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ARTICLE

Information management systems on construction projects: case reviews

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Abstract

Purpose – This paper aims to present the findings from research that sought to evaluate the construction industry's approach to information management at the project level and to review the operation of an information management systems (IMS) on selected projects.

Design/methodology/approach – Data from three IMS used on three separate construction projects were extracted over a four-year period as the life of the construction stage of each project came to an end. Three distinct databases of the IMS were analysed and document statistics were extracted to demonstrate the level of activity within the construction project, and between members of the construction team, using a simple counting technique for each document type.

Findings – The paper finds that major construction projects generate, process and store considerable quantities of real-time information prior to, during, and post on-site construction. The construction activities are shrouded in information and management of the construction project requires appropriate systems which facilitate bi-directional data input, information processing, dissemination and functional access. Historically, the onus of storing, disseminating and managing project information has fallen to each of the individual project team members of the many organisations involved within the project. Hardware advances, coupled with improved electronic and paper-based IMS facilitate synergistic standardised filing and information control, which reduces the reliance on each individual or organisation to undertake the task of storing and controlling information. An IMS also has the capability to engage with performance management and reporting systems which aid not only management of the project, but also management of the organisation.

Practical implications – Case reviews show that in today's complex construction environment the use of an appropriate IMS has the potential to bring about team syntegrity and engender increased collaboration and integration among project members. The findings from completed projects exemplify a number of benefits to be accrued from adoption of an IMS and the resultant change in operating culture. Crucially, however, the pitfalls of such IMS systems are also identified.

Originality/value – The findings provide new knowledge about the management of information from construction projects.

Keywords Communication management, Information systems, Construction industry

Paper type Research paper

Construction project information

Construction projects are highly complex collaborative events involving many different bodies and organisations, e.g. clients, designers, consultants, contractors, and inspectors. Inter- and intra-discipline communication between these distinctive professionals is often problematic. The lack of integration and co-ordination between the industry's distinct professions can be perceived as a major contributory factor to poor project performance (Faniran *et al.*, 2001).

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The growing clamour to meet the ever more demanding needs of the client and improve project performance helps drive the construction industry towards fully integrated project teams where project participants have instantaneous access to all project information through the use of information management systems (IMS) (Moore and Dainty, 1999). Over the life of a project, individuals and organisations will accumulate huge amounts of real time information and this coupled with the fluctuating nature of construction contracts, and the increased vulnerability of project personnel, has often meant that project information is not transferred nor stored in the way it was intended to be.

Xerox (2002) have shown in Figure 1 that the information generated within an organisational setting is poorly captured and in many instances the volume of meaningful knowledge exiting the organisation on a daily basis exceeds that available for immediate use within the organisation.

The information generated within the broad umbrella organisation that is the construction project suffers from the same constraints as outlined within the Xerox work. The question arises on construction projects as to where the information is generated and by whom.

Aim of the research

The research sought to evaluate the construction industry's approach to information management at the project level and to review the operation of an IMS on selected projects.

In order to achieve this aim, a number of objectives were established:

(1) Develop a thorough understanding on the uptake of information management systems within the industry.

(2) Identify a number of projects using an IMS and carry out operational reviews and analyses.

(3) Report on the findings from the reviews and analyses.

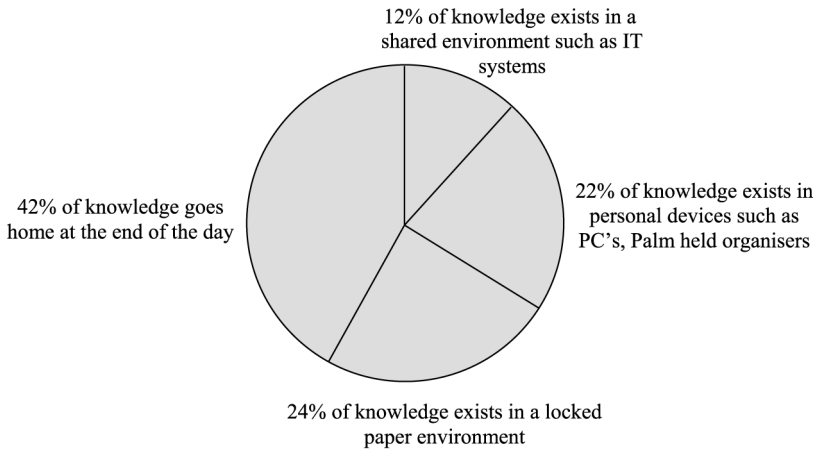


Figure 1.
Repositories of corporate knowledge

Source: Xerox (2002)

Each of the objectives, while being interesting actions in their own right, was designed to integrate into a composite whole which would deliver the desired outcomes. It was necessary to develop a robust methodology that would identify and source appropriate cases and constituent data, and at the same time ensure validity.

