The State of Construction e-Business in the UK

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TG83: e-Business in Construction

The State of Construction e-Business in the UK

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TG83: e-Business in Construction

International Council for Building (CIB) Task Group TG83: e-business in Construction

www.construction-ebusiness.org

The TG83 is an international collaboration forum established to generate a programme of actions directed at identifying best practice and promoting e-business in construction. It was established in March 2011 with the objectives of conducting joint research with interested parties, to appraise and promote the use of web-based technologies for collaboration and e-business in construction, and to provide a forum for discussion, debate and the evaluation of technologies, research and concepts in the area. This survey and the report have been produced as a key output of TG83 in association with Construct IT for Business.

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Construct IT for Business

www.salford.ac.uk/construct-it

Construct IT for Business is an industry-led not-for-profit collaborative membership-based network, comprising leading edge organisations representative of the construction industry supply chain in addition to professional institutes and R&D/academic institutions. Its aim is to improve industry performance through the innovative application of IT and act as a catalyst for academic and industrial collaboration. The mission of Construct IT is “to be an effective enabling and co-ordinating force (agent) in the application of IT within the construction process as a contribution to innovation and the development of best practice”.

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TG83: e-Business in Construction

The TG83 is an international collaboration forum established under the auspices of International Council for Building (CIB) to generate a programme of actions directed at identifying best practice and promoting e-business in construction. The primary objectives of TG83 are:

- to conduct joint research with interested parties
- appraise and promote the use of state of the art web-based technologies for collaboration and e-business in construction
- provide a forum for discussion, debate and evaluation of technologies, research and concepts in the area.

1.0 Background

The UK Construction industry has gradually ebbed out of the great recession which started in 2008. Output from the construction sector in the UK in 2015 currently sits at around the 2005 level in real terms (Rhodes, 2015). However, its direct contribution to the GDP (over 6.5%) makes it a key sector in the national economy (DBIS, 2013). This is due to its size: the contracting sector is responsible for 2 million jobs, the services sector for 580,000 jobs and the products sector for another 310,000 jobs (DBIS, 2013). ONS (2015) states that compared with April 2014, output in April 2015 in the construction industry increased by 1.5%, resulting in positive growth for the 23rd consecutive month year-on-year. Despite this growth within the construction industry, little work has been carried out to determine the current level of Information and Communication Technology (ICT) / e-Business penetration within the sector.

ICT often infuses innovation into the way that the Construction industry functions. This report defines construction e-Business as ICT lead innovations and adoption of ICT within business processes utilised in the construction industry (Ashworth & Perera, 2015). Researchers have shown it provides a more efficient means of project delivery (Cordella and Tempini, 2015; Ashworth & Perera, 2015). In addition to producing a leaner work flow in construction, technology has also provided increased and faster communication through the implementation of Building Information Modelling (BIM), cloud based applications, internet solutions and other ICT systems (Alwan et al, 2015). This has led to a greater awareness of the importance of ICT in the construction industry. Despite this, consideration of ICT in construction organisations has been described as piecemeal and lacking depth (Ashworth & Perera, 2015).

For the purposes of this research e-Business has been
defined as process innovation and adoption of ICT in construction related activities.

Government reports have often promoted the use of ICT from time to time, with government led initiatives stipulating various targets and deadlines for adoption. An example of this is the deadline for the implementation of BIM on UK government contracts being April 1st 2016 (McKane, 2015). ICT can be used for the benefit of all aspects of the construction administration process, such as all elements of the design process, specifications, estimating, cost planning / cost control, tender documentation and process, project programming, valuations and the final account, project monitoring, and communication. Bédard, (2006) acknowledges that "Undoubtedly, professionals in the AEC Industry (Architecture, Engineering and Construction) are now routinely using computing and ICT Tools in many Tasks" without examining the extent or scope of this ICT use. He considered its use from a design and maintenance perspective in the AEC industry.

Therefore this report seeks to fill this knowledge gap in the United Kingdom with an investigation into e-business implementation and future trends.

2.0 Purpose of the study

The purpose of the survey is to assess the state of adoption of ICT within the UK Construction industry. It will attempt to identify new developments and trends in relation to e-business in construction.

3.0 The Questionnaire Survey

The questionnaire was structured into six main sections to investigate electronic business (e-Business) in the UK construction industry. The main sections of the survey were: Background Information, e-Business in Respondent Organisations, IT Investment Advice and e-Skills Development, Drivers, Impact and Barriers of e-Business, Improvement of e-Business and Future of e-Business. The survey was disseminated to UK construction organisations through LimesurveyTM software. This contains a web-based user interface linked to a MySQL database for collection and analysis of data. Analysis of responses to the questionnaire provides a transparent view of e-business activity and proposed level of future ICT implementation within the UK construction industry.

3.1 Overall Method

This study was carried out using a structured electronic questionnaire. Scaled questions were presented using a scale of High, Medium, Low and none. Then an elemental ranking for this scale was carried out on the basis of coding the results and using the relative importance index (RII) formula to determine the ranking. A "High" was coded 3, a "Medium" 2, "Low" 1 and "none" 0.

The standard RII formula was then used to establish the respondent's ranking on each of the questions which related to a ranking.

RII is defined by the following formulae:-

$$\text{Relative Importance Index (RII)} = \frac{\Sigma W}{A \times N} \quad (0 \leq \text{index} \leq 1)$$

Where:

W is the weighting given to each element by the respondents. This will be between 0 and 3, where 0 is the least significant impact and 3 is the most significant impact;

A is the highest weight (3 in our case); and

N is the total number of respondents.

3.2 Survey Method and Composition

Contact was made with 513 construction organisations who agreed to do the survey. However, only 69 responses were received. Of the 69 only 41 of the surveys were fully complete, another 14 were partially complete and 14 chose to opt out prior to completing any of the survey. Therefore the survey was analysed based on 55 responses.

