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Information Management in Construction Organisations – Drivers, Constraining Factors and Barriers

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Abstract.

The urge to improve collaborative working, knowledge sharing and operational effectiveness has made effective Information Management a growing priority for organisations in the Construction Industry. While significant research has been carried out in the construction industry on project Information Management, limited work has been carried out to understand Information Management from an organisational paradigm. This paper presents the findings of an investigation into the nature of Information Management within consulting organisations in the UK Construction Industry. Interviews were conducted with experts across nine large architectural and multidisciplinary consultancies, the outputs of which were analysed using thematic analysis. From this, 26 themes across three core categories classed as drivers, constraining factors and barriers which shape Information Management practices in construction organisations emerged. The findings show that Information Management is indeed of strategic significance to organisations and an organisational dimension is necessary to better align information needs with an organisation's operational processes. They also show that context dependent factors exist which shape the nature of Information Management in line with the specific needs of each organisation. Therefore, the effectiveness of an organisation's Information Management practices is not absolute, but relative to its level of alignment to the organisation's chosen mode of operation. The findings provide a much needed practical view of the complexities of Information Management, highlighting that particularly

within multi-disciplinary organisations; a unifying approach is much more practical and appropriate than a single approach to managing information.

Keywords: Information Management; Content Management; Document Management; Information Management Strategy; Strategic Management.

INTRODUCTION

Information is the product of the contextual understanding and interpretation of Data. It is the essential medium through which knowledge, expertise, judgement, emotions and decisions held by individuals is expressed, shared and communicated with others (Davenport and Marchand, 2000). Hicks et al (2006) define Information Management (IM) from an organisational perspective to include the activities that support the information lifecycle from creation, representation and maintenance through to communication and reuse. An information intelligent organisation is one which understands the value of information and can successfully search, find, assemble, analyse, use and reuse all forms of information products required for any of its tasks (Evgeniou and Cartwright, 2005). This is particularly important as competitive advantage today makes information a core requirement for doing business, improving organisational performance and obtaining operational efficiency (Christian, 2002; Chaffey & Wood, 2004; Hicks et al, 2002; Hicks et al, 2006; Laundon & Laundon, 2009). Being information intelligent requires a more strategic view of information as a corporate asset, aligning the information needs of the organisation to its business processes (Buchanan and Gibb, 1998; Brigl et al, 2005). It requires a fundamental rethink of information, its position within the organisation and its potency as a means of securing long term competitive advantage. It also requires information to be viewed in a holistic manner balancing an appreciation of technologies with the capabilities of people within the business to harness and use the information to improve performance (Marchand, 2000).

HOLISTIC APPROACH TO INFORMATION MANAGEMENT

A holistic approach to IM requires the integration of strategies, tools, processes and skills within an organisation to manage all forms of recorded information through its complete lifecycle from creation until deletion supported by necessary technological and administrative infrastructures (Boiko, 2002; Tyrvaenen et al, 2002; Nordheim and Paivarinta, 2004; Munkvold et al, 2006; HP, 2007). Such an approach needs an appreciation of how the organisation can best use, structure and exploit information to achieve desired results across its diverse processes (Marchand, 2000; HP, 2007). Numerous technologies do exist which aim to enable this, however critical to the success of a holistic approach is emphasis on corporate wide strategies and policies guiding the use and implementation of the appropriate technology (Paivarinta & Munkvold, 2005). A holistic approach to IM consists of four key components a clear appreciation of which is essential to ensure the approach is contextual, appropriate and implemented effectively to support the

organisation (Marchand, 2000; Paivarinta & Munkvold, 2005; Bridges, 2007). These are discussed in more detail by the authors in a previous publication (Sheriff et al, 2008). In brief, the components are:

- **The Content Model**, denoting the nature of the content, its lifecycle, structure, attributes, business applications and its suitability for the organisation. This also includes metadata and taxonomy.
- **The enterprise Model** based on an analysis of the organisation, its distinct operations, culture, partners and supply chain based on their interaction with information through time (also referred to as *process*).
- **Technological** needs to facilitate the implementation of the predefined strategy (also referred to as *technology and systems*).
- **Implementation & Change Management** to manage the transition and support the implementation of the strategy (also referred to as *people*).

Prior to presenting the findings, it is necessary to differentiate between IM and other associated concepts in both research and practice.

Information Management and Knowledge Management

Hicks et al (2006) explain that significant research has been conducted into Knowledge Management (KM) practices within organisations, particularly explicit KM, as being synonymous or indeed interchangeable with Information Management. Davenport (2000) and Ghani (2009) relate this to KM being a key driver for improving IM. There are a plethora of definitions for KM including those put forth by Webb (1998); Davenport and Prusak 2000; Carrillo and Chinowsky (2006). Robinson et al (2005) define KM as the means through which knowledge (in the broadest sense) is exploited and transformed for organisational use. Its continuous importance is predicated on an increasing appreciation of the strategic significance of knowledge as a competitive resource in a modern knowledge economy (Egbu, 2004). Bishop et al (2009) argue that the breadth of KM includes soft or human components as well as hard or explicit elements. Thus while Knowledge can be explicit codified, shared and exchanged as information products, its scope is much broader than information as not all knowledge can or indeed would require codification. KM should therefore not be synonymous with IM. As similarly observed by Davenport and Marchand (2000), IM can enable KM and is a significant component of it, but does not in itself represent a KM solution. IM also extends to the administration of content through their lifecycle most of which fall outside the scope of KM, even though similar processes, technologies and practices may be employed in

both fields. This research considers explicit knowledge as a type of information and therefore a part of IM but the scope of this study and indeed IM in general is inherently different from KM research and practice.

