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IDENTIFICATION OF E-PROCUREMENT DRIVERS AND BARRIERS FOR UK CONSTRUCTION ORGANISATIONS AND RANKING OF THESE FROM THE PERSPECTIVE OF QUANTITY SURVEYORS

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SUMMARY: *The possibilities afforded by E-business are evident, but the level of implementation and penetration was not as expected within the construction industry. The potential benefits for construction are suggested by the E-business accomplishments in other industries. Yet its poor uptake (less than 20% of documentation is currently tendered electronically) suggests the unpopularity of e-procurement in UK construction. Many drivers and barriers to general e-procurement have been identified in published literature. Previous studies in the US (Davila et al, 2003, Minahan and Degan, 2001) and Australia (Hawking et al, 2004) have ranked these drivers and barriers for the general procurement of goods and services. In previous research, Eadie et al (2007) ranked the drivers and barriers to e-procurement from a construction contractor's perspective in the Northern Ireland public sector in a pilot study for this current research.*

In the current research, a focus group was established consisting of five domain experts, who represented the various aspects and levels of expertise of construction procurement, namely: web-based materials procurement, e-auctions, compact disc write once (CDR) e-tendering, the contractor's perspective and electronic document production. This group produced a comprehensive list of construction-based e-procurement drivers and barriers. A detailed questionnaire for a web-based survey was produced from the findings of this focus group to ascertain the importance rankings of these drivers and barriers. A telephone survey of all Quantity Surveyors within the United Kingdom, listed on the Royal Institute of Chartered Surveyors (RICS) website, identified those who used e-procurement. This was followed by a web-based questionnaire survey of the identified organisations on e-procurement for construction-based activities. This paper presents the findings of the driver and barrier verification study and the driver and barrier importance ranking survey. Further research will link the drivers and barriers to e-procurement to the five maturity levels in Paulk's maturity model through factor analysis. This research and development will result in the production of a tool to analyse the e-readiness of an organisation, and hopefully this tool will allow them to harness drivers and to mitigate barriers.

KEYWORDS: *e-procurement in construction, ranking of drivers and barriers to e-procurement*

REFERENCE: *Eadie R, Perera S, Heaney G (2010) Identification of e-procurement drivers and barriers for UK construction organisations and ranking of these from the perspective of quantity surveyors, Journal of Information Technology in Construction (ITcon), Vol. 15, pg. 23-43, http://www.itcon.org/2010/2*

1. INTRODUCTION

The Improvement and Development Agency (IDEA, 2004) defines e-Procurement as 'a tool to enable procurement activities, including sourcing, ordering, commissioning, receipting and making payments for the whole spectrum of an authority's activities'. In construction procurement, where a tender process is utilised to procure contracts, this is accomplished electronically through e-tendering. IDEA (2008) defines e-tendering as 'an electronic tendering solution that facilitates the complete tendering process from the advertising of the requirement through to the placing of the contract'.

The perceived advantages of monitory savings and efficiency gains prompted the UK government to set targets for all procurement activities to be fully electronic by the end of 2005 (Local eGov, 2004). Martin (2003) had shown that only 2.9% of Contract Documentation was being transmitted and received in Construction Industry Trading Electronically (CITE) format. Five years later, Martin (2008) shows that less than 20% of tender documentation is sent out and received through e-tendering, suggesting that implementation of e-procurement targets set by the government is proving unpopular in UK construction resulting in a poorer level of uptake than expected. This paper seeks to investigate the reasons for the poor uptake of e-procurement in construction through the identification of drivers and barriers to construction e-procurement and investigating how these drivers and barriers are perceived by the quantity surveying discipline who due to the procurement and cost management nature of their work are the most likely proponents of e-procurement.

1.1 E-Procurement in Construction

In a number of industry sectors it has been shown that the development of business process models has supported the embedment of the business process within the organisation (Alshawi et al, 2004). The study of these other industries show the many benefits that construction could potentially harness through e-business savings and efficiencies.

