's key findings with conclusions drawn as to the level of meeting the questions. Reference should be made to the Connectance diagram shown in Chapter 1 as Figure 1.1.

Q1. What is supply chain management in housebuilding and what is accepted as current best practice?

The literature review has shown there is very little research published on housebuilding supply chains compared with general construction and other industries. This is particularly the case when considering the holistic view of the supply chain as opposed to a more fragmented view. What also emerged from the literature review was that the adoption and application of improvement techniques is a major enabler for removal of waste and consequential improvement in effectiveness and efficiency. However there is evidence that there is little use made of improvement techniques within the housebuilding industry. Most research on housebuilding supply chains concentrates on specific and specialist areas; a major example being partnering, especially the recommendation to move away from the traditional adversarial relationships. Other published work and research is related to materials and building waste, design and project management including protocols for computer control of the project as a whole.

Another growing area in the literature is that of sustainability and environmental considerations in the construction and housebuilding industries. Within the author's reference data base of some 600 references associated with this dissertation topic area only eight are concerned with the improvement of the housebuilding supply chain in a holistic sense. A few publications mention the importance and relevance of the person at the end of the supply chain (termed foreman or last planner by various authors) who understands the problems and can lead the focus for solutions. Thus this work has identified a substantial gap in the evidence base of published literature which the subsequent research activities seek to fill.

Chapter 4, which researched a group of companies in a housebuilding supply chain, showed that there was poor communication and culture (mind set) for improvement and adoption from exemplar industries. These partners were assessed for communication technology, partnering, supplier management, supply strategy and performance measures, and showed there was much room for improvement compared with other manufacturing industries. The best performer within the group was an extractor fan manufacturer who was subjected to non-construction industry competitive pressures and was proactive in adopting improvement methodologies.

It may be summarised is that housebuilding supply chain management lags behind other manufacturing industries and although much guidance from academics and government abounds there is little evidence of the adoption of best practice.

Q2. What is the current level of supply chain management competence, including the adoption of best practice?

This question was partially covered by Chapter 4's findings but the results from the survey, Chapter 5 show conclusively that there is a general lack of competence across the UK private housebuilding industry on many key issues regarding supply chain management. It is evident that there is some move towards recognising the importance of supply chain management; but there is a low level of strategic direction, and very few actual supply chain performance measures are being used. Also the results show that many commonly used quality and improvement tools are not recognised in housebuilding, and even the targeted government initiatives for benchmarking, such as KPI's have not been adopted. As mentioned earlier, moving away from traditional adversarial relationships into partnering is a key government initiative, but this also has not been embraced to any real extent. Finally, the penetration and use of communication technology is low with most housebuilding still using traditional telephone and paper based systems.

The research has shown that the current level of supply chain competence is low and adoption of best practice is not occurring at a rate comparable with other manufacturing industries.

Q3. Which are the significant causes of waste for major UK private housebuilders?

The survey established via open questions and through rating scale questions, the position of the major UK housebuilders regarding their problems and performance. This showed that the major waste areas were related to material availability (by far the greatest), schedules and build plans and call-off's and site manager issues. The results of the survey are supported and triangulated by the site manager interview data Chapter 6 concluding that the correct material availability is the significant cause of waste. The site manager research showed that technical information and support, and then schedules and build plans were major problem areas to them, reflecting a slightly different perspective than the survey where respondents were procurement and supply chain management personnel. It is also important to note that both the survey and the site manager data shows a high level of potential for improvement across many performance measures; some 30% scope for improvement generally and 45% potential specifically relating to 'snagging'. This represents a low quality level and a poor quality culture within the industry, and is also indicative of the supply chain performing badly. The root causes of these problems relate back to the findings from the first empirical data, that is, those of lack of awareness, mind-set (relationship/trust/culture), process orientation (total value perspective), and communication and learning issues.

Q4. What are the key methods and techniques that can be adopted for improvements?

The literature review discussed and listed a range of potential improvement techniques and highlighted their adoption by other industries. Many authors on operations management and quality have promoted improvement techniques and indeed many of these are now adopted as standard practice in most manufacturing and related industries. In contrast, the results from the survey, from the improvement workshop and Stage 3 survey clearly show a lack of knowledge and application of such techniques in the housebuilding industry. What is an important issue here is the cultural background and 'mind set' of the industry, as discussed above, and whether there is an impetus to improve. The work at the improvement workshop using the cause and effect (fishbone) tool proved to be useful in determining the major likely causes for the problems from the site manager interviews; and the failure mode and effect analysis (FMEA) techniques created a list of corrective actions to improve these major problems. The FMEA is one of the few 'off line' preventative methodologies now supported by the quality standard ISO9000:2000. The work concludes that improvement techniques which are used in manufacturing, such as cause and effect tools and FMEA used here, are applicable to housebuilding and should be adopted more widely. This leads to the conclusion that other process and quality improvement techniques known to be successful in manufacturing are equally applicable in housebuilding.

8.3 Contribution to Academia

There was a gap in published literature relating to how the UK housebuilding industry perceived supply chain management. In addition, there is little information on what the major areas of waste are, and what methods can be used to improve the situation. This gap is particularly apparent when considering the holistic view of housebuilding supply chains.

This thesis has added to new knowledge by first evaluating the supply chain awareness of the UK private housebuilding industry and establishing that there is an overall lack of understanding within this criticised but important area of business. It has also identified and evaluated waste within housebuilding supply chains first from a generic perspective but also specifically through collaboration with a major UK private housebuilder.

The research presented here also shows how existing improvement tools can be successfully employed to undertake academic research if applied systematically, especially when carried out in a collaborative setting with industry. It has also established that there is a low level of awareness of improvement tools by housebuilders, including those techniques which have been strongly supported and advocated by the UK government initiatives. The work shows that improvement tools such as cause and effect and FMEA can be applied successfully to housebuilding by considering housebuilding in the same way as a 'manufacturing' process. This has not been done before to the author's knowledge. Because of housebuilding's similarity to traditional batch manufacturing it is very amenable to the successful use of such improvement tools, and the work in the final stage of empirical research has proven the case.

The work has identified certain key specific areas in need of improvement in housebuilding supply chains. These areas offer an inducement for focussed academic research which will extend the knowledge base even further and lead to corresponding and much needed improvement.

8.4 Contribution to Industry

A major justification for selecting this topic area is that the UK housebuilding industry is still underperforming as is attested by both its customers and the UK Government. This work in set out in this thesis has not only clearly demonstrated that there is a definite lack of awareness around supply chain management within the industry but also that there is great potential for improvement. It has also shown that methodologies for process improvement and quality improvement which are the norm in some industries are currently seriously lacking within housebuilding. The housebuilding industry needs to address this if it is serious about meeting the needs of its customers, the UK Government and UK society as a whole.

The results of the national UK housebuilders survey, together with the collaborative work, have not only highlighted in detail the specific problem areas and but also presented ways to improve. The work has also built on previous studies showing that many existing manufacturing and quality improvement techniques are effective within the housebuilding industry. Particular techniques for the analysis and identification of problem areas, as well as a technique for assessing the severity of potential causes, has, as stated previously been successfully applied. Although the industry personnel involved had not used such techniques before, this was not a barrier to implementation. Indeed, as shown in the findings chapter, they became an effective team achieving a successful result which shows that other housebuilders could also use such methods and improve their processes and supply chain. A major obstacle to this, as mentioned in the collaborative workshop, was that demand for housing is currently high and because of the consolidation within the private housebuilding industry it is possible that some builders feel there is no competitive need to improve. Such a state of affairs is to be regretted especially when considering the fate of much of the UK's manufacturing industry and the results of outside competition.

8.5 Contribution to Goodbuild

The author has been assured that Goodbuild are going to implement the changes recommended as a result of this work. This has created an opportunity for a more open and communicative environment for process analysis and improvement. The findings from the survey and site manager research have been discussed in depth with Goodbuild personnel and the potential for benefits examined. This work has also created awareness at Goodbuild, in that although they are a major housebuilder there are still opportunities, currently not exploited, where improvements to their supply chain can be made. The workshop participants found the exercises stimulating and enlightening and are intending to build on this initial learning experience. This re-enforced the recognition that there was a lack of awareness and knowledge in this area. The author is currently awaiting an invitation to hold a further improvement workshop using the FMEA technique and concentrating on the quality of build, which directly relates to the major potential for improvement represented by the 'snagging' concerns raised by the empirical data in this research.

8.6 Reflection

Reflecting upon the work, it is possible that the time gaps between the three research stages could have meant that the industry had changed and this could have affected the comparison and triangulation of the data used in this phased methodology. However the time periods are relatively short in context of the industry, when considering against the timeframe of the UK government initiatives that started decades ago and with a major review in 1994.

With more time and resource the research could have been improved by conducting interviews with some of the survey respondents prior to gathering the site manager data. Such work would have given a more qualitative perspective to the survey and so enhanced the overall findings. It is a positive factor that Goodbuild were represented in all three stages of empirical research as this adds to the reliability of the work.

From a personal perspective this work has increased the author's overall knowledge on supply chain management and relevant improvement techniques through the literature review. A most useful aspect to the work was the close working relationships with first the MCNS practitioners, and then with Goodbuild, which gave industry insights and practical knowledge and understanding regarding housebuilding supply chains. Such collaborative work embedded much of the theory and contributed to a more 'realist' base within this field of knowledge.

8.7 Implications for Further Research

Further work is now planned by the author. This includes follow up activities with Goodbuild who recognise the potential of the improvement tools already applied and wish to continue by focusing directly on quality issues within the process. This further engagement will also act as a training mechanism and may increase enthusiasm for further development and implementation of improvement, hopefully leading to a 'learning organisation' culture.

The author also plans to undertake a longitudinal study using the same research tool in 2006, to measure any changes over the intervening time period. There will have been a three year gap and this will re-test the UK Governments initiative to improve the industry's awareness and understanding of supply chain management and related issues. It is also planned to extend this work by carrying out interviews with the Top 10 housebuilders so as to resolve the quandary, shown in the survey data, that this group felt partnering was less strategic than did the 'remainder'. The author is also keen to build on the knowledge gained by this dissertation on the application of improvement techniques and aims to work with other major housebuilders.

Despite the success of the tools and techniques employed and the identification of the need for improvement and suggestions for how that could be achieved the author is concerned about the underlying complacency that exists within the UK housebuilding industry and which is a barrier to improvement. At present it appears the buoyancy of the business is such that the complacency is difficult to overcome. The latest development in this area is the quest by the UK Government to secure affordable housing, leading to the challenge to achieve a build cost of £60,000, where construction will be mainly from a pre-fabricated factory pre-assemble units. Currently several businesses, including IKEA (Anon 2005b), have responded to this challenge. The Office of the Deputy Prime Minister has selected nine building consortia to compete in the construction of two-bedroom developments which could become the template for affordable housing (Sherman 2005). Although affordable housing may not represent the main-stream housing demand in the UK this development is certainly a wake up call for UK housebuilders.

8.8 Concluding Notes

This work has shown that rigorous academic methodologies can be applied to the business world and can improve a particular business situation. It is evident that some improvement techniques are transferable from one industry to another and the main barriers are those of awareness and culture. It is hoped that this and further work planned by the author will aid progress towards achieving improvement within housebuilding.

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Appendix 1

SITE NAME: ______________________

WEEK ENDING: ______________________

COMPLETED BY: ______________________

JOB NUMBER:

SHOW HOMES:

HAND OVERS:

Plot No.	Hse Type	Excavation	House Blockwork	House Slab	Garage Blockwork	Garage Slab	Drainage	First Stage Sitework	Scaffold Start	1st Lift House	2nd Lift House	Joists	3rd Lift House	4th Lift House	Top Out House	1st Lift Garage	Remainder Brwk Garage	Main Roof Timbers	Garage Roof Timbers	Main Roof Tiling	Low Level Roof Timbers	Garage Roof Tiling	Low Level Roof Tiling	Leadwork / Externals	Garage Doors	External Doors	Glazing	Painting - External	2nd Stage Sitework	Fencing	Plumbing - 1st Fix	Carpenter - 1st Fix	Internal Partitions	1st Fix Electrician	1st Fix Alarms	Dryline & Cove	Screed / Insulated Flr	2nd Fix Carpenter	2nd Fix Plumber / San	2nd Fix Heating	2nd Fix Electrician	2nd Fix Alarms	Loft Insulation	Kitchen Units	Fireplace / Surround	Wall Tiling	Painting - Internal	Appliances	Finals	Floor Tiling	Turfing	Planting	Cleaning
Progress Stage		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52

FLY-BY CUSTOMER INTERFACE QUESTIONNAIRE

This questionnaire contains product specific questions. These products have been chosen to represent your company activities in relation to housing construction. Please consider these products alone when completing this questionnaire.
Only one main customer is considered for each product (only two customers are taken into account), so please answer this questionnaire only in relation to these two customers. Thank you.

Product A: ______________________ Customer A: ______________________

Product B: ______________________ Customer B: ______________________

A. FINISHED GOODS DELIVERY

		PRODUCT A	PRODUCT B
A.1	**Customer Locations** State the number of customer locations the specified products are delivered to.	1-10 O 11-20 O 21-50 O 51-100 O 101-200 O 200+ O	1 O 2-3 O 4-6 O 7-10 O 11-20 O >20 O
A.2	**Handling Characteristics** Please state the products handling characteristics when they are in finished goods form.	Bulk O Single Unit O Unitised (pallet, container) O Specified: ____ Other, please specified ________ O	Bulk O Single Unit O Unitised (pallet, container) O Specified: ____ Other, please specified ________ O

		CUSTOMER A	CUSTOMER B
A.3	**Delivery Lead Time** Please state the average time between when you receive a firm order and when the product is delivered.	________ Days ________ Weeks ________ Months	________ Days ________ Weeks ________ Months
A.4	**Delivery Lead Time Range** Please give a typical variation on this delivery time, i.e. usually late or early and by how much.	Early ________ Days or Late ________ Days	Early ________ Days or Late ________ Days

		CUSTOMER A	CUSTOMER B
A.5	**Delivery Frequency** How frequently do you deliver the two specified products to your customers?	________ Per day ________ Per week ________ Per month	________ Per day ________ Per week ________ Per month
A.6	**Delivery Distance** State the average delivery distance for the two specified customers.	________ Miles (________ km)	________ Miles (________ km)
A.7	**Delivery Location** Give the names of the nearest towns/cities for deliveries to the 2 customers give up to 5 locations – most major first.	________ ________ ________ ________ ________	________ ________ ________ ________ ________
A.8	**Orders type** How frequently do you receive order from your customers for the specific products?	________ Per day ________ Per week ________ Per month	________ Per day ________ Per week ________ Per month
A.9	**Quantities Delivered** State the amount of products/parts you deliver to your customer per delivery.	________ Per delivery	________ Per delivery
A.10	**Supply Source** How do your supply your customer?	O Supply to order (from production) O Supply from stock (existing stock) O Other: ________	O Supply to order (from production) O Supply from stock (existing stock) O Other: ________
A.11	**Transport Organisation** Who is organising the transport of the products?	O Customer O Your company O Other: ________	O Customer O Your company O Other: ________
A.12	**Transport Means Provider** Who is providing the transport means (e.g. trucks)?	O Customer's fleet O Own fleet O Sub-contractor/carrier's fleet O Other: ________	O Customer's fleet O Own fleet O Sub-contractor/carrier's fleet O Other: ________

	CUSTOMER A	CUSTOMER B
A.13 Special Transport Requirement Are there any specific transport requirements for the products?	O Truck size: ______ O Truck weight: ______ O Special packing: ______ O Other: ______	O Truck size: ______ O Truck weight: ______ O Special packing: ______ O Other: ______
A.14 Ordering Method How do you receive your orders from your customers?	O EDI O Paper O Fax O Telephone O E-mail O Other: ______	O EDI O Paper O Fax O Telephone O E-mail O Other: ______
A.15 Length of Customer Relationship For how long have you been their supplier?	______Years ______Months	______Years ______Months
A.16 Contract Agreement What kind of contract agreement do you have with your customers?	O Standard contract O Specific contract O Informal agreement O Other: ______	O Standard contract O Specific contract O Informal agreement O Other: ______
A.17 Customer Relationships On the whole how close a relationship do you have with these customers?	Adversarial 1 O 2 O 3 O 4 O Partnership	Adversarial 1 O 2 O 3 O 4 O Partnership
A.18 Satisfaction Level How would you rate your customer satisfaction level towards your services?	Dissatisfied 1 O 2 O 3 O 4 O Satisfied	Dissatisfied 1 O 2 O 3 O 4 O Satisfied
A.19 Problem What difficulties for you arise from working with these customers? i.e. What do you see as the biggest problem that hampers your work and why?	______ ______ ______	______ ______ ______

For the following questions, we would like you to grade your relationship with the two specific customers on particular issues.

	CUSTOMER A	CUSTOMER B
A.20 Trust	Low 1 O 2 O 3 O 4 O High	Low 1 O 2 O 3 O 4 O High
A.21 Commitment	Low 1 O 2 O 3 O 4 O High	Low 1 O 2 O 3 O 4 O High
A.22 Cost transparency	Low 1 O 2 O 3 O 4 O High	Low 1 O 2 O 3 O 4 O High
A.23 Joint R&D programmes	Low 1 O 2 O 3 O 4 O High	Low 1 O 2 O 3 O 4 O High

Perceptions of internal suppliers: In the following questions the term "internal supplier" relates to the process area that feeds (preceding) your own process area in the material flow.

Please indicate below which internal suppliers directly feed into your process and about which these questions relate concerning the two specific products studied.

____

____

____

	PRODUCT A	PRODUCT B
A.24 Your Internal Supplier Problem What do you believe is your internal supplier biggest problem with your work?	______ ______	______ ______
A.25 Problem with the Internal Supplier What difficulties arise from working with this supplier? i.e. What is your biggest dissatisfaction towards your internal supplier work?	______ ______	______ ______

LSDG LINK MCNS PROJECT standardised components in house building

CARDIFF UNIVERSITY

Data collection/Interview – Phase 1 Supply Chain mapping

Company_______________ Main Contact_____________

Product 1___________ Product 2 _____________ Date _______

Supplier 1___________ Supplier 2 _____________

Q1 Have you already worked in a supply chain/partnering relationship – YES/NO
Please give your experience____

____

____

____

____

____

Q2 How would you describe your relationship with the two supplier and two customers ? (partnership?)