Information Management; Information Systems and Information Technology

Also identified in the literature was the extensive research into Information Systems and technologies including Document Management Systems, as part of Information Management research. The three areas of Information Management (IM), Information Systems (IS) and Information Technology (IT) are frequently used interchangeably further amplifying this apparent lack of clarity (King et al, 1988; Marchand, 2000). For example, Maddison and Darnton (1996) present an approach to aligning Information Management with organisational processes which puts emphasis on IS and IT, neglecting IM. Similar findings are apparent in the works of Craig and Sommerville (2006) and Hicks (2007). The result is a largely technological view of Information Management that excludes the organisational dimension. While all three areas focus on information, the emphasis placed on certain themes make each a distinct field of study with different requirements and focus areas. Marchand (2000) outlines these streams as:

- *IT* is primarily concerned with the infrastructure of the organisation ranging from desktop based infrastructure to servers and networks, with emphasis placed on reliability, responsiveness, flexibility and ease of use of the various technologies;
- *IS* focuses on the applications and database software which perform defined business functions ranging from design, manufacturing and production to accounting, human resource management and other associated processes within the organisation; and
- *IM* relates to the information required to carry out distinct tasks/processes. It is strategy and process driven aligning with the various business units across the organisations. The emphasis here is on developing a suitable approach to managing and leveraging content to support business processes.

Each stream, with its distinct paradigm emphasises that organisations can choose to gain competitive advantage through technology (IT); software (IS); or information (IM) (King et al, 1988). Inter-relationships and interdependencies do exist between all the above streams. However, a focus on IT or indeed IS does not imply a focus on IM as neither IT nor IS focus on the content or information which an organisation creates or uses; or the behavioural dimensions of managing information (all of which are the focus of IM). Thus while appreciating the need for and importance of IT and IS, this research focuses on IM.

Information Management in the construction Industry

The Design and Construction process is composed of numerous stakeholders and participants working together as a “temporary enterprise” through a procurement process to develop and implement unique solutions to meet client needs (Caldas, 2003; Craig and Sommerville, 2006). The solutions resulting from this often complex interaction are developed through the creation and continuous exchange of information (Anumba et al, 2008). Due to the critical nature of this information for executing the task at hand, managing it has been identified as crucial to effective project delivery (Bjork 2001; Hicks et al 2002). Construction research into IM focuses on the project environment frequently highlighting the need for improved collaboration and co-ordination between stakeholders (Bjork, 2001; Caldas, 2003; Peansupap and Walker, 2005; Yeomans, 2005). Indeed, strides made in this area have given rise to emergent standards such as the BS1192:2007 standard for collaborative data environments.

While organisations in the Construction Industry primarily work on projects, a merely project centric view does not represent all the information created, shared and managed within organisations, nor does it enable organisations working on multiple projects to manage cross-project information. Neglected are the internal company specific IM challenges posed by increased digitization of corporate information. Managers also lack an understanding of the broader issues around IM, the type of information various people within their organisations need and want, and critically, how to develop and implement a suitable IM strategy to support their respective organisations (Davenport 2000). There exists a need to develop an effective inter project approach to support IM process within organisations. This paper looks presents the findings from a detailed study into IM in construction organisations. The specific methods employed and the findings from the research are presented below.

OUTLINE METHODOLOGY

A thorough review of related literature established the state of the art in IM; KM; Content Management; Enterprise Content Management and Document Management. Semi structured interviews were then carried out with IM experts taken from a sample of organisations within the Construction Industry. As the sample size sought was principally illustrative (in line with a principle of conducting case study research (Yin 2003)), a non probabilistic purposive sampling approach was used to identify a sufficient sample. Twenty five organisations were targeted based on their status as consulting organisations within the Construction Industry; and their size as medium – large consultancies. All companies have headquarters in the UK with all but one having significant international operations. The annual Construction Industry

ranking by the *Building Design* magazine (2009) was used to define the initial shortlist. These consisted of architectural firms (14) and multi-disciplinary consultancies (11). Experts within each of these organisations responsible for IM were specifically targeted with email requests, 11 of whom accepted.

In a study of sufficient sample sizes using non probabilistic purposive sampling, Guest et al (2006) found that a sample of twelve was sufficient to establish a stable view of parameters, particularly if the research is aimed at describing perception or behaviour among participants. Similarly, Romney et al (1986) also explain that even a sample of four may be sufficient to provide an accurate explanation of phenomena so long as these four were experts in their field. In total nine interviews were carried out with Senior Partners (2); Directors (2); Group Knowledge Managers (1); IT Systems professionals (3) and a Senior Business Analyst (1), all of whom were experts responsible for IM and/or KM within their respective organisations. As purposive samples were sought (where participants are selected based on the research criteria) not probabilistic sampling, the sample size was considered sufficient to meet the research objectives. The organisations involved in the research are listed in table eight below (note: the data on the number of employees was taken as of August 2008 when the sample was defined).

	No of Employees	Global Offices	Scope of Operations	Additional Notes
Company 1	800	15	Multidisciplinary Engineering	Now part of a global company with 8500 employees
Company 2	3500	35	Construction Management and Multidisciplinary Engineering Consultancy	
Company 3	10,000	92	Multidisciplinary Engineering; Architecture; Planning and Project Management	
Company 4	3000	30	Multidisciplinary Engineering and Project Management	Now part of a global company with 35,000 employees
Company 5	1000	15	Architecture; Product design and Planning	
Company 6	420	6	Architecture; Project Management and	
Company 7	45	1	Architecture and Planning	
Company 8	2700	69	Consulting Services; Project and Cost Management	
Company 9	14000	150	Management Consulting; Multidisciplinary Engineering and	

Table 1: Organisations Interviewed

Semi structured interviews were deemed the most appropriate medium of data collection in line with the type of data required and the paradigm adopted. To ensure the questions were clear, unambiguous and appropriate, a three page questionnaire was prepared and piloted with a sample of four individuals within a company similar in context to the sampled companies. This was carried out iteratively until the questionnaire was deemed suitable. All interviews were conducted face to face, each lasting approximately 90 minutes, after which each was transcribed then analysed.