The identification of the drivers and barriers to e-procurement in construction is vital to gaining an understanding of how the benefits of e-procurement can be used to increase its uptake and to provide a model to embed e-procurement. A limited study had been carried out in this field; Eadie et al (2007) carried out a preliminary study into drivers and barriers in construction and ranked these from a Northern Irish Public Sector Contractor's perspective. The study applied drivers and barriers identified from other industries to e-procurement in construction and produced a ranking of the importance of drivers and barriers. The drivers and barriers commented on by Martin (2008) were also analysed to identify those which are applicable to construction; the relevant ones were subsequently added to Eadie's list of drivers and barriers. It was felt a more rigorous verification of the application of general e-procurement drivers and barriers to construction e-procurement may provide a clear outlook for the potential for the advancement of e-procurement in construction. This paper shows the results of this rigorous verification process of each driver and barrier identified from literature applied to construction e-procurement. The verification process was completed by a group of domain experts, using the Delphi methodology, who analysed the applicability of each driver and barrier to construction e-procurement throughout the entire UK construction industry.

Perera et al (2007) identified a methodology to produce an e-capability maturity model for construction organisations using drivers and barriers to e-procurement. The drivers and barriers identified and verified in this paper will provide the basis for the further development of the e-capability maturity model proposed in Perera et al (2007).

1.2 Construction E-Procurement drivers and barriers identified from literature

The variables which impact on the uptake of e-procurement were divided into two sections. These are the determinants of whether the implementation of e-procurement will be successful or not. Depending on their actions, these variables can either act as drivers promoting e-procurement or as barriers causing challenges to its embedment within the organisation. Those actions which produce a positive result will be denoted by the term Drivers and conversely those producing a negative effect as Barriers. The literature search revealed a collated set of drivers and barriers to e-procurement containing 21 drivers and 31 barriers. These are identified in Table 1 and Table 2 respectively.

TABLE 1: Drivers to construction e-procurement identified from Literature

No	Drivers from Literature	Referenced in:
1	Process cost savings - (Tender / Purchase Process)	Knudsen (2003), Minahan and Degan (2001), Martin (2008)
2	Service / Material / Product Cost Savings	Minahan and Degan (2001), Martin (2008) – Reduced Waste
3	Transaction Administration Cost Savings	Davila et al (2003) and Panayiotou et al (2003)
4	Reduced Administration Costs	Egbu et al (2003), Hawking et al (2004), Raghavan and Prabhu (2004)
5	Increasing Profit Margins	McIntosh and Sloan (2001), Wong and Sloan (2003) , Ribeiro (2001)
6	Strategic Cost Savings	Knudsen (2003)
7	Enhanced Inventory Management	Hawking et al (2004), Martin (2008)
8	Decrease in Costs through reduced staffing levels	Kong (2001), Davila et al (2003), Egbu et al (2003)
9	Shortened Overall Procurement Cycle Times	Minahan and Degan (2001)
10	Shortened Communication Cycle Times	Knudsen (2003)
11	Reduction in time through greater transparency (Less objections)	Panayiotou et al (2003)
12	Reduction in Evaluation Time	Panayiotou et al (2003), Martin (2008)
13	Reduction in Time through improved internal workflow	Panayiotou et al (2003)
14	Reduction in purchasing order fulfilment time - Contract Completion	Davila et al (2003)
15	Reduction in time through increased visibility	Kalakota et al (2001)
16	Increased Quality through increased competition	Kalakota et al (2001)
17	Increased Quality through Benchmarking (Market Intelligence)	Hawking et al (2004)
18	Increased Quality through increased visibility in the supply chain	Minahan and Degan (2001) and Hawking et al (2004)
19	Increased Quality through increased efficiency	McIntosh and Sloan (2001), Ribeiro (2001), Martin (2008)
20	Increased Quality through Improved Communication	Hawking et al (2004)
21	Gaining Competitive Advantage	Wong and Sloan (2003)