3.2.1 Respondent Profile

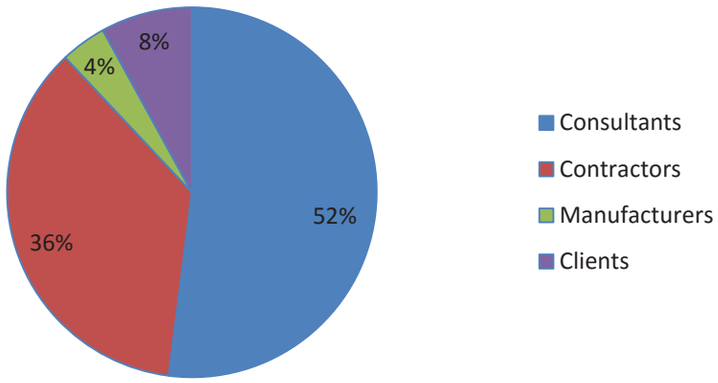

Figure 1 Survey Response Composition based on Organisation Type

Figure 1 provides the sample composition based on organisation type indicating a good spread of organisation types: 52% Consultants, 36% Contractors, 4% Manufacturers and 8% Clients.

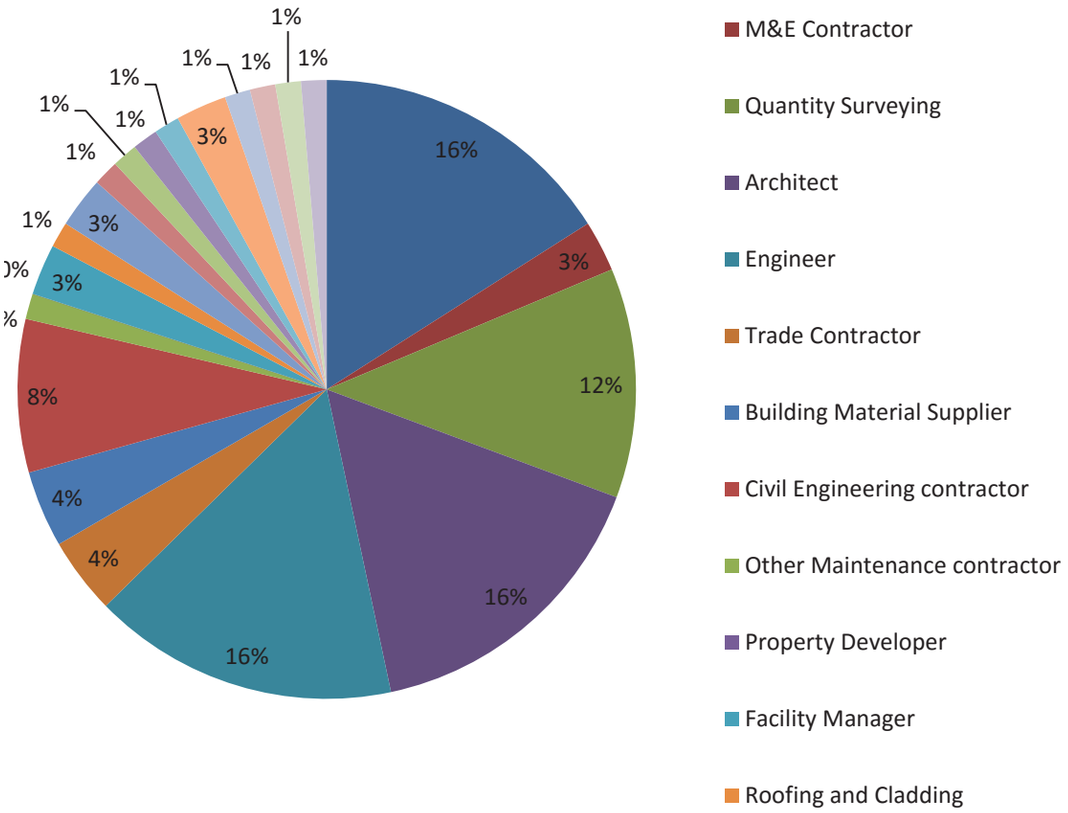

Figure 2 Classification of respondents based on work specialisation

Figure 2 provides the classification of respondents based on work specialisation and indicates the wide variety of specialisms which contributed to the survey.

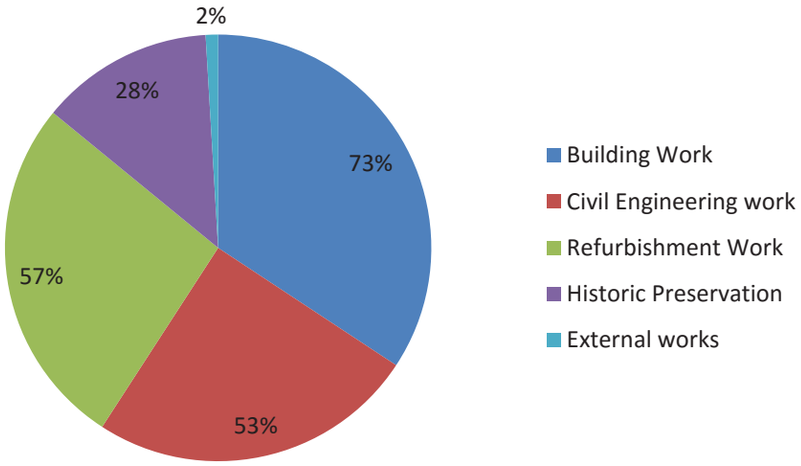

Figure 3 Classification of respondents based on area of work

Figure 3 indicates the breakdown of respondents based on the area of work: Seventy three percent (73%) of these were involved in building work, 53% in civil engineering work, 57% in refurbishment, 28% in historic preservation and 2% in external works.