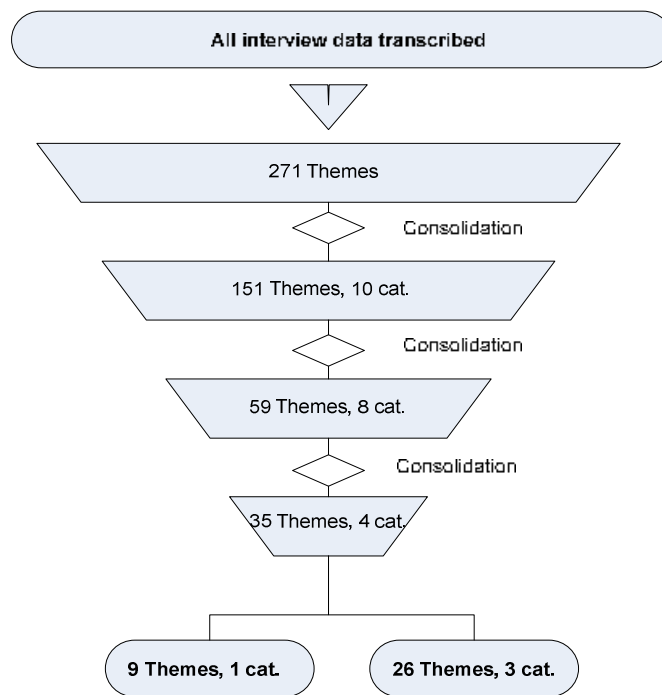


Figure 1: The Data Analysis Process

The analysis was carried out following the thematic analysis process as outlined by Boyatzis (1998). The process required the iterative reading (in detail) of the textual data to identify appropriate themes (the complete process is illustrated in fig. 1 above). From this, an initial list of 271 themes emerged. Based on the definitions of the codes for each theme, a number were observed to be repetitive while several others were inter-related. Further iterative refinements were therefore carried out to aggregate and consolidate these into distinct selective codes. This consolidation process involved combining certain themes and grouping other associated themes together as categories. This initially gave rise to 151 themes across 10 categories and then 59 themes across eight categories. The final consolidation carried out resulted in 35

themes across four core categories all of which define distinct areas of Information Management. No further consolidations were apparent as the categories had become saturated. The four categories are Drivers, Constraining Factors, Barriers and Lessons learnt. Only the findings from the first three categories (a total of 26 themes) are presented in this research. The core variable in this research is organisational Information Management with all the categories and themes aimed at explaining its meaning and its nature within construction organisations. The final 26 themes across the three categories are shown in table two below.

Drivers	Constraining Factors	Barriers
	Organisational Factors	Organisational Barriers
1 Improve Product	1 Size and Structure of the Organisation	1 Project needs take precedence
2 Improve Processes	2 Number of Disciplines	2 Leadership
3 Transfer of Learning	3 Corporate Strategy	3 Limited Resources
4 Legal and Regulatory Requirements	Project Factors	Content and Technological Barriers
5 Mitigate Risk	1 Scope of Project Services	1 Complicated Taxonomies
	2 Diversity of Projects	2 New forms of content
	3 Diversity of Operating Markets	3 Inconsistencies in the use of Metadata
		4 Poor performing technology
	Future Innovations	Construction industry wide
	1 Processes and Practices	1 Lack of guidance
	2 Content and Technology	2 Skills Shortages
	3 Organisational Structure	3 Nature of Construction Projects
		Cultural Barriers
		1 Resistance to Change
		2 Fear of being driven by technology
		3 Poor Sharing Culture

Table 2: Summary of the final themes and Categories

RESEARCH FINDINGS

The following section is divided into four parts. First a general overview of the current state of IM practices within all the organisations is presented to put the results in the appropriate context followed by details of all three categories.

General Information Management Practices

Scope

The organisations differed in their overall perception of IM. For three organisations, it is not considered 'important enough' to focus on at an enterprise level. Instead the focus is on finding specific point solutions to address specific problems (mainly on projects). The other six interviewees however stated that IM was *"very important"* and sponsored at a strategic level across their companies. In the words of one interviewee *"Yes, Information Management is fundamental to what this business is about. That's what we're dealing with. We design buildings and the output of that for our business is information. How we manage that is critical to what we do and so it's certainly core to what we're doing"*. Another interviewee added *"Our company doesn't build anything, we are a pure consultancy so what we deliver to our client is information and that could be documents, drawings, reports, data, presentations, etc, a variety of media but its all about what we deliver to our client being information"*. Seven of the organisations also have a standard approach to structuring information to enable consistency across their project teams such that *"if one project team member moves projects, they land in another project that is broadly organised in a similar way"*. The extent of this however varied. In six of the organisations, it is firmly established practice, i.e. routinely carried out and accepted across the company, while for one organisation it is emergent practice, i.e. currently being developed and implemented with varying levels of maturity across the company.

Differences were also apparent in the relationship between IM and KM practices. All but one has distinct teams for each with limited mutual lines of reporting. For all however, there is a significant working relationship between both teams in agreeing, implementing and pursuing a collective vision for improving company performance. IM strategy and overall corporate strategy were also found to be linked in all the organisations. The nature and extent of this link however varied considerably from one organisation to the other. For four of the organisations it is a very direct link, with the IM strategy modelled to support their long term aspirations. For example, one interviewee explained *"All the reasons that we're doing this, relate back to the company 5 year plan, which is the operational strategy, so all of the rationale and hence the requirements support the corporate strategy"*. For the other five, there is no conscious link but a more general organisational need to better manage information to improve front line project delivery processes. As one interviewee put it, *"It's never really been thought through in quite those clinical terms"*.