TABLE: 2 Barriers to construction e-procurement identified from Literature

No	Barriers from Literature	Referenced in:
1	Upper Management Support / Lack of Leadership	Davila et al (2003), Hawking et al (2004)
2	Other Competing Initiatives	Kheng et al (2002)
3	Resistance to change	Davila et al (2003), Martin(2008)- Natural Inertia
4	Lack of a widely accepted solution	Davila et al (2003) , Martin (2008)
5	Magnitude of Change	Kheng et al (2002)
6	Lack of a national IT policy relating to e-procurement issues	Carayannis et al (2005)
7	Lack of Flexibility	Carayannis et al (2005)
8	Bureaucratic dysfunctionalities	Carayannis et al (2005)
9	Complicated procedures and extended relationships	Carayannis et al (2005) show how excessive state intervention is a barrier to e-procurement.
10	Lack of technical expertise	Davila et al (2003), Martin (2008)
11	Staff turnover	Kransdorff (1998)
12	Slowdown in the uptake of internet services since the dotcom bubble burst	Christensen et al (2002)

13	Company access to the internet	Smith (2006) - BBC Webpage
14	Religious objections to the internet	McMullan(2005) Correspondence to CPD
15	Insufficient assessment of systems prior to installation	Forrest (1999)
16	Security in the process - Data transmission to the wrong person	Gebauer et al et al (1988), Kheng et al (2002) -59% of Singapore sample cite security as the main barrier
17	Confidentiality of information - unauthorised viewing	Gebauer et al et al (1988),Julia-Barcelo (1999)
18	Prevention of tampering with documents - changes to documents	Gebauer et al et al (1988), Feniosky and Choudary (2001)
19	Data transmission reassembly - incorrect reassembly of data transmitted in packets	Jennings (2001)
20	Partial Data Display - incomplete documents provided	Jennings (2001)
21	Lack of pertinent case law	Hawking et al (2004),Price Waterhouse Coopers (2002), Julia-Barcelo (1999), Martin (2008)
22	Different national approaches to e-procurement	Carayannis et al (2005)
23	Proof of intent - electronic signatures	Julia-Barcelo (1999), Rawlings J (1998), Dumortier et al (1999), Wright (1999)
24	Clarity of sender and tenderer information	Wright(1999),Dumortier et al(1999)
25	Enforceability of electronic contracts	Jennings (2001), CITE website (2004)
26	Information technology investment costs	Irani and Love (2002),Wong and Sloan (2004), Martin (2008)
27	Cost of assessment of systems to find correct system to fulfil tasks	Forrest (1999),Wong and Sloan (2004)
28	Internal Compatibility	Davila et al (2003),Boeing (1996)
29	External Compatibility	Davila et al (2003), Boeing (1996)
30	Investment in compatible systems	Davila et al (2003)
31	Reluctance to 'buy-into' one off systems	Irani and Love (2002)

Those drivers and barriers identified from the literature in Table 1 and Table 2 represent general e-procurement drivers and barriers and are not verified as specific to construction. The verification process identified earlier was used to filter which of these drivers and barriers were significant to the construction industry while adding any new drivers or barriers that were shown to exist in the industry.

2. THE METHODOLOGY FOR THE IDENTIFICATION AND RANKING OF CONSTRUCTION E-PROCUREMENT DRIVERS AND BARRIERS

The project was divided into four distinct phases – the literature search, the Northern Ireland study, the Driver and Barrier Verification process and finally the Main UK wide study. Firstly, the literature search identified the divers and barriers already detailed in Tables 1 and 2. The process of driver and barrier identification and verification is reported in this study. The Main UK-wide study took the form of a telephone and web-based survey which ranked the drivers and barriers from the perspectives of different construction organisations. The main study is broken into two portions. It consisted of a phone based survey which determined whether the organisation carried out e-procurement and a web-based survey which recorded the ranking of drivers and barriers from those organisations which had implemented it. The approach is explained in Figure 1.

This paper reports on the findings in regard to ranking of the verified set of drivers and barriers from a Quantity Surveyor perspective (Boxes A and B in Figure 1).

Quantity Surveyors are the professionals of the construction industry who normally perform the tender process and procurement in traditionally procured contracts. They are therefore one of the most important disciplines for this study and it was considered important to analyse their responses separately from other disciplines. Further work will be carried out in future research to provide an assessment of the overall ranking of drivers and barriers in regard to other construction disciplines. The data for the Quantity Surveyors was recorded as part of this study but a cross disciplinary driver and barrier study will be published comparing the results from the disciplines and providing a documented set of ranked drivers and barriers to e-procurement.

