AN INFORMATION STRATEGY TO SUPPORT EFFECTIVE CONSTRUCTION DESIGN DECISION MAKING

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It has been established that problems of effective communication within the Construction Industry are due to its multi-party fragmented nature. New and alternative procurement arrangements have been adopted by clients dissatisfied with the quality of the product produced by more traditional arrangements. These arrangements have the potential to improve the level of integration between the building design and production processes. Recent studies that have considered effective communication within these arrangements have shown a lack of understanding of the information needs of the parties involved at the design stage. It is felt that the problem lies in the social cognitive domain of information and depends on how information is utilised in decision making.

The paper seeks to review the literature on communication in construction and establish the case for an investigation of the role of communication in the design decision-making process. It also considers the research methodology adopted for the study.

Keywords: .Building procurement, design decision-making, group communication.

INTRODUCTION

Since the publication of the Latham Report (1994), much work has focused on improving the management of the construction process. One of the areas within construction management being given attention, partly due to the increased uptake of Information Technology (IT), is the field of construction information management. Construction, as a process, relies heavily on information being communicated effectively between the parties to ensure the successful management of projects. The problems of effective communication are primarily due to the multi-party, fragmented nature of the building industry, particularly between the parties involved in the design and production stages. To redress the situation, the industry has invested resources in ongoing initiatives to identify and find new ways (and technology) where integration can be made possible. This can be seen in the introduction of new procurement arrangements, management techniques and highly sophisticated information technology.

New and alternative procurement arrangements have been seen as having the potential to achieve better productivity by improving the level of integration between building design and production (Akintoye 1995). Within the context of information management, what was hoped from the application of these alternative procurement routes was that information, both in content and meaning, would be communicated more effectively. This is particularly the case when design and construction personnel

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work towards a common object under the Design and Build procurement route. Within the Design and Build route, parties managed under one administration, it was anticipated that information on production cost and buildability (i.e. information essential to economic design) would be incorporated. However current research has established this was not the case (Ross and Fortune 1997). A need to investigate the underlying reasons why information is not well communicated and how information may be incorporated to inform design decisions is then necessary.

PROCUREMENT SYSTEMS AND THE COMMUNICATION PROBLEM

The process of building consists of several diverse and fragmented sub-processes. Effective management of the construction process depends on the systemic treatment of its constituent sub-processes. To function as a whole, it is necessary for the sub-systems (sub-processes) to interact in some way, i.e. there must be some form of communication between them. Each sub-system can be said to receive **inputs,** which stimulate further activity to produce **outputs**, passing either to other sub-systems, or to the environment. Many of these messages are concerned with control, defined by Checkland (1981) as the means by which a whole entity retains its identity and/or performance under changing circumstances. The issue of communication within the Construction Industry has been an active area of research ever since the publication of the Banwell Report in 1964. That report and subsequent others, published, attributes the problems faced by the industry to the separation between the design and production sequence of the construction process. This conclusion was arrived at by comparison to the minimal problems faced by those in the field of manufacturing.

The success of any construction activity rests on its ability to manage information (Austen and Neale 1984). The high dependence of the construction process on information puts pressure on the industry to improve its flow of information and communication capabilities. The structure upon how information is managed and organised is formalised by the form of procurement strategy employed. Among the main objectives of building procurement systems is to facilitate the delivery of projects, which will fulfil clients' objectives with respect to time, cost and quality. A major obstacle to improving communications, however, is created by the traditional form of contract, where most construction projects are currently being tendered. This procurement route has tended to nurture the already competitive and adversarial culture prevalent in construction. Teams and working groups that operate within such antagonistic cultures tend to encourage defensive routines that hinder effective communication (Argyris 1990). To improve the situation, various approaches have been adopted by the industry to redress the issue at hand. Among them is the introduction of alternative forms of procurement, one of them Design and Build. They were introduced to bring together the fragmented parties and processes together. What Design and Build, in particular offered, was to bring together the relevant parties under the management of a single contractor to co-ordinate the various design, planning and construction activities. This was with a view to managing the critical interface between design and production.

Reflecting on the conclusions highlighted by the Latham Report (Latham 1994), and research conducted into the use and utility of Design and Build, it can be seen that little progress has been made to improve the situation. For example, in a study conducted by Ross and Fortune (1997), it was observed that organisations operating as Design and Build contractors still tended to operate the same procedures and

documentation e.g. the production and use of Bills of Quantities, as in the traditional route. Several possible explanations may be inferred. First, it may be due to the reluctance of the industry to embrace fully the new "culture" initiated by the alternative system or second, that the industry is still undergoing a substantial learning curve (AMEC 1998). One important benefit seen from the adoption of Design and Build has merely been an improvement from a co-ordination point of view, but the added value expected by the industry clients with respect to time, cost and functionality have yet to be realised.