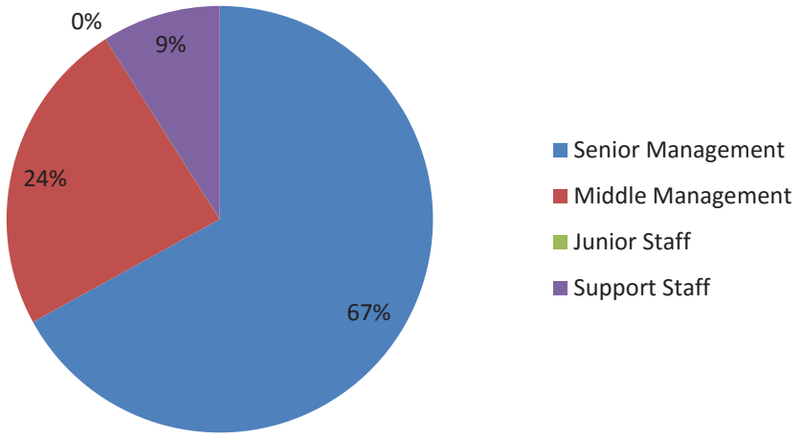

Figure 4 Classification of respondents based on job title

Figure 4 indicates that the majority of responses came from Senior Management 67%, with 24% from middle management and only 9% support staff. This indicates that the sample is ideal for the construction industry in the UK.

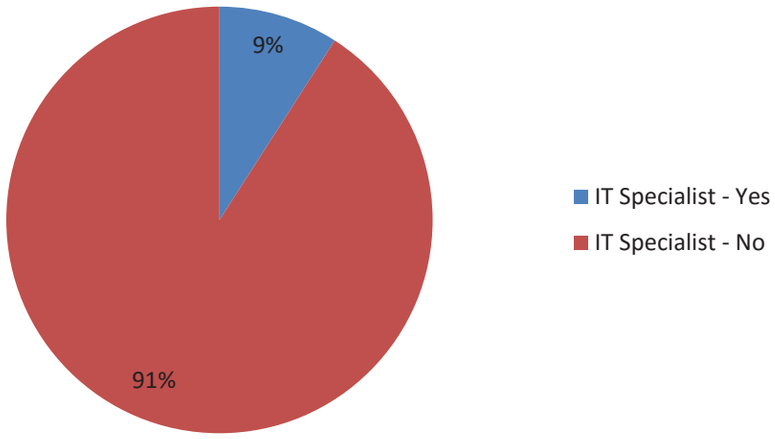

Figure 5 IT Specialist or not

Figure 5 indicates that only 9% of the sample work solely as an IT specialist within the organisation. This indicates that in the Construction Industry most combine their initial specialism with their ICT skills.

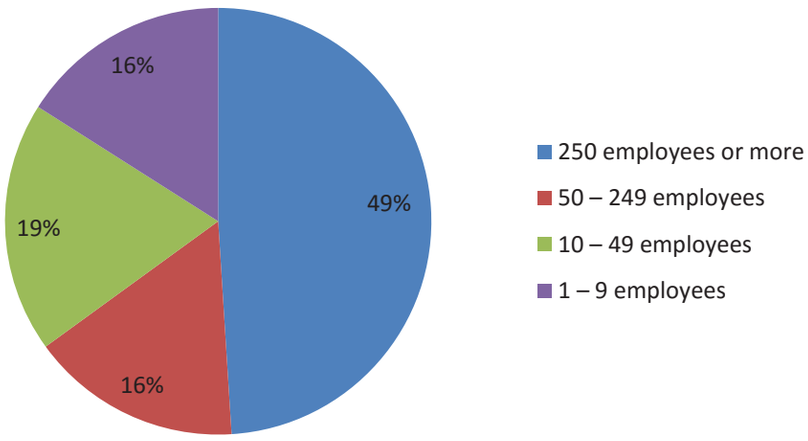

Figure 6 Classification of organisations based on number of employees

Figure 6 indicates that larger companies dominated the response with 49% of the sample having 250 employees or more. The remainder of the sample was evenly matched 1 – 9 employees 16%, 10 – 49 employees 19%, and 50 – 249 employees 16%.

The sample targeted companies which are larger and therefore more likely to use ICT thus providing a more accurate view of ICT usage within the construction industry.

4.0 Questionnaire Survey Results

The survey results are reported in a similar structure to the layout of the questionnaire. Therefore the details are in the following divisions: e-Business in your organisation; IT investment and e-Skills development; Drivers, impact and barriers of e-Business; improvement of e-Business and future of e-business in your organisation. There are a wide variety of different applications of ICT in construction. This section of the report discusses applications from an e-business standpoint. E-business can be defined as business conducted electronically or using electronic means. Zhua et al (2015) show that the processes incorporated in e-business can be divided into technical, relational and business components. These can all be part of a computerised Enterprise Resource Planning (ERP) system. ERP systems streamline organisational activities, through the automation and replacement of paper based existing systems, by combining the activity into a single information system connected to a database. This database allows access to all necessary information and aids communication and access to data across the organisation. Duan et al (2012) draw distinctions between hosted and on-premise ERP solutions. Licensed software is installed on servers in-house accessible only to employees internally within the organisation. This is known as an intranet. An intranet is maintained by the organisation itself and care must be taken to ensure that backup and recovery methods are in place. An extranet provides an ERP through a hosted service provided by an external organisation with storage space elsewhere that is normally specific to an organisation, project or group of collaborating organisations. An extension to this has been the advent of cloud computing. Tang (2015) states that ERP systems have advantages if they are integrated with cloud-based technologies. However, extensive study of these different methods has not previously been carried out in a construction context. This section of the report examines the elements of business sometimes connected via an ERP and most affected by the transition to electronic processes.

4.1 e-Business in your organisation

This section considers the elements of e-business within a particular organisation. It firstly considers the activities related to e-business in relation to document management and then core activities. It further examines the communication networks used and level of e-business usage.

4.1.1 e-Business activities

This section examines the different elements within a construction organisation that can be dealt with electronically. Figure 7 indicates the degree to which documentation is exchanged electronically within the UK construction sector.