Use of Technology

Multiple technological platforms rather than a single enterprise wide solution are used by eight of the nine organisations to suit various needs. For example, five organisations use a web based Content Management System to capture and disseminate knowledge around the company while four organisations have a Document Management System for managing project documents. As an interviewee explained *“there isn’t one tool, there’s CAD, GIS, documents and email management and so on. It’s a suite of systems”*. All the organisations regularly deploy extranets and ftp sites to meet project needs such as facilitating the exchange of information between project teams. However, even where these are used, the primary storage medium in all but one of the organisations is the network drive.

The organisations also differed in the extent to which technology was used for managing electronic content. One interviewee explained that a decision was made to minimise the use of technology as they found few solutions that add value to their chosen methods of operation. Within five organisations however technology is extensively used to support core processes including enterprise-wide Knowledge Management Systems; Document Management Systems and Extranets. Generally, the following factors were identified as impacting on the selection of appropriate tools to meet company needs.

- The nature of the company’s projects (either generally or specific demands of each project);
- The geographical distribution of projects and offices;
- Skill sets available to support the technology through its lifecycle;
- Previous experiences in using a similar technology;
- The distinct task or series of tasks to be carried out either across the enterprise or on projects (or both) which the technology is expected to support;
- The robustness and usability of the system; and
- The cumulative cost of procuring and maintaining the technology over time

Use of Metadata, taxonomies and Naming conventions

Naming conventions and not metadata are exclusively used in three organisations. Five organisations whilst also using naming conventions for projects, confirmed having a metadata and taxonomy standard either being developed or currently being implemented across the company. For one organisation however, a conscious decision was made to not use metadata. The interviewee explained *“I don’t think that many people have found that categorising things is helping them a great deal in the design process if I’m being honest”*. The naming conventions used in the eight organisations were observed to be either entirely bespoke or variants of the BS1192:2007 standard. Similarly six organisations who anticipate a

move towards the use of standard metadata enterprise wide explained that any standard they will use will be bespoke. As one interviewee explained *“yes it’ll be designed to fit our internal needs but certainly fits within ISO 9001”*.

Details of the three categories; Drivers, Constraining factors and Barriers identified are presented below.

CATEGORIES 1: DRIVERS

The drivers are defined as those themes which form the principal impetus for developing a holistic approach to IM. The themes include:

Improve Product

Improving IM is perceived as being necessary for improving the quality of products offered to clients and building/sustaining competitive advantage. In the context of consulting organisations, ‘product’ was defined as knowledge and information necessary to create a building; a form of infrastructure and/or advisory services. Emphasising this priority one interviewee explained *“certainly a core principle of what our company is about is that we we’re passionate about engineering and we want to drive our engineers and give them the tools to move the business forward and move forward as engineers, and therefore giving them access to the best practice that we developed on other projects”*.

Improve Processes

Another significant driver identified was the need for improvements in operations. The most prevalent reasons cited for this were to increase the *efficiency* of processes; ensure *consistency* of practices and enable *collaborative working* across the organisation and on projects. Efficiency was defined as *“saving time”*; *“reducing duplication”* and *“not having to reinvent the wheel every time a task is to be carried out”* where such tasks have been previously conducted in other parts of the organisation. Other reasons cited include the need to standardise processes; increase global accessibility to recorded knowledge/information and enable continuous improvement within their respective organisations. As captured in the words of one interviewee, this is necessary because *“the size of the firm implies that ad-hoc processes cannot be sustainably carried out in a cost effective manner”*.

Process improvement also aims to ensure consistent working practices across the organisation, a critical need highlighted by all interviewees. For example, one expert explained *“Better quality, better*

management of our product that goes out the door, requires better consistency. So if you deal with the London office, or if you deal with the Glasgow office, you get the same and I think that's important as well so that as a brand people say we always deliver this type of product and it's excellent". Corroborating this point, another interviewee added *"we've got 50 offices in the UK and probably 100 offices worldwide, so if everyone's working in their own little way it's going to cause you some sort of issues in terms of Information Management".* Consistency also makes collaborative working across the different disciplines much easier and more effective. Such collaboration can be vertical by *"enabling people who are senior help people who are junior so you get that exchange of information and knowledge"* or horizontal, to support multi-disciplinary often non co-located project teams. As an interviewee explained *"what's happening now is that the firm is 10,000 people and you've got a project where you bring together people working in the Madrid office, the San Francisco Office, the Doha office and Newcastle office".* Problems also get solved quicker as a holistic approach enables quicker access to the people and the resources needed to solve them.

Transfer of Learning

A critical need for organisations is to effectively disseminate solutions including innovations and lessons learnt across the organisation. Learning is essential for improving the competencies of employees as (in the words of one interviewee) it is only *"by looking back at what we've done in the past and building on that to make it better in the future"*. Here, transfer of learning is focussed on all solutions which improve the competency of employees by providing access to the global pool of knowledge and experience existing within the organisation. This category was greatly emphasised by interviewees from the larger organisations where diverse disciplines and non co-located teams are prevalent. For example, one expert explained *"in our parent company, we've got 35,000 people across the world who have got an awful lot of knowledge and you've got to remember that these are assets, these people and every day when they walk out at 5 or 6, all that knowledge walks with them"*. This organisations need to enable diverse employees leverage their collective expertise prompted a move towards a holistic strategy. The themes highlighted emphasise organisations perceive that in the generation of new ideas and the emergence of new knowledge and making it available to staff lay their competitive advantage. This was also found to be an integral part of one organisations strategic positioning as a centre of knowledge for external clients and partners. As the interviewee explained *"we want to be seen to be a learned organisation and a learning organisation which go together I suppose. It is quite a key thing for this company"*.