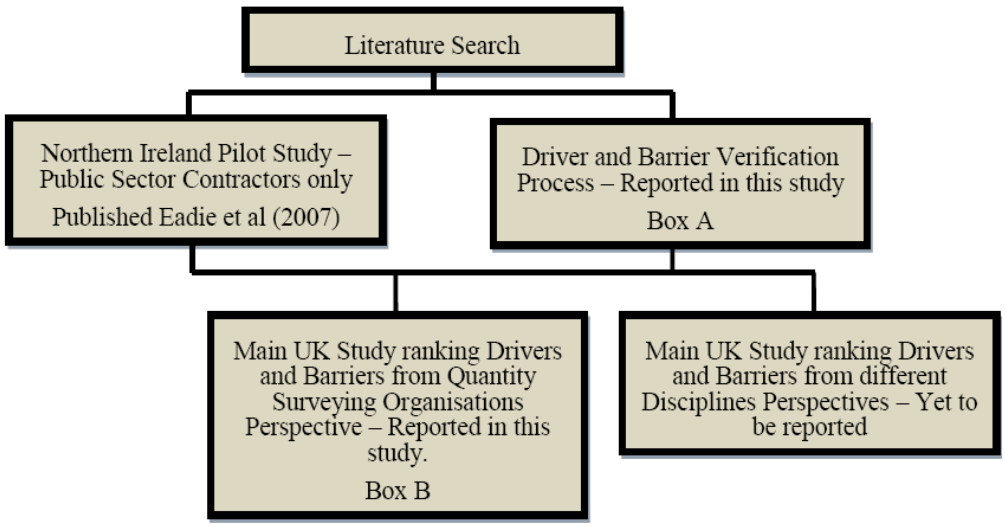

FIG. 1: Methodological Approach to Study

In this study 483 Quantity Surveying organisations listed on the RICS website (from of a total of 775 cross disciplinary organisations) were surveyed. Initially they were contacted by telephone to ascertain whether they carried out e-procurement within construction. If they had experience in e-procurement systems they were asked to rank the drivers and barriers. If they had no experience they took no further part in the study. This process is described in greater detail in section 3 of this paper.

The approach described in Figure 1 is more fully developed in the following sections which describe the different stages of the study.

2.1 Northern Ireland Pilot Study

A preliminary study on the views of the public sector construction contractors in Northern Ireland was reported in Eadie et al (2007) ranking drivers and barriers for e-procurement in construction. This study was narrow in scope and limited to public sector construction contractors. Therefore, further work was needed to expand this study to incorporate both public and private sector responses while expanding the study throughout the entire UK. A driver and barrier verification process ensured greater rigour in determining the applicability of general e-procurement drivers and barriers to construction e-procurement. Although the findings of the verification process agree in general with the results of Eadie et al (2007) there were many new drivers and barriers identified. The verification process described in this paper is positioned alongside the Northern Ireland study and prior to the formulation of the main web-based questionnaire. The web-based questionnaire described later in the paper was based on the findings of the verification process.

2.2 The Process of identifying Drivers and Barriers to e-procurement

A full Delphi methodology was carried out to ensure that the drivers and barriers identified from general e-procurement studies were applicable to the construction industry. It was also used to identify any further drivers and barriers to construction e-procurement. This verification process is explained in detail in the following sections.

2.2.1 Delphi Methodology definition and application

The Delphi methodology can be defined as '*A social survey technique which involves polling experts and others for their prediction on important demographic, political, economic, technological, and social trends'* (Wilson, 1991). The Delphi methodology is a defined process allowing the collection of tacit knowledge from a group of experts utilising a series of questionnaires and additional controlled opinion feedback (Skulmoski et al, 1996). It is well suited as a research instrument when there is imperfect knowledge about a problem or experience (Skulmoski et al, 2007).