A way forward to redressing the situation was observed with the introduction of the Value Management (VM). Studies into VM practice have indicated that success in attaining the stated client's objectives lie in the proper evaluation of strategic decisions at the front-end incubation period of construction (Mohsini 1996). It is within this front-end stage that decisions with respect to alternatives in design solutions, in relation to cost and buildability, may consciously be appraised. This is important as considerations made and decisions taken during the design stage have significant impact on informing the subsequent construction stages. In practice, however, the benefits of such a procedure are constrained by demands imposed by clients (Allen Building 1998). Due to pressures of time, designers rarely have the opportunity to consider alternative designs. Clients seem less inclined to invest resources at this front-end stage. This leads us to acknowledge that the strategic decision-making process in construction projects is developing into a concept that is becoming more client-led. Many of the considerations associated with the procedure depend upon the client's insistence of its inclusion into the design/construction process.

This appreciation warranted a study into how building designs were developed by architects and, more importantly, how, under these circumstances, they were being informed by the participating parties.

INFORMED DESIGN DECISIONS

Basic to the design process is the decision-making process. The thrust of any managerial process relies on the process of decision-making and its communication (Mead 1994). Communication is essential within the decision-making process to ensure not only that shared meaning is constructed in the organisation but that the solution has considered all angles of the problem. Furthermore, design teams are increasingly multi-disciplinary; they approach the design situation with pre-existing patterns of work activities, specialised work languages, different expectations and perceptions of quality and success, and different organisational constraints and priorities. Therefore it is important for construction-related decisions to be properly informed, integrating the various perspectives and differences, leading towards a satisfactory solution. Failure to do so may result in decisions made that have a negative impact on other members' work and on the built product as a whole. It is acknowledged however that most decisions are based on incomplete knowledge (Harris 1996). This is dictated frequently by pragmatic considerations of time, cost and availability. Nevertheless, research has indicated that most construction-related decisions, typically those pertaining to design and estimating were not comprehensively informed, due to an over reliance on the use of self-informing strategies employed by designers (Mackinder and Marvin 1982, Newland and Powell 1995). For such decisions to be effectively informed this requires the collaborative participation of all parties, contributing actively to the design process. However, a

major obstacle to making this possible, exists within how designs are presently developed.

Sonnenwald (1996) in her review of design research literature, concluded that studies into design methods and how designers carry out design have traditionally focused on design tasks and design management whereas studies into communication among design team participants have not been explicitly discussed. This she assigns to the prevalent view, that it is the responsibility of design professionals to know what is best when it comes to design. This view is also shared by Reich *et al.* (1996), in their research on user involvement. They pointed out that active user involvement is often considered not useful and in most cases it is avoided. Such a viewpoint, to a degree, emerged as a result of isolating architects from the process of building, introducing into the scene the professional designer (Fowles 1984). Professionalism was further reinforced by the establishment of professional bodies and in the way professionals were educated and trained (Schön 1983). This separation between the design and construction processes, coupled by the multi-party nature of the industry has been a major source of uncertainty within construction projects. This uncertainty, and the ambiguity stemming from it, is a by-product of individual parties' perception and interpretation of data. In practice this is observed as contractors are required to "interpret" design drawings into physical structures. This, more often than not, exposes the project to variations from the intended design purpose. Without providing essential communication channels, problems of miscommunication and abortive work are anticipated. What intensifies the problem is the variety of perception that the individual participants contribute in (and to) the construction design activity (Reich *et al.* 1996).

In the context of communication and decision-making, several studies have been carried out to further enhance the organisational potential within Design and Build. Recent work conducted has sought to study the flow of information within these processes (both between and within the design and construction domains). This is with a view to model the processes involved and hence formulate strategies for intervention. Work recently conducted by Fisher *et al.* (1997) presented several case studies of contracting organisations that adopt a variety of procurement routes. The study looked into the problem of information transfer during the development of design stage and had modelled the flow of information. The data collected was then used to develop conceptual models for use in the development of Object-Oriented database systems. Others, such as Baldwin *et al.* (1997), modelled the flow of information involved at the briefing stage within Design and Build organisations, to enable the timely provision of strategic cost advice prior to design development. The primary focus of the research quoted above was centred on the co-ordination of processes. A similar line of reasoning is used in research into Construction IT application. The employment of modelling techniques, database technology and process engineering, among others, sought to establish a normative model of the industry, whereupon its information structures and requirements can be identified. Lera *et al.* (1984) are of the view that these approaches tend to be underpinned by two basic premises. First, that if information is well presented and has relevant content and if it is stored accessibly, then designers will use it. Second, if designers use such information, they will produce "better" buildings. This approach to managing complexity in construction very much follows the problem solving, optimisation model of design, expressed by Simon (1969). This paradigm has driven research towards searching for a more systematic method at reducing complexity by

emphasising the need for the structuring of information and formalising procedures (Holt *et al.* 1985).

