

INTERFACE MANAGEMENT FROM AN OFFSITE CONSTRUCTION PERSPECTIVE

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This paper is the subject of an ongoing PhD study with the primary research question: what is the relationship between offsite and interface management? While interface management takes many forms, the focus of this study has been organisational interface management to determine the various process and people factors, which have an effect on efficiency. The literature on offsite construction has been analysed to determine the relationship of the process and people factors identified. The changing nature of the construction process to a more specialist sub-contractor format has created new problems in the management of interfaces, none more so than the interfaces that have emerged from the offsite production and onsite incorporation of bathroom construction. The focus of the research is to determine a pragmatic framework of the main process and people factors which have an impact on the interface management of offsite and onsite forms of bathrooms/wet rooms. This paper includes a summary of a literature review on offsite and interface management. A pilot study using semi-structured interviews was carried out with six academics and industry practitioners to gauge the validity of the questions and the relevance of the 16 factors. The data gained from the pilot study was analysed using a five point Likert scale. This paper focuses on the process factor of design management and the people factor of communication. The results from the small sample clearly indicate the importance of early engagement of the contractor in the design process and that open communication between all stakeholders is essential to resolving organisational interfaces issues. The results of this study have also confirmed that the management of interfaces are of equal, if not more importance when incorporating offsite forms of bathroom construction into the construction process. In conclusion further research is required to determine the main factors, which will impact on successful organisational interface management.

Keywords: interface management, offsite construction, people factors, process factors.

INTRODUCTION

The traditional construction processes that existed in the UK until around the 1970's, saw a large proportion of the work on site carried out by workers directly employed by the main contractor and required little input from subcontractors. The dominant organisational structure that has functioned within the vast majority of construction projects since those days, now relates to a division of the works, with many

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subcontractors on site engaged in their own area of the project. The many divisions created by this approach have led to various forms of interface which must be managed. One approach adopted on some projects and which reduces the number of trades working on site is the use of 'offsite construction'.

This is the first paper that relates to a PhD study aiming to understand the effects of process and people factors on interface management in relation to offsite production and onsite incorporation of bathroom pods. An appreciation of traditional construction is provided, highlighting the domination of specialist subcontractors. The theme of offsite construction is introduced, confirming that although offsite forms of construction are considered by many to be new to the industry, processes such as prefabrication and industrialisation have been integrated into traditional construction for many years. From a review of the existing literature on offsite construction and, in particular, offsite forms of bathroom construction, a number of process and people factors are identified.

The fragmentation of the industry has accentuated the need for research into interface management. Literature confirms that little research has been carried out into interface management; the main contributors to interface management theory consist of Wren (1967), Morris (1983), Stuckenbruck (1983), Healy (1997) and Gibb (1999). With the construction industry now a specialist subcontractor based industry, adopting offsite forms of bathroom construction, new interface problems have emerged from the offsite manufacture and onsite incorporation, which need to be identified and managed. Gibb (1999) has proposed three forms of interface which have direct relationship to construction: physical, contractual and organisational. This research will focus on organisational interfaces.

The review of literature on offsite construction and interface management identified nine process factors and seven people factors. This paper will focus on the process factor of design management and the people factor of communication within the analysis of the pilot study.

TRADITIONAL CONSTRUCTION

'Tradition' is defined as a specific custom of long standing (Collins, 2004). 'Traditional Construction' is a term regularly used in construction management literature to define the onsite construction processes. Moreover, the traditional view of building construction consists invariably of "a process of preparing a site, bringing in materials and components, forming materials into elements such as frames, walls and roofs, assembling readymade components, installing services and then finishing ready for occupation" (Morton, 2008, p.152). While simplistic in description, it outlines the construction process which has operated for centuries. Prior to the 1970's, large construction organisations carried out all the associated work 'in house', directly employing trades such as joiners, electricians, plumbers, painters etc. The Architect, while directly responsible for design on the project, also held the role of contract administrator, controlling lines of communication within the team. In the 1970's extensive use of subcontractors emerged. Dainty *et al.* (2001) argue that main contractors adopted this form of contracting due to the 'volatility of the market', thus leading to the fragmentation which is dominant in today's UK construction industry.