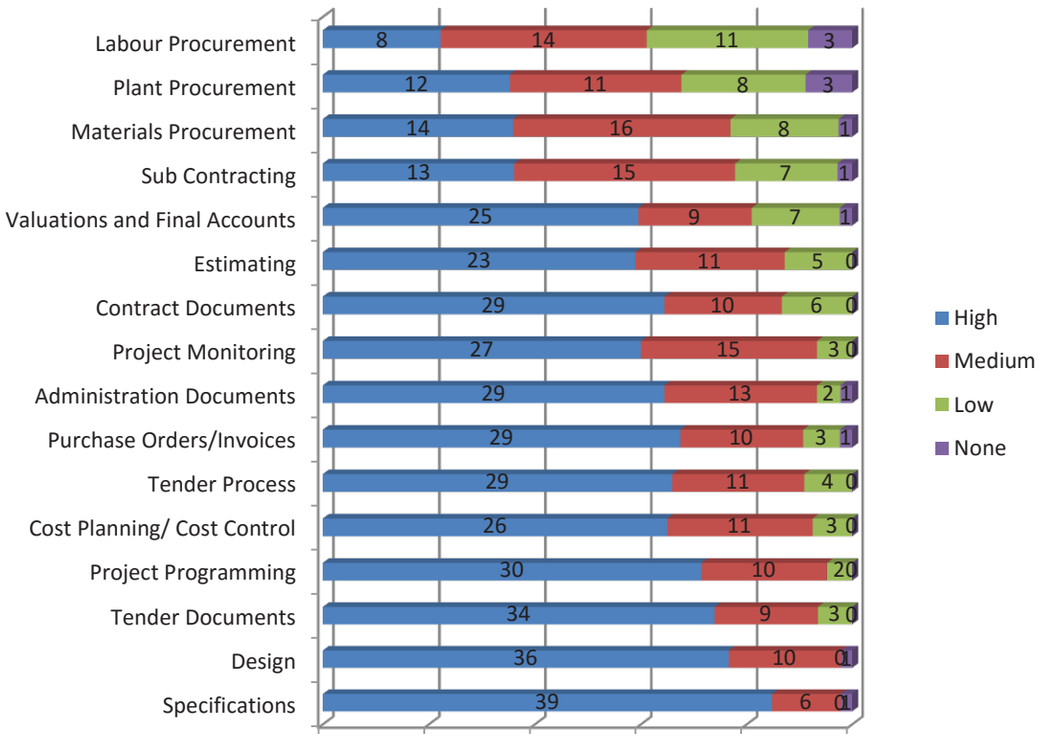

Figure 7 degree to which construction documents are exchanged electronically

This indicates that elements of procurement such as Labour, Plant and Materials are underutilising electronic methods of document dissemination. Table 1 ranks the different elements using the Relative Importance Index (RII). This shows that, in the investigation of the various elements exchanged electronically, specifications are the most likely documents to be exchanged electronically, followed by design documentation such as calculations.
It is interesting that the top six types of documentation most commonly transferred electronically are all included in the design and tender process and are therefore linked to mandatory government deadlines related to implementation. These are 1) Specifications which are included in the tender documentation, 2) Design which will include the Building Information Model and related calculations, 3) The Tender Documents themselves, 4) Project Programming which is included as a prerequisite in all NEC forms of contract documents which are specified by government departments, 5) Cost Planning/ Cost Control which is necessary to complete a construction tender and finally, 6) The Tender Process itself. E-tendering is being made mandatory across Europe from 2016. Costa and Grilo (2013) examined the link between Building Information Modelling (BIM) and the procurement process. They suggested incorporating Model-Driven Architecture (MDA), Service-Oriented Architecture (SOA) and Cloud Computing in advancing the interoperability aspects of e-procurement and BIM. The development and implementation of e-procurement first commenced in the late 1990's through development of Electronic data Interchange technologies via the internet (Neef, 2001). Zarli et al (2009) indicated that "E-Procurement has gained huge popularity" but did not gather empirical evidence on this.

They considered it vital for supply chain management. Griloa and Jardim-Goncalves (2011) concluded that while other industries were implementing e-procurement, the construction industry was lagging behind. Eadie et al (2010) indicated that "Process, Transaction and Administration Cost Savings" was the greatest benefit of e-procurement from a construction professional's perspective. This work indicates that Government department deadlines in relation to BIM and e-tendering have worked to some extent, pushing electronic documentation in these areas to the top of the rankings in Table 1.

Table 1 ranked degree to which construction documents are exchanged electronically

Use	High	Medium	Low	None	Ranked Sum	No. of Responses	RII Value	Rank
Specifications	39	6	0	1	129	46	0.935	1
Design	36	10	0	1	128	47	0.908	2
Tender Documents	34	9	3	0	123	46	0.891	3
Project Programming	30	10	2	0	112	42	0.889	4
Cost Planning/ Cost Control	26	11	3	0	103	40	0.858	5
Tender Process	29	11	4	0	113	44	0.856	6
Purchase Orders/ Invoices	29	10	3	1	110	43	0.853	7
Administration Documents	29	13	2	1	115	45	0.852	8
Project Monitoring	27	15	3	0	114	45	0.844	9
Contract Documents	29	10	6	0	113	45	0.837	10
Estimating	23	11	5	0	96	39	0.821	11
Valuations and Final Accounts	25	9	7	1	100	42	0.794	12
Sub Contracting	13	15	7	1	76	36	0.704	13
Materials Procurement	14	16	8	1	82	39	0.701	14
Plant Procurement	12	11	8	3	66	33	0.647	15
Labour Procurement	8	14	11	3	63	36	0.583	16

Core activities within the organisations were considered next and each element ranked in order of its use in the Construction Industry. Figure 8 provides the results in a bar chart.