The Delphi methodology is regarded as the most appropriate instrument to collect data to enable the formation of a list of drivers and barriers to construction e-procurement; it allows solicitation and aggregation of informed judgement from a group of experts on specific questions or issues (Strauss and Zeigler, 1975). The identification and confirmation of drivers and barriers to e-procurement does not lend itself to precise analytical techniques but

is more suited to the collection of group opinions from experts who can contribute experiential knowledge as they represent diverse backgrounds within the construction industry.

The 'classical' Delphi methodology was used, wherein data is collected from experts individually over a number of rounds of questioning. The results of each round are fed into the next until the results are stable and a consensus is reached through iteration. Figure 2 sets out the process used in this study.

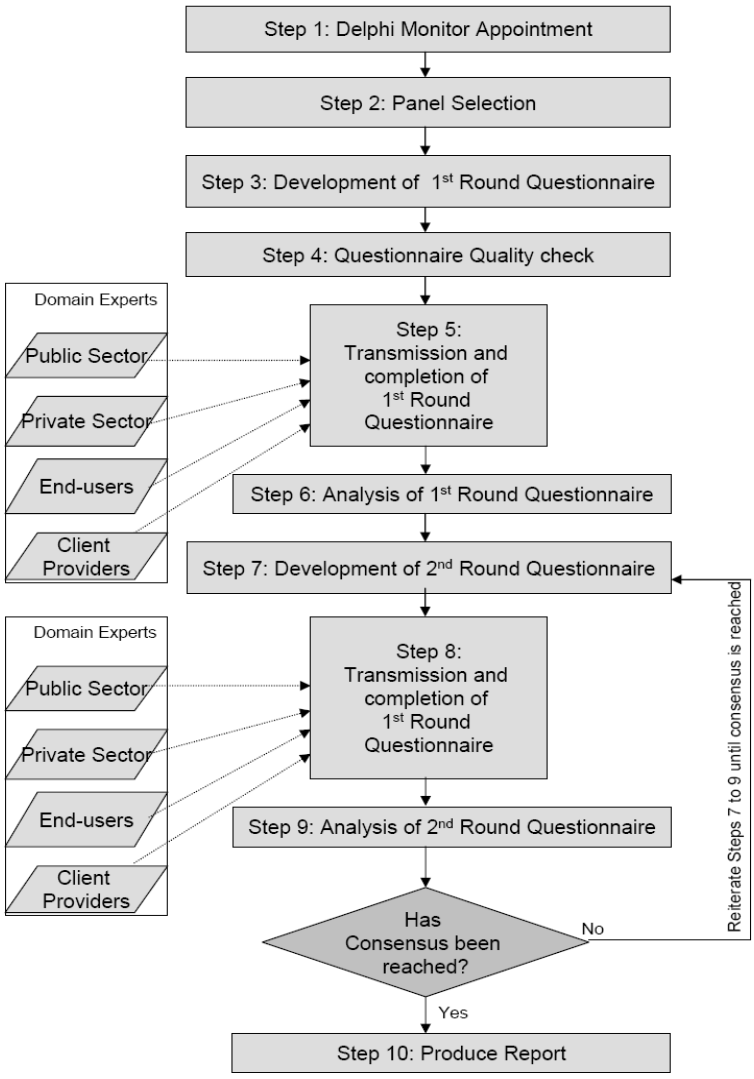

FIG. 2: Schematic of the Delphi methodology as adapted for this study

The above procedure is more fully documented throughout the forthcoming sections of the paper.

2.2.2 Verification Group Panel Selection

Turoff (1975) states that the panel members in the Delphi methodology had to be experts in the field. The entire panel in this research consisted of industry stakeholders, as shown in Table 3, who had direct knowledge of e-procurement from a construction perspective and had used or implemented e-procurement systems. The experience from the stakeholder community allowed the panel to add their extensive 'everyday experience' to the data from previous studies in other fields.

This knowledge is evidenced in the length of experience within construction that the panel exhibited; all panel members had worked in the construction industry for more than seven years.

Ludlow (1975) concludes that panel members are more receptive if the techniques are tailored to specific groups on the basis of their training and experience. As well as being directly affected and involved in e-procurement

each panel member was also chosen for his/her clarification, organisational, stimulation and analytical skills. Each panel member had also experience of writing internal reports on contractual issues for their organisation.