Supplier 1 ____

____

____

____

____

Supplier 2 ____

____

____

____

____

Customer 1 ____

____

____

____

____

Customer 2 ____

____

____

____

____

ALL ANSWERS WILL BE TREATED IN THE STRICTEST CONFIDENCE

Q3 How do your measure supplier performance?

Supplier 1____

Supplier 2____

Q4 What is your ordering rule (process of deciding production levels)?

Q5 At what stage(s) of the house building process are you normally involved? (any revisits?)

Q6 At what stage(s) of the house building process would you like to be involved?

Q7 What is the normal duration of your activities in a typical house building project?

Q8 What amount of your activities could be carried out before site work if house building process was mainly pre-fab with standard parts? 0% 20% 40% 60% 80% 100%____

Q9 Please state/list which activities could be carried out before site work

Q10 What proportion of your components/products currently use, or are used as, standardized components? 0% 20% 40% 60% 80% 100%,
comments

Q11 What proportion of your components/products currently use, or are used as, pre-fabrication? 0% 20% 40% 60% 80% 100%,
comments

Q12 Do you think you could successfully work in the house building industry which uses standardized components? - what effect would these have on your normal working practices?

Q13 Do you consider any of your activities to be best practice? YES/NO
Which ones? Why do you say this? (ask several different people!!)

Q14 How could final customer choice in houses be increased? What effect would this have on your working practices?

Q15 If we produced Pathfinder I with a real integrated supply chain how would this affect your activities and culture?

Q16 What is your new product introduction cycle ? that is, your product and information flows ? (draw product and information flow on reverse of sheet !)

Q17 Any general comments on how you could see standardization and pre-assembly methodology being successful?

Appendix 4

Joe Bloggs
Xxxxxxx
Xxxxx
Xxxxxxx
Xxxxxx
Xxxxx
Xxxx
Xxx

29th July 2003

Housebuilding Supply Chain Awareness Survey

Dear Joe,

We talked over the phone the other day regarding the above survey. Thanks again for agreeing to take part. This cover letter gives more background information for you.

As part of my PhD research into improving housebuilding supply chains, I am trying to assess the current awareness of the major 100 private UK housebuilding companies. I am doing this with the support of the House Builders Federation, (contact Alex Mitchell), who recognise the relevance and usefulness of the research to the industry.

A copy of the overall results will be available to you so that you can benchmark your company against others. I promise confidentiality, in that individual respondents will not be identified **under any circumstances**; only academic staff will see the returns. The questionnaires have been numbered only to progress returns.

Response rates with postal questionnaires is often very low, therefore your reply is very important to me so that my results represent a true picture of the major housebuilders in the UK. It should only take you about 20 minutes (honest!)

Please complete the questionnaire so as to represent only the housebuilding side of your company if it is also involved in general construction. Please return by Friday 8th of August 2003 if possible.

If you have any concerns or problems please contact me (see below):
Thanks again,

Mr. Ralph Barker,
Senior Lecturer, Business School, Glamorgan University, Pontypridd, Wales CF39 1DL;
Tel 01443 482958/48; Fax 01443 482380; e-mail: rbarker@glam.ac.uk;
http://www.glam.ac.uk/bus/People/StaffCVs/Management/RalphBarkerCV.php

business school
University of Glamorgan

Housebuilding Supply Chain Awareness Survey

This survey is part of my PhD research and aims to establish the current awareness of supply chain management in the major private housebuilders in the UK. All replies will be in strict confidence (only academic staff involved) and no individual responses identified. A copy of the overall results is available on request – please see end of questionnaire.
Please answer all questions to represent your housebuilding company – for further information or to contact me see covering letter.

Thanks for your help,
Ralph Barker Form No

Section 1 – General Information

Q1 – Please state approximate Turnover in £'s for 2002 = ______________

Q2 – Maximum number employees in total for 2002 = ______________

Q3 – Number of houses completed 2002 = ______________

Q4 – In what housing sector does your company work. (tick one box):-

Private ☐ Social ☐ Both ☐

If both what proportions in 2002? - _______% Private; ______% Social

Q5 – Is your company part of a larger housebuilding group? Yes ☐ No ☐

If yes, please indicate if you buy regionally or as part of a group. (tick one box):-

Regionally ☐ Group ☐ Both ☐

Q6 – Does your company have a Supply Chain Management Strategy? (tick one box)

No ☐ Not yet ☐ In some ways ☐ Definitely ☐ Don't know ☐

Q7 – Please state number of dedicated people involved in controlling and managing your supply chain (not just buying/purchasing) ________

Q8 – Please indicate general awareness of supply chain. (tick one box for each factor)

Factors	Not heard of	Heard of but not used	Some use	Extensive use	Don't know
KPI's for housebuilding					
cbpp					
Rethinking Construction					

Section 2 – Relationship Related Issues

Q9 Please indicate the approximate total number of suppliers and sub-contractors used in:

1997 ___________ and in 2002 ___________

Q10 Please describe the kind of relationships you have with your most important 3 suppliers and top 3 sub-contractors as a whole. (circle or complete as appropriate):

a) Their level of trust with you	none low fair high total
b) Your level of trust with them	none low fair high total
c) Their level of commitment to you	none low fair high total
d) Your level of commitment to them	none low fair high total
e) Level of cost transparency	none low fair high total
f) Amount of joint R&D carried out	none low fair high total
g) Amount of Early Supplier Involvement i.e. how much suppliers involved in design/process prior to delivery	none low fair high total
h) Relationships are:	contractual mix informal
i) State length of relationship for top 3 suppliers (in months)	Supplier 1 _________ months Supplier 2 _________ months Supplier 3 _________ months
j) State length of relationship for top 3 sub-contractors (in months)	Sub-contractor 1 _________ months Sub-contractor 2 _________ months Sub-contractor 3 _________ months

Q11 Please describe the general situation regarding "partnering" in your company. "Partnering" being defined as a long-term commitment that includes trust and working together, for mutual shared benefits. (circle or complete as appropriate):

a) Procedures are used for partnering	never sometimes always
b) Partnering is classed as	Strategic mix short term
c) State number of partners you had in:	1997_________ 2002_________

Section 3 – Supply Chain Related Issues

Q12 Please indicate your company's general awareness of supply chain issues (tick as appropriate):

Factors	Not heard of	Heard of not used	Some use	Extensive use	Don't know
Just in Time (JIT) principles					
Demand amplification principles					
Lean construction /process principles					
Value stream mapping					

Q13 Please rank the following criteria for choosing your key suppliers (1 most important; 8 least important)

Criteria	Rank
Partnering philosophy	
Quality of work	
Technical ability	
Personal relationships	
Total acquisition cost	
Reputation/past history	
Service	
Other, please specify:	

Q14 Does your company have formal procedures on measuring your supply chain performance? Yes ☐ No ☐ Not sure ☐

If Yes – please describe ____

____

____

If No – please state why not ____

____

____

Q15 Please indicate how you communicate with your 3 most important suppliers/subbies. Please give approximate %'s for each category.

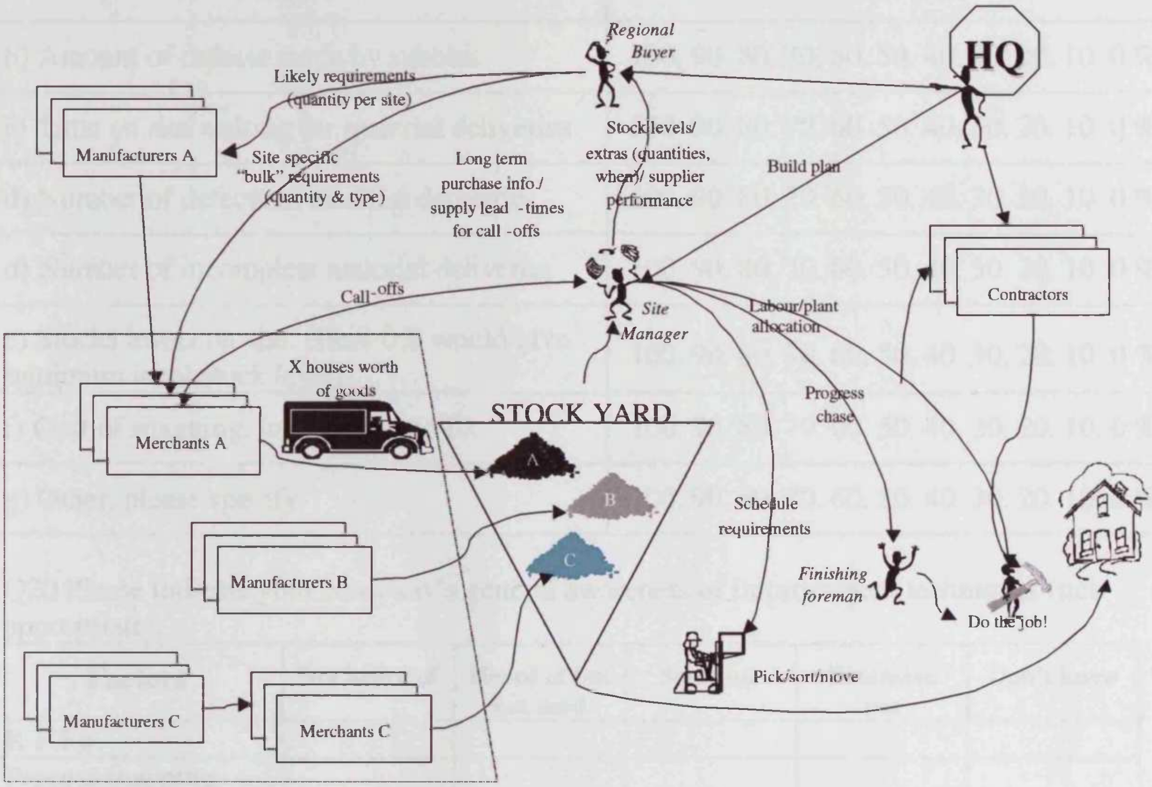
Communication method	Orders, invoices and payments	General information, drawings, tenders and quotes
Telephone		
Fax		
E-mail		
Post		
EDI		
Internet		
Meetings		
Other, please specify		
Total	**100%**	**100%**

Q16 As an indication of supply chain integration, please indicate your company's situation regarding the following: (circle as appropriate)

a) We share goals and objectives within the supply chain	0. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100 %
b) We hold regular meetings to agree direction in the supply chain	0. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100 %
c) We have firm agreements to resolve problems	0. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100 %
d) We deeply understand our key suppliers/ subbies and their businesses	0. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100 %

Section 4 – Supply Chain Improvement

Q17 Please consider the following "rich picture" as roughly representative of a normal housebuilding process, where there is some HQ buying, some more local buying and the site manager controls the day to day activities. Please estimate the 5 greatest problem areas or potential areas for improvement you feel exist in your supply chain. i.e. consider everything - processes, people, relationships, communication etc. Identify these 5 areas by annotating the diagram with 1 – for the greatest, through to 5 for the least significant.



Q 18 Improvement of supply chain – please describe below these 5 problem areas and how you are currently try to improve them.

Area	Description of Problem	Improvement – techniques/methods
1		
2		
3		
4		
5		

Q19 Please indicate how good your company is regarding the following activities.
i.e. 100% means very poor - the worst, and 0% means ideal perfect situation – cannot be improved upon! (circle as appropriate)

a) Re-quotes from suppliers/subbies	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
a) Poor information to suppliers/subbies	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
b) Time on site waiting for subbies	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
b) Amount of defects made by subbies	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
c) Time on site waiting for material deliveries	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
d) Number of defects in material deliveries	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
d) Number of incomplete material deliveries	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
e) Stocks levels on site. (Here 0% would give minimum ideal stock level)	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
f) Cost of snagging, inspection and fix	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
g) Other, please specify:	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %

Q20 Please indicate your company's general awareness of improvement techniques (tick appropriate):

Factors	Not heard of	Heard of but not used	Some use	Extensive use	Don't know
K P I's					
Process mapping					
FMEA					
TQM					
Benchmarking					
Balanced score card					

Q21 If you wish please give any general comments regarding supply chain management and overall improvement, or about this survey:

____

____

____

____

Thanks again for your help in this survey!

If you would like a copy of the overall results please tick the box ☐
If possible please give me an email address to use:

Please return to: Mr. Ralph Barker, Senior Lecturer, Business School, Glamorgan University, Pontypridd, South Wales, CF37 1DL (envelope provided) If necessary contact via: http://www.glam.ac.uk/bus/People/StaffCVs/Management/RalphBarkerCV.php

Appendix 5

Top 25 Housebuilders by Build 2002 - from Building Magazine		
1	Persimmon	12,352
2	Barratt Developments	12,250
3	Wimpey	12,145
4	Taylor Woodrow	6,238
5	Bellway	6,044
6	Westbury	4,461
7	Wilson Bowden	4,091
8	Wilson Connolly	4,002
9	Redrow Group	3,908
10	Berkeley Group	3,182
11	Bovis Homes	2,556
12	Miller	2,298
13	Bloor Holdings*	1,911
14	Crest Nicholson	1,899
15	Countryside Properties	1,854
16	General London Construction Holdings*	1,700
17	McCarthy & Stone	1,671
18	Linden	1,085
19	Bett Brothers	916
20	Stewart Milne*	900
21	Galliford Try	899
22	Kier	877
23	MJ Gleeson	479
24	Cala Homes	460
25	David McLean	318
	Total Dwellings	88,496

Source Anon (2005 a)

SURVEY HOUSEBUILDERS LIST

Ken Prosha Purchasing Manager ABBEY DEVELOPMENTS LTD Abbey House 2 Southgate Road Potters Bar Hertfordshire EN6 5DU Tel: 01707 651 266 Fax: 01707 646 836	Andrew Bailey, Senior Buyer A W G Construction Grange House West Mains Road West Mains Industrial Estate GRANGEMOUTH FK3 8YE Scotland Tel 01324 483 555
Phil Goold, Senior Buyer Allison Homes Ltd, Allison House, Banbury Close, West Elloe Avenue, Spalding, Lincolnshire PE11 2BS, Tel: 01775 724701	Colin Priestley Senior Buyer ARNCLIFFE HOMES Arncliffe House 1 Acorn Business Park Killingbeck Drive Leeds LS14 6UF Tel: 0113 235 0356 Fax: 0113 235 0894
Joan Meakin Chief Buyer BEN BAILLEY HOMES LTD Elizabeth House Cliff Street Mexborough South Yorkshire S64 9HQ Tel: 01709 586 261 Fax: 01709 570 006	Eric Nani, Chief Buyer BANNER HOMES Riverside House Holtspur Lane Woodburn Green High Wycombe Bucks HP10 0TJ Tel: 01628 536 200 Fax: 01628 810 620
Bob Hindley Senior Buyer ROLAND BARDSLEY (BUILDERS)LTD Globe Square Dukinfield Cheshire SK16 4RG Tel: 0161 330 5555 Fax: 0161 343 1862	Michael Finn Group Design & Technical Manager BARRATT DEVELOPMENTS PLC Wingrove House Ponteland Road Newcastle upon Tyne NE5 3DP Tel: 0191 286 6811 Fax: 0191 271 2242
Mike Thompson Senior Buyer Bellwinch Homes Malcolm House, Empire Way, Wembley, Middlesex HA9 0LW Tel: 020 8902 1101 Fax: 020 8903 4974	C/O Beverly FAO Kevin Smith BELLWAY PLC Seaton Burn House Dudley Lane Seaton Burn Newcastle upon Tyne NE13 6BE Tel: 0191 217 0717 Fax: 0191 236 6230
Alan Finnis Senior Purchasing Manager BENNETT PLC Hallmark Building Lakenheath Suffolk IP27 9ER Tel: 01842 863 220 Fax: 01842 861 539	Euan Wallis Chief buyer BETT HOMES Argyll Court The Castle Business Park Stirling FK9 4TT Tel: 01786 477 777 Fax: 01786 477 666

SURVEY HOUSEBUILDERS LIST

Frank Simes Chief Buyer Berkeley Homes (Chelsea Bridge Wharf) Limited Queenstown Road London SW8 4NF Tel: 020 7720 2600	Mark Tolley, Senior Buyer Berkeley Homes (North East London) Ltd Berkeley House Oakhill Road Sevenoaks Kent TN13 1NQ Tel: 020 7321 2122 Fax: 01732 227 601
John Robeson, Purchasing Manager Berkeley Homes (Southern) Limited Broadlands Business Campus Langhurstwood Road Horsham West Sussex RH12 4QP Tel: 01403 211 230 Fax: 01403 211 753	Steve Ridout , Senior Buyer Berkeley Homes (South East London) Ltd Berkeley House Oakhill Road Sevenoaks Kent TN13 1NQ Tel: 01732 227 666 Fax: 01732 465 394
Keeley Cross Berkeley Homes (East Thames) Limited Berkeley House Arsenal Way London SE18 6TF Tel: 020 8331 7272 Fax: 020 8331 7273	Nick Page-Smith, Senior Buyer Berkeley Homes (Oxford & Chiltern) Ltd Berkeley House, Abingdon Science Park Barton Lane Abingdon Oxfordshire OX14 3NB Tel: 01235 537 457 Fax: 01235 559 333
Nick Brutey, Chief Buyer Berkeley Homes (Hampshire) Limited Berkeley House London Street Basingstoke Hampshire RG21 7NY Tel: 01256 474733 Fax: 01256 479 605	Sonal Vithlani, Chief Buyer Berkeley Homes (West London) Limited Berkeley House 18 Horton Road Datchet Berkshire SL3 9ER Tel: 01753 211 500 Fax: 01753 211 505
Colin Cornaby, Chief Buyer Berkeley Homes (Eastern) Limited Berkeley House 7 Oakhill Road Sevenoaks Kent TN13 1NQ Tel: 01732 227 500 Fax: 01732 227 580	Graham King, Chief Buyer BEWLEY HOMES PLC Inhurst House Brumpton Road BAUGHURST Hampshire RE26 5JJ Tel: 0118 970 8200
Richard Hollingsworth, Buyer J S BLOOR (Measham) LTD - TBA Ashby Road Measham Swadlincote Derbyshire DE12 7JP Tel: 01530 270 100 Fax: 01530 272 665	Alex Pearce Regional Surveyor J S Bloor (Sudbury) Ltd. 4 Boldero Road Bury St. Edmunds Suffolk IP32 7BS Tel: 01284 752295 Fax: 01284 752213

SURVEY HOUSEBUILDERS LIST

Trevor Despera Regional Surveyor J S Bloor (Northamption) Ltd. Stirling House The Avenue Northampton NN1 5BT Tel: 01604 232110 Fax: 01604 232090	Les Hurst J S Bloor (Tamworth) Ltd. Ninian Way Wilnecote Tamworth Staffordshire B77 5DE Tel: 01827 283224 Fax: 01827 251514
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Alan Curtis, Chief Buyer Matthew Homes Ltd., Matthew House, 45-47 High Street, Potters Bar Hertfordshire. EN6 5AW Tel 01707 6555500	David Goold, Chief Buyer MACTAGGART & MICKEL 126 West Regent Street Glasgow G2 2BH Tel: 0141 332 0001 Fax: 0141 248 4921
Ian Kostelyk, Chief Buyer MCCARTHY & STONE (DEVEL'TS) Homelife House 26-32 Oxford Road Bournemouth Dorset BH8 8EZ Tel: 01202 292 480 Fax: 01202 557 261	C/O Christy - FOA Linda Tees Chief Buyer MILLER HOMES LTD Miller House 18 South Groathill Avenue Edinburgh EH4 2LW Tel: 0131 315 6214/6000 Fax: 0131 315 6263

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Appendix 7

business school
University of Glamorgan

Housebuilding Supply Chain - Semi-Structure Interview

Part of my PhD research and aims to examine likely problems and potential solutions with Goodbuild's housebuilding supply chain.