Legal and regulatory requirements

Legislation and regulatory requirements within operating markets often require organisations to improve IM practice. Two of the interviewed organisations had already faced legal challenges in which IM has proved critical. As one explained *“Previously we have had issues where we have needed to rely on something, a piece of information in the past and if we can't find it then we're in trouble. It's becoming more important now that we take care of that information”*. The direct impact of this was even more apparent in another organisation where the interviewee explained *“at the board level they are more aware of that now. They are more aware that we need a proper Information Management strategy...they've seen other companies in our sector that have fallen foul on legal things”*. Organisations also seek to attain quality management accreditations such as the ISO 90001 which are increasingly being required for winning new work. In the words of another interviewee *“as a team we are also very closely tied in with the quality management side of things. So the ISO 9001, 14001 which are specific quality management issues surrounding how you manage information. Once you get to a certain size the only way you're going to win work is if you have these accreditations. This is way you have got to do business”*.

Mitigate Risks

Improving IM practices is also seen as essential to reducing business risks. The risks identified here are process related mainly arising from misinformation; developing wrong solutions and potentially poor project/design management. These illustrations may be representative of the fact that all the sample are consulting organisations. On this, one expert explained *“risk is a big fact because it obviously drives a lot of what we're doing at the moment”*. Developing a holistic strategy was therefore seen as a means to address this business risk as another interviewee explained *“unless you have rigorous processes, you can't have that level of confidence, so it was about addressing the risk”*. These themes were highlighted by all the interviewees.

CATEGORY 2: Constraining Factors

Constraining Factors (unlike drivers) are the factors which shape or influence the exact nature of the IM strategy developed and/or implemented within organisations. These are grouped under three principal subcategories as explained below

Organisational Factors

Nature of the organisation

The relative size of the organisation, with its number of employees and distribution of offices, impacts on the perceived need, approaches to, implementation and governance of a holistic IM strategy. For example, implementation and governance is identified as being *“easier across the smaller organisations in comparison to other larger, geographically dispersed companies”*. Similarly, single offices (even large ones) were said to be *“significantly easier to develop solutions for”* than multiple offices even where those offices were within the same country.

In single discipline organisations undergoing similar processes across various teams, the structures and solutions required are consistently similar. In multidisciplinary organisations however, different ways of working are often required to suit the diversity of work/products. Emphasising this, one interviewee explained *“This organisation is broken down into separate businesses. While we do operate as a group, each business has its own quality management system that is not a technical system (i.e. not a technology) but it’s like a procedural thing written down”*. Each discipline within a multidisciplinary organisation with its unique client deliverables; unique specialism on a project and unique tasks therefore have unique information needs.

Corporate Strategy of the Company

The wider corporate strategy of the company also influences the nature, appropriateness and/or evolution of the IM strategy. One interviewee explained, *“If we want to be double the size we are over the next X years, we have to factor that decision to the procedures and technology we have in place. In some ways this starts from the size of the business, the sectors we want to work in and the disciplines we want to operate in. That gives a general feel of the overall business and the direction we are heading in. Key to achieving this is Information Management”*. Thus the corporate strategy can serve to define the most appropriate IM strategy to support it. While this theme was consistent across all the interviewees, the extent of its influences was unclear as for example, it was unclear whether project specific requirements were a bigger influence than the broader corporate strategy.

Project Factors

The project based structure of construction organisations also impacts IM practices as one interviewee put it, *“we’re very much project based and everything the company does is project by project literally and that very much relates to how we manage the information as well”*. Three factors identified here include:

Scope of Project Services

The scope of services offered by an organisation impacts on the feasibility of having a singular approach for managing information. For example, one organisation (a global architectural practice) focuses on conceptual design. The interviewee explained, *“What our clients are looking for is as many great ideas that we can possibly come up with in a short space of time, then present those ideas and develop that with them. So there is a general feeling that 90% of the information we create becomes abandoned quite quickly”*. He further added *“but another organisation might wish to store all of that information in a repository; support that by a database; tag and reference that information; and publish that through some kind of publishing portal. And although we do have the technology to do that, it (i.e. our information) is not structured in that way. So its not as if we are a manufacturer of widgets and we discovered a new way to take a penny off the cost of a widget and therefore we make that knowledge known”*. The fluid nature of work here, the speed at which information is created (and discarded); and the very limited need to re-use project information implies that the strategy adopted here will be different to that adopted by an architectural practice focussed on say detailed design. This theme resonated across all the other interviewees suggesting an association between the tasks carried out within an organisation; its inherent processes and the way the organisation either manages or needs information to be managed.

Diversity of Projects

A similarly influencing factor is the variety of projects an organisation engages in. With building design as an example, projects can range from large multipurpose complexes to single building components such as staircases. As one interviewee explains it, *“we do such a varying and wide range of things that to get some kind of commonality is very difficult and perhaps too difficult”*. This diversity is reflected in the bespoke nature of construction projects, with each project potentially involving unique thoughts, actions, solutions, delivery mechanism, partners, etc. Another interviewee explained *“Being a project based organisation we are very much influenced by the specifics of any given project and the strategy of our client and particularly the design team that might build up around that”*. Within a multidisciplinary company, this distinction can create more marked variations in practices as working in one sector may differ from another and thus impact on a single holistic strategy.

Diversity of operating markets

Metadata standards, operational requirements, regulations and practices may also differ in the various global markets some organisations operate in. This was particularly highlighted by all of the multinational, multi-disciplinary organisations, one of whom explained working practices *“need to vary according to their local market”*. Some such differences are in terminology and thus internal differences while others may be regulatory differences for which entirely different approaches may be required. For example, one respondent explained *“we’ve got highways in the UK which means something different in America. As highways mean something different, transportation also means different things. So that is quite challenging”*. Another interviewee observed *“different parts of the world have different cultures and you have to respect that So again, it is difficult”*. Similar challenges emerge where organisations operate in diverse sectors and also different time zones even within the same market. One interviewee explained *“the problem our organisation has is that because we’re quite a large organisation, we work off so many different sectors and clients all of whom have very differing requirements. The standards which we work to are just too complex, too varied for our enterprise content management system’s CAD management tool (alone) to cater for”*. This invariably influences the nature of the IM solution required in the organisation.