Access to three IMS used on three separate construction projects (although all using the same system) was gained as part of a grade One knowledge transfer partnership (KTP) between Glasgow Caledonian University and innovative information technology (IT) company Sysnet. The project began in 2001 and project data from the distinct construction projects was extracted over a four-year period as the life of the construction stage of each project came to an end. Three distinct databases of the IMS were analysed (drawings, contract/design management and correspondence) and document statistics were extracted to demonstrate the level of activity within the construction project using a simple counting technique for each document type. This also identified the level of activity between members of the construction team.

The expectation from the research was that the findings from these reviews and analyses would provide us with a solid view of the construction industry's utilisation, or otherwise, of IMS and, to a lesser extent, the locus of information generation.

Information creation and destination

As the uptake and usage of within the construction industry spreads, increased quality of documents, integrated and structured communication channels, speed of work and ease of access to project information will become more common place (Rivard, 2000). Many major construction industry clients and indeed main contractors are now adopting integrated construction processes using IMS with the underlying premise being all project participants are able to develop core skills in creating, communicating and transferring project data electronically.

Traditionally on large construction projects, the co-ordination of the numerous project members involved has been viewed as a daunting experience as can be seen in Figure 2 (Wasek *et al.*, 2000).

The parties contracted to a construction project rely on personal contact and the traditional methods of telephone and paper to manage information created within the project environment with overall responsibility historically resting with the main contractor. Marsh and Flanagan (2000) argue that paper is undoubtedly the main medium for document exchange and electronic exchange of information at a range of stages in the project life-cycle is rare even though the uptake of IT is increasing. A similar view is held by Bowden (2005) who indicates that site based personnel are both senders and receivers of paper-based documentation. As the construction industry begins to support integrated and collaborative ways of working, the change from the traditional ways of communicating to new ways based on electronic means of co-ordination will take time to become fully embedded within the construction process (Sun and Aouad, 1999).

Crucial to the running of any major construction project is the movement of project information amongst the professionals, all of whom have conflicting priorities and objectives (Faniran *et al.*, 2001). The different professions use their own unique processes to undertake tasks but to undertake these tasks efficiently they become reliant on information supplied by others (Sun and Aouad, 1999). Generally, information provided is rarely available in a format that is suitable for all users. In

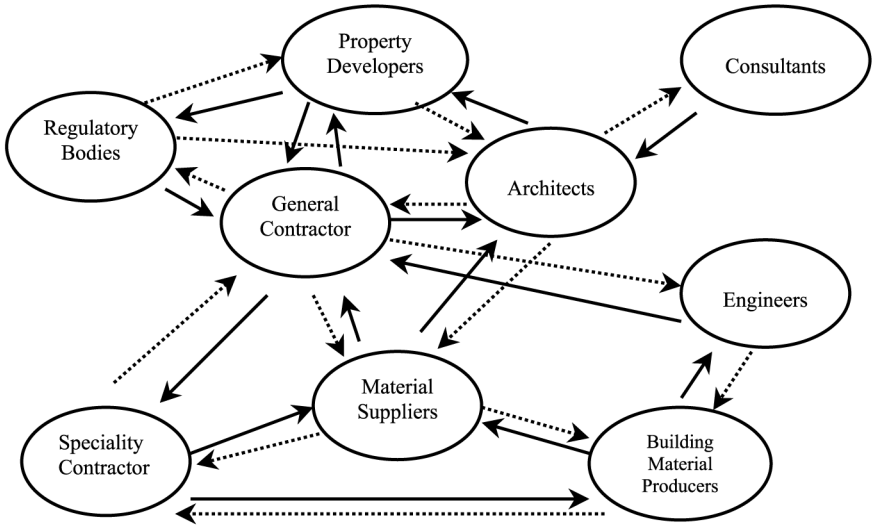


Figure 2.
Traditional bi-directional communication and information flows

Source: Wasek *et al*. (2000)