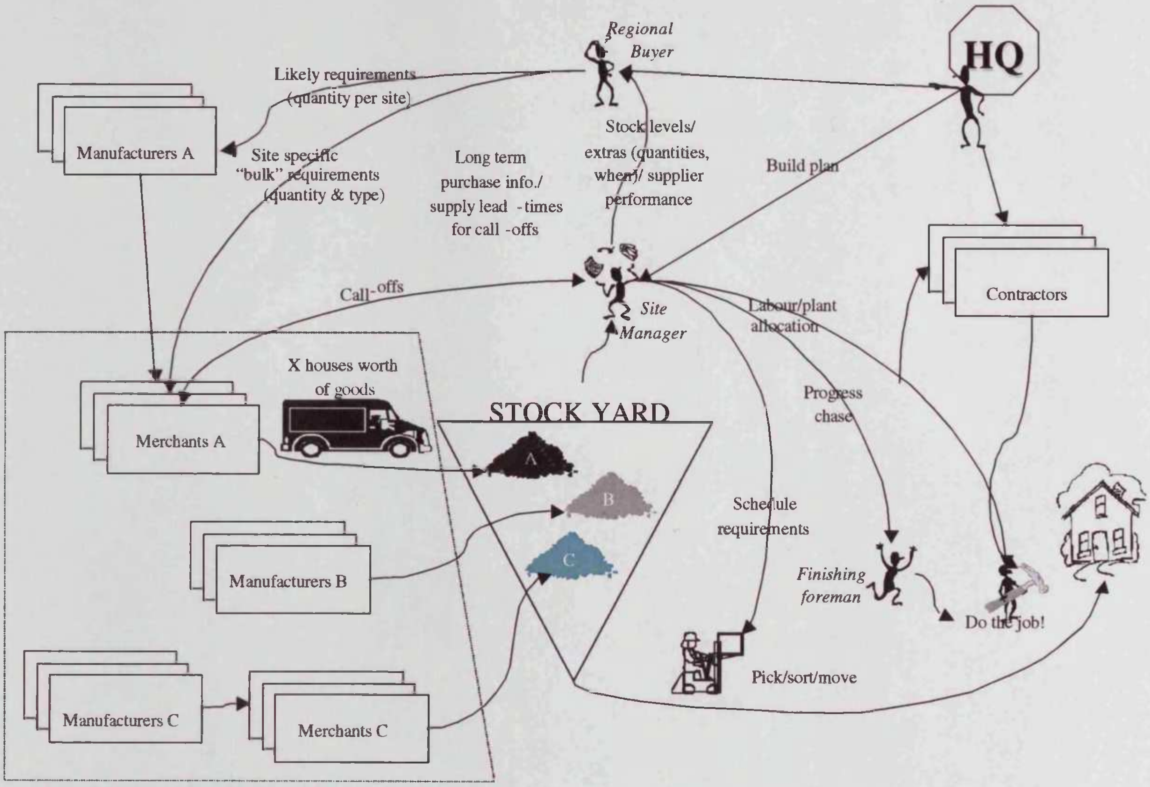
It is a short questionnaire – only a few questions – given 20 minutes – **Confidential honest**!

Please answer as YOU understand things at Goodbuild, not from a general industry point of view.

If not sure what I mean – tell me.

Name of Person -	Site -	Date/Time -

Q1 Please consider the following "rich picture" as roughly representative of a normal housebuilding process, where there is some HQ buying, some more local (regional) buying and the site manager (that's YOU! I've put you in the middle!) controls the day to day activities.



In the following table - Please estimate the 3 greatest problem areas or potential areas for improvement you feel exist in the **whole supply chain** from your perspective. Remember you are at the sharp end of it!
Please consider everything - processes, people, relationships, communication etc.
In the table below describe these 3 areas with 1 the greatest, through to 3 for the least significant problem, also state what you think the root cause is and what could be done to improve.

P.T.O. >

	Description of Problem	Root cause of problem	Possible improvement
1			
2			
3			

Q2 Please indicate how good your company is regarding the following problem areas – **from your point of view**. i.e. 100% means very poor - the worst, and 0% means ideal perfect situation – cannot be improved upon! (Circle as appropriate)

a) Needs re-quotes from suppliers/subbies comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
b) Poor information to suppliers/subbies comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
c) Time on site waiting for subbies comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
d) Amount of defects made by subbies comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
e) Time on site waiting for material deliveries comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
f) Number of defects in material deliveries comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
g) Number of incomplete material deliveries comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %

h) Stocks levels on site. (Here 0% would give low stock level – because suppliers are reliable). comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
i) Cost of snagging, inspection and fix (Time) comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
j) Any Other?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %

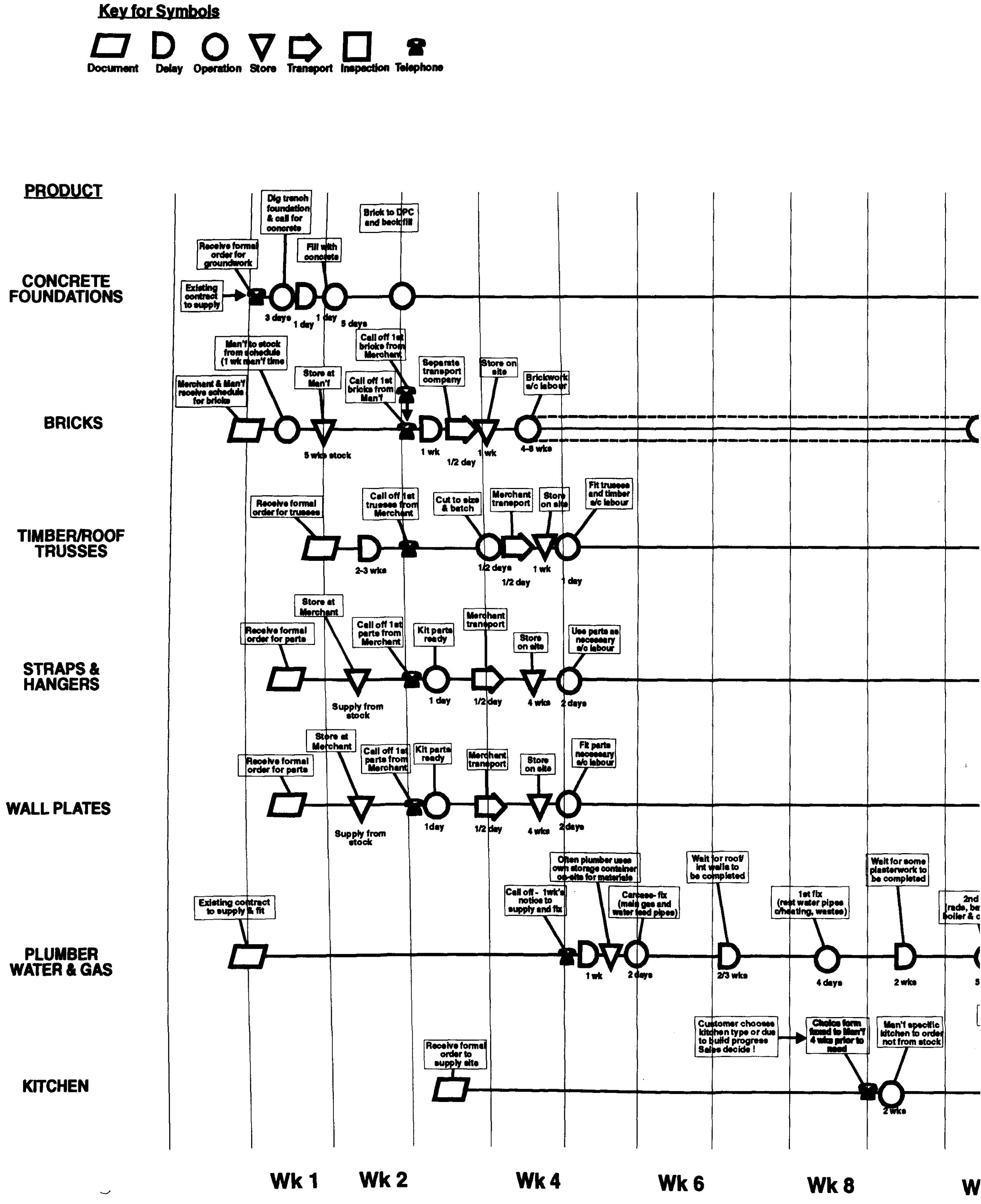
Q3 - From a National Survey last year - I have found the following top 5 general problem areas - please indicate how severe **these problems are for you**. Again 100% means very poor - the worst and 0% means ideal perfect situation – cannot be improved upon! (Circle as appropriate)

a) Stock level, late/poor deliveries comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
b) Scheduling and build plan related comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
c) Call offs and Site Manager related comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
d) Supplier/subbies problems comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
e) Communications comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
f) Design/Specification/buildability comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
g) Labour problems comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %
h) Group/Regional buyers/purchasing information comments/examples?	100. 90. 80. 70. 60. 50. 40. 30. 20. 10. 0 %

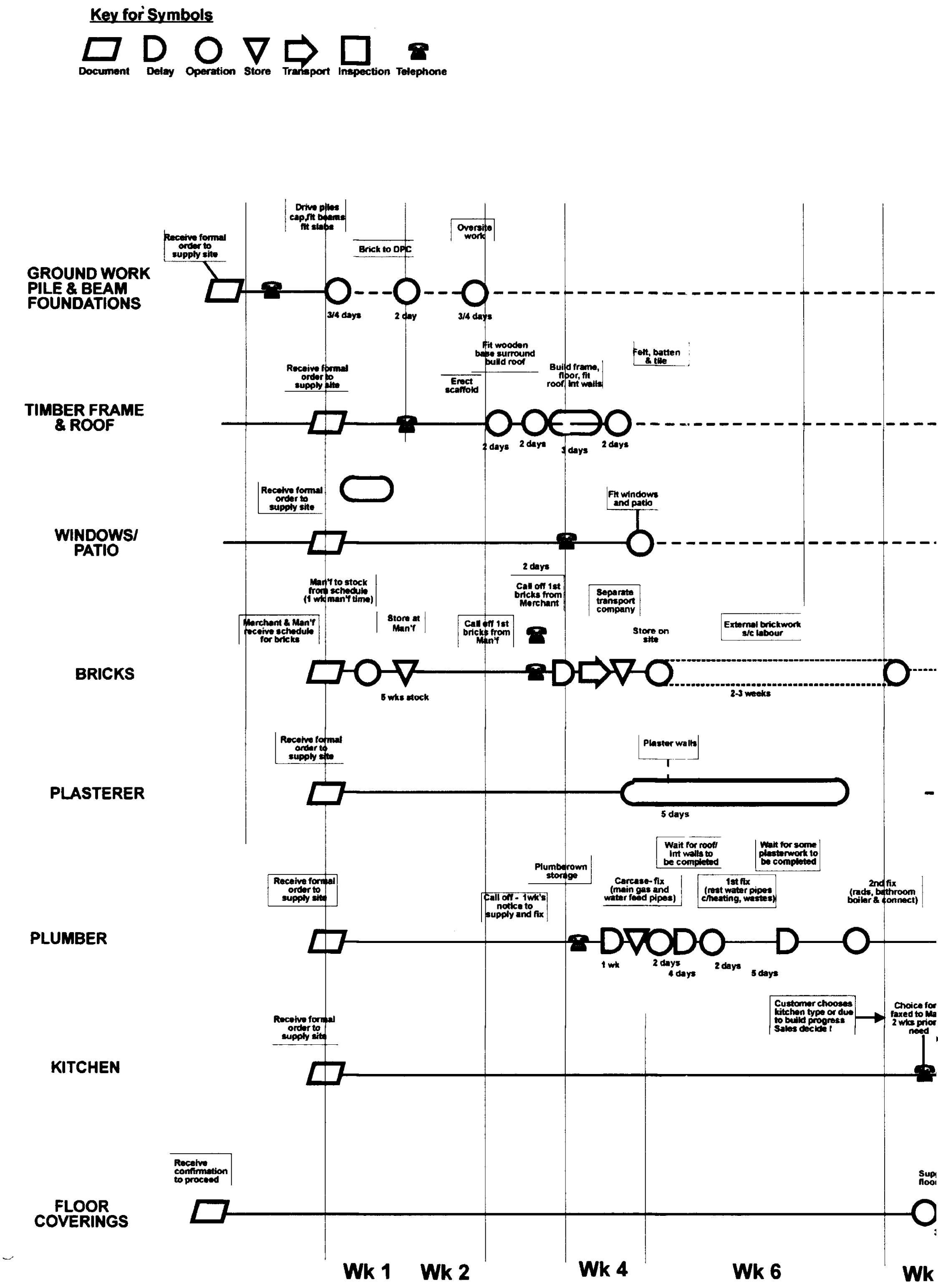
Q4 If you wish please give ANY comments regarding supply chain management and overall improvement:

Thanks again for your help in this interview!

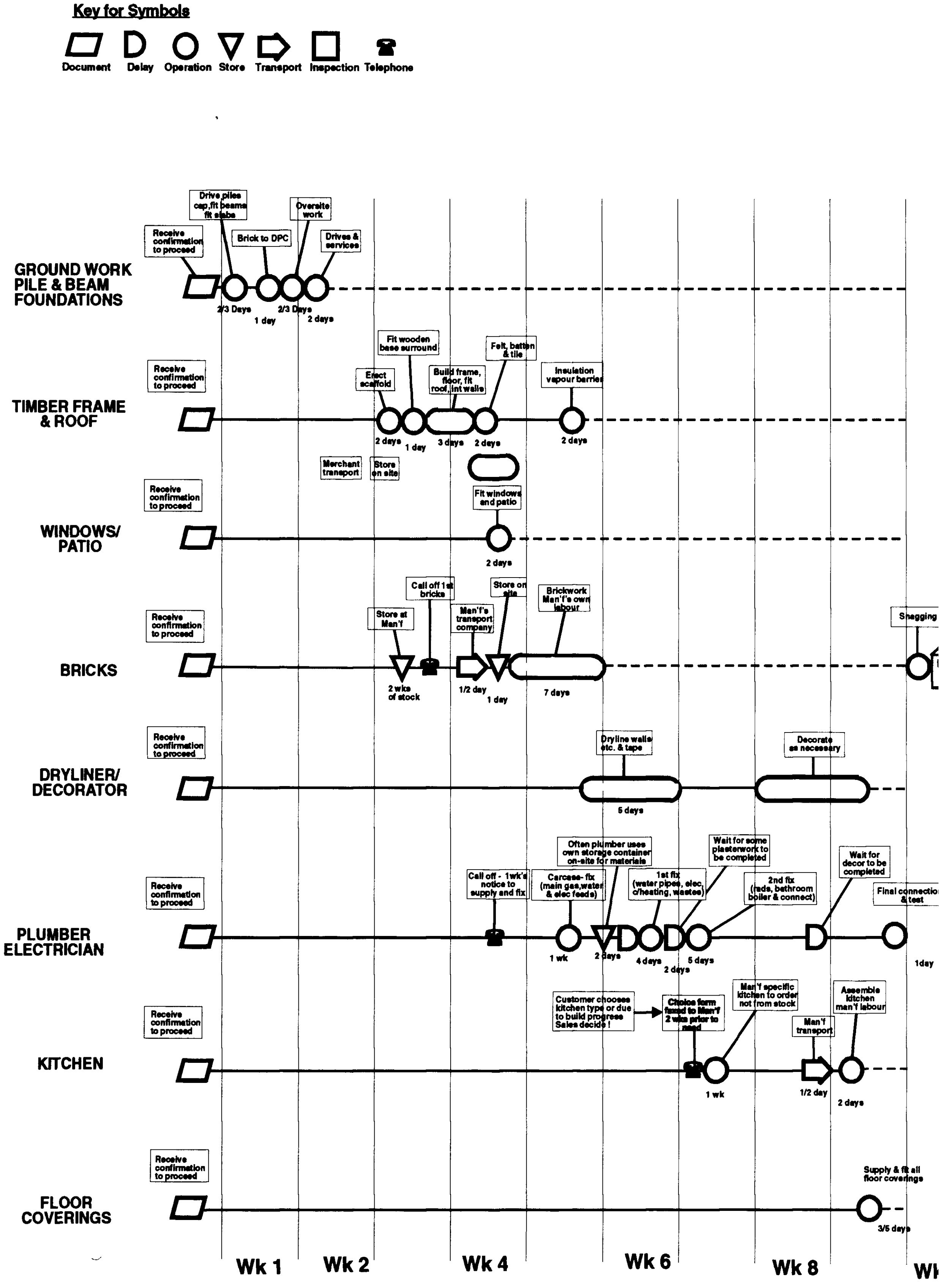
TRADITIONAL PRIVATE HOUSE BUIL[D…]
FOR BRICK & BLO[C…]