Future Innovations

Emerging innovations in three key areas were identified as potentially impacting on the nature of IM strategy within organisations.

Processes and practices

Changes will invariably emerge in the future in the way tasks are carried out and people collaborate with each other both internally as well as across organisations. Organisations will also be driven to leverage the increasing capabilities technology will offer to streamline processes and make work easier for their staff. As an expert explained *“certainly for us now and looking into the future, one of the key challenges that I see we face is further streamlining our procedural things by just making it more straightforward continually. I think technology has moved on there and we have to kind of use that”*.

Content and Technology

Evolving technologies and new types of content will also impact on current approaches to IM. Particularly highlighted by the interviewees were innovations in Building Information Modelling (BIM), Geographical Information Systems (GIS) and cloud computing with its enhancement of Software-as-a-Service (SAAS). As one interviewee explained, the emergence of software as a service is particularly appealing to organisations *“because there is not a big upfront investment and perhaps somebody else is worrying about how do I keep that SQL database stable and do I have some redundancy in my design for this system? Whereas at the moment individual companies on their own have to solve all of those problems within their own IT departments, requiring their staff to become big and knowledgeable to be able to facilitate that”*. This method of working is already been applied to the use of Extranets and increasingly Enterprise Content Management Solutions.

Organisational structure

A challenge for IM is to remain continually malleable to support ongoing changes to the organisational structure. In the words of one interviewee *“The system is going to have to react to the business whichever way they change. For example we find that parts of the business merge each year. All these kind of things happen and will continue to happen. We acquire new companies on a regular basis to join the group”*. Similarly, as organisations continue to work in or source project teams from different parts of the world, the current approaches and strategies employed may not be adequate to support them. One respondent highlighted that *“certainly within our company, we have global groups and obviously with the sort of night/day situation around the globe, we can actually start to do never ending work if you like. Yes this will have a big impact”*. Another added *“As we consolidate the business in the future, more and more people are going to collaborate and use each other’s information. I think it’s just going to be a natural progression”*. Just as the current approaches to IM were designed to support the current processes and structures of organisations, future evolution of the said management structures will invariably require an evolution of IM practices.

CATEGORY 3: BARRIERS

A number of barriers were identified which impact on a holistic approach to IM in Construction Organisations grouped under the four subcategories below.

Organisational Barriers

Project specific needs take precedence

Any procedure outside of project procedures is perceived as an unnecessary task with one interviewee observing *“they see the organisational way of doing things as needless red tape, where as the project is for client then of course I’ll do that”*. This strictly project-to-project view implies that a holistic project agnostic approach, while adding value to the company in the long term, is seen as an immediate hindrance and therefore is not as easily justified or adopted. Tight project deadlines also create very little room for additional tasks that fall outside the specific needs of a specific project. This, experts explained, limits both the risk tolerance of employees in identifying/complying to new processes and also the rate at which process related innovations are adopted within the organisation. In the words of one interviewee *“You will naturally get barriers because everybody when they get a project is on shorter time frames to deliver it than before. So naturally the resistance is, I know how to do stuff now and you’re telling me to reinvent it. That leaves me feeling exposed and that feels like too much risk”*.

Leadership

Senior leaders in some organisations whilst acknowledging the necessity of improved IM (mainly in response to increasing regulatory requirements) still don’t understand what it actually means and how to develop/implement it. Describing this, one interviewee explained *“They see the importance of it but I don’t think they fully understand it”*. Similarly, the diverse areas that need to be accommodated in understanding the complexity of the construction process; organisational needs/processes; IM and the right technology tool sets to support these require a different skill set which interviewees identified as uncommon in their organisations.

Limited Resources

The size of the implementation team relative to the task at hand can also limit the rate at which appropriate solutions are identified, developed and implemented. For example, in one organisation *“because the team was quite small, if you’ve got a problem it takes 95% of your effort [to solve], that’s what you’re focussed on”*. Similarly, another interviewee explained *“And certainly the hardest thing for us is that we can only deliver so much. The team is only so big and we can only do so much work”*. Resource constraints and the magnitude of work requires organisations to prioritise areas of importance as in the words of another respondent *“there is only so much time in the day you can work on these things so I have to prioritise them so again that is quite challenging”*.

Content and Technological Barriers

Complicated taxonomies

The complexity of projects can result in any taxonomy structure becoming complicated and difficult to use. For example, referring to their taxonomy, an interviewee explained *“there are a few areas where it’s not entirely intuitive because our business is quite complicated. This means our taxonomy covers an awful lot of things from building control to where do I file information about bricks? etc”*. In response to the diversity of their business offerings, elaborate taxonomies are designed to accommodate all the possible known scenarios are developed. These taxonomies while appropriate at the time pose a challenge with the growth in the volume of content; number of employees and the types of content managed. The result as one expert explained is that *“I spend all day kind of in and out of enormously deep folder structure system thinking there must be a better way of doing this”*. It can also affect the willingness to procure fit for purpose technology as it creates the fear that any enterprise system may not be able to cope with the company’s specific requirements. On this, an interviewee explained *“It does have to be quite complicated or quite rich. It’s partly why I feel quite nervous to going to someone like Union Square (a software provider). Its all just put it in the dust bin the tags will get you to it”*.

New forms of content

The continuous emergence of new forms of content such as BIM and GIS create challenges in the way content is currently structured in organisations. A lack of a clear understanding on the structure of these new forms of content and how to develop appropriate taxonomies, technologies and solutions to support them also hinders improved IM practices. A respondent explained *“Increasingly we’re using 3D at an early stage and at the moment our folder structure and naming convention isn’t quite rich enough to capture all of the 3D stuff”*. The current taxonomies are created to manage documents each of which is treated as a single instance of content. The emergence of single integrated models however makes the taxonomy previously developed no longer sufficient. This creates a problem for organisations unable to grasp how to restructure taxonomies to support this new content type as one interviewee explained *“Drawing in 3D, you have got the power to do cuts here or there. So how do you manage the outputs for that? We haven’t really thought through that”*. This also impacts on the use of single enterprise wide solutions to manage all types of data as specialist applications were found to be incapable of being supported by general Document Management solutions.