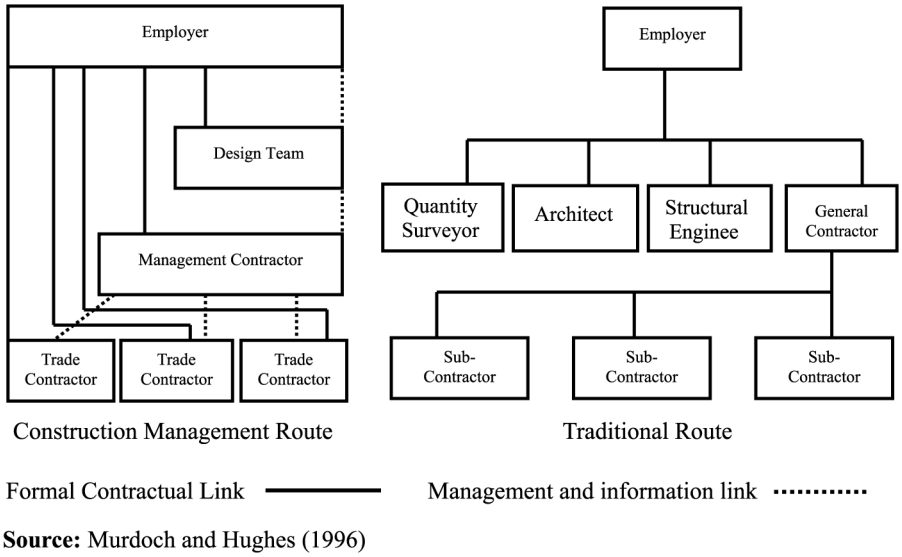
effect the different professions seldom, if ever, recognise the needs of others and in some cases the information is so incompatible that the recipient sees the next process as being how to re-construct the information provided (O'Brien and Al-Soufi, 1993).

The flow of data within the construction industry

The control of construction project information too a large extent depends on who has created the information. The main controller of information within a construction project can range from the architect, to the contractor or even the client: the end result is often being moderated by the type of contract and procurement route adopted for the project as displayed in Figure 3.

With regard to the control of information within the traditional procurement route it is the contractor who takes responsibility for the works section and therefore they become responsible for most communication and information flows: although the client can still influence directly. However, under the construction management procurement route, the transfer and channelling of information is not as well defined as overall responsibility for the control of information within the project may shift during the various phases of the project due, in part, to the nature of the project and the procurement route adopted. This implicit flexibility within the management structure is essential if the contract, and the project, is to be successful. In effect, the rigidity of the contract can often hinder the communication behaviour of the project parties. Communication breakdown may be inevitable and will occur if there are conflicts of interests between the contracting parties (Murdoch and Hughes, 1996).

If the patterns of flow and sharing of information is to become more efficient, and to some extent, automated, then some of the boundaries that currently exist within the industry need to be broken down and removed. Figure 3 also illustrates the role the client plays in being the party with the principal contractual links to the other parties within the contract: the client therefore is in a strong position to influence others in the



Source: Murdoch and Hughes (1996)

Figure 3.
Construction management and traditional procurement routes: views on the contractual linkages

adoption and use of integrated IMS that force integration, aid the transfer of project information and increase communication between all parties within the contract. Sharing information will go some way to solving the problem of incompatible communication and also help in establishing integration where information is freely exchanged in a disciplined manner amongst the project parties.

Current IT strategy within the construction industry

The underlying perception of the UK construction industry is that of an industry which is highly fragmented, non-collaborative and distinctly unique. In order for the industry to improve its performance, and by association its image, the industry needs to change its prevailing culture towards a culture which supports continuous improvement by adopting collaborative working practises between clients and contractors i.e. integrated synergy, syntegrity (Beer, 1994, Sommerville *et al.*, 1999). Latham (1994) and Egan (1998) have argued that this collaborative culture should facilitate information sharing between projects and teams and across organisational boundaries (Egbu, 2000).

The adoption and utilisation of IMS within the construction industry has not been as rapid as other industries, e.g. manufacturing. However, over the last few years significant advances in the collaborative technology sector and increased levels of uptake have been recorded especially on the larger projects where IT budgets can be justified. This shift in attitude is mainly due to pressure from clients for contractors to improve productivity and value for money (Ingirige and Aouad, 2000). The current thrust of IT in construction has been centred on the automation of tasks and processes that were previously carried out manually, e.g. letter writing (Thomas *et al.*, 2001).

The UK's Department of the Environment (DoE) as far back as 1995 developed an IT strategy for application in the construction industry consisting of three main elements (DoE, 1995):

(1) Encouraging improved sharing of information through the use of integrated project databases.
(2) Developing an industry wide knowledge, base that facilitates the sharing of information and promotes team syntegrity.
(3) The use of IT to improve project processes.

Given this drive from the DoE, construction organisations began to recognise the importance of information management with regards to the creation, gathering and storing of information. Many public sector clients have been promoting the use of IMS in order to improve the communication and information transfer process (Thomas *et al.*, 2001). Ultimately the hope is that improvements in project processes will flow from the "push".