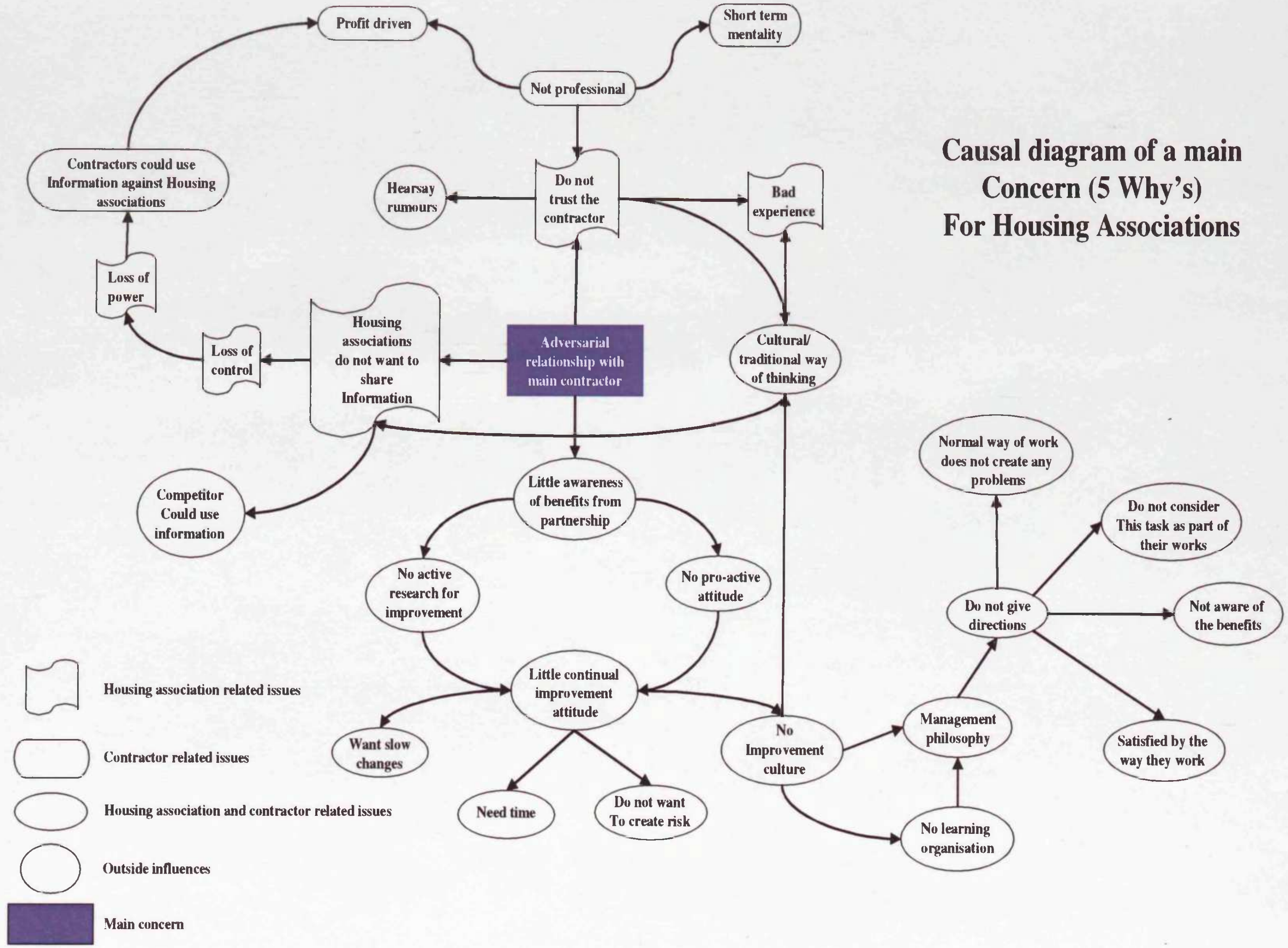
SUPPLY CHAIN- PRIVATE HOUS
CURRENT TIMBER FRAME AP



DREAM SUPPLY CHAIN- PRIVATE HOUS
TIMBER FRAME APPROACH

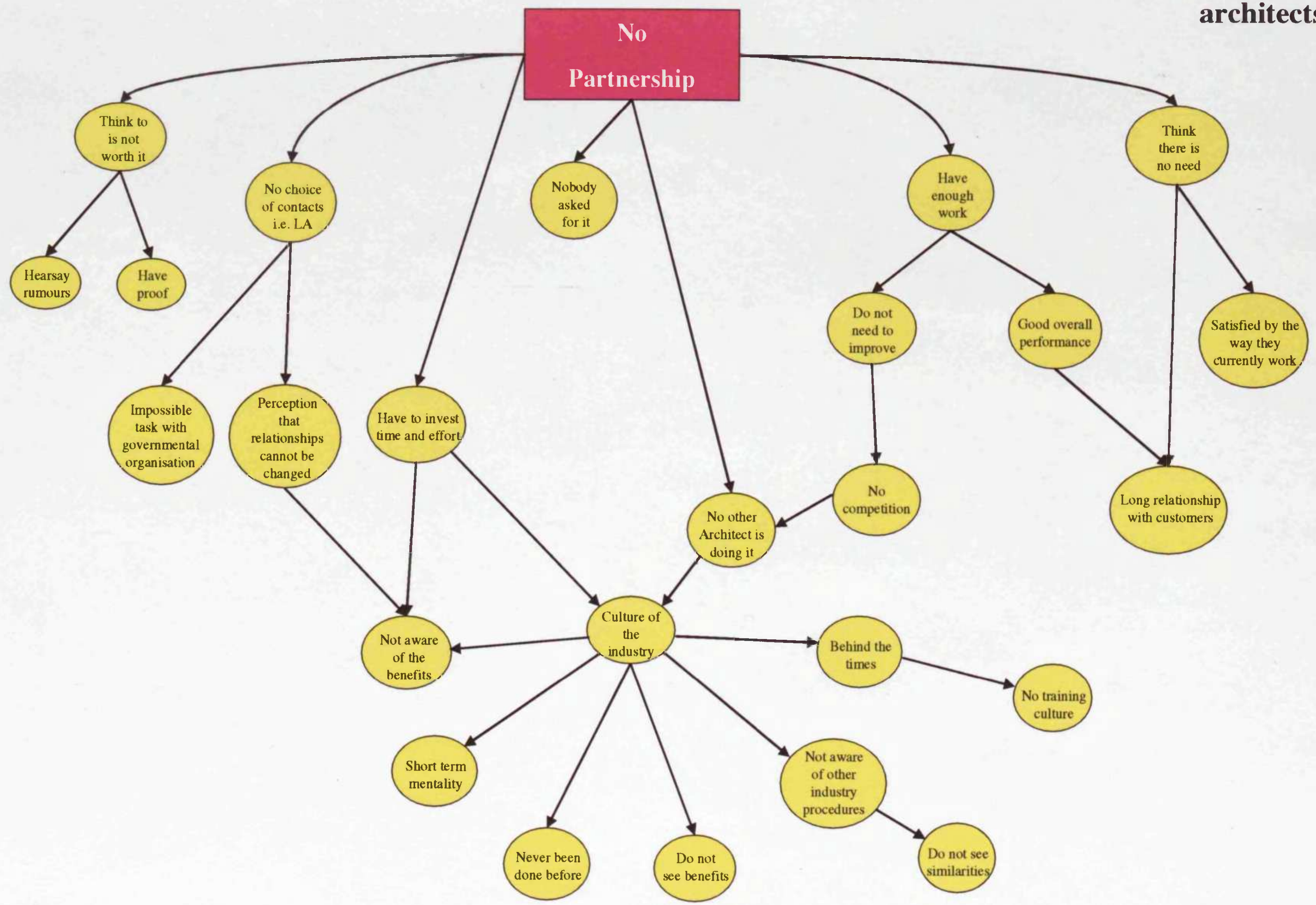


Causal diagram of a main Concern (5 Why's) For Housing Associations



Appendix 11

Causal diagram (5 Why's) for Partnership improvement for architects



Example of feedback presentation in MCNS Research Project

1

Company A
Fly-by Feedback

Split the areas covered into :-
- Good practices
- Poor practices
- Potential improvements
- Conclusions
- Next steps

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2

Good Practices

- Good working atmosphere: employees enjoy working for company A
- Stock on site (around 1 weeks): good compare to manufacturing
- Weekly construction report - reference to specific sites
- Appears good relationship with suppliers
- Keep suppliers inform
- 8 buy pack: good idea

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3

Poor Practices

Operational:
- Bad design of housing (reference to specific site - 5/7 were new)
- Tidiness of site
- On site storage problem
- Late call-offs
- No fixed completion date

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4

Poor Practices

Operational:
- High percentage of extra parts allowed (scrap, waste, damage, theft)
- Health and safety
- Little early involvement of site manager

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Poor Practices

Supplier/Customer:
- End users focus on delivery time
- No formal supplier appraisal
- No formal on-going supplier measures (vendor rating)

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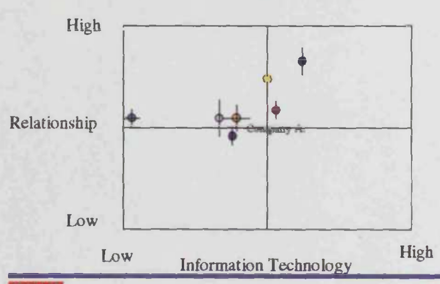
Relationship-IT Matrix



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Appendix 13

5

Potential Improvements

Operational:

- Need material handling procedures, planned material location
- Fix an achievable completion date with the site manager (risk management)
- Earlier involvement of site manager (trial for possible improvements)

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6

Potential Improvements

Supplier /Customer:

- PR level could be higher?
- Customer satisfaction questionnaires
- Show house and sales negotiators open until 7:30pm
- Use IT for customer monitoring information
- Increase customer choice: prepared list of options with extra costs

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SWOT Analysis: for increased customer choice

STRENGTHS

- Increase customer choice
- can respond immediately to requests and give costs implications
- appear professional and flexible
- meet customer needs (most cases)
- Provide detail information (illustration) on options
- Customer only needs to deal with one company

WEAKNESSES

- Increase complexity of administration
- Increase complexity of construction
- Increase administration, material costs
- Increase supplier base
- Increase of basic design infrastructure (allow different options)
- Complex preparation (costing, choice) and implementation
- Could not target the options to the site
- Could miss important options (can depend on regions)
- Bad costing analysis/planning
- Wilcon could not be able to handle it

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SWOT Analysis: for increased customer choice

OPPORTUNITIES

- Competitive advantage (leader)
- Sell more houses
- Could increase profits
- Could create a good public image (launch it with PR campaign)
- Could create new job opportunities
- Develop supplier relationship (supplier products would be advertised by Wilcon)

THREATS

- Idea would not be popular/ not welcome
- Competitor could do it first
- Too complex, have too many choices and decisions
- Customers could perceive that Wilcon is more expensive (price of options), trying to make money out of them

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8

Conclusions

- Good futuristic ideas: 8 buy packs
- Good incentive: marketing audit by external consultancy
- Main driver in construction industry, Wilcon has the power to initiate changes

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9

Next Steps

Would like to pass on (as good practice):

- Good system for ordering and calling off
- Supplier workload knowledge (long lead time knowledge)
- 8 pack idea

Project :

- To construct a supply chain model(s) depending on customer type

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National housebuilders survey – Data spreadsheet.

Question/ House-builder	Q1 T/O 2002 K £'s	Q2 Number Employ	Q3 Houses Com '02		Q4 Type Priv/Soc/Both 1/2/3	% Private	% Social	Used to det total private	Q5 PartGroup Yes/no 1/2	How buy R/G/Both 1/2/3	Q6 HaveSCM Strategy 1/2/3/4/0	Q7 Ded staff on SCM
1	108000	80	460	235	1			0	2		1	13
3	75000	44	220	341	3	80	20	44	1	3	3	9
4	23000	50	230	100	1			0	2		2	
10	67000	60	520	129	3	98	2	10.4	1	3	3	5
17		28			1			0	1	3	4	4
21	24000	65	78	308	3	88	12	9.36	2		3	3
22	15000	230	200	75	1			0	2		3	30
24			505	0	3	95	5	25.25	1	3	4	3
27	60000	7150	400	150	1			0	1	2	4	9
30	72000	100	279	258	3	90	10	27.9	2		3	12
31		60	95	0	3			0	1	3	0	
32	450000	980	1800	250	3	60	40	720	1	1	2	35
41	780000	2000	4091	191	3	85	15	613.65	1	3	4	28
42	40000	50	200	200	3	80	20	40	1	1	3	4
44	50000	100	400	125	3	80	20	80	1	3	3	6
51	40000	80	265	151	3	95	5	13.25	1	3	4	3
54	30000	15	50	600	3	90	10	5	1	3	3	5
55	30000	50	360	83	3	85	15	54	1	3	3	4
57	25000	120	400	63	1			0	2		3	40
58	130000	80	350	371	3	90	10	35	1	3	4	20
59	28387	40	159	179	3	90	10	15.9	1	1	3	3
61	70000	200	650	108	3	70	30	195	2		3	10
62	50000	100	210	238	3	70	30	63	1	1	2	3
65	70000	75	477	147	3	92	8	38.16	1	3	3	30
67	145000	220	504	288	3	80	20	100.8	1	2	3	6
69		150	300	0	3	90	10	30	2		1	3
71	130000	140	231	563	3	80	20	46.2	1	3	3	13
74	43000	24	261	165	3	75	25	65.25	1	3	3	5
77	17000	40	132	129	1			0	1	1	4	
78	65000	120	420	155	1			0	1	3	3	6
78.1	133000	250	1000	133	3	98	2	20	1	3	3	12
79	55000	80	481	114	3	85	15	72.15	1	1	3	8
80	40000	45	283	141	1			0	1	3	0	unknown
82	450000	1200	3700	122	3	90	10	370	1	3	2	30
85	60000	500	300	200	3	50	50	150	2		3	5
86	30000	56	247	121	3			0	1	1	3	2
87	1000000	3000	6013	166	3	85	15	901.95	1	3	3	30
92	40000	218	630	63	1			0	1	3	3	60
93	64000	140	590	108	1			0	1	1	3	
97	1800000	3750	12850	140	3	80	20	2570	1	3	1	52
98	100000	100	230	435	3	70	30	69	1	1	1	10
99	260000	520	2000	130	3			0	1	3	3	unknown
102	70000	500	275	255	3			0	2		3	5
105	90000	100	70	1286	1			0	2		1	4
109	790900	1000	5000	158	1			0	1	3	4	12
113	20000	30	125	160	1			0	2		1	2
114	47000	88	208	226	3	95	5	10.4	1	3	2	
121	45000	50	180	250	1			0	1	1	1	1
126	50000	50	120	417	1			0	2		1	
128		25	200	0	1			0	2		1	3
129	43000	37	287	150	3	95	5	14.35	1	1	1	n/a
130	24000	26	142	169	3	85	15	21.3	1	1	3	11

Appendix 14

Q8 KPI	Q8 cbpp	Q8 Rethinking	Q9a No.Supp'rs 1997	Q9b No.Supp'rs 2002	Q10a Their trust n/l/f/h/t 1/2/3/4/5	Q10b Your trust n/l/f/h/t 1/2/3/4/5	Q10c Comm-you n/l/f/h/t 1/2/3/4/5	Q10d Comm-then n/l/f/h/t 1/2/3/4/5	Q10e Cost Trans n/l/f/h/t 1/2/3/4/5	Q10f R&D n/l/f/h/t 1/2/3/4/5	Q10g ESI n/l/f/h/t 1/2/3/4/5	Q10h Rel are Con/M/Inf 1/2/3
1	1	1	60	80	4	4	4	4	3	2	4	3
3	1	3	375	425	4	4	5	4	3	3	4	2
3	1	2			3	3	3	3	2	2	2	2
1	1	1	50	38	4	4	4	4	3 ?		4	2
4	1	4		80	4	4	4	4	4	4	4	3
3	3	2	71	93	4	4	4	4	3	2	3	1
2	1	2	75	85	4	4	4	4	3	3	4	2
2	1	2		unknown	4	4	4	4	3	2	2	2
4	1	1	60	85	4	4	3	4	3	3	3	2
1	1	1	250	400	4	4	4	3	3	3	2	2
2	1	1			3	3	3	3	2	3	2	2
2	2	3	400	600	4	4	3	3	2	2	2	3
3	1	3	3500	2750	3	3	4	4	3	3	3	2
1	1	2	250	300	4	4	3	3	4	2	2	2
3	2	3	130	80	5	4	4	4	5	3	4	2
1	1	4			4	3	4	4	4	4	4	2
2	1	1	n/a	100	4	4	3	4	3	2	2	3
3	3	3	120	95	3	3	3	3	2	2	2	3
3	1	2	70	50	4	4	4	3	3	3	3	2
3	2	3	38	45	4	4	3	3	2	1	2	3
1	1	1	100	150	5	4	4	5	5	2	3	3
2	1	2	400	400	4	3	3	4	3	3	3	2
4	1	4	unknown	140	4	4	3	4	2	2	2	2
1	1	2	120	200	4	4	4	4	3	3	2	3
3	2	3		250	3	3	4	3	3	4	4	2
1	1	2	250	150	4	4	3	3	3	3	2	2
2	1	1	70	110	4	4	4	4	3	2	3	2
1	1	3	65	103	3	4	4	3	2	2	2	2
3	1	2	n/a	70	4	4	4	4	2	3	3	2
3	3	3			3	3	4	4	3	3	3	2
2	2	3	1200	2000	4	4	4	4	3	3	3	2
2	1	2		45	4	4	4	4	4	3	4	2
2	0	2	n/a	200	3	3	3	3	3	2	2	2
2	2	2			4	4	3	3	3	2	2	2
2	1	1	?	?	4	4	4	4	3	3	4	2
3	2	2	n/a	100	4	4	4	4	3	3	3	1
3	2	3		5000	4	3	3	4	2	2	3	2
3	1	2	120	350	4	4	3	3	2	2	2	2
1	1	2	Ring?		4	4	4	4	3		4	2
2	1	2	200	250	4	4	4	4	3	2	3	3
2	2	3	150	200	3	3	4	4	3	2	3	2
2	2	2	52	79	3	3	4	4	3	2	2	2
3	1	2			3	3	3	3	2		3	3
1	1	1	300	350	4	4	4	4	2	1	2	3
4	1	1	?	?	4	4	4	4	4	2	2	2
1	1	1	200	100	4	4	4	4	3	1	3	2
3	1	3		90	3	3	3	3	3	4	3	2
1	1	1	300	300	4	4	4	4	4	3	3	2
3	1	2	150	180	3	4	3	3	3	2	3	3
1	1	1 ?		100	4	4	4	4	3		2	1
1	1	1	60	66			4	4	3	3	2	3
2	2	2	400	280	4	4	4	4	3		2	3