CURRENT DRIVERS AND CONSTRAINTS

Whilst it is acknowledged that prefabrication already existed in the traditional construction sector, the Egan report 'Rethinking Construction' (1998) attempted to

develop offsite forms of construction, by following the principles already in use within the manufacturing industry. Egan (1998) considered that greater use of prefabrication and standardisation would greatly enhance the productivity of the construction industry. It is widely accepted that cost, time and quality are the traditional drivers which operated within the industry (Blismas *et al.* 2005). However, Blismas *et al.* (2005) argue that when consideration is given to offsite construction, additional drivers need to be included such as design management, whole life costing, health & safety and sustainable construction, thus adding to the capability and skill set required for the management of the process. Gibb and Isack (2001) carried out interview surveys with 59 leading client representatives across a wide spectrum of markets. The outcome of the survey identified that, from a client's perspective, lowest whole life cost was considered the main driver applicable from the pre determined list of drivers contained in the study. Whilst it is generally perceived that cost is the main driver, it is encouraging that clients' are considering 'whole life costing', which may lead to value for money being considered by enlightened clients as the main driver, thus allowing cost comparison to include not only direct costs but also indirect costs.

METHODS OF BATHROOM CONSTRUCTION

The bathroom/wet room area of a construction project is commonly identified as the most intense area of a project in terms of the number and variety of activities and trades required to successfully construct it (Taylor *et al.* 2009). The continuum of construction methods available for the construction of commercial and public bathrooms, range from total onsite construction to total offsite manufacture, with various forms of hybrid in between. Taylor *et al.* (2009) use a case study approach to compare two methods of constructing a bathroom. One method is the use of bathroom pods and the other is a pre-finished 'kit' of parts.

The pre-engineered kits came in the form of 'flat pack' panels with sanitary ware attached to them, designed for ease of assembly. The pre-engineered kit form has a heavier reliance on the skills of the onsite fitter but still less than the traditional onsite bathroom construction.

Benefits include:

- Reduction in personnel on site
- Reduction in construction programme
- Reduction in waste
- Reduction in snagging

Taylor *et al.* (2009) found that traditional bathroom construction demands a high level of supervision, which in turn leads to a considerable level of trade interaction compared to other areas of traditional construction. Snagging works are a challenge due to the interface coordination of other trades. Although pod and kit construction reduce the level of interfaces between trades, it is impossible to avoid a level of interface between offsite and on site. What is important is to recognise the variations in the types of interface which may, in certain situations demand a higher level of management expertise to achieve the benefits of offsite construction. In a similar study, Pan *et al.* (2008) reviewed the maintenance costs applicable to bathroom construction via case studies of student accommodation. A comparison is made of the maintenance cost of offsite and traditional *in situ* bathrooms, by reviewing four forms of bathroom construction; precast concrete modules, GRP modules, and two different types of traditional built in-situ bathrooms. A quantitative study of the maintenance

records resulted in the traditional built in-situ bathrooms being classed as the most expensive to maintain, followed by the precast concrete modules, resulting in the GRP module being classed as the cheapest to maintain. Considering the level of data analysed and the recognition given to the constants and variables between the various types of bathrooms, it is feasible to conclude that the findings of this study can be used as a general indicator of the level of maintenance cost attributable to the types analysed in the study. However, caution should be given to generalising the findings (Pan *et al.* 2008).

INTERFACE MANAGEMENT

The concept of interface management would appear to have had little exposure in general management literature and construction research in particular, evident by the limited publications and time gaps between same. Wren (1967) developed the concept of interface management to review the relationships between two or more organisations, thus indicating the issues which arise from people and processes. The organisational interface is the contact point between organisations which, in one sense, are independent of each other, but which interact and become interdependent to achieve a common goal. The management of the construction interface would appear to be a major contributor to the success of a project, thus reinforcing Morris's (1983) call for more in depth research into interface management theory. Morris (1983), in a review of the life cycle of a project, considers that the design phase plays a significant factor in contributing to the many interface issues that arise in both a technical and organisational sense. Traditionally, the RIBA plan of work is used as the vehicle that details the various steps from inception to start up. However, no check points exist in the plan to take account of interfaces at the various stages, which possibly contributes to the lack of reference to interface management. This is surprising considering the effects of design on interfaces and the success of a project (Morris 1983). Stuckenbruck (1989) further argues that project integration and project interface are similar in detail and where the project allows, personnel involved at the design stage should continue their involvement during the construction phase.