The wide scale use of IMS would also allow project stakeholders to make smarter requests for drawing detail's, ask for and receive instructions rapidly, receive and retrieve information when needed, avoid information overload by filtering information and, enhance general administration procedures within construction projects. The potential benefits of collaboration among project members have been well argued by a number of authors (Sun *et al.*, 2000). The benefits to be gained include cost savings, time savings, productivity increases, promoting partnerships and increasing harmony among the project team members. The general drive for improvements in the management of information on projects aids the project and also brings benefits to the wider organisation.

The barriers to successful information management integration

Many information management tasks within the industry are still carried out using the same old traditional method, by using pen and paper. This outdated practice is undertaken despite the fact that many tasks and projects are geographically distributed which means traditional methods of information exchange are slow and arduous, resulting in conflict, errors, delays and losses. The lack of an IMS can often lead to the information becoming lost because it is not stored in the appropriate electronic format which effectively means others who may wish to use the information are deprived of the opportunity of doing so as finding the information inside of a paper mountain can take enormous amounts of time (Sun *et al.*, 2000). The growing demand for integrated collaborative construction will, hopefully, lead to construction industry practitioners and professionals becoming more open with each by disseminating information that is meaningful, effective and moiré importantly can be used to make decisions.

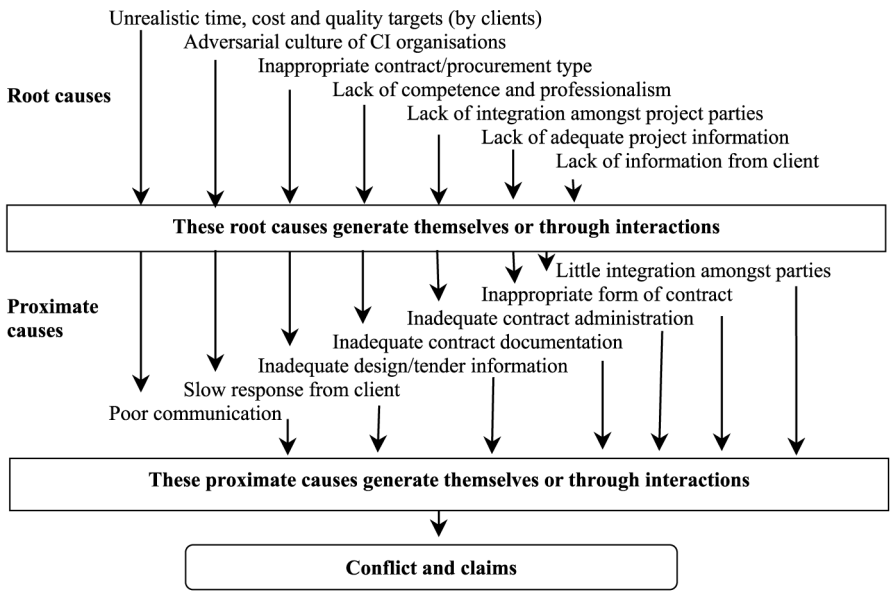
What may arguably be seen as the main objective of integration and collaboration is to achieve coherent management, associated with this is electronic sharing of information during all phases of a construction project (Sun and Aouad, 2000). Construction projects therefore require IMS that facilitate this task and force construction disciplines to collaborate, co-ordinate and co-operate with others and, ultimately bring about more relaxed, open and smoother project processes. The solution is to adopt an integrated IMS that will aid the construction process and manage the creation and distribution of project information. The use of project databases and the internet will also encourage the free transfer of information between all parties within the contract before finally processing the finished product through

the necessary formal channels. Dealing with information in real-time and providing the necessary and correct information through the adoption of an IMS is essential if construction projects are to become better more flexible collaborative organisations.

The impact of non-integration

Because of the peripatetic nature of construction projects, delays on site are almost inevitable and result in conflict/claims situations arising (Alkass *et al.*, 1995). Disputes between construction parties are of great concern to the industry as a whole through both direct and indirect losses. Effective management of conflict/claims can be achieved if based on reliable evidence and/or the correct information.

Project information is extremely important when settling conflict/claims. Structured recorded documentation is crucial for justifying and settling conflict situations (Ren *et al.*, 2001) although analysing the piles of project information to sort out conflict/claims is a meticulous task and we now have the "Forensic Planner" whose task it is to work backwards from a claim and establish underlying facts (Alkass *et al.*, 1995). Historically, the sources of project information are often ad-hoc and varied and although the quantity of information can be vast, it is often poor, inaccurate, inappropriate, late and contains the wrong information. Claims and disputes during a construction project arise because of the technical complexity of construction projects, the overlapped nature of design and construction and the fragmented nature of project teams which, very often means there are comprehensive changes within the design of a project (Moore and Dainty, 1999). An advantage of keeping track of project information is that when a conflict situation arises the information is readily retrieved. Figure 4 identifies the typical sources of conflict/claims within a major construction project.