Appendix 14

Q10i LengthRel Suppl'r 1	Q10i LengthRel Suppl'r 2	Q10i LengthRel Suppl'r 3	Q10i LengthRel Subbie 1	Q10i LengthRel Subbie 2	Q10i LengthRel Subbie 3	Q11 Proc's N/S/A 1/2/3	Q11 Class S/M/St 1/2/3	Q11 Partners No.in '97	Q11 Partners No.in '02		Q12 JIT 1/2/3/4/0	Q12 Dem Amp
60	60	60	60	60	60	1		0	0	2	4	1
180	120	120	156	132	120	2	1	16	35	1	1	1
120	120	120	60	60	48	2	2	0	10	1	2	1
210	210	144	unknown	unknown	unknown	2	1	2	10	1	4	1
24	24	24	24	24	24	2	1	0	4	1	4	1
276	130	72	300	270	216	1					3	1
120	120	120	120	120	120	2	1	40	60	1	3	1
96	96	96	unknown	unknown	unknown	2	3		unknown		4	1
12	12	12	48	48	48	2	3	2	3	1	1	1
120	24	60	120	60	60	1					3	2
						2	2				1	1
180	180	180	60	60	60	2	2	10	20	1	3	2
60	60	60	60	60	60	2	2 Ring				3	1
100	100	80	100	100	100	2	2	0	4	1	3	2
120	96	60	36	30	24	2	1	7	15	1	3	3
120	120	120	120	120	120	3	1	2	40	1	4	4
12	12	12	12	12	12	2	3 n/a		5	2	3	1
130	130	100	130	130	130	2	3	4	10	1	3	2
36	36	36	36	36	36	2	1	3	12	1	3	1
36	48	48	36	36	36	2	1	0	4	1	2	2
120	60	60	120	60	60	3	2				3	1
96	168	168	120	120	72	1					2	1
36	60	24	12	8	24	2	1	0	5	1	4	1
144	144	132	144	144	144	2	2				1	1
36	24	24	24	24	12	2	2	0	10	1	4	2
36	36	36	36	36	36	2	3	0	10	1	1	1
60	60	24	72	72	72	1		0	0	2	2	1
240	120	36	96	48	48	2	3	4	6	1	2	1
36	36	36	36	36	36	3	1 n/a		15		3	2
120	240	120	240	240	240	2	1	12	20	1	3	2
120	120	96	120	120	120	2	2	20	40	1	3	1
120	120	120	120	120	120	2	1	0	20	1	4	1
30	30	30	20	20	15	2	2	0	6	1	3	1
240	180	150	180	110	90		2				3	1
60	60	60	60	60	60	2	?	?			2	1
12	12	12	12	12	12	2	2	0	2	1	3	3
72	48	36				2	2	0	50	1	3	2
84	84	84	84	84	84	2	2	10	30	1	3	1
36						2	2		30		4	1
120	120	120	Unknown	Unknown	Unknown	3	1	45	65	1	3	1
60	60	84	90	90	90	1	2				3	0
360	120	120	120	120	120	1		0	0	2	2	2
60	60	60	60	60	60	2	1				4	3
240	180	120	240	144	180	2	1	50	68	1	1	1
48	36	24	48	36	24	2	2	5	27	1	3	1
60	60	60	60	60	60	3	1	50	28	2	3	1
6	36	18	24	18	17	2		0	12	1	3	3
60	24	18	60	24	18	2	2	20	50	1	3	1
36	10	10	15	10	12	2	2	6	10	1	2	1
15	15	15	15	15	15	2	2 ?		10	2	1	1
20	6	8	15	10	6	3	2	25	20	2	2	1
240	144	144	144	144	72	2	2	0	10	1	3	3

Appendix 14

Q12 Lean	Q12 Val Stream	Q13 Partnering Rank1-7	Q13 Quality Rank1-7	Q13 Technical Rank1-7	Q13 Personal F Rank1-7	Q13 TAC Rank1-7	Q13 Reputation Rank1-7	Q13 Service Rank1-7	Q13 Other Rank1-7	Description of Other	Q14 MeasSC Y/N/NS 1/2/3
1	1	1	5	5	4	2	2	5			2
1	1	7	1	6	4	2	5	3			3
1	1	6	2	5	7	3	4	1			2
1	1	7	2	4	5	3	6	1	8	didn't say	1
4	4	Ring									1
2	1	7	2	5	6	3	4	1			1
1	1	7	1	2	4	5	6	3			1
2	2	7	4	3	6	1	5	2			2
1	2	6	1	4	5	3	7	2			1
3	1	7	2	4	4	1	6	2			2
1	1										3
3	2	6	1	3	5	4	7	2			2
1	1	5	2	4	3	6	7	1			1
2	2	Ring									2
4	2	2	4	5	1	6	7	3	8	didn't say	1
4	4	7	2	6	8	3	5	1	4	National recognition	1
1	1	7	2	3	5	1	4	6			2
2	2	Ring									2
3	0	7	4	3	5	1	6	2			2
3	3	4	3	2	5	6	7	1			2
1	1	Ring									2
3	0	7	4	3	6	2	5	1			3
2	1	7	2	5	6	3	4	1			3
1	1	4	2	3	7	6	5	1	8	didn't say	1
3	3	5	2	4	3	6	7	1			1
1	1	Ring									2
1	1	8	1	4	5	6	2	3	7	Geographical	1
3	1	6	3	4	7	2	5	1	8		2
3	2	4	1	4	1	7	4	1			1
2	2	6	1	5	4	3	7	2			1
2	2	7	2	4	6	3	5	1			1
4	2	6	1	1	7	5	1	1			3
2	1	5	2	4	6	1	7	3			2
1	1	7	4	3	6	1	5	2			2
1	1	5	2	3	7	6	4	1			2
2	2	6	1	3	6	5	4	2			1
2	3	6	1	4	7	3	5	2			1
2	1	Ring									1
2	2	6	2	4	5	1	7	3			1
2	1	6	1	5	7	4	2	3			2
3	3	7	2	3	4	5	6	1			2
2	2	7	2	5	6	3	4	1			2
3	2	7	3	1	5	4	6	2			2
1	1	6	4	5	7	2	3	1	8	didn't say	2
1	1	5	3	4	7	2	6	1			1
1	1	7	2	3	6	1	4	5			2
3	2	7	3	5	2	4	6	1			2
2	1	Ring									2
2	2	7	2	5	6	3	4	1			2
1	1	6	2	5	7	4	3	1			2
2	3	7	2	6	5	3	1	4			2
2	1	7	2	5	4	3	6	1			2

Appendix 14

Q15 Orders invoices and payments
How Comm with top 3 Suppliers/Subbies - Give approximate % for each category

Q14 If Yes please descibe	Q14 If No say why not	Tel	Fax	E-mail	Post	EDI	Internet	Meetings	Other sum-check!
	company is conservatiive in methods	Ring							0
		65	15	2	15			3	100
	Not taken SC philosopy on board - only measure non-conformance - quarterly	50	40		10				100
Group buyers meetings		15	80	5					100
quality of product/mat'ls delivery on time continual monitoring of SC									0
Monthly supplier & works contractor assessments			10		90				100
not all but some level of appraisals carried out to assess pref on site		30	10		60				100
	too busy	80	5	5	10				100
Benchmarking performance areas quarterly reviewed			50		50				100
	we rely on end users of info on suppliers/ pref, we only hear when a problem	70	18	2	5			5	100
		20	20		40				80
	Just look at now	30	28	5	15		2	20	100
internal measurement process		15	5	5	70			5	100
	Cost beenfit ratio - too expensive to admin monitoring procedures	60	20		10			10	100
Quality assurance questionnaire and postcontract supplier reviews			10		90				100
Mtgs of buyers-share info from regionson mat'l/supp'rs perf.			10		80			10	100
	Time involved	80	10	5	5				100
	deemed not necessaty by diectors		5		80			15	100
	Departmental procedures as apposed to "company"	60	5	5	5		5	20	100
	Difficulty in have group wide KPI's	85	10		5				100
	Only small business three in supply, so know what each other is doing	40	20		40				100
		20	20		60				100
			30		70				100
A supplier/subbcontractor perf sheet is completed by every side every 2mths		25	35		20			20	100
product design,application, cost		40	10	30				20	100
	Possibly other priorities at present	50	50						100
Subcon perf is monitored at fortnightly mtg & full review on completion		10	10	10	60			10	100
	small overheads-no time, present system not allows timedue to other pressures/paperwork exercise	30	10		60				100
Quarterly performance review		30	10	20				40	100
measure;prog adherence,qualutyof work,customercare,invoicing,dayworks,d esign,tendering issues		20	25		50			5	100
In infancy		10	35	5	35			15	100
									0
	New region still in development stage								0
		?	?	?					0
	Time constraints	25	11	1	50	1	1	11	100
KPI		10	20	10	50			10	100
Feedback from regions and sites		20	10	5	60			5	100
Sub-contractor performance monitor		25	25		50				100
Supplier questionnaire for monitoring perf		60	15	10	10			5	100
	Meas'd thro' daily perf on site	40	40		10			10	100
	No set procedures, but good long term rels. Also if poor supp'r don't use again	70	20	5	5				100
	No time allowed to do this	10	8	4	70			5	97
	Lack of time/personnel to develop mangement system	20	40	10	20			10	100
	No time	25	40	5	30				100
Quarterly mtgs to exchange feedback/comments from each region			10		90				100
	relatively small operation, measured on a daily basis	15	20	5	40			20	100
	It's sometimes done informally	60	20		20				100
	we are a small company	50	30	2	15			3	100
	Does not form essential part of overall policy	65	25	1	8			1	100
	Not necessary	50	20	10	20				100
	Not interested . Lets get the job done!!	40	20	5	25	0	0	10	100
	Not enough staff to monitor it/woory about it	50	25	5	20				100

Appendix 14

Q15 General information

Q16
SC Integration - 0% -100% on 4 categories

Tel	Fax	E-mail	Post	EDI	Internet	Meetings	Other sum-check!	Share goals	Reg.Mtgs	Agreements	Understand
30	20	10	30			10	100	60	60	20	30
30	30		20			20	100	30	30	30	40
		10	90				100	20	10	20	80
							0	100	100	100	90
5	3	2	80			10	100	20	30	40	50
20	20	20	20			20	100	100	100	100	100
	5		90			5	100	10	10	40	40
20	20	20	40				100	100	70	80	60
5	15		75			5	100	80	30	70	90
10	30		40				80				
	30		70				100	30	30	20	50
10	10	10	55			15	100	40	30	30	30
40			50			10	100	30	50	40	50
10	10	30	30			20	100	70	60	90	80
	10		80			10	100	100	100	100	80
80	10	5	5				100	50	50	50	70
25	0	5	60			10	100	0	0	0	0
60	5	5	20		5	5	100	40	70	30	60
	5		95				100	60	40	30	30
10	10	5	50		10	15	100	50	20	60	80
5	10	5	80				100	20	10	20	80
			100				100	30	10	10	40
	10		60			30	100	50	30	50	60
		30	60	10			100	80	80	80	70
	50		50				100	20	30	30	30
10	10		10			60	90	90	90	0	90
5	5		80			10	100	60	70	60	60
40		20				40	100	70	70	70	60
15	25	5	50			5	100	60	30	30	50
15	20	5	45			15	100	70	40	60	90
							0	50	80	80	80
							0	20	10	40	50
							0	70	70	70	70
20	20	5	50			5	100	50	10	50	90
2	18	10	50			20	100	40	30	100	50
5	10	5	75			5	100	70	80	70	60
30	10	5	40			15	100	70	90	90	70
							0	70	30	80	70
40	40		10			10	100	30	50	90	100
							0	60	30	60	60
6	4		85			5	100	0	0	50	30
10	40	20	10			20	100				
		20	80				100	80	30	50	70
	20	10	70				100	80	80	80	70
30	10	5	15			40	100	60	10	70	70
20	30	5	40			5	100	20	30	30	70
50	30	2	15			3	100	90	0	50	70
15	20	1	49			15	100	80	30	50	70
50	20	10	20				100	40	30	30	70
	10		90				100	20	50	20	50
		10	90				100	100	70	80	60

Appendix 14

Q17 & Q18 See Separate analysis sheet	Q19 - Indicate how good company on following - 100% very poor --to -- 0% perfect situation Re-quotes Supp/sub	Poor Info to Supp	Time wait for Subs	Defects by Subs	Time wait mat'ls del	Material defects	Incomplete deliveries	Stock level on site	Snagging cost	Other
	50	60	20	20	10	10	10	10	20	
	30	20	20	30	30	40	60	20	30	
	40	40	30	50	40	50	60	40	30	
	20	40	60	50	20	20	40	60	60	
	50	10	60	60	40	20	50	60	60	
	Ring	10	20	20	20	10	20	10	30	
	30	10	20	10	30	20	30	20	20	
	80	80	50	50	50	80	60	70	70	
	30	60	50	40	70	60	60	20	70	
	30	60	50	10	20	20	30	40	20	
	30	40	20	10	30	20	20	40	10	
	50	60	50	40	40	50	40	40	70	
	60	60	40	40	20	20	70	40	80	
	80	90	30	80	20	20	30	0	80	
	10	20	40	40	20	10	10	30	20	
	50	50	80	80	30	30	30	50	80	
	60	70	30	20	10	10	10	50	30	
	30	40	20	20	20	30	20	50	30	
Ring	30	40	40	50	30	50	40	50	40	
	0	20	40	20	20	10	50	50	30	
	30	20	30	20	10	30	30	40	40	
	50	60	50	60	30	20	40	60	60	
	30	20	30	30	20	20	30	50	40	
	40	80	30	30	20	10	10	20	30	
	40	50	70	80	60	50	70	50	80	
	30	20	20	30	10	10	10	20	10	
	20	40	50	30	30	50	70	20	10	
	50	20	30	40	30	20	40	30	70	
	10	40	80	70	40	20	20	50	60	
	20	50	50	50	40	20	30	60	50	
	50	50	30	20	10	10	20	30	40	
	20	20	20	10	10	10	20	40	30	
	60	70	60	60	40	50	60	50	60	
	20	20		20	10	10	10	20	10	
	50	50	50	50	50	50	60	80	80	
	30	60	30	50	40	30	20	60	60	
	10	10	10	10	10	10	10	30	50	
	10	40			30	30	50	60	70	
	30	40	30	30	20	20	20	10	20	
	30	50	30	30	20	20	50	20	20	
	50	50	40	60	30	30	70	40	40	
	30	10	10	20	10	20	10	10	10	
	80	40	60	40	80	70	90	30	90	
	30	40	30	50	30	20	20	70	40	
	10	10	10	10	20	10	20	20	20	
	10	20	30	50	20	10	10	30	70	
Ring - no answer	30	30	30	30	30	20	40	70	40	
	50	30	40	60	30	40	40	30	20	
	20	30	30	40	20	30	40	10	40	
	30	20	10	30	10	50	70	20	10	
	30	70	50	20	10	20	20	50	40	

Q20 - Indicate company's general awareness of improvement techniques

KPI's	Process Mapping	FMEA	TQM	Benchmark Marking	Balanced Scorecard	Q21 General comments	Request Results Yes =1	E-mail Address
						company very set in its ways. p.s. most people here think "Latham" was a cricketer	1	no
3	1	1	1	1	1	none	yes	yes
3	1	1	2	2	1			
1	1	1	1	2	1	none	1	1
4	4	3	3	4	3	didn't like Q17/18!	no	no
3	1	1	1	3	1	none	1	1
2	1	1	3	2	1	none	1	1
2	1	1	1	2	1	The industry is generally under resourced	no	no
4	2	1	1	4	2	none	No	No
1	1	1	2	2	1	none	yes	yes
1	1	1	1	1	1	none	no	no
3	2	2	2	2	2	Just appointed Group Managing Buyer to address these problems. Would you like to do a talk on Supply Chain managmeent and the results?	yes	yes
3	2	1	1	3	1	none	1	1
2	2	2	2	2	2	none	1	no
4	3	2	2	4	4	SCM must be bought into at top then down. Must be benefit to all, KPI's must be inward&outward looking	1	1
0	0	0	0	4	4	SCM not structured but developed with group purch/partnering strategy as company grown	1	1
2	1	1	1	2	1		yes	yes
3	2	2	2	3	2	none	1	1
3	2	0	3	3	1		yes	no
3	3	2	2	3	1	none	1	No
1	1	1	1	1	1	to be honest had no experience of SC management solutions	1	1
2		1	1	3	2	none	1	1
2	1	1	3	3	1		no	no
1	1	1	1	2	1	none	1	1
3	2	1	4	3	1	none	1	1
1	1	1	1	1	1	none	1	1
2	1	1	2	2	1	none	1	no
1	1	1	1	1	1	none	1	no
3	1	2	3	4	2	Suppliers aware of need for SCM, suggest subbies need education as does construction industry	yes	no
2	2	2	4	3	3	none	no	no
2	3	2	3	3	3	In process of changing way of working, becoming far more pro-acticve in SC relationships - give more planned responses	yes	
2	1	1	1	3	2		1	1
2	3	1	1	3	2	Region only 3 years old, & respondant only there 1 year not sure info OK		
							no	no
3	2	2	3	3	2		no	no
3	2	2	2	3	2		yes	no
3	3	2	2	3	3	SCM means trust openness & honesty - something our industry is slowly leaming	1	no
3	1	1	2	3	1	none	1	no
1	2	1	3	4	2	none	1	1
2	1	1	3	2	1	none	1	No
2	2	0	0	3	2	none	1	1
2	2	1	1	2	2	none	1	1
3	2	2	2	2	1	none	1	no
1	1	1	1	1	1	none	no	no
4	2	2	4	2	2	Believe construction industry behind in SCM compared to auto and many others	1	1
1	1	1	1	1	1	We use same subbies and suppliers and build same/similar type houses - so have relatively few problems	no	no
3	3	1	4	3	1	SCM good concept if all conditions perfect-maybe 1 element at a time, then progress. Difficult to administer	1	1
1	1	1	1	2	1	none	No	No
3	3	2	3	2	2	Difficult to give accurate report on every aspect because so many different areas - SCM may be too reliant on Utopia	no	no
1	1	1	1	2	1	none	no	no
1	2	1	1	2	1		yes	no
2	1	1	3	2	1	none	no	no

National Housebuilders survey – Data for Q 17 & 18.