Inconsistencies in the use of Metadata

Obtaining consistency in the definitions of certain attributes within a metadata/taxonomy structure particularly in large multi-disciplinary organisations can be difficult. This, five of the interviewees explained reflects the diversity of tasks; cultures; clients and markets their respective organisations worked in (all of which are constraining factors). For example, one expert explained *“what’s certainly quite interesting in our organisation is that when we’re talking about sectors, we have the idea that it’s sort of commercial, residential, healthcare, that’s what sectors mean to us. And if you talk to the holding company, sectors mean something completely different. So there could be that difference already existing and if you’re trying to implement a metadata standard that is going to suit a company that is 7,000 strong, then yes you’re going to definitely run into that problem”*.

Poor performing Technology

Even where the solution has been implemented, interviewees explained that technologies implemented often end up *“not doing exactly what they wanted it to do”*. It remained unclear to the researcher if this was due to the organisations not being clear about their original requirements; limitations in the ability of the technology to do what it said it would do; or expectations not being effectively managed through the procurement process, all of which can affect the perception of adequacy. Implicit in this is also an apparent lack of confidence from end users in the ability of the IT systems to support defined strategies. This was reinforced by a respondent who stated *“I think another thing is that we’re talking about an IT system at the end of the day. Its never going to be perfect, you’re always going to have down time; you’re always going to have a server over heating or something”*. While for this organisation none of these problems have actually materialised, it was observed that all interviewees anticipated failure or inadequacy in the performance of IT systems, impacting on their confidence to implement a holistic strategy. Some problems however do materialise and as one interviewee explained, it is to be expected. *“We hit some real technical problems and I think you’re always going to find that with a new IT system when a company is new to it, even though we’ve got a very skilled set of technical IT staff here”*. Similar challenges were highlighted by another respondent who explained *“we certainly had I think every technical issue you could throw in. We’ve just been absolutely besieged by technical issues”*.

Construction Industry wide Barriers

Lack of guidance

There is limited clear useable guidance on the process of developing and implementing an Information Management Strategy in Construction Industry based organisations. While clear standards such as the BS 1192:2007 have emerged that provide guidance on managing information through the project lifecycle, no similar solutions have been proposed for how IM can be aligned to organisational processes or how context specific metadata standards can be developed and implemented to suit an organisations needs. As an interviewee explained *“people have started to get hold of the fact that to make this work we’re going to need things like standards. There are been precious few, either British or European or global standards around”*. The responses indicate that guidance is required because non-content specific standards, particularly metadata standards may not be suited to an organisations needs without requiring some form of modification. This does not include content standards such as IFC’s.

Skills Shortage

There is a shortage of professionals with the requisite skill sets to enable organisations develop and implement the required strategies. Emphasising this, one expert stated that *“it is difficult to find the right people to fill these boxes. People that have the breadth of knowledge and interest in this area are quite hard to come across with the right personal and project management skills as well”*. This hinders the ability of organisations to make the necessary transition, as captured in the words of one interviewee who while acknowledging their challenges exclaimed *“I can’t really see how we can; I can’t see the transition at the moment”*.

Nature of Construction Projects

The nomadic project based nature of the Construction Industry, its resultant ways of working and the project specific standards that inevitably emerge, is often at conflict with the solutions developed to be applied internally within organisations. As one interviewee explained, organisations partnering on a project are faced with this challenge because *“they all have their own different dynamics and whilst we have our own internal standards, so do all of those organisations”*. This is particularly the case in the use of naming conventions and folder structures (or taxonomies) where as one expert put it, they often *“just have to go with the flow”* and by so doing undermine any established company procedures.

Cultural Barriers

Resistance to Change

Where new solutions have been developed and introduced, a recurring theme is the difficulty in getting people to change their ways of working and adopt new methods. The challenge here was summed up by one respondent who explained *“getting information on the system, capturing it at source and allowing people to view it in different forms isn’t that difficult once you put the initial systems in place. What is difficult is getting people to use it. That’s what our primary role at the moment is, it’s people”*. One expert stressed that resistance to change is a difficult challenge because *“you can’t avoid it. You can mitigate it but you can’t avoid it. People feel they know exactly what their doing. And you can’t tell them how to do it differently because they feel they are very intelligent”*. Similarly challenging is getting users to add/use the relevant metadata when introduced. On this an expert explained *“if you filled massive amounts of information for each document, yes you’re going to be able to search for those documents, you’re going to find them easily but you’re only going to end up with 10 documents because people just won’t do it”*.

Fear of being driven by technology

Similarly organisations sometimes fear that adopting an enterprise system may alter company processes to suit the way the system operates. The themes here highlight a certain wariness of enterprise systems among organisations. For example, a respondent elucidated *“There have been systems that we’ve looked at that have seemed exceptionally well. We’ve spoken to people who suggest that they worked well but quite often the companies have adapted to use the systems and we don’t particularly want to do that. We much prefer the systems being adapted to suit the people, hence the preference for a bespoke solution”*. This does not imply a dependence on bespoke technological solutions but instead the need for solutions which align with and conform to the specific needs and business model of the organisation.

Poor sharing culture

The uptake of such an integrated vision is dependent on a willingness to share information, a culture which sometimes can be lacking within organisations. According to one respondent *“I think the problem we had was sharing information. You always get this knowledge is power and I quite like to share with other people around me, but I’m not going to put it out there”*. This was similarly echoed by others, one of whom explained the mindset of those who resist collaborative working to be that *“they think that they’re bits of information is the most important bit and no one else can possibly understand it”*.