Recent research on construction management has begun to question the usefulness of such attempts. The focus of the studies still hinges upon the management of information, but has taken a more qualitative and systems view of the problem. Work on communication conducted by Bowen (1995) redirected the focus of more recent work by highlighting the more personal (human) element involved in the use of information. He reinforced, in the context of provision of cost information, the need for shared mutual understanding of information by the parties involved. This reduces the likelihood of misrepresentation and misinterpretation so critical to ambiguity. This is achieved, he asserted, by facilitating the process of interpersonal communication through an idealised framework. A criticism of the model proposed by Bowen is that its feedback loops to the communication process are limited to what is termed single-loop learning as opposed to double-loop learning (Argyris 1988). Within the design process, this implies that parties' input to the design solution is merely communicated to the architect and feedback is relayed back as a procedure to ensure that shared meaning has been attained. This, as in the case of Bowen's work into cost planning, merely directs the design process, so as to make certain that it keeps within the budget limits. It does not, however, encourage the participants to question assumptions rigorously and to formulate creatively more effective alternatives based on informed discussion. Double-loop learning involves surfacing and challenging deep-rooted assumptions and norms of an organisation (or process) that have previously been inaccessible, either because they were unknown or known but undiscussable. Bowen still implicitly holds to the model that construction processes are problem-solving activities. This view cannot be extended to the design process. Many attempts have been made to model the complex, iterative nature of design (Lawson 1997). Such attempts were deemed necessary to provide an understanding into the information needs of the designer, enabling its associated decision-making process to be informed. But due to its creative, almost ad-hoc manner of development, such models have proven to be of little use or insight. However, the need for an understanding of the design process is still essential. Design, being positioned at the front-end of the construction process has a strategic influence on the effective management of subsequent stages (Mohsini 1996). Design, according to Schön (1983), unlike that proposed by Simon (1969) above, is more likened to that of a learning process. Holt *et al.* (1995), where they describe design as a creative endeavour which involves an imaginative leap beyond what already exists, shares this perspective. This imaginative leap, they assert, is not spontaneous but the result of a physical development of the gnostic mechanisms of the brain; design is a learning process. Hence any attempt at improving the design decision-making capabilities of the design team should be focused at facilitating the learning process of the design team. Learning, according to Espejo *et al.* (1997), may be defined as an increase in the individual's or organisation's capability for effective action. This implies individual team members whose actions will be based on common understanding. Team learning is possible through the process of shared mental models. Capturing (and enhancing) individual mental models alone is not sufficient to achieve organisational learning. There needs to be a way to get beyond the fragmented learning of individuals and spread the learning throughout the organisation. The spirit of the learning should be one of active experimentation and inquiry where everyone participates in surfacing and testing each other's mental models (Kim 1993). There needs to be what Schön (1983) terms *reflection-in-action*.

Among the barriers to learning is the practice of defensive routines (Argyris 1990), where individuals are unwilling to undertake dialogue, so critical to exchange shared mental models. It is within this process of dialogue that double-loop learning (mentioned above) take place.

RESEARCH APPROACH

Past research as quoted above, in information management and communication in construction has informed us of the extent of the communication problem in the industry. These problems are characterised by the structural fragmentation of the industry, minimal appreciation of industry processes, lack of co-ordination and conservative attitude to change. This particular research extends on previous work by investigating the extent of information use within the development of conceptual design and how the interpersonal character of communication may be extended to that of design groups within the Design and Build system. The study, instead of looking only at information (and its flows), or the interaction between designer and information, seeks to focus on the interaction between the members of the design team within the collaborative process of designing. From this, the study may then establish the main factors that may facilitate (or impede) informed decisions.