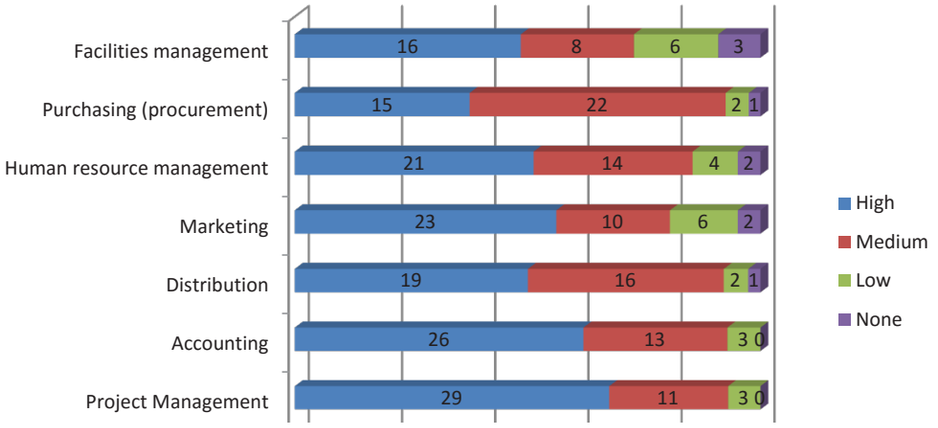

Figure 8 degree to which core business documents are electronic

Figure 8 and Table 2 indicate that financial systems such as electronic banking, programming with project management and accounting are the most used and therefore highest ranked electronic enabled core activities within UK construction organisations. The financial health of an organisation is necessity for survival and it is good to see that it ranks at the top of the list in relation to ICT incorporation within UK Construction organisations. ICT has allowed computerised systems to be developed to deal electronically with organisational income and expenditure. Vital to the construction industry many of these ICT applications have modules allowing project specific elements such as rental of plant, salaries, and material costs to be determined against individual projects. Depending on the complexity of the ICT system, some systems allow tax documentation, payment to be completed and automatic invoicing generated. Just Payroll Systems (2015) is an example of a system with these capabilities with a construction specialism. Most banking systems now allow transactions relating to loans and money exchange to be transferred electronically so it is no surprise that it came top of the rankings.

Table 2 ranked degree to which core business documents are electronic

Use	High	Medium	Low	None	Ranked Sum	No. of Responses	RII Value	Rank
Finance	28	13	1	0	111	42	2.643	1
Project Management	29	11	3	0	112	43	2.605	2
Accounting	26	13	3	0	107	42	2.548	3
Distribution	19	16	2	1	91	38	2.395	4
Marketing	23	10	6	2	95	41	2.317	5
Human resource management	21	14	4	2	95	41	2.317	5
Purchasing (procurement)	15	22	2	1	91	40	2.275	7
Facilities management	16	8	6	3	70	33	2.121	8

What is surprising is the low ranking given to Human Resource (HR) Management. Troshani et al (2011) show that Human Resources are key to the smooth and efficient running of any organisation. In order to get the maximum gain from ICT HRM has been incorporated into Enterprise Resource Planning (ERP) systems. Burger (2015) shows that HRM is one element of an ERP system that can be fully automated by ICT. There are many examples of HRM software available such as Sage HRMS (formerly Sage Abra HRMS) which is HRM system software that includes modules which automate integrated HR, payroll, benefits, and attendance functionality and provide reporting and analysis (Practical Software Solutions, 2010). Laursen and Foss (2003) in a study into HRM of 1900 organisations in Denmark showed that ICT had a major beneficial effect on the HRM function especially in the region of organisational financial performance. Unfortunately its low ranking shows that these benefits are not being fully realised by many construction organisations.

Another disappointing element along with the HRM ranking is the joint ranking with marketing. The invention of the internet has seen the invention of a whole new brand of marketing known as digital marketing. Where previously people were using glossy brochures as a sole means of marketing their organisations, they have now moved on to a web presence in digital form. Berg (2015) indicates that social media can be used to allow construction organisations to connect to their key stakeholders and address a large audience using limited financial resources. Using Web 2.0 technologies such as Facebook or Twitter allows dissemination of information and interaction at little or no cost to the organisation. Therefore getting involved in this type of e-Business would be a "win-win" solution for many construction organisations.

Distribution of documentation electronically has been identified by Alaghbandrad et al (2012) as being more efficient and cheaper than paper based processes. This is especially relevant to the tendering process where large tender documents, often many hundreds of pages, need to be transmitted to tenderers. Liao (2002) illustrates this with a Taiwanese case study showing that the "Electronic Tender Obtaining and Submitting System" results in savings of US$40 million each year through making the process more efficient. The Hong Kong government, similarly, have achieved savings through the "Electronic Tendering System (ETS)" system as documents are downloaded and submitted via the Internet (Chu et al., 2004). In UK procurement the devolved administrations are responsible for documentation. Therefore England, Scotland, Wales and Northern Ireland have implemented systems for distributing procurement tender documentation leading to process transaction savings. More take-up of electronic distribution systems is necessary to fully realise the potential of the savings on offer.

4.1.2 Communications Network

The responses to the questionnaire in this section provide answers to two main issues: the type of network the firms/organisations use and the degree to which they communicate electronically internally and externally.

4.1.2.1 Network communication type

The results of this section shown in Figure 9 and Table 3 indicate that the various types of network are equally balanced in the UK. While Intranet use is the largest way of transferring documents on a network, particularly of interest is that Sky Drives / Cloud Networks are just above the use of an Intranet and an extranet together.

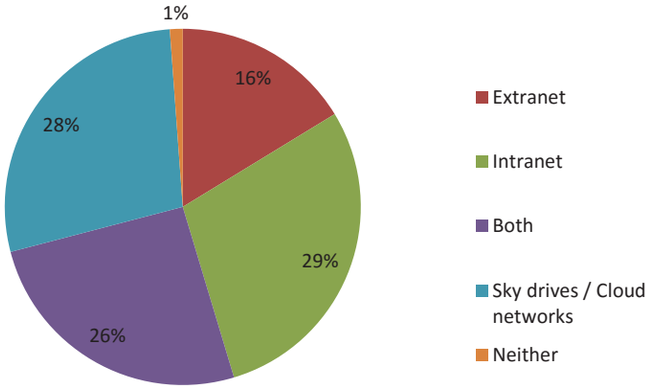

Figure 9 Communication networks in respondent organisations

The cloud computing result is interesting as AutoCAD 360 and other software for construction related activities have moved many of the design drawings and 3D models to the cloud. Matthews et al (2015) indicate that this move has meant that many paper-based processes have been re-engineered to encompass the use of cloud-based BIM during construction. As the deadline for BIM for all government projects in the UK approaches in 2016, it is anticipated that this percentage will grow.

Table 3 Communication Networks in Respondent Organisations

Communications Network	No. of Responses	Percentage of responses
Intranet	25	29.1%
Extranet	14	16.3%
Both	22	25.6%
Neither	1	1.1%
Sky drives / Cloud networks	24	27.9%

4.1.2.2. Internal and External Communication Levels

This section compared the degree respondents communicated electronically internally and externally. Figure 10 indicates that internal communication within an organisation outstripped the external communication. It can be seen that Medium to High levels of both internal and external communications exist in the UK construction industry.