Question 17 - Rich Picture Problems							
Areas of Rich Picture - annotated	1	2	3	4	5	Total	Rank
Note: only 24 out of 51 annotated the diagram!							
Head Quarters (HQ)/Regional buyer		2	2	2		6	
Contractors	4	4	3	2	3	16	1
Labour and Plant	1	2		1	2	6	
Site Manager	6	1	1	1	2	11	3
Call offs	3	1	1	1		6	
Manufacturers/Merchants		3	2	1	1	7	
Stockyard & stock levels	2	2	2	6	3	15	2
Build plan	3			2	3	8	
Long term purchase information, supply lead-times for call offs	2	1	2		2	7	
Schedule requirements		3	1	1		5	
Likely requirements/site requirements	2	1	2	3		8	
Miscellaneous	1	2	5		3	11	
Totals	24	22	21	20	19	106	
Note: Regard very generally due to spurious interpretation of annotation. Some marked only 1;or 1-3 etc.							

Question 18 - Problems							
Problem Categories	1	2	3	4	5	Total	Rank
Need more central buying				1		1	
Picking materials/not in house lots			1		1	2	
Unreliable/late material deliveries	7	5	3	6	3	24	1
Under resources suppliers					1	1	
Specified items - not standard	1	1	1			3	
Product variety		2				2	
Poor Communications with site/buyer		1	1			2	
Poor Communications with Works Contractor/site labour	1					1	
Poor Communication methods - fax, e-mail poor					1	1	
Poor Communications - general, incl. Suppliers/subbies	3	2	1	1	1	8	6
Lack of works contractor labour		1				1	
Lack of Subbies labour	3	2	1			6	
Subbies problems	3	3	1		4	11	5
Works contractor not adhering to H & S			1			1	
Purchasing information - long term	1				1	2	
Poor start up information	1					1	
Poor planning/scheduling/build plan	6	2	5	5	4	22	2
Poor bulk calls offs	1			1		2	
Paperwork going missing				1		1	
Poor quality of delivered product		1		3	1	5	
Supplier problems-multi-sourcing, too many, poor relationships	1	3				4	
Group/HQ and Regional information poor				1		1	
Regions resist Group buying					5	5	
Site management - ability		2	1	1	1	5	
Poor calls offs - from site and subbies	5	1	4	3	2	15	3
Equipment and plant- poor, wear/tear etc.					1	1	
Stock level - high/low/problems	1	4	4	1	3	13	4
Skill level of labour			1	2	1	4	
HQ - too high targets/ profits			1			1	
Pre-start meeting - ensure all are there			1			1	
Design information/buildability	2	1	1			4	
Financial planning/budgets			1		1	2	
Incorrect product supplied		1				1	
Totals	36	32	29	26	31	154	
	Initially No.of problem categories=					33	

Rationalised Problems Categories	1	2	3	4	5	Total	Rank
Communications	4	3	2	2	2	13	5
Scheduling and build plan related	7	2	5	5	4	23	2
Call offs and Site Manager related	6	3	5	5	3	22	3
Labour	3	3	2	2	1	11	
Stock level, late/poor deliveries	8	11	7	10	7	43	1
Supplier/subbies problems	4	6	2	0	5	17	4
Group/Regional buyers/purchasing information	1	0	1	2	6	10	
Design/Specification/buildability	3	4	3	0	1	11	
Miscellaneous categories (Finance, equipment, pre-start mtg.)	0	0	2	0	2	4	
Totals	36	32	29	26	31	154	

National Housebuilders Survey results

1

Returns

The 52 replies covered for year 2002 the equivalent of:

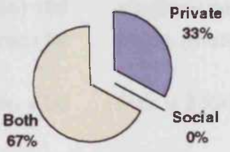
- Total Turnover of : £7,850 million
- Total Staff of: 24,216 people
- Total Homes built: 49,178

(These were the first three questions)

2

Question 4

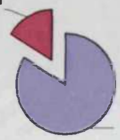
Type of housing - Private, Social or Both



3

Question 4

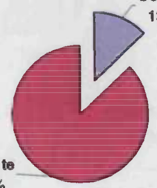
Breakdown of Both - Private & Social



4

Question 4

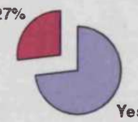
Total Private/Social Split



5

Question 5

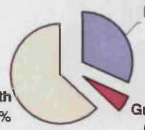
Part of Larger Housebuilding Group?



6

Question 5

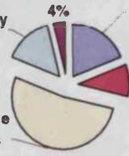
If part of Group - Buy Regionally or Group



7

Question 6

Do you have a Supply Chain Management Strategy



8

Question 7

Number of dedicated staff on Supply Chain Management:

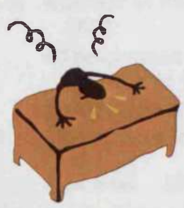
43 responses with 509 in total

Average = 13

Median (middle) = 6

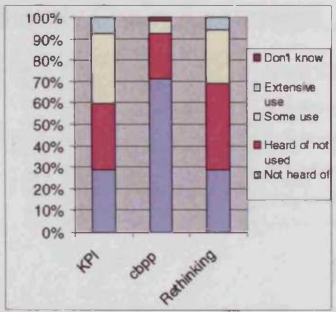
Mode (most freq) = 3

Max = 60 Min = 1



Question 8

9



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Question 9

10

Suppliers & Subbies in 1997:

31 responses gave average of 309

Median (middle) 130

Mode (most freq) 60

Max = 3500 Min = 38

Suppliers & Subbies in 2002:

42 responses gave average of 395

Median (middle) 125

Mode (most freq) 100

Max = 5000 Min = 38

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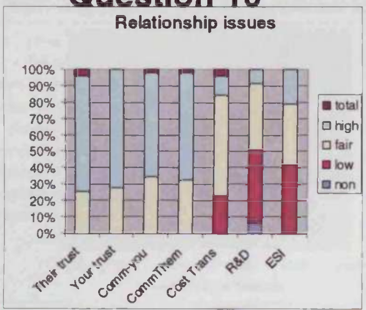
Question 10

11



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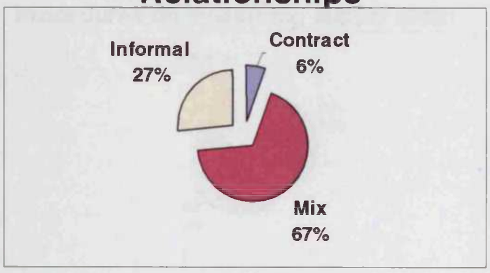
Question 10 - Type of Relationships

12



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Q 10 - Length of Relationship (months)

13

	Sup1	Sup2	Sup3	Sub 1	Sub 2	Sub 3
Mean	99	83	71	84	74	69
Median (middle)	72	60	60	60	60	60
Mode (freq)	120	60	120	60	60	60
Max Min	360 6	240 6	168 8	300 12	270 8	240 6

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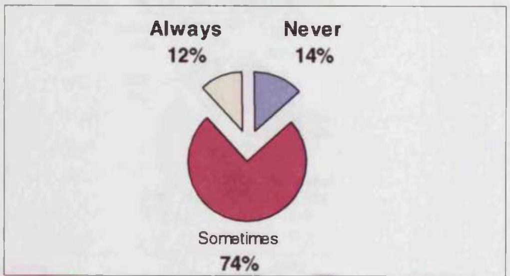
Question 11

Procedures are used for Partnering

14



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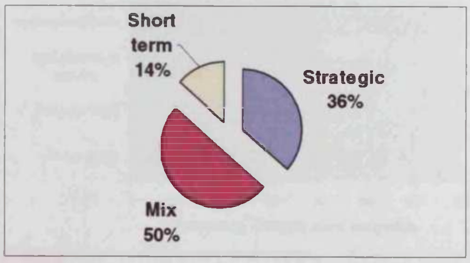
Question 11

Partnering is classed as

15



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Question 11

16

Number of Partners in 1997:

36 responses gave average of 9

Median (middle) 2

Mode (most freq) 15

Max = 50 Min = 0

(many had none [16], may be companies didn't exist?)

Number of Partners in 2002:

40 responses gave average of 19

Median (middle) 11

Mode (most freq) 10

Max = 68 Min = 0

(some have clients as partners not just suppliers)

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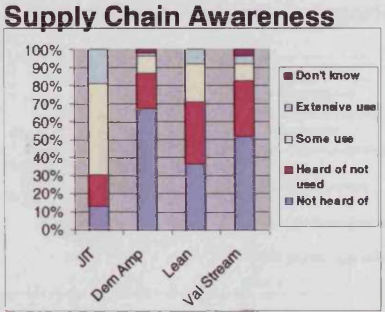
Question 12
17

Supply Chain Awareness



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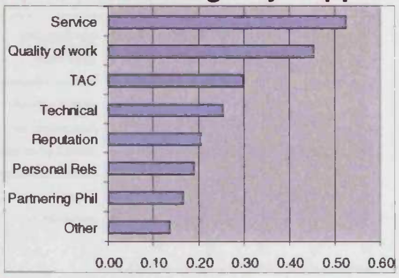
Question 13
18

Criteria for Choosing Key Suppliers



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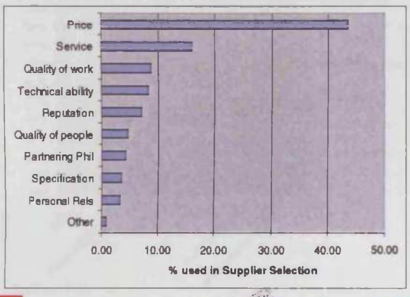
Compare previous slide with this from The Housing Forum: Improving your Supply Chain - October 2001
19



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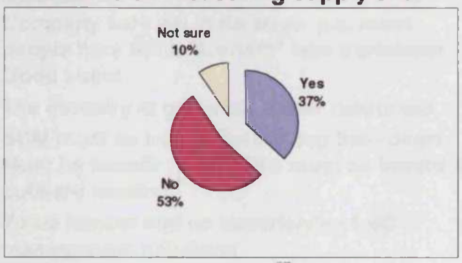
Question 14
20

Procedures on measuring supply chain



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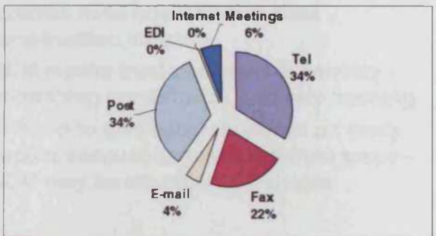
Question 15
21

Communication with top 3 Suppliers/Subbies Orders invoices payments



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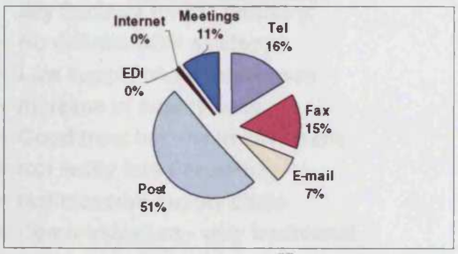
Question 15
22

Communication with top 3 Suppliers/Subbies General information



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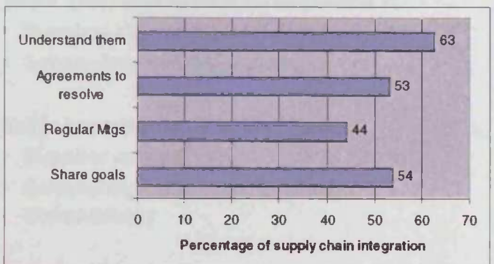
Question 16
23

Situation on supply chain integration



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Question 17 & 18 - Problems
24

Rationalised Problems Categories	1	2	3	4	5	Total	Rank
Stock level, late/poor deliveries	8	11	7	10	7	43	1
Scheduling and build plan related	7	2	5	5	4	23	2
Call offs and Site Manager related	6	3	5	5	3	22	3
Supplier/subbies problems	4	6	2	0	5	17	4
Communications	4	3	2	2	2	13	5
Design/Specification/buildability	3	4	3	0	1	11	6
Labour	3	3	2	2	1	11	7
Group/Regional buyers/purchasing information	1	0	1	2	6	10	8
Miscellaneous categories (Finance, equipment, pre-start mtg.)	0	0	2	0	2	4	9
Totals	36	32	29	26	31	154	

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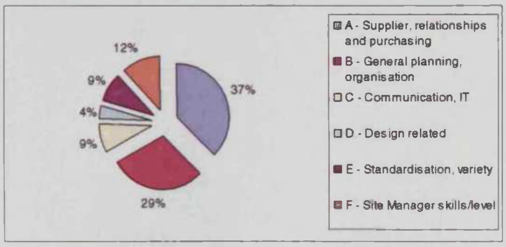
Question 18 - Improvement Areas for Top 5 Rationalised Problem Categories

25



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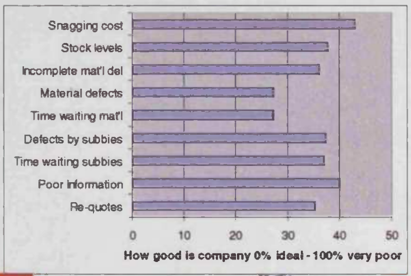
Question 19

26



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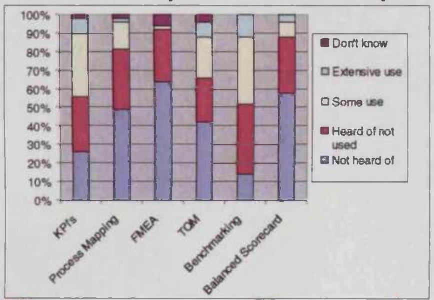
Question 20

27

Awareness of Improvement techniques



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Respondents Comments

28

Here are some of the replies to the final open question:

- Company very set in its ways. p.s. most people here think "Latham" was a cricketer - Good Luck!
- The industry is generally under resourced
- SCM must be bought into at top then down. Must be benefit to all, KPI's must be inward & outward looking
- To be honest had no experience of SC management solutions

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Respondents Comments (cont'd)

29

- Suppliers aware of need for SCM, suggest subbies need education as does construction industry
- SCM means trust openness & honesty - something our industry is slowly learning
- Difficult to give accurate report on every aspect because so many different areas - SCM may be too reliant on Utopia

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Summary of Survey Findings

30

I have interpreted the results into the following key findings for the industry:

- No definite SCM strategy
- Low supply chain awareness
- Increase in supply base
- Good trust but low involvement
- Not really into Partnering
- Not measure supply chain
- Communication - very traditional

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Summary of Survey Findings

31

Major Problems appear to be related to:

- Supplier deliveries/stock level related
- Scheduling and build plans

Major Improvements appear to be;

- Supplier related
- Scheduling/build plan, information transparency

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Thanks

32

- Thanks again for your involvement in the survey
- I hope the results have been useful and informative.

Ralph Barker
Glamorgan University

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National housebuilders survey results – Top 10.

1

Top 10 Group

This presentation looks at the top 10 replies by completions in 2002.

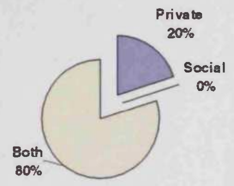
Of all replies (52) these top 10 represent:

- 74% Turnover
- 54% Staff
- 77% Dwellings Built

2

Question 4

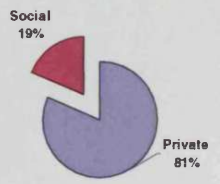
Type of housing - Private, Social or Both



3

Question 4

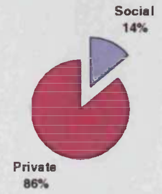
Breakdown of Both- Private and Social



4

Question 4

Total Private/Social Split



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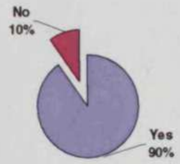
Question 5

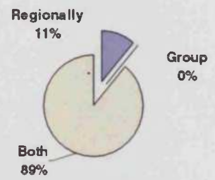
Part of a Larger housebuilding Group?



6

Question 5

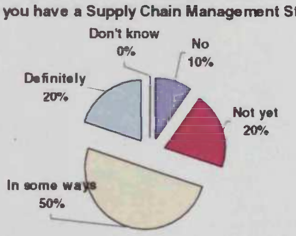
If part of a Group - Buy Regionally or Group



7

Question 6

Do you have a Supply Chain Management Strategy



8

Question 7

Number of dedicated staff on Supply Chain Management:

9 responses with 269 in total

Average = 30

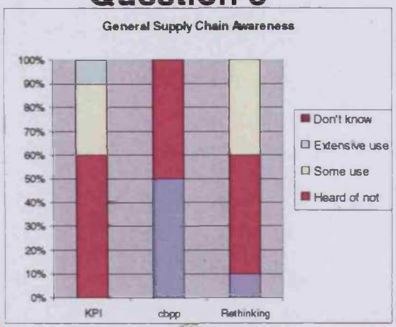
Median (middle) = 30

Mode (most freq) = 30

Max = 60 Min = 10

Question 8

9



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Question 9

10

Suppliers & Subbies in 1997:
- 7 responses gave average of 839
- Median (middle) 400
- Mode (most freq) 400
- Max = 3500 Min = 52

Suppliers & Subbies in 2002:
- 8 responses gave average of 1429
- Median (middle) 500
- Mode (most freq) n/a
- Max = 5000 Min = 79

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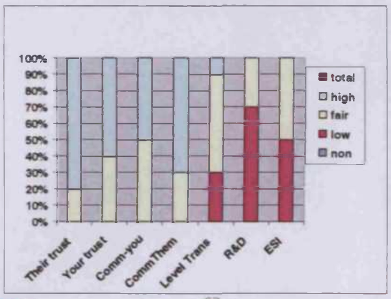
Question 10

11



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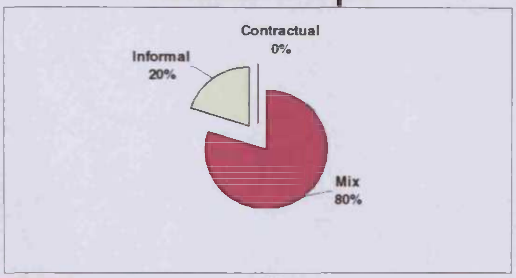
Question 10 - Type of Relationships

12



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Q 10 - Length of Relationship (months)

13

	Sup1	Sup2	Sup3	Sub 1	Sub 2	Sub 3
Mean	138	112	104	99	89	79
Median middle	108	120	108	102	97	78
Mode (freq)	120	120	120	120	120	60
Max Min	360 42	180 36	168 24	180 48	120 36	120 24

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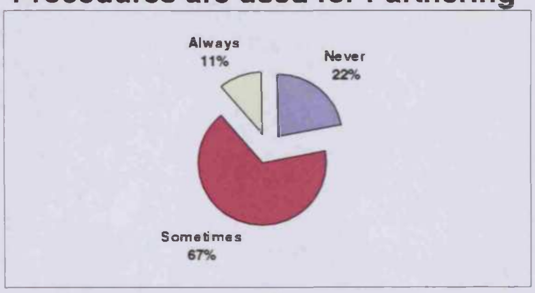
Question 11
Procedures are used for Partnering

14



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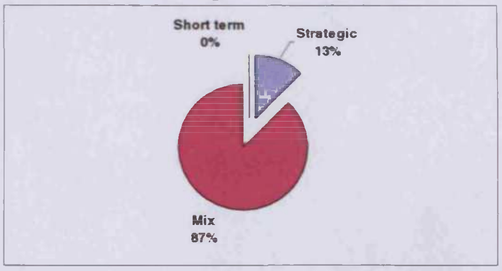
Question 11
Partnering is classed as

15



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Question 11

16

Number of Partners in 1997:
- 7 responses gave average of 13
- Median (middle) 10
- Mode (most freq) 0
- Max = 45 Min = 0
- (2 had none may be companies didn't exist?)