DISCUSSION

This research presents the findings from a detailed review of IM within organisations in the UK Construction Industry. The findings demonstrate that for consulting organisations, information includes explicit knowledge. It also shows that KM and IM initiatives are aligned (the extent of this alignment however was not investigated). Indeed, improving the sharing and the exchange of knowledge is a key driver for improving IM within consulting organisations. With respect to the drivers, while all the organisations were driven by the same five themes it was observed that organisations placed greater emphasis on some themes above others resulting in a different type of strategy for each company. For example, one organisation was driven more by the need to mitigate risks and conform to legal/regulatory requirements than it was by the need to transfer learning. Thus a workflow based Document Management System is currently being implemented. Two other organisations, with distinctly architectural leanings however, put more emphasis on improving the product and transfer of learning, thus making knowledge sharing a priority with little or no workflow related defined processes. These approaches are reflective of each company's business strategy. Consciously or unconsciously, all have placed emphasis on areas of strategic significance. No attempt was made to compare the findings across the organisations as the research did not aim to measure the relative maturity of IM and/or KM practices within Construction Industry based organisations. This is also reflective of the fact that strategies developed are likely to be so context specific that maturity is not a measure of appropriateness but a measure of how aligned the strategies are to the core strategic drivers for each organisation.

The Constraining Factors also affect each organisation in a different way resulting in differences in the type of solutions required and the modes of implementation (also making a like for like comparison inappropriate). Context specific factors often need to be accounted for in developing and implementing an IM strategy. These factors could range from the Constraining Factors which shape the exact nature of the strategy vis-à-vis the strategic needs of the organisations, to include solutions developed in response to specific barriers. For example, organisations which deployed Enterprise Content Management (ECM) solutions were not extending its use to CAD files (both 2D and 3D models) due to the perceived inability of standard ECM systems to adequately manage large CAD files. The findings therefore illustrate that defining a single approach to managing information using a single enterprise wide system across multidisciplinary organisations can be both impractical and undesirable. As the Constraining Factors show, certain organisational, technological and environmental factors emerge which will require an approach focussed enough to align/support the overall corporate business strategy yet flexible enough to

accommodate the differing needs of specific discipline groups. This also reflects the fact that despite often differing needs which make standardisation difficult, there are sufficient commonalities between diverse disciplines and processes within organisations which create both a need for and the basis of a holistic approach. Thus rather than a single approach, organisations instead require a 'unified approach' which focus on integration while remaining tailorable to the distinct tasks, projects, sectors, countries and products across the organisation.

The themes identified here are similarly identified in existing literature on IM albeit in diverse publications not particularly aimed at the Construction Industry. In a study of engineering SMEs Hicks et al (2006) identified a number of issues which impact on IM. The study focused on the barriers to IM and did not include constraining factors or drivers. The barriers were also focused more on IS and IT rather than purely IM or its organisational dimension. Similarly, Earl & Feeny (1998) identify the four strategic imperatives (drivers) for Strategic Information Management within organisations (particularly global organisations) as global efficiency; enable local responsiveness; transfer learning and enable external alliances (collaborative working across multiple organisations). While the drivers identified in that study are similar to the findings here, new themes have been identified here which are absent from that study. These findings are also context specific reflecting the peculiarities of the UK Construction Industry.

The themes which emerged from this study are organisational with limited technology related drivers, barriers or constraining factors. This re-emphasises that IM unlike IS or IT is not a technological issue. Indeed the challenge for organisations is having the right capabilities to appraise their strategic information needs; develop appropriate holistic solutions to support these; implement the strategy effectively and maintain it through its lifecycle. Appropriate technology can then be selected to best support the defined strategy as similarly observed by Gyampoh-Vidogah and Moreton (2003) as well as Hjelt and Bjork (2006).

CONCLUSION

This paper presents the findings from an investigation into the nature of IM in the UK Construction Industry reflecting the multidimensional nature of a holistic approach. The findings highlight the significance of an organisational perspective on IM and the increasing emphasis practitioners are placing on how information can be better managed to support their core processes. The findings also highlight that despite progress, organisations within the industry are hindered by the shortage of the right skills to

effectively analyse and understand the various facets of a holistic approach to IM and hence develop appropriate solutions to meet their needs. Clear inter-relationships exist between the various themes identified in this study. For example, the cost of a solution is perceived as a barrier relative to the earning power of the organisation; the functionality of the system being procured; the business process for which the technology is intended and the perceived value of the innovation for the business. This interconnectedness between the various themes provides a more complete understanding of the themes and their influence on IM.

The themes are also defined by or influenced by external factors, in particular, the wider industry in which the organisations are based. The Construction Industry, its people, structure and working practices invariably influences the very nature and outcome of any strategy. For example, product improvement as a driver places emphasis on the need to improve both the quality of services the organisation offers as well as the final product or built form emanating from actual construction activities. Thus, while all the themes provide a better understanding of IM in the Construction Industry, they are all in turn a product of the specific context of the organisations as being in the Construction Industry.

The findings highlight areas in which further research is required. Despite a realisation of the need to improve IM, the findings show that organisations within the UK Construction Industry do not have the requisite capabilities to effectively develop well aligned holistic IM strategies that support their overall operations. Further research is required to develop appropriate toolkits to enable organisations appraise their needs vis-à-vis the drivers, understand their current context; and then translate the outcome into targeted solutions that add value for their respective organisations. Further research is also required to develop appropriate measurement criteria for determining the effectiveness of IM strategies in organisations, not focused on the targeted implementation of technology but on assessing the 'suitability' of the strategy for supporting business processes.

In the future, it is anticipated that information will continue to emerge as critical to innovation and operation in organisations. New types of content and technological innovations will also demand new ways of working. Organisations able to better structure themselves to best leverage this information will emerge with greater competitiveness. Thus a holistic approach, defined by the themes identified in this study will undoubtedly be important in improving collaborative working and the operational effectiveness of Construction Industry based organisations.

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