Source: Adapted from Kumaraswamy (1997)

Figure 4.
Common sources of conflict claims

Many IMS utilised within the construction industry, both paper and IT-based, have not been designed to support conflict/claims situations because they are often inaccessible or incomplete or fail to address the end-use of the information required (Ren *et al.*, 2001). Thus an integrated IT system would support integration and aid the collaborative, integrated team-working culture that both the Latham and Egan reports of the 1990s urged. It is highly likely that the use of an IMS would offer new possibilities for the efficient conduct of conflict/claims situations that arise within the industry as a result of poor project information. Indeed Kangari (1995) suggests that Arbitrators often feel aggrieved by the fact that smaller organisations and those with limited resources often present their documentation in an unorganised manner. Construction organisations that support the notion of information and document management will have a distinct advantage in any dispute resolution proceeding due to their ability to extract the information they need in a fast and efficient manner.

The construction industry and IMS

In essence, an IMS provides a highly structured system focused around a construction project: such a tool will create a central repository for information within a secure environment that facilitates all project partners transferring project information electronically. However, many construction organisations still have not taken the initial steps towards the adoption and implementation of IT (they can exist and compete without using this type of technology) (O'Brien and Al-Soufi, 1993). Perhaps though the most compelling reason why the construction industry is not moving as swiftly as it should towards IT implementation is the lack of robust industry-specific systems that can adopted at the lower end of the supply chain.

Development of IMS and the pan-global nature of the construction industry are driving forward the issue of integration and making it all the more critical (Ahmad *et al.*, 1995). Software and systems development within the construction industry is still highly centric to fine tuning the established systems. What is required is a wider, more holistic, perspective which looks beyond the needs of individual and singular organisations and examines the specific needs of the industry: this will result in competitive advantages for firms as it has in other industries, e.g. manufacturing (O'Brien and Al-Soufi, 1993). IMS will facilitate the existence of multiple real and virtual organisations that work co-operatively and will also facilitate organisations in their drive for improved operational efficiency. IMS enable inter-organisational integration of information and achieve reductions in processing of project critical information (Molad and Back, 1995).

Benefits to be expected from operation of an IMS

Within any construction project the exchange of information is perhaps the principal components/functions in ensuring success. The success of this function is highly dependent on the efficiency and effectiveness of the actual IMS (Ahmad *et al.*, 1995). A key benefit to be derived from an integrated IMS is that it allows all organisations instantaneous access to project information dependent on their role within the project. Before adopting IMS as a tool for collaboration it is important to understand the benefits and pitfalls that can be derived from implementing such systems. The main benefits to be expected from the adoption of an IMS can be attributed to a human (H), project (P) and organisational (O) perspective. These benefits include:

- Reduces need for bureaucracy and hierarchy (H, P, O).
- Use as a facilitator to build teams and overcome barriers (H, P, O).
- Encourages flexible communication and eliminates redundant activities or work that no longer adds any value (H, P, O).
- Saves participant's time and increases their productivity as a result of minimising errors (H, P, O).
- Increases the quality and speed of work allowing faster simpler access to common data (H, P, O).
- Paper based issues such as printing and distributing (O).
- Improvement of project processes (H, P, O).
- Improved project management (H, P, O).
- Standardisation of project tools (O).
- Promotes and supports quality assurance (O).

The pitfalls of implementing an IMS include:

- Poorly written brief – this is a key document and provides the foundations on which other documents can be built. It helps to determine direction and outlines specific objectives. A brief must accurately reflect what is to be done. If the brief does not address the underlying issues the adoption of the IMS will fail.
- Lack of robust specification documentation – the specification has to be 100 per cent correct at the out-set otherwise you may not get what you expect to get. The system specified may not function the way it is intended to function and therefore will not be adopted and utilised within the organisation.
- Initial financial outlay – this can be extremely high depending on the size of the project, number of users and the size of the organisation although many IMS can be used on a "rental basis".
- Future financial outlay – this is often overlooked and would include items such as hardware and software upgrades, system upgrades, process upgrades and further training.
- Culture – people like to work the way they feel comfortable. The adoption of IMS will change the way people work. Operatives need to be fully convinced that the adoption of IMS is for their benefit as well as the organisations.