2.2.3 Verification Group Panel Representativeness

The panel had to represent the entire construction industry; a list of attributes is set out in Table 3. It was decided to select two subject-matter experts from public sector departments, one from a wholly-owned government company and two private sector panellists to give this balance. Each individual selected was working in the field of e-procurement within their organisation, and was willing to participate in the process, which made the stimulation of a response unnecessary.

Experiments by Brockhoff (1975) and Boje and Murnighan (1982) suggest that under ideal circumstances, groups as small as three or four can perform well in the Delphi methodology. Brockhoff (1975) also suggests that a general positive relationship between group size and group performance cannot be recognized and smaller groups perform equally well to larger groups. One prerequisite is that the panel must be homogeneous in its makeup. As noted earlier, the members of the selected panel were involved in e-procurement within their respective organisations and were members of the construction industry. Therefore the panel had a homogeneous population which could permit a reduction in size.

TABLE 3: Representativeness of the various panel members

Attributes necessary	**Criteria (Turoff, 1975, Brockhoff, 1975, Boje and Murnighan, 1982)**	**How Achieved with panel**
Member of the Construction industry	100% of panel	5 out of 5 **adequate**
Membership of Professional Body	100% of panel meeting requirements of Shields et al (1987)	5 out of 5 **adequate**
Male / Female	Equal number	3 – 2 **adequate**
Public / Private Sector	Equal number	2 public, 2 private, 1 government-owned company **adequate**
Implementation of a system of e-procurement from a client perspective	50% of panel – knowledge of implementation issues	3 out of 5 – 60% of the panel had been instrumental in implementation within their organisation **adequate**
User (Formation of Documents from a client perspective)	40% of panel – knowledge of issues relating to the use of e-procurement	4 out of 5 – 60% of panel had formed contract documents. 3 public and 1 private sector. **Adequate**
User (Completion of Documents from an end user perspective)	40% of panel – knowledge of issues relating to the use of e-procurement	2 out of 5 – 40% of panel had completed contract documents. **Adequate**
Willing to take part in Delphi Process	100% of panel	5 out of 5 **adequate**

2.2.4 Verification Process Results

On the first round of the verification process the panel was provided with the initial list of identified drivers and barriers to e-procurement from literature (Table 1 and Table 2). They were asked to rank these as to their importance to construction. The scale chosen was 1 – very important, 2 - important, 3 – necessary and 4 – not very necessary. Panellists were requested to add other drivers and barriers that they felt would also impact upon construction e-procurement.

2.2.5 List of Verified Drivers and Barriers to e-procurement

Boje and Murnighan (1982) show that while confidence increased as the number of rounds increased, accuracy decreased. It is therefore important to get a consensus of opinion in as few iterations as possible. Consensus was reached after two iterations.

TABLE 4: Delphi First Round Diver responses

No	Drivers to e-procurement	Response Number					Median Value- (Green Test with mean, Red send to 2nd Round)	Mean Value (Green accept, Red Send to 2nd Round)
		1	2	3	4	5		
1	Process cost savings -(Tender / Purchase Process)	1	1	1	1	1	1	1
2	Service / Material / Product Cost Savings	1	1	2	1	2	1	1.4
3	Transaction Administration Cost Savings	1	1	4	1	2	1	1.8
4	Reduced Administration Costs	1	1	2	1	3	1	1.6
5	Increasing Profit Margins	1	2	3	3	2	2	2.2
6	Strategic Cost Savings	1	2	2	1	3	2	1.8
7	Enhanced Inventory Management	3	2	4	2	3	3	2.8
8	Decrease in Costs through reduced staffing levels	3	2	4	2	2	2	2.6
9	Shortened Overall Procurement Cycle Times	1	2	1	2	3	2	1.8
10	Shortened Communication Cycle Times	1	3	1	2	3	2	2
11	Reduction in time through greater transparency (Less objections)	2	3	1	2	4	2	2.4
12	Reduction in Evaluation Time	1	3	1	2	4	2	2.2
13	Reduction in Time through improved internal workflow	1	2	2	2	3	2	2
14	Reduction in purchasing order fulfilment time - Contract Completion	2	2	2	1	4	2	2.2
15	Reduction in time through increased visibility	3	2	1	2	4	2	2.4
16	Increased Quality through increased competition	3	1	1	2	4	2	2.2
17	Increased Quality through Benchmarking (Market Intelligence)	2	1	4	2	3	2	2.4
18	Increased Quality through increased visibility in the supply chain	3	1	4	2	2	2	2.4
19	Increased Quality through increased efficiency	1	1	1	2	2	1	1.4
20	Increased Quality through Improved Communication	1	2	1	2	3	2	1.8
21	Gaining Competitive Advantage	2	2	1	3	1	2	1.8