Number of Partners in 2002:
- 7 responses gave average of 33
- Median (middle) 30
- Mode (most freq) n/a
- Max = 65 Min = 0

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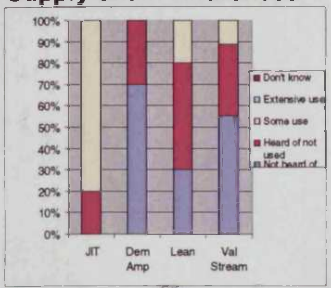
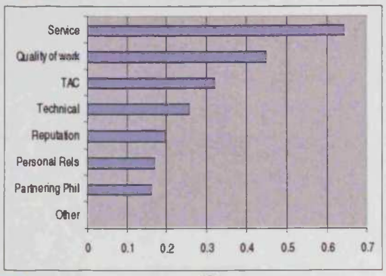
Question 12
Supply Chain Awareness

17



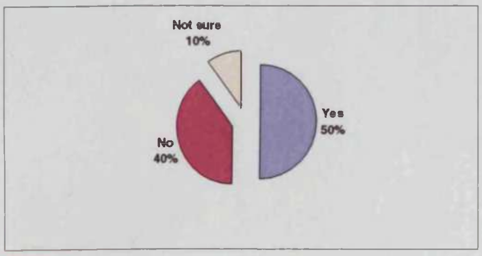
Question 13
Criteria for Choosing Key Suppliers

18



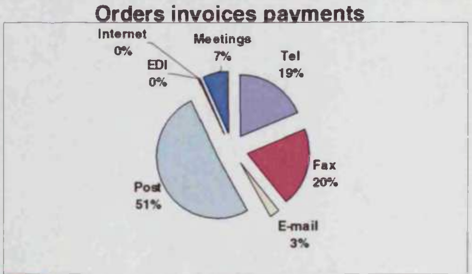
Question 14
Procedures on measuring supply chain

19



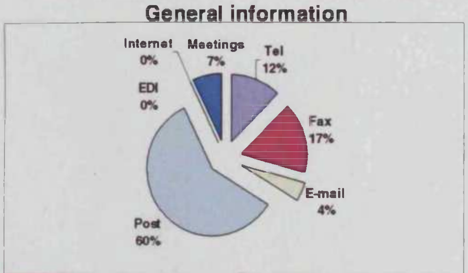
Question 15
Communication with top 3 Suppliers/Subbies Orders invoices payments

20



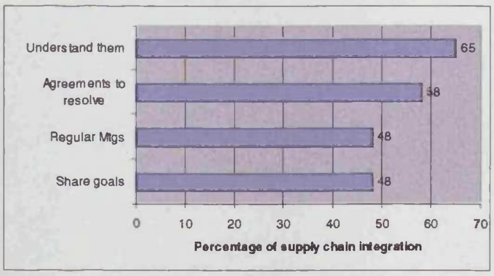
Question 15
Communication with top 3 Suppliers/Subbies General information

21



Question 16
Situation on supply chain integration

22



23

Question 18 - Problems for Top 10 Respondents						
Problem Categories	1	2	3	4	5	Total
Note: 8 out of 10 listed problems in some way						
Need more central buying				1		1
Picking materials/plot in house lots					1	1
Unreliable/late material deliveries		1	1	2	1	5
Product safety			1			1
Poor Communications with site/buyer						
Poor Communications with Works Contractor/site labour						
Poor communication methods - fax, e-mail poor						
Poor Communications - general, incl. Suppliers/subbies	2					2
Lack of works contractor labour						
Lack of Subbies labour		1	1			2
Subbies problems		1				1
Works contractor not adhering to H & S						
Purchasing information - long term						
Poor start up information						
Poor planning/scheduling/build plan	2		1	1		4
Poor bulk calls offs	1					1
Paperwork going missing						
Poor quality of delivered product						
Supplier problems-multi-sourcing, too many, poor relationships		2			2	4
Labour HQ and regional information poor				1		1
Regional/group buyer					1	1
Site management - ability				1		1
Poor calls offs - from site and subbies	2	1	1	1	1	7
Equipment and plant - poor, weather etc						
Stock level - high/low/problems		1	1	1	1	4
Skill level of labour						
HQ - too high targets/ profits						
Pre-start meeting - ensure all are there						
Design info/buildability	1	1	1			3
Financial planning/budgets					1	1
Incorrect product supplied						[illegible]
Totals	8	8	8	8	8	40
	Initially No. of problem cats used=					[illegible]

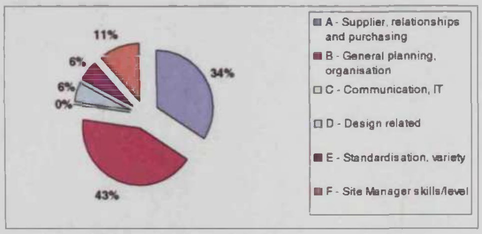
Question 18 – Problems for Top 10 Respondents

24

Rationalised Problems Categories	1	2	3	4	5	Total	Rank
Call offs and Site Manager related	3	1	2	2	1	9	1
Stock level, late/poor deliveries	0	2	2	3	2	8	2
Supplier/subbies problems	0	3	0	0	2	5	3
Design/Specification/buildability	1	1	2	0	1	5	4
Scheduling and build plan related	2	0	1	1	0	4	5
Group/Regional buyers/purchasing information	0	0	0	2	1	3	6
Communications	2	0	0	0	0	2	7
Labour	0	1	1	0	0	2	8
Miscellaneous categories	0	0	0	0	1	1	9
Totals	8	8	8	8	8	40	

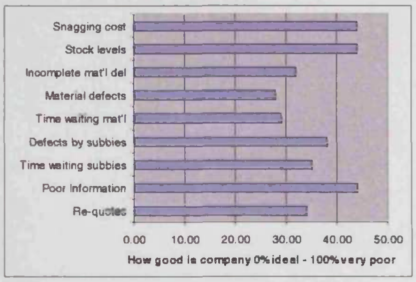
Question 18 - Improvement areas for Top 10 Respondents

25



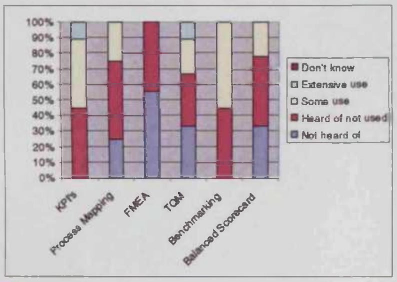
Question 19

26



Question 20
Awareness of Improvement techniques

27



Summary of Top 10 Comparison

28

- 9 out of 10 are part of a Group and 8 of these buy both Regionally and Group-wise.
- Greater proportion have SCM strategy and more dedicated staff.
- Still low supply chain awareness - with 60% not using KPI's or cbpp and still 60% not applying "Rethinking Construction".
- Appears even Top 10 have an increase in supply base

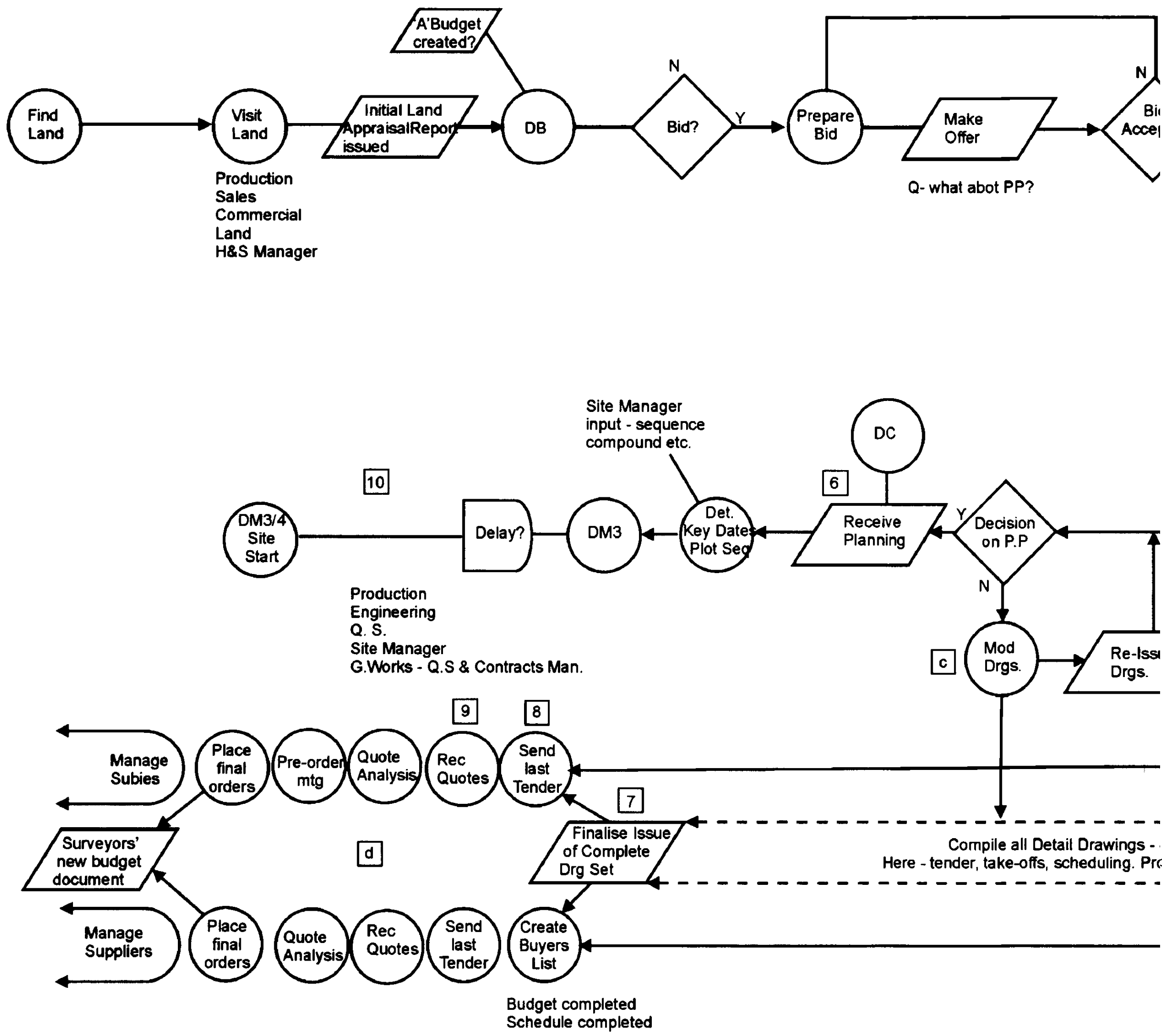
Summary of Top 10 Comparison

29

- Same level of trust as main replies but more informal relationships.
- No better on partnering procedures, but do class partnering as more strategic.
- Less awareness and use of Demand Amplification and Lean than main replies.
- More procedures and measurement of supply chain.
- No significant difference in communication - only some increased e-mail use.

GoodBuild - Process Flow chart of prior to build - (Buy la

Note - Flow chart is not linear time-based, but is sequence linked. Refers to single site process, W



Key

Activity

Delay

Decision

Document

Nomenclature

AB - Architects Brief
DA - Detailed Application
DB - Development Brief
DG - Detailed Drgs. for tender
DL - Digitised Layout
HS - Health & Safety Plan
SK - Sketch Drgs.

Explanations

a - Assumes 8-12 wks to obtain P.P.
b - Here material split into 60/40 - 60% via "Relfections" - just order through system; 40% bespoke so tender to approved suppliers (some/rare new suppliers through search etc.).
c - Usually only some drgs. modified that affect quotations
d - Minority of orders placed before site start, (usually brks/blk & concrete beams)balance of copies passed to Site Manager, within 1 to 3 months.

Timescales (approx)

1 - 2 = 2 wks
2 - 3 = 2 wks
3 - 4 = 6-8 wks
4 - 6 = 4-8 wks
5 - 7 = 4-8 wks
5 - 10 = 6 wks
6 - 7 = 4-8 wks
6 -10 = 2 days -?wks
8 - 9 = 2/3 wks

Site manager interview data

Question 1

Site	Problem 1	Root cause 1	Solution 1	Problem 2
7	Poor labour skill/ability	No training/apprenticeships	Vet for skills, have apprentices	Tech info too late
8	Build packs short	Errors @ kitting	Allow for wastage - be accurate	Purch/Tech support lacking
9	Started late on site - 4mths	To much pressure not enough resourc	More resource @ Region	Lack of build continuity - loose trades
10	Lack of skilled labour	Not trained - use subbies	Work with subbies > - apprenticeships	Poor delivery of mat'ls (not in stock)
11	Build programme too tight	Want numbers - profit/shareholders	Need longer build prog-say18>20mth	Material quality low
12	Poor material delivery esp. replaceme	Prevent damage/loss	Quicker delivery	Poor quality of materials
13	Initial start-up no pre-start mtg	No-one in charge	Make someone responsible	Not ordering in time (subbies+mat'ls)
1	Tech info - incorrect	Fragmentation of functions	Better co-odination, buildability	Incomplete delivery of mat'ls
2	Cheap work/materials	Company profit oriented	poor customer care	national deals -poor service
3	No comms link - no PC etc.	Don't know tried telephoning etc.	More resources to sort it	Lack of tech info; esp. response
4	No control over utilities	Separate authorities/private co's	Company do utilities/Partnership	Poor national suppliers
5	Initial start-up no pre-start mtg	Not organised/no time	More resource/time	Tech info incorrect/not got/slow
6	Bulk materials not spec'd correct	Lack tech knowl - house types	Better comm. Region & HQ	Items not ordered

Above is 13 out of a total of 21 Site Managers in Region as at July 2004

xxxxxxxxxxx xxxxxxxxxxx xxxxxxxxxxx

Analysis and Categorisation

List of all Problems	Number of problems & severity	If 3=1 2=2 & 1=3 then scores	Problem as a % of total
Technical information/support	1, 2,2,2,2,3,3,3,3,3	16	20.51
Materials quality/quant/incorrect	1,1,1,1,2,2,2,2,2,2,2,3,3,3	31	39.74
Communications/IT/PC	1,	3	3.85
Controlling utilities	1,	3	3.85
Initial start-up/no site start meeting	1,1,	6	7.69
Poor labour/skills/quality of work	1,1,3,3,3	9	11.54
Start late on site/build prog	1,1,	6	7.69
Lack build continuity/planning/org	2,3	3	3.85
Not given- no comment	3	1	1.28
		78	100

List of all Root causes		If 3=1 2=2 & 1=3 then scores	Problem as a % of total
Lack of training	1,1,3	7	8.97
Errors at kitting	1	3	3.85
Lack resource/time at Region	1,1,2,2,2,2,2,2,2,2,3,3,3,3,3	25	32.05
Profit oriented	1,1	6	7.69
Prevent damage/loss	1	3	3.85
Poor organisation	1,1,1,2,3,3	13	16.67
Unknown	1,	3	3.85
Separate Authorities	1,	3	3.85
No wastage in BOQ	3	1	1.28
Not given- no comment	3	1	1.28
Supplier related	2,2,2,2,2,3,3,3,	13	16.67
		78	100.00
Sub anaylsis of supplier related:-			
National agree'ts-price/cheap mat'ls	2,2,2,	6	7.69
Poor supplrs selection	2,	2	2.56
Suppliers/Subs overworked	2,3,3,	4	5.13
Subcontractors-speed not quality	3	1	1.28

List of all Solutions			
Improve skills	1,1,3,3	8	10.26
Accurate BOQ (wastage)	1,3,	4	5.13
More Region resource	1,1,1,2,2,2,2,2,3,3,3,3,3	24	30.77
Longer build plan	1,3	4	5.13
Better Suppliers/Subbies	1,2,2,2,3,3	11	14.10
Better organisation/comms	1,1,1,2,2,2,2,2,3	20	25.64
Better customer care	1	3	3.85
TWD do utilities	1	3	3.85
Not given -unknown	1	1	1.28
		78	100.00

KEY to Colour Scheme

Site Numbers are identified by colour [yellow] use a kitting type of material control

Remaning colours show how Problems, Root causes and Solutions have been categorised on left hand

Root cause 2	Solution 2	Problem 3	Root cause 3
Start after land buy - no prep	More pre-plan'g; info@start mtg	Material leadtimes change (bulk)	Lack of comms, over suppl cap
Too much work/lack resources	More resource?	BOQ doesn't allow wastage	Include wastage in BOQs
Don't start in time -need more plannin	Plan continuity between sites	Comm. of changes poor a/w info	too busy - not enough resource
National agreements based on price?	Need subbies/man'f - greater capacity		
Poor national deals - price?	Pay more - listen to contractors!	Poor skill levels - many areas	High pay; no training, no commitment
Use/spec cheap materials	Spec better materials	Poor tech support/comm.	Afraid of resp of making decisions/
Resource at region/HQ?	Need overview/weekly mtg/organise	Poor response by region to problems	Resource at region/HQ?
BOQ not prof ; kitting - good	Better info; better supplier staff	Poor quality from subbies	Subbies-speed not quality the norm
poor vetting of suppliers	use SM feedback	poor tech info @ start mtg	pressure to build/land/resources
Lack of resource@Regional	More resource?	kitting - poor not complete	kitting/supplier liaison
They are over worked	Monitor work/capacity	poor partnered subbies	They are over worked
More resource at Region	More resource at Region	Subbies not in place when start	More resource at Region
Attention to detail	Region/HQ - resource?	Poor mat'l specs to suppliers	Attention to detail
xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxxxxx

low quality/wrong spec mat'ls	poor/late delivery
1,1,2,2,3 = 11 = 14%	1,1,2,2,2,2,2,2,3,3 = 20 = 26%