As construction projects become more complex in scope, cost and duration (e.g. public private partnerships have gestation periods of several years and a life-span of between 20 and 30 years), the establishment of longer term integrated business relationships becomes more meaningful and cost-effective. The options for construction organisations to partner and engage in joint ventures become more appealing. IMS enable construction organisations to respond to client needs and the end result, of client pressure, could be full-scale adoption of IMS throughout the industry. IMS and indeed IT is not the only answer to the construction industry's problems, but will go a considerable way to promoting the much needed integration (Ahmad *et al.*, 1995).

Functionality of an IMS at project level

The sheer amount of information being created, the management of project specific information and the need for near-instantaneous resolution of conflict situations are key drivers in the take-up of IMS on site. All types of IMS, document management systems and also project extranets (web-based systems) should ensure that critical project information is communicated and shared among the appropriate system users in a coherent, systematic and integrated manner. The fundamental requirements of a construction industry IMS are therefore: that the system supports all types of construction contracts and procurement routes together with comprehensive design and contract management procedures which help to strengthen the decision-making process within construction projects when it comes to dealing with design and variation issues which at the forefront of dispute situations. To be effective at the sharp-end of the project and the phase at which most information is exchanged i.e. the construction stage, the design and contract management sections of the IMS must include, but is not limited to the following functionality:

- Change control (variations) process – this process, pre-determined before the beginning of the contract and dependent on the contract and procurement route includes the proposal/variation, the intended direction, the impact analysis factors (costing), the process recommendation and final decision.
- Formal or recognised instruction process, which again is pre-determined and dependent upon the contract and procurement route adopted at the outset of the project.
- Site instruction process structured to suit the site management structure.
- Technical query process with a robust flow pattern.

Discussion on the use of correspondence-based information, drawings-based information and design/contract management procedures within an IMS in a construction context can be better explained by studying data received from three recently completed projects, all three of which adopted an IMS as their tool for managing project information.

Evaluating an IMS: Sysdox

Sysdox is a Lotus Notes IT-based application that has been developed as a collaborative productivity enhancement tool for construction projects. The system has been used very successfully on construction projects worldwide worth in excess of £8 billion and includes projects such as civil engineering (road building, rail networks, and underground rail), local authority (schools), private finance initiative (PFI) hospitals and refurbishments.

The system itself manages the creation, securing, distribution, dissemination and management of all project data including all correspondence, orders, variations, instructions and computer generated architectural drawings. The vast databases of information created by project members can then be coupled together with the systems intelligent mailroom feature which allows documents that arrive from outside sources such as e-mail, fax and letter to be routed to the correct recipient or department with the confidence of knowing that those who require to be informed have been notified automatically. Information distribution is effected by sending electronic links to

documentation ensuring only one copy of a document existed: lockdown features, full audit trails and a full history of document access were available, empowering users and making them fully accountable for their actions. By adopting the electronic link technique it placed fewer demands on the human to code and file the information and also less pressure on the project IT system to cope with data/document storage. The main features and benefits of Sysdox as an IMS can be summarised as follows:

- Central repository (database) of project information.
- Faster processing and retrieval of project information.
- Consistency of information between system users.
- Less emphasis placed on the human to file and distribute information.
- Reduced administration and postage costs.
- Project wide access to controlled project information.
- Improved productivity problem solving and decision making.
- Access 24/7/52 to the system for all project participants.
- Unlimited amount of system users. This feature is accessible over the internet to those who do not wish to sign up to the central system.

A typical network infrastructure for Sysdox can be seen in Figure 5. The system can be tailored to include a design/contract management system, which caters for architect's/engineer's variations and other instructions, variation proposals and a host of technical queries. The project workflows can be designed to suit the differing needs of different projects.

Data analysed from three projects shows that Sysdox is an IMS that provides significant organisational benefits and improves process management. The data retrieved from these project case reviews shows that incorporating an IMS within current industry practices would make significant differences to the operations of the construction units, resulting in a range of benefits which are of value to the construction companies/clients who adopt the use of an IMS. Effective and efficient communication on the three distinct projects could only be achieved by using the Sysdox IMS as a bedrock platform. The data created within these projects have been considerable and varies with the nature of the project being undertaken and the type of