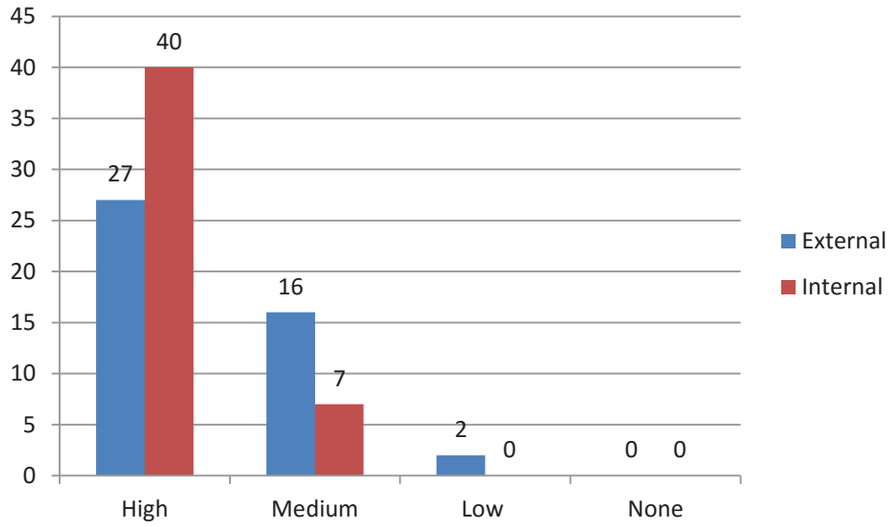

Figure 10 degree of electronic communication internally and externally

4.1.3 Level of e-business usage

Organisations were asked to respond on the degree certain activities were carried out on the internet. The responses are listed in Table 4. Ranking using the RII resulted in project collaboration and management being the activity the internet is most used for. This supports the findings of Eadie et al (2013) which indicated that the greatest driver for Building Information Modelling was that communication is vital. BIM allows this to take place and communication between team members increases. The use of BIM in e-business use for communication purposes is not to be underestimated.

Table 4 Ranking of preferred activities for internet use

Use	High	Medium	Low	None	Ranked Sum	No. of Responses	RII Value	Rank
Project collaboration and management	23	18	4	0	109	45	0.807	1
Electronic Procurement (purchase material and equipment)	18	18	6	0	96	42	0.762	2
Bidding and tendering online (whole project delivery)	22	12	8	1	98	43	0.760	3
Product Service Promotion	14	20	4	2	86	40	0.717	4
Supply Chain Management	14	17	9	0	85	40	0.708	5
Customer relationship management	8	25	9	1	83	43	0.643	6
Lessons Learned Documentation	11	15	13	1	76	40	0.633	7

Respondent organisations were then asked if they use e-business enabling technologies and comment on the degree of usage within their organisation. Again RII was used to rank the most preferred e-business enabling technologies. It can be seen from Table 5 that the Internet was the greater enabling technology for e-business.

Table 5 Ranking of preferred e-business enabling technologies

Use	High	Medium	Low	None	Ranked Sum	No. of Responses	RII Value	Rank
Internet	40	6	1	0	133	47	0.943	1
CAD	27	9	8	2	107	46	0.775	2
BIM	15	9	14	7	77	45	0.570	3
Cloud Computing	7	17	12	5	67	41	0.545	4

4.2 IT investment advice and e-Skills development

This part of the report explores how respondents operate and maintain e-business systems with a view to the future. This section contains an investigation of IT investment advice, IT expenditure and e-Skills development.

4.2.1. IT investment advice

Respondents were asked to identify where they sourced their IT advice from. Table 6 indicates that the majority obtain advice on IT investment from professional IT providers. This indicates that the salespersons who sell IT need to be aware of all the developments and what meets the needs of the organisations that they are visiting.

4.2.2 IT expenditure

This section investigates respondent's average annual IT budgets, including hardware, software, services and personnel over the last five years. It can be seen from Table 7 that over half (52.9%) only spent 1-4% of their annual budget on IT on average over the last 5 years. Eighty-eight (88%) percent of the respondents spent less than 9% of their annual budget on IT over the last five years. This indicates either that there is underinvestment in keeping up to date with the latest software or that existing software functions correctly to the correct level of efficiency required to make the required return on investment. It would be expected that this might rise over the next number of years as relatively expensive BIM software needs to be purchased to meet the UK Government deadlines for implementation.

Table 6 type of IT investment advice

Advice	Count	Percentage of Responses
Obtain advice on IT investment from professional IT providers	30	38.96%
Obtain advice from own IT department or IT practitioners	29	37.66%
Learn through university or other research parties	9	11.69%
Implement IT investment through government/third party recommendations	9	11.69%

Table 7 degree of IT expenditure in the last 5 years

Average annual share of your IT budget, including hardware, software, services and personnel, as percentage of your total company costs in last 5 years		
	Count	**Percentage**
1-4%	18	52.9%
5-9%	12	35.3%
10-14%	3	8.8%
20%+	1	3.0%

4.2.3 e-Skills Development

Organisations were asked to rank how their employees developed e-Skills in this section. They were given three options: Staff learnt new computerised skills through self-learning, Staff attend training courses outside your organisation and the organisation hires IT practitioners to train their staff. It can be seen from Table 8 that the majority of staff are self-taught. This emphasises the importance of manuals and step-by-step guides to new software. The RII value given to this shows that this type of learning is 23% higher than the next ranked method which is that staff attend courses outside the organisation.

Table 8 Ranking of e-Skills development

Use	**High**	**Medium**	**Low**	**None**	**Ranked Sum**	**No. of Responses**	**RII Value**	**Rank**
Staff learn new computerised skills through self-learning	18	19	6	2	98	45	0.726	1
Staff attend training courses outside your organisation	5	14	24	2	67	45	0.496	2
Hire IT practitioners to train your staff	4	13	20	8	58	45	0.430	3

4.3 Drivers, Impact and Barriers of e-Business

This section of the report comments on three elements of e-business: the drivers for it, the impact of it and the barriers to it.