Healy (1997) further highlighted that, considering the importance of interface management to the success of a project, it has received little attention in project management research. This may be due to the difficulty in succinctly quantifying/measuring the tangibility of interface management. However, in a practical sense, it takes up a considerable amount of management time and energy. Healy (1997 p 268) defines interface management in the context of project management as “a boundary where an interdependence exists across that boundary and where responsibility for the interdependency changes across that boundary”.

The importance of interface management in the construction industry has been succinctly captured by Pavitt and Gibb (2003, p.8): “Interfaces, joints and connections between different elements or sections cause more problems than most of the rest of the building”. Furthermore, the shift from the traditional form of contract to more varied management forms has seen a significant shift in the employment of labour from direct to indirect; therefore highlighting the need to better manage the interfaces between the parties (Pavitt and Gibb, 2003).

The introduction of various forms of offsite construction into the construction process does not appear to alleviate the problems associated with interface management. Gibb (1999) defines interface management by identifying three distinct forms of interface,

which are considered of particular relevance to construction in general and offsite in particular:

- Physical Interfaces – as the term suggests refers to the actual physical connection between elements or components, which form actual linkage, physical interface can be related to hard interfaces.
- Contractual Interfaces – relates to how the work packages have been formed from a contractual basis, i.e. can influence the number of process and people interfaces.
- Organisational Interfaces – refers mainly to the soft interfaces, which affect the successful management of a project. Organisational interfaces can relate to individual and /or group relationships.

The main focus of this paper in relation to interface management will be on organisational interfaces, with an emphasis on the people and process issues. Whilst offsite construction as an element of the process will possibly reduce the organisational interfaces, consideration should be given to the following:

- The project management issues may vary from the traditional.
- Interface issues will need to be incorporated into the process at an earlier stage than traditionally.

THE INFLUENCE OF DESIGN ON INTERFACE MANAGEMENT

Traditionally the design phase and the construction phase were seen as separate operations, each able to function independently. However, recent research has identified the importance of the design-construction interface and its effect on the project. A study carried out by Alarcon and Mardones (1998) of four projects associated with the same construction company, using a qualitative research approach to gather data by observations and interviews, identified that 40-50% of design time is taken up by rework and design changes and that a considerable amount of time was wasted during the flow of design information. Alarcon and Mardones (1998) also highlighted the lack of communication and coordination between designers, which directly affects the design interface. It is suggested that this may be attributed to a lack of knowledge in areas related to buildability/constructability by designers and a lack of input by the various specialists involved in the project, thus emphasising the need for a design manager to coordinate the design process. Alarcon and Mardones (1998) argue for the inclusion of the principal contractor in the design process. However, this is very much dependent upon the method of procurement used.

THE INFLUENCE OF COMMUNICATION ON INTERFACE MANAGEMENT

Chua *et al.* (2003) propose a 'Process-Parameter-Interface Model' to aid the management of the design process. The model has been developed to encourage transparency in communication and collaboration. The component parts of the model include the interface, which encourages specialist designers to share essential design information with other specialists. This will aid the overall design process, thus creating a more transparent environment. The other component parts of the model include the engine, which promotes collaboration between the various parties and the design dictionary, which acts as a vehicle for accumulation of information from other designers. All designers can access this to gain a better appreciation of other design functions. Whilst in practice the model may not be considered a new approach to the

design process, its value can be attributed to highlighting the importance of sharing information, which in turn can have a positive effect on the interface issues when reviewing the design process. Chua and Godinot (2006) argue that better communication between all actors involved in the process would result in improved interface management.