One of the limitations of past research was that of the methodology employed. Methodologies adopted to gather information concerning the communication processes have thus far been unable to capture the problem in sufficient depth. In order to uncover and understand the dynamics involved in arriving at design decisions, we have sought to adopt a qualitative methodology. The adoption of such an approach was deemed necessary, as opposed to a quantitative paradigm. Among the considerations for such a choice was the nature of the research question that attempts to understand how design decisions were made and informed, and subsequently how they may be improved. The focus here is on developing a context-based, process oriented description and explanation of the phenomenon, rather than an objective, static description expressed strictly in terms of causality. It does not aim to produce information suitable for conventional statistical analysis and hypothesis testing, but rather adopts an interpretative epistemology that seeks to understand the complex social process within design practice. This is achieved by taking the point of view of individual practitioners, their values and practices, as the focus of the research. This includes how they view or perceive the issue under study, the factors involved, views on the practice of others and how the situation, in their view, may be improved.

The research strategy considered for this study involves describing and analysing several in-depth case studies to develop rich insights of the design development process, at the concept stage, and how decisions pertaining to them are informed by the relevant parties. This approach therefore fits within the interpretative case study approach to Information Systems (IS) research advocated by Walsham (1995). The case description will be based on a field study carried out on several typical projects involving large Design and Build contractors undertaking design development at the conceptual stage. It is worth noting here the sampling strategy adopted. Purposive sampling (Patton 1990) is adopted, where samples (subjects) for the research are selected based on its potential and ability for informing the research question. Bias responses are addressed within the analysis procedures. Design and Build contractors are selected as the arrangement most representative of an integrated construction team. Within this arrangement, members responsible for the design, planning and

constructing of the building are put together under one management. Projects as opposed to Design and Build contracting organisations are selected as units of analysis. This was due to the existence of a more coherent taxonomy with regards to project types. The industry has found it difficult to establish an acceptable taxonomy in classifying contracting organisations, small, medium or large. In the past, project turnover has been used, but this has proven to be unreliable. However project types may be easily categorised as, commercial, process, housing or retail. Activities within the tender stage are selected for as indicated by previous studies (quoted above) decisions taken at this stage have a significant impact on the management of subsequent stages.

Data will be gathered by means of; unstructured and semi-structured interviews with design team members, design-build managers and project co-ordinators; observation of design group meetings and analysis of procedural documents and those produced from the exercise. These interviews are conducted to elicit information concerning; how design team is assembled, how the team approaches the design problem, the communication channels set-up, how information is assembled and communicated, how design solutions and alternatives are generated, how information on cost and buildability are incorporated (or considered) and how are decisions made. Data gathered from the respective cases (projects) are expected to provide an illustrative description of the design decision making process. This description will not only clarify the processes involved it will also include both social and political considerations of the parties to the design team. Team learning may also be evaluated. Applying the team learning model will provide us with an appreciation of design as a learning process, revealing the ongoing "dialogue" that takes place when decisions are made. The description will then provide a sound empirical basis from which prescriptions (for the information strategy) can be made.

It would also be appropriate to reflect on the limitations, of our own approach. A critical issue for research concerns the generalisability of the results from their work. Theoretical conclusions derived from case studies are not considered to be valid unless the cases can be demonstrated to be typical of the phenomenon under investigation. While the in-depth investigation will enable insights to be gained into the complex interactions of the key players through closer observation of the behaviour of the team members, it also means that care to avoid generalisations from cases need to be taken. As Walsham (1995) argued, the generalisations from research based on case studies should be based on an empirical interpretative research in the projects selected. This should provide a basis for understanding similar phenomena in other settings, rather than enabling the prediction of behaviour in others contexts. In short, case studies, as Yin (1994) points out, are generalisable to theoretical propositions. Here the generalisation is of theoretical concepts and patterns, different from the typical statistical generalisation that generalises from a sample to a population. What this means in the case of the projects selected, is that explanations formed from the particular cases studied may be extended to situations that hold similar characteristics.

CONCLUSION

In the above discussion it has been highlighted that decisions made during the front-end stage of construction, particularly involving design decisions has significant impact subsequent stages. In the past these decisions have been made in isolation, without making a strategic assessment of the overall process and perspectives

involved in construction. Hence, as pointed out by this paper, the strategic decisions being undertaken at the design stage should involve a collaborative effort from all the parties involved. This will allow construction design decisions to be sufficiently informed, from a technical, economic, logistical and buildability perspective. To make this possible, an information strategy needs to be formulated, enabling the different parties to effectively contribute and inform the design process, through generating and evaluating alternatives.

Many attempts have been made in the past to bring these parts together. However, they have shown a lack of understanding of the information needs of the parties involved in the design stage. It is felt that the actual problem lies in the social cognitive domain of information and hinges on how information is perceived in decision making. Thus, for an information strategy to be useful, it must not only be normative, but, to an extent, descriptive of the process to be improved, requiring that the elements within the strategy be firmly grounded in the process. This necessitates a qualitative research methodology as proposed.

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