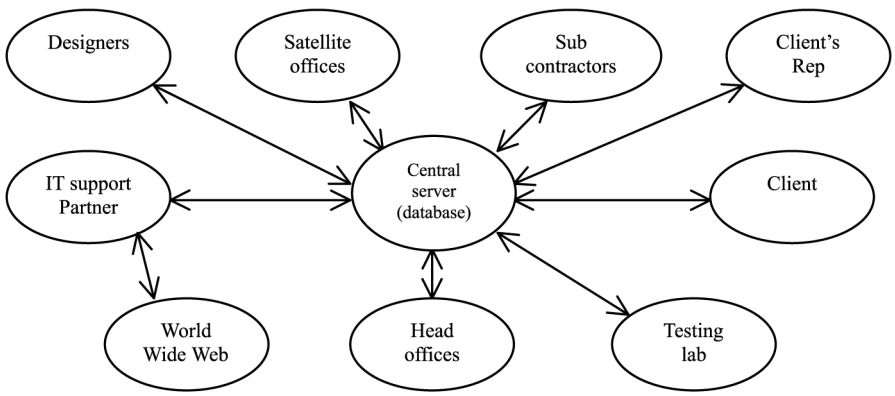


Figure 5.
Sysdox network infrastructure

contract/procurement route utilised. Actual quantities and types of information generated within the three projects highlights the workflow procedures adopted and to some extent the integration amongst project partners.

The details of three significant construction projects

The projects examined in these case studies comprise a PFI-funded motorway extension in Scotland; a major office building refurbishment for a leading financial sector institution; and, a PFI hospital. Table I shows some general data on each of the projects and the quantities of documentation associated with each. The data shown in Table I indicate the typology of information created within the projects (for reasons of clarity and simplicity, not all information types are shown).

While Table I shows the general nature of the project and levels of documents generated, a more focused discussion on each of the projects helps in shedding light on the impact of the IMS on each project.

The road project

The actual works on site were split into two sections, the project involves the construction of a new road surface (value: £96 million) and the maintenance of this road for the first five years after completion (value: £14 million). The contract was awarded to a collaborative partnership consisting of four main contractors. The ethos of working together towards a common goal in a spirit of openness and harmony was evident from commencement. To facilitate this harmony, Sysdox was implemented allowing all project members' access to the IMS. The scale of the project is evident from the number of people involved i.e. over 1,000 staff geographically dispersed over 28 km on various site locations and 230 dedicated system users.

The project partners identified many benefits of using the IMS including accessibility to project information 24/7/52, collaborative nature of the contract, automated work flows shortened management processes, quality of project information, accountability and traceability features, security of the system and consistency of information. Some of the key statistics the project partners identified include: over 3,000 contacts were listed in the project database, which meant that there were over 3,000 potential users of the system. The number of contacts generated and shared amongst system users also compliments the openness of the partnering culture adopted between the four main contractors. Cost savings achieved from adopting the IMS were also estimated to be in the region of £600,000 (reduced photocopying of drawings, management time savings per system user, rapid distribution of information and fewer delays) although the estimated savings have been calculated without the use of a standard financial model which is something sadly lacking.

The PFI hospital

This particular project was delivered under the design and build contract regime (where the design can change as the project proceeds). The effective working relationship of the project team has been facilitated by a structured change and variation protocol process within the contract management database and final decisions were not made until all the relevant information had been received from project partners and only after all the different possibilities and solutions had been examined. The change/variation documentation created within the project resulted in a

Table I. Range of projects being reviewed

Project	Correspondence		Contract management		Drawings		Total items	Project value (£ million)	Duration (months)
	Documents generated	Percentage of total	Documents generated	Percentage of total	Documents generated	Percentage of total			
M74, 28 km motorway rebuild	36,186	66.6	16,082	29.6	2,094	3.9	54,362	110	36
PFI new hospital	25,750	28	15,200	16.5	51,000	55.5	91,950	100	30
Major office refurbishment	19,623	31.7	25,687	41.6	16,500	26.7	61,810	20	24
Totals							208,122	230	

further 7,200 workflow documents being distributed increasing the collaboration and integration among the project team.

The major contractors and project partners have come to rely on the IMS as their main source for project information. The design and build procurement route chosen explains why there is so much documentation that relates to drawings and contract management (see Table I). The most significant benefit to the project team was that all of the documentation processes were structured. The IMS also allowed the main contractor to track documentation response times and in effect performance manage the supply chain.

The insurance company's office refurbishment

Built using the construction management procurement route, communication among the partners could only be achieved by use of the IMS which was driven by the client. Information was uploaded and distributed via the IMS and features within the system such as audit trail, lockdown, document access history and accountability allowed for the control of documentation in an efficient effective manner.

The IMS included a correspondence tracker, contract/design management module, configuration module (project set-up) and a drawings module. Table II indicates the amount and types of project information created on this particular refurbishment project using the three main system modules. The shear amount of information created within the project highlights the workflows adopted within the IMS and to some extent the amount of integration amongst project partners. A particular statistic that stands out from this project is that there were over 7,200 requests for architect's instructions.