4.3.1 Drivers for implementing e-Business

The drivers or positive forces behind e-business were ranked by the respondents. The reasons were ranked in order of importance in Table 9.

It can be seen from Table 9 that organisations acknowledged that competitive advantage is the most convincing reason to engage in e-business. In second place is customer expectations and this is impacted on by the demands of public sector clients.

Table 9 Ranking of drivers for e-business

Use	High	Medium	Low	None	Ranked Sum	No. of Responses	RII Value	Rank
Competitive advantage	26	12	1	0	103	39	0.880	1
Customer expectation	20	13	6	0	92	39	0.786	2
Supply chain expectation	15	16	8	0	85	39	0.726	3
Competitors engage in e-business	14	16	5	4	79	39	0.675	4

4.3.2 Impact identified for e-business implementation

This section ranks the perspectives of the respondent organisations in regard to the impact of e-business. Table 10 provides the rankings from the analysis of the results. Table 10 shows that efficiency of business process was ranked as the most important impact area.

The management and control provided by the project management elements of e-Business is ranked in second position, followed by the time and cost savings. Productivity ranked in fourth position with competitive advantage in fifth position.

Table 10 Ranking of impact of e-business

Use	High	Medium	Low	None	Ranked Sum	No. of Responses	RII Value	Rank
Efficiency of business processes	28	11	0	0	106	39	0.906	1
Management and control	27	12	0	0	105	39	0.897	2
Time and cost savings	27	10	2	0	103	39	0.880	3
Productivity	24	15	0	0	102	39	0.872	4
Competitive advantage	28	8	1	2	101	39	0.863	5
Accounting and administration	21	16	2	0	97	39	0.829	6
Improving collaboration	18	20	1	0	95	39	0.812	7
Quality of customer service	18	14	6	0	88	38	0.772	8
Innovation	18	15	5	1	89	39	0.761	9
Organisational innovation	18	14	6	1	88	39	0.752	10
Growth of revenue	15	18	5	1	86	39	0.735	11
Procurement cost of supplied goods	14	18	6	1	84	39	0.718	12
Market reach	13	17	8	1	81	39	0.692	13
Visibility to supply chain	13	15	9	2	78	39	0.667	14
Staff training	9	21	9	0	78	39	0.667	14
Research and development	15	11	10	3	77	39	0.658	16
Internal organisation relationship	11	16	12	0	77	39	0.658	16
Quality of products	9	21	8	1	77	39	0.658	16
Expansion of partnership	10	15	11	3	71	39	0.607	19

4.3.3 Barriers to e-Business implementation

It is evident from the findings in Section 4.1.3 that the use of e-business can expand in the UK. It must therefore also be evident that there are a number of barriers that conspire to hold it back from full implementation. Respondent organisations were asked to rank the importance of these barriers. The ranking is provided in Table 11. It is interesting that Security of data transaction and submission is the biggest barrier to e-Business. This matches the largest barrier to e-procurement in construction described in Eadie et al (2010) where prevention of Tampering with Documents - changes to documents and confidentiality of information - unauthorised viewing were viewed as the greatest barriers to e-procurement implementation. A similar situation exists in relation to e-business. Cost of investment ranks in joint first position suggesting that government subsidies to assist with the purchase of e-business software would increase implementation. The interoperability issue again ranks highly in third position overall suggesting that "open" systems need to be developed to increase uptake. Three barriers are ranked in joint fourth place: Resistance to change, Lack of technical skills and Confidence in using new technology. All three of these relate to the personnel involved in e-business and training should lessen the impact of these barriers.

Table 11 Ranking of barriers of e-business

Use	High	Medium	Low	None	Ranked Sum	No. of Responses	RII Value	Rank
Security of data transaction and submission	15	9	13	1	76	38	0.667	1
Cost of investment	11	18	7	2	76	38	0.667	1
Interface with other systems	10	17	10	1	74	38	0.649	3
Resistance to change	9	17	10	2	71	38	0.623	4
Lack of technical skills	9	16	12	1	71	38	0.623	4
Confidence in using new technology	7	20	10	1	71	38	0.623	4
Modification of legacy systems	7	14	15	2	64	38	0.561	7
Changeable IT technical needs of an organisation	6	18	10	4	64	38	0.561	7
Legal barriers	3	8	24	3	49	38	0.430	9
Lack of research in IT in construction (R&D)	2	11	21	4	49	38	0.430	9
Availability of professional software	2	11	19	6	47	38	0.412	11
Cultural influence	2	7	22	7	42	38	0.368	12
Basic competency in IT	1	8	23	6	42	38	0.368	12
Socio-economic problems	0	8	21	9	37	38	0.325	14
Lack of power supply (mainly developing countries)	2	1	8	27	16	38	0.140	15

4.4 Improvement of e-Business

4.4.1 Internal resources

Organisations were asked to select all the statements that best describe their organisation's desire to improve e-Business with regard to internal resources. The responses were added together and a percentage of the responses that related to each element examined.

Table 12 indicated that the best internal resource to improve e-Business was the training working staff better. In joint second place was expenditure in IT infrastructure and more involvement of senior staff. IT investment funding was in last position, indicating that it was they considered that people to operate the technology was more important than just spending money of on infrastructure.

Table 12 organisation's internal respources used in improving e-Business

Internal Resources	Count	Percentage of Responses
More IT Investment Funds	15	16.0%
More expenditure in IT infrastructure	18	19.1%
Increase IT working staff or hire professionals to help	17	18.1%
More senior management involvement	18	19.1%
Better training for working staff	26	27.7%
Other	0	0.00%

4.4.2 Business process

Organisations were asked to select all the statements that best describe their organisation's desire to improve e-Business with regard to business processes. The responses were added together and a percentage of the responses that related to each element examined. Table 13 indicated that the best business process that would be most useful in improving e-business was the integration of e-business processes. The issues relating to the interoperability of e-business and e-procurement have been highlighted by Eadie and McClean (2015). The second highest improvement will arise from the Integration of different business processes.