PROCESS AND PEOPLE FACTORS

The review of the existing literature, which relates to offsite construction and interface management, was used as the vehicle to identify the main process and people factors central to the overall research. The process factors include procurement, supply chain management, whole life costing, health and safety, design management, lean construction, sustainability, tolerance and quality. The people factors include communication, role of the project manager, culture, client/design team, leadership, perception and integration. While the majority of the aforementioned factors were identified in literature, the people factors of culture and client design team were included following unstructured interviews with two experienced offsite professionals.

METHODOLOGY FOR PILOT STUDY

Creswell (2009) argues that it is incumbent upon the researcher to have an understanding of their philosophical stance before choosing the appropriate research method. The philosophical stances reviewed include 'ontology', which relates to the study of things as they actually are and 'epistemology' the theory of knowledge, how we know what we know (Easterby-Smith *et al.* 2002). This study will follow the epistemology stance. Fellows and Liu (2003) argue for the importance of the identification of the intended paradigm when analysing data, two approaches include 'positivism' deals with empirical evidence i.e. facts and figures, while 'social constructivism' relates to the contribution of people and the interpretation of the spoken word. This study will follow the social constructivism paradigm.

The research process starts with a review of the existing literature, to gain an understanding of the relevant theory and research questions, which contribute to identifying the process and people factors which are relevant to the research. Two unstructured interviews with industry professionals were carried out to gauge the relevance of the process and people factors identified. Interview questions were formulated to form the basis of six pilot studies which will aid the refinement of the actual questions used in the case study research (Yin 2009). While nine process and seven people factors have been identified as applicable to the overall research, the focus of the analysis of the pilot study will be on design management and communication. The data was analysed using a five point Likert scale to gain interviewees opinions, which allowed comparative views to be established between the participants (Fellows and Liu 2003).

ANALYSIS OF PILOT STUDY

The pilot study was used to check the validity and interpretation of the questions asked. The sample participants consist of three academics (P1-P3) and three practitioners (P4-P6) with varied levels of experience.

Table 1: designation/experience of Interviewees

Interviewee	Discipline	Academic Experience (years)	Traditional Bathroom Experience (years)	Offsite Bathroom Experience (years)	Total Experience (years)
P1	Research Fellow	10	6	Nil	16
P2	Lecturer	10	Nil	Nil	10
P3	Lecturer	20	27	2	49
P4	Senior Project Manager	Nil	35	4	39
P5	Senior Project Manager	Nil	24	1	25
P6	Project Manager	Nil	22	2	24

The main questions used in the semi-structured interviews utilised the Likert scale (Strongly agree, Agree, Neither agree nor disagree, Disagree, Strongly disagree) to gauge the respondents' view followed by a comment section to gain further information.

The first two questions relate to 'interface management in general' to gauge the perception of the respondents. P1, P3 and P5 'Strongly agreed' that "effective interface management is more important when using offsite solutions", citing the technical interface as more important, it is crucial to involve the contractor early and the benefits of using offsite components can be lost if the interface is not managed well. P2, P4 and P6 'Agreed' with the premise of the question, stating it is important in relation to the construction process, the need to be aware of interfaces at the early stage and the need to coordinate the design early in the process. The responses demonstrate a unanimous agreement that effective interface management is important when using offsite solutions both by academics and industrialists. The second question reversed question one by claiming, 'using offsite solutions improves interfaces management'. P1, P3 and P5 disagreed, claiming it is made more difficult, that the use of offsite by its very nature creates interface problems and can cause more difficult problems than what would be the norm on traditional projects. P2, P4 and P5 agreed with the statement citing it improves management not only offsite but also onsite, the need to be aware of the interfaces at the early stage and by agreeing the design early allows information to be passed to other trades thus improving communication. It is worth highlighting that the three interviewees that 'Strongly agreed' with question one, also 'Disagreed' with question two, while the three that 'Agreed with question one also 'Agreed' with question two, which suggests an effective link and relevance of both questions although the limited sample size is acknowledged.