Appendix 19

Q2 - Indicate how good company on following - 100% very poor --to -- 0% perfect situation

	a	b	c	d	e	f	g	h	i	j
Solution 3	Re-quotes Supp/sub	Poor Inforr to Supp	Time waitii for Subs	Defects by by Subs	Time waitii mat'ls del	Material de mat'ls del	Incomplete mat'ls del	Stock level on site	Snagging (snagging	Other
More suppls/better rels/cap?	20	30	40	60	40	10	10	70	30	90
as built' surveys - change BOQs	10	80	70	80	50	20	50	40	90	70
more resource - Region	20	30	10	10	10	1	5	10	10	
	5	10	30	20	5	5	50	30	30	20
Apprenticeships/National schemes??	60	60	80	80	30	30	50	20	30	
Need skilled people/abilities	50	20	20	40	25	30	20	20	40	
Need overview/weekly mtg/organise	60	50	10	10	10	10	10	30	30	50
Weed out bad; Groundworkers - best	80	80	10	20	40	20	10	20	80	60
need more time/resources	30	20	10	45	45	10	20	30	50	10
Resource?	20	15	10	10	10	5	5	10	39	45
Monitor work/capacity	5	80	40	20	100	0	10	55	70	60
More resource at Region	30	40	20	10	15	5	10	5	30	
Region/HQ - resource?	0	30	0	30	0	10	0	0	50	
xxxxxxxxxxx	:xxxxxxxxx	:xxxxxxxxx	:xxxxxxxxx	:xxxxxxxxx	:xxxxxxxxx	:xxxxxxxxx	:xxxxxxxxx	:xxxxxxxxx	:xxxxxxxxx	:xxxxxxxxx
	390	545	350	435	380	156	250	340	579	405
	13	13	13	13	13	13	13	13	13	8
	30.00	41.92	26.92	33.46	29.23	12.00	19.23	26.15	44.54	50.63
	4	**2**	**6**	**3**	**5**	**9**	**8**	**7**	**1**	**Ranking**
	70.00	58.08	73.08	66.54	70.77	88.00	80.77	73.85	55.46	49.38
	30.00	41.92	26.92	33.46	29.23	12.00	19.23	26.15	44.54	50.63

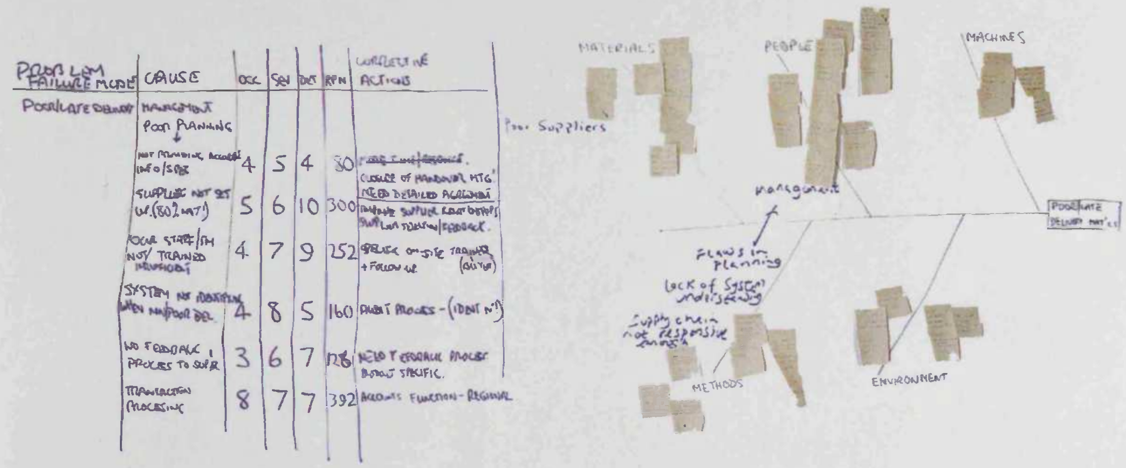
Site	Comments
7	No vendor rating only a veto mechanism; some subbies don't manage; H&S take up lots of time - specialist H&S a few sites?
8	Have more but smaller build packs say 10 not 5. Problem with PC/IT brick usage programme - erased now using paper record.
9	Difficult to correct build schedules (BOQ?) Customer care problem - contacting them - delay build
10	Poor labour skills - low pay?/not long term . Different house designs (greater variation) due to local authority requirements
11	Poor labour skills - pay more get better skills - different areas different levels
12	Lack of skill labour - all subbies. Too much admin for SM prevents core activities.
13	Apprentices - CITM could return levy. Persimmon have own skilled people who stay.
1	No feedback; no order conformation; IT unreliable
2	Senior Management - numbers; IT OK but less visible in office
3	Timber frame - problems; lack of tech support on queries - see egs.
4	Supplier change Lead-time without notice; house spec inaccurate; too much work not enough experience - no WCL used
5	Need pre-start mtg; - not need oasis! Main problem lack of tech support- region too slow
6	No comments

Appendix 19

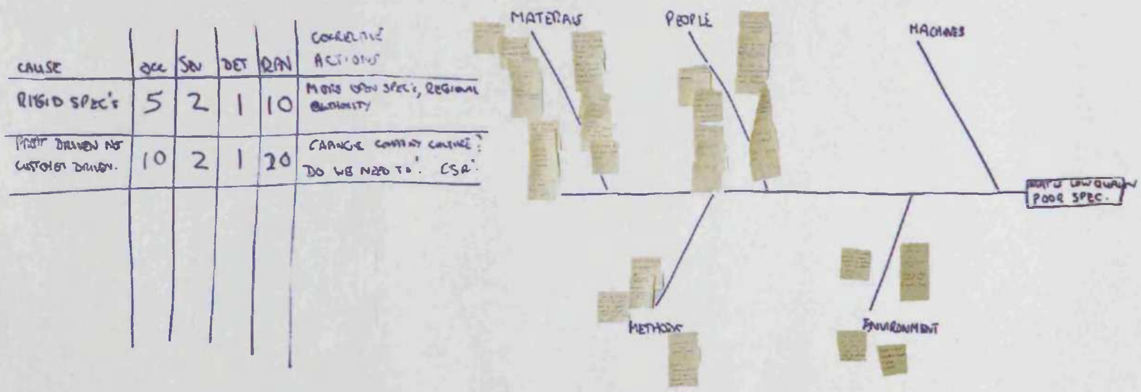
Q3 - Indicate how good company on following-100% very poor-to-0% perfect situation

		a	b	c	d	e	f	
Other - description	Ave %	Stock level poor dels	Schedule/t Buildplan	Call offs/S. & S.M.	Suppliers Subbies	Communic	Design/ Buildable	Site
Poor site set-up, moved office	40	60	70	20	40	20	30	7
Lack of site planning & org	56	50	80	75	70	70	90	8
	12	10	20	1	10	10	20	9
Lack of tech info-only 50%@sta	21	30	25	10	10	10	10	10
	49	2	80	50	80	30	30	11
Comm. with subbies and SM	29	25	20	10	25	20	35	12
Cheap mat'l/subbies	27	60	40	30	20	50	30	13
chasing progress/corrections	42	30	30	20	30	70	30	1
key dates unrealistic	27	30	25	35	20	30	50	2
too many site visitors	17	15	20	5	10	60	40	3
technical info wrong/late	44	60	0	10	25	40	50	4
	18	10	30	10	10	40	40	5
	13	0	0	0	0	0	20	6
Average SM perspective? =	30							
xxxxxxxxxxx		xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxx	xxxxxxxxxxx
		382	440	276	350	450	475	
		13	13	13	13	13	13	
		29.38	33.85	21.23	26.92	34.62	36.54	
	Ra	**5**	**2**	**7**	**6**	**4**	**1**	
		70.62	66.15	78.77	73.08	65.38	63.46	
		29.38	33.85	21.23	26.92	34.62	36.54	

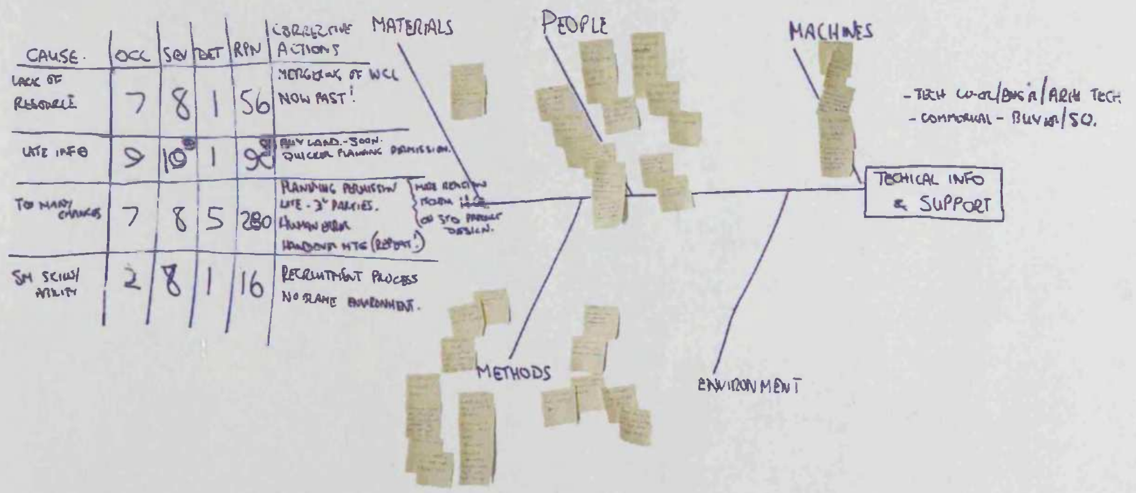
Problem 1 Poor/late delivery of material: FMEA and Cause and Effect diagram



Problem 2 Low quality/wrong specification materials: FMEA and Cause and Effect diagram



Problem 3 Technical Information/Support: FMEA and Cause and Effect diagram



Improvement workshop - Individual potential causes arising from discussion.

Problem – Material poor/late Delivery (43 comments)

KEY – V means a more likely cause and X a less likely cause (only applies to this first problem)

Environment
X Access difficulties - not aware/known prior
X Type of construction given site conditions
X Access issues on site, delivery can not be made
X Not fully understanding the requirements.
X Health and safety in the construction of/ use of materials
X Incorrect health and safety on site

Machines
X No fork lift on site
X Transport problem i.e. traffic jam
X Provision of wrong tools for the job
V Our famine/feast at half-year and year end - insufficient delivery facilities to cope with our demands
X Restriction on the type of machinery to be employed

Methods
V Need emergency procedures with back-up contingencies (not excuses)
V Call off time too long
X No back-up procedure in place if the material cannot be unloaded
V Better checking/verifying systems for deliveries
V Not providing accurate details often causing work to be redone
V Accounts wiping off orders from site call-off system
X Larger compounds with store-man working out of compounds
V Better information flow back to supply chain on bad suppliers.

People
V Information flow and training
V Time! People allocated to reading drawings and understanding designs i.e. management of information
X Employing more skilled labour
V Late delivery by supplier
V Need it to accept suppliers as a service to us
V Insular approach of supplier
V Quality of people sorting deliveries
V Material called off late by site
V Turnover of site staff
V Quality of people, taking delivery of requests for material
V Provision of complete information by technical
V Interpretation of design
X No-one on site to receive delivery
V Site managers not being sufficiently proactive in ordering materials
X Order not in place on time

Materials
V Problem with supplying of raw materials
X Use of the right suppliers for specific materials
V Manufacture of materials problem
V Too many 'Just in Time's

X None of payment of bills (suppliers)
V Flexible delivery dates to suit our changes on site (weather/trades)
X Cost increase of material
X Specification not unknown
V Not providing accurate information

Problem – Material low quality/wrong specification (37 comments)

Environment
Use local suppliers to reduce transport costs
Material choice governed by surrounding area
Greener product normally equate to more expensive
Construction process on site means exposure of materials which can reduce quality
Choose materials with minimum of waste i.e. off cuts joists, wastage of plasterboard, design issue

Machines

Methods
Economics of material/design
Properly research methods not choose materials which are unsuitable
Lack of innovation i.e. we do not look at different methods/products which could improve quality
Better protection than necessary?
Delivery process i.e. wrong packaging on delivery

People
Interpretation and using wrong that material
Material used on the basis of health and safety/skill available not correct skill
Sometimes poor handling/installation or not following manufacturer's requirements
Lack of skill leading to long call off so different material chosen
More regional input into spec
Standard spec not challenged
Standard specification used
Budget very low
Revenues on site
Price of land
Working within budgets
Economics
Competition in our market, what the value in that better spec? (Can we realise this?)

Materials
What is an acceptable lifespan of any particular product? (NHBC = 2 yrs)
What does it our Bryant brand demand for our customers?
Price the value
Customers' expectations?
Lack of vision on what people want!
We are after all in a throw-away society
Hand crafted Materials not used
Too much out-sourcing by manufacturers?
Make suppliers more accountable for their products
Resource of steel/concrete planks
Standard product used everywhere
Too much control from head office on spec
Do we get effective/constructive feedback?
Specification of materials not within the control of people delivering the product

Problem – Technical Support/Information (38 comments)

Environment

Machines
Late information
Administration by receiving parties i.e. production/commercial/sales
Understanding the process and the third party political/people input
Too much a detail v not enough detail
Understanding information, being able to co-ordinate information

Methods
Available time to deliver information
Unnecessary restrictions on machines/processes
No up-to-date technical library
Technical information issued not complete
Not enough time given for full design
Feedback from site not acted on and same problem re-occurs
No standard procedures in place
Drawing registers and drawings held centrally and up dated so easy to get info quickly
Too many drawing it changes
DM meeting minutes not closed out
Ensure that methods are appropriate and practical
Drawings issued to site but not to Commercial
Always have to chase information rather than being told when it won't be received
Drawings are not checked prior to being passed to commercial
At the mercy of feeding the numbers beast (rush/rush)
Standard information changes from head office not issued

People
The unrealistic time frames being agreed
High turnover of staff
Commitment of department members (some)
Consultants over worked
No real structure to department
Part time worker in the department
No department split for land and technical support issues
Badly managed department from the top down
No trainee/Junior in department
Unable to get quick answer to technical questions
Provide dedicated teams of people responsible for delivery
Quality of technical staff available mainly consultants!
System of organisation and limit on the staff numbers
Reliance on third party input i.e. utility companies
Ensure that the agreement are in place with local authorities

Materials
Ensure that extras are compatible to design
Ensure that the Materials off properly researched, <u>not</u> just based on cost

business school
University of Glamorgan

Improvement Techniques Awareness Survey

This survey is part of my PhD research and aims to establish the current awareness of improvement techniques in the West Region Office.
All replies will be in strictly anonymous - no names please.
Individual responses will not be identified. A copy of the overall results will be posted in the office later.

Thanks for your help,

Ralph Barker

JOB TYPE
Please indicate your job type by ticking the one box that most applies:

Management/ Technical/ Production	Administration/ clerical

AWARENESS OF TECHNIQUES
Please tick the box that most indicates **your** awareness and knowledge of various improvement techniques:

Technique	Not heard of	Heard of but not used	Used a little	Reasonable use	Extensive use
Cause & Effect/ fishbone					
FMEA					
SPC					
KPI's					
Pareto					
Process mapping					
QFD					
TQM					
Benchmarking					
Balanced score card					

Supply Chain – Problem's Workshop
Held 17th February 2005 Goodbuild Regional Office

Overview

The workshop was held to discuss and build on the findings from the site manager interview research carried out in July 2004, where 13 of the 21 regional sites were visited.
This work identified that the key problems according to the site managers were:

1. Materials – poor/late delivery
2. Material - low quality/wrong spec
3. Technical information/support

The objectives for the workshop were to try and:

- Identify the key causes for these problems by using a 'cause and effect' brainstorming technique
- Assess the size/importance of the problem and what could be done to prevent occurrence by using the failure mode and effect analysis tool (FMEA).

Activities

After 'team rules' had been agreed including confidentiality and openness etc. copies of the raw data for problem areas given out and these plus the results from the interviews were discussed.

An explanation of how the cause and effect technique worked. Using a large wall chart for each problem, potential causes were 'posted' on three different cause and effect fishbone diagrams. Once all three had been completed then, again in turn, all the potential causes were scrutinised for their likelihood. This involved a good deal of discussion, grouping of individual comments, and eventually arriving at a consensus of the main likely causes for each of the 3 problem areas.
A listing of all the comments made is shown under the Appendix A.

A copy of an FMEA instruction booklet was given out and the process explained.
All the likely causes were then placed in an FMEA chart where, again by consensus, the probabilities of occurrence (Occ), severity (Sec) and detection (Det) were decided so as to form a judgement of relative importance by the risk priority number (RPN). In doing the scoring it was assumed that the 'end product' was in this case really the 'process' of housebuilding – such an assumption does affect the scoring especially that for severity. After deciding the RPN corrective actions were then discussed and added to the chart.
The 3 FMEA diagrams are shown in Appendix B

Findings

The main outcomes from the exercise are the 'causes of failure' used in the FMEA formats, the relative importance and the corrective actions also shown on the FMEA format. In assessing these against what could/should not be done is a matter for regional and group management.
Some of the areas I think are definitely for discussion and possible action appear to be:

- Better hand over meetings with detailed agreement – this appeared on two occasions
- Need active supplier feedback mechanisms specific to products/services (not an overall supplier rating)
- Improvement on supplier selection and relationships – it appears as if suppliers are not bothered?
- Site manager awareness of the IT ordering system – seems insufficient training here. Idea of buyers involved in training would promote knowledge and teamwork.
- Need some fail safe modification to the IT ordering system to prevent incorrect cancelling of blanket orders when delivery is only partially complete?
- Over coming or working around planning permission and fixed standard specifications form HQ – needs discussion.
- Is the culture really right for quality and no blame – are site managers views really sought? What improvement techniques are regularly used?

What next

Suggest a few days of reflection and then a discussion over the outcomes.

Post note: for Appendix A referred to in this report please see Appendix 21 and for Appendix B these FMEA diagrams are included in the text of Chapter 6 section 6.4.5.