Table 13 organisation's business processes used in improving e-business

Business Processes	Count	Percentage of Responses
Automation of business processes	23	25.3%
Integration of different business processes	31	34.1%
Reengineering business processes	17	18.7%
Connect e-business value to business performance	19	20.9%
Other (Live Reporting)	1	1.0%

4.4.3 Organisational culture

Organisations were asked to select all the statements that best describe their organisation's desire to improve e-business with regard to their organisation's culture. The responses were added together and a percentage of the responses that related to each element examined. Table 14 indicated that the two most important cultural elements impacting on the improvement of e-business were to recognise the benefits and importance of using e-business and to encourage staff to use e-business tools.

Table 14 organisation's cultural elements used in improving e-business

Organisational Culture	Count	Percentage
Recognise the benefits and importance of using e-business	31	32.3%
Encourage staff to use e-business tools	31	32.3%
Commit to address issues/inhibitions when using e-business	16	16.7%
Change organisation culture to suit for e-business adoption and use	18	18.7%
Other	0	0.00%

4.4.4 Business Goals

Respondent organisations were asked to select one statement that best described their organisation's desire to improve e-business with regard to business goals. With reference to this, three statements covering different policy areas were provided. It can be seen from Table 15 that e-Business policy integrated with the overall business goal and e-Business policy incorporated as part of the overall business goal came out in joint top positions with the cheaper option of the sell-side e-business policy with no integration having only a third of the count of the other two options.

Table 15 organisation's business goals used in improving e-business

Business Goals	Count	Percentage of Responses
Sell-side e-business policy, no need to integrate with the overall business goal	6	14.4%
e-Business policy integrated with the overall business goal	18	42.8%
e-Business policy incorporated as part of the overall business goal	18	42.8%
Other	0	0.00%

4.5 Future of e-Business in your organisation

This section of the research investigated the future investment policy for e-business in the respondent organisations and when they intended to launch an e-business policy.

4.5.1 Future investment in e-Business

Respondents were asked to select one statement that best describe their organisation's commitment to e-business. It can be seen from Table 16 below that the impending BIM deadline has resulted in approximately 75% needing to invest in ICT in the next year. Most (48.65%) were going to invest in the next 6 months.

Table 16 Planned future investment in e-business

Future Investment	Count	Percentage
Plan to make an investment in 0~ 6 months	18	48.65%
Plan to make an investment in 6 months ~ 1 year	10	27.03%
Plan to make an investment in 1 ~ 1.5 years	3	8.11%
Plan to make an investment in 1.5 ~ 2 years	2	5.41%
No plans to make an investment	2	5.41%
Other (As below)	5	13.51%
Unknown	1	2.71%
Already Invested	2	5.41%
Annual Subscription	1	2.71%
Not Applicable	1	2.71%

4.5.2 Launch of e-Business policy

Respondent organisations were asked about their views on e-business implementation policy and when they were to implement such a strategy. Table 17 indicates that 40% have a short term plan (up to two years) in place. However, 30% do not know yet whether they will be implementing an e-business strategy. Only 20% envisage a medium term policy with 10% having a long-term policy.

Table 17 Planned Launch date for an e-Business strategy

e-business policy	Count	Percentage of responses
Short-term (up to 2 years)	16	40.0%
Medium-term (3~5 years)	8	20.0%
Long-term (over 5 years)	4	10.0%
Don't know yet	12	30.0%

5.0 Summary and Key Findings

The key findings of the questionnaire survey include the following:

1. Analysis of the results from the questionnaire indicated that e-Business activities, within the UK construction industry, are relatively high. All but four activities had over 50% of respondents exchanging documents electronically. The top six elements are all directly linked to UK and European government initiatives. These initiatives and consequent deadlines have significantly impacted on electronic business use in the construction sector.

2. Investment in e-business is very small in relation to the respondent's budgets with 88% spending 9% or less of their overall budget on e-business (ICT in construction related activities). Realisation of the potential benefits is not enough if they cannot be accrued through investment.
3. There is a shortage of investment in skills development as the majority of staff in the construction industry learnt ICT skills through self-learning. This has a 23% higher uptake than those going on external courses. It is therefore important that manuals and step-by-step help guides are user friendly and up to date for all e-business adoptions. Despite this lack of training, the UK construction industry recognises the need for staff development ranking it the highest internal resource that could positively impact e-business.
4. Construction organisations in the main rely on professional IT providers for investment advice. This may be an issue if they do not have the expertise to know what they are buying. An independent third party would have a role to vet salespersons and ensure that organisations get the best fit e-business software. Alternatively, there is great scope for SaaS (Software as a Service) providers to enter the market to fulfil ICT needs of construction organisations.
5. Construction organisations acknowledged the competitive advantage of e-business ranking it above customer expectation. They also indicated that e-business has the potential to promote efficient business process. The management and control that electronic systems deliver was also recognised as a major impact in delivering e-business. However, they ranked security of data transaction and submission as the highest barrier and worried about the investment costs of ICT. This would indicate the need for a higher level of cyber security and open source solutions in ICT to bring down the costs.
6. The integration of business processes was ranked the highest positive improvement in the business process category. This shows that the interoperability issue raised in literature is important and software developers should concentrate on providing fully interoperable solutions.
7. The construction industry also identified the need to adapt the current culture within the industry to recognise the benefits and importance of using e-business and encourage staff to use e-business tools.
8. The construction industry also stated that 75% are due to invest in ICT in the next year. This can be put down to the deadlines for BIM and e-procurement solutions stipulated by the UK Government. Further, the development for ICT has resulted in 40% of organisations adopting a short term approach to ICT (up to two years).

6.0 Way Forward

This report prescribes further investigation into e-business in the UK construction industry with a larger number of responses. The scope of such research needs to be widened to determine how to develop training methods suitable in encouraging staff to use e-business tools and recognise its benefits and importance. It also needs to consider a plethora of enabling technologies available for the construction industry and their potential use. This (or an expanded survey) can be rerun once the UK and European Government deadlines of 2016 have fully worked through to the coalface. This will allow the full impact of these to be measured. It is of importance to focus further investigation on infrastructure/ technology/interoperability issues, uptake and capacity levels and education/ training as these areas appear to be the main elements of e-business that need development.

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