TABLE 5: Delphi First Round Barrier responses

No	Barriers to e-procurement	Response					Median Value- (Green Test with mean, Red send to 2nd Round)	Mean Value (Green accept, Red Send to 2nd Round)
		1	2	3	4	5		
1	Upper Management Support / Lack of Leadership	2	1	3	1	2	2	1.8
2	Other Competing Initiatives	3	2	3	2	3	3	2.6
3	Resistance to change	1	1	3	2	2	2	1.8
4	Lack of a widely accepted solution	1	1	3	2	4	2	2.2
5	Magnitude of Change	2	1	3	2	3	2	2.2
6	Lack of a national IT policy relating to e-procurement issues	1	2	1	2	3	2	1.8
7	Lack of Flexibility	2	3	3	2	2	2	2.4
8	Bureaucratic dysfunctionalities	3	2	1	2	1	2	1.8
9	Complicated procedures and extended relationships	3	2	1	2	2	2	2
10	Lack of technical expertise	2	2	3	1	3	2	2.2
11	Staff turnover	3	3	4	2	4	3	3.2

12	Slowdown in the uptake of internet services since the dotcom bubble burst	3	3	4	2	4	3	3.2
13	Company access to the internet	3	2	4	1	4	3	2.8
14	Religious objections to the internet	3	3	4	3	4	3	3.4
15	Insufficient assessment of systems prior to installation	3	1	3	2	3	3	2.4
16	Security in the process - Data transmission to the wrong person	1	1	1	2	2	1	1.4
17	Confidentiality of information - unauthorised viewing	1	1	1	2	3	1	1.6
18	Prevention of tampering with documents - changes to documents	1	1	1	1	3	1	1.4
19	Data transmission reassembly - incorrect reassembly of data transmitted in packets	2	2	3	1	3	2	2.2
20	Partial Data Display - incomplete documents provided	3	2	3	1	3	3	2.4
21	Lack of pertinent case law	2	2	1	2	3	2	2
22	Different national approaches to e-procurement	2	2	1	3	4	2	2.4
23	Proof of intent - electronic signatures	2	2	1	1	3	2	1.8
24	Clarity of sender and tenderer information	2	2	3	1	3	2	2.2
25	Enforceability of electronic contracts	2	2	1	1	3	2	1.8
26	Information technology investment costs	3	1	3	1	2	2	2
27	Cost of assessment of systems to find correct system to fulfil tasks	3	1	3	1	3	3	2.2
28	Internal Compatibility	3	2	3	1	2	2	2.2
29	External Compatibility	2	2	3	1	2	2	2
30	Investment in compatible systems	3	2	3	2	2	2	2.4
31	Reluctance to 'buy-into' one off systems	3	2	1	2	2	2	2

It can be seen from Table 4 and Table 5 that the panel considered all the drivers identified from literature in other disciplines. The Drivers and Barriers identified in green passed the threshold for inclusion. Those identified as being suspect (negative skew) are denoted in red. In investigating the barriers three barriers were identified as being suspect. These were *staff turnover, slowdown in the uptake of internet services since the dotcom bubble burst* and *religious objections to the internet*. These were forwarded to the second stage for further analysis. Additional Drivers and Barriers were identified by the panel and the subsequent action agreed is demonstrated in Tables 6 and 7.

TABLE 6: Results of Clarification stage on Additional Drivers

	Additional Drivers