Nine questions in the pilot study related to the process factors identified earlier. However, the analysis focuses on one process factor in this section namely 'Design Management'. The interviewees were asked three separate questions in this section. All six interviewees 'Strongly agreed' with the part A statement that 'effective management of the design process significantly improves interface management'. Comments ranged from an organised approach very important to the process, crucial

to the success, imperative that the design manager incorporates contractors' designs, such that ultimately the design team take full responsibility and the key to the success of the project relies on someone taking ownership of the design. P1, P3, P4, P5 and P6 all 'Strongly agreed' with the statement that 'design management can significantly affect interface management in bathrooms', qualifying their response by restating the same responses as part A and adding the need to involve the supply chain in the coordination of design. P2 'Agreed' with the statement but qualified that he was unsure as to relevance of the question. Part C stated that 'design management has more influence on offsite than onsite bathroom construction' P1, P2, P4 and P6 'Agreed' with the statement citing that, in principle there should be no difference. However, offsite construction requires early design freeze to be effective. P3 and P5 both expressed 'No view', stating that design management is equally important to both onsite and offsite. Overall the responses demonstrated a strong link between design management and interface management in relation to offsite bathroom construction. What is also evident is the importance of interviewees commenting on statements, as the responses in relation 'Agree' and 'Have no view' denoted comments that were very similar.

Following on from the questions which focused on the process factors were a further seven questions relating to people factors, including 'Communication'. Part A of the communication question asked "Does effective communication improve interface management?" All interviewees 'Strongly Agreed' adding comments such as: communication is key to effective interface management, communication is the most important factor, it is very important that parties speak to each other and communication is key to the whole construction process. Part B suggested that "Effective communication has more influence on offsite than onsite bathroom construction". P1 'Strongly Agreed' explaining that communication has more relevance with offsite as there is more potential for things to go badly wrong. P2 agreed with the statement, citing that a higher level of communication is necessary within a manufacturing process. P3 and P4 'Disagreed', professing that effective communication is required regardless of the process and effective communication is more important onsite than offsite as the parties involved in the manufacturing are more focused. P5 and P6 'Neither agreed nor disagreed' citing that effective communication is equally important to both offsite and onsite. Of interest to the responses for part B are that the two academics with no industrial experience considered that effective communication is more relevant to offsite bathroom construction, whereas the academic with substantial industrial experience and the three project managers 'Neither agreed or disagreed'/'Disagreed' commenting that the importance is the same regardless of whether offsite or onsite construction, which highlights the divergence views of academics and industrialists in relation to communication within the platforms of offsite and onsite bathroom construction.

DISCUSSION ON THE PILOT STUDY

The mixture of academics and industrialists was used to check the relevance and wording of the questions before proceeding with the main case studies. The authors considered that the academics contribution would be most relevant to the structure of the questions while the industrialists main contribution would be with the data gained. However, in reality, all participants made effective contributions to both the structure and the data.

The data collected confirmed that when using offsite forms of bathroom construction, effective interface management is vitally important, even more than when using onsite forms of construction. Also it is considered necessary to be aware of the interface early on in a project, which in turn will improve the management of the technical and people processes. The questions applicable to the process factor of design management, unanimously supported the view that management of the design is crucial to the success of a project, none more so than when using offsite forms of bathroom construction. The analysis of the questions relating to communication also confirmed that communication is central to effective interface management. However, subsequent questions revealed that communication has the same relevance regardless of whether the main process is offsite or onsite. While it is acknowledged that the pilot study has a small sample size, it is encouraging that the interviewees all considered that the identified process and people factors had relevant to the study of interface in relation to offsite forms of bathroom construction.

CONCLUSIONS

The 21st century construction industry is now firmly ensconced in the use of specialist subcontractors to construct the full range of buildings in the UK. This has highlighted the need for the industry to recognise the essential nature of interface management. Interface management is a subject that has not been researched in great detail by academia nor industry. This may resonate from the vast array of interfaces which exist in traditional onsite forms of construction.

This study has focused on offsite forms of bathroom construction and integrated the theme of interface management, as an area of research, which should be more manageable to research in depth than the vast area of interfaces which prevail in traditional construction. Offsite forms of bathroom construction by the very nature of the construction methods should have fewer interfaces to manage and therefore be less of a management issue in terms of project success. However, the results of the pilot study highlight that the management of interfaces is more important when introducing offsite forms of bathroom construction into the project, emphasising the need for early engagement of the construction parties during the design stage.

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