Table III highlights the breakdown of correspondence documents that can be attributed to each of the parties to the contract. A total of 14 main design team members (DTM) were responsible for the creation of over 82 per cent of general correspondence and received nearly 80 per cent of total correspondence. The most information intensive user was the main contractor who created and received over 45 per cent of total correspondence documentation. (The figures do not include contract/design management and drawings.)

Database types used				
Correspondence tracker		Contract management		
Document types	Totals	Document types	Totals	Drawings
Archive documents	1,469	Request architect's instruction	7,218	
Fax documents	2,678	Architect's instruction	7,273	
File	4	Construction manager's instruction	7,297	
Incoming documents	5,030	Change control proposal	468	
Letters	1,932	CCP direction	482	
Memorandums (e-mails)	7,829	CCP impact analysis factor	1,294	
Minutes of meetings	665	CCP recommendation	471	
Telephone notes	16	CCP decision	417	
		Technical query	767	16,500
Total	19,623	Total	25,687	16,500

Note: Project total = 61,810

Table II.
Information statistics from the refurbishment project

Correspondence tracker breakdown					
Originator	Totals	% of total	Recipient	Totals	% of Total
DTM1	14	0.07	DTM1	27	0.14
DTM2 (architect)	2,848	14.51	DTM2 (architect)	1,947	9.92
DTM3	182	0.93	DTM3	79	0.40
DTM4	15	0.08	DTM4	13	0.07
DTM5	106	0.54	DTM5	72	0.37
DTM6	935	4.76	DTM6	898	4.58
DTM7 (main contractor)	8,925	45.48	DTM7 (main contractor)	8,994	45.83
DTM8	88	0.45	DTM8	80	0.41
DTM9	1119	5.70	DTM9	754	3.84
DTM10	351	1.79	DTM10	183	0.93
DTM11	310	1.58	DTM11	90	0.46
DTM12	573	2.92	DTM12	710	3.62
DTM13	146	0.74	DTM13	184	0.94
DTM14	647	3.30	DTM14	450	2.29
Sub-contractors (circa 260)	3,364	17.14	Sub-contractors (circa 260)	4,477	22.82
			Minutes documents	665	3.39
Total	19,623		Total	19,623	

Table III. Correspondence data from the refurbishment project

The IMS utilised on this particular project was an integral part of the overall supply chain and could be seen as the main driving force behind the successful collaborative culture that was created. This collaborative culture being essential to the overall success of the project and also indicates that construction organisations, that in the past were reluctant to collaborate with other distinct identities, are indeed moving towards a spirit of sharing of information and becoming more integrated and open with each other.

Conclusions

This paper has examined the drive for IMS within the construction industry and found that if the construction industry is to continue improving its operating processes then it must adopt a collaborative culture where all project participants have access to all project information. The sharing of project information is essential to any construction project and the Sysdox IMS identified is an IMS that supports collaborative open networks within the construction industry.

Historically, the nature and scope of the industry often meant that many processes were replicated, resulting in waste and inefficiencies amongst project partners. The management of information therefore needs to be structured in a systematic manner and in a way which will ensure that all project participants have instant access to all project data. The case review data have shown that standardised IMS are the way forward and the evaluation of the Sysdox system as a collaborative management system demonstrates the enhanced effect on project delivery.

Benefits to the users of the IMS have been identified and discussed. It is important to emphasise that all of the organisations did not experience all of the benefits: rather, they enjoyed benefits that were particular to their needs and expectations. More importantly many of the drawbacks of adopting the IMS have also been identified

which is of equal or greater importance to the adopting organisation. Total financial savings were identified (although estimated), in one case being in the order of £600,000, which was more than enough to cover the cost of setting up the IMS. The main benefits, however, which cannot be accurately quantified, were to the contractor who had instant access to all project information because all incoming correspondence and correspondence created by users was easily managed and automatically filed, taking away the need for every user to manage project information.

The requirements to comply with BS and ISO standards relating to document management, information management and electronic document security mean that organisations will have a stronger base from which to ply their case should they be forced to resort to litigation: however, the mere fact that an IMS has been adopted should ensure that the risk of litigation is mitigated. IMS that enhance the collaborative culture of the industry will ultimately lead to a more competitive and effective construction industry. There is a growing awareness of the value that IMS can bring to the numerous parties that are involved within a construction project. For the industry to benefit, however, major cultural changes and an improvement in communication methods must be experienced so the people within a project share and transfer information more widely in accordance with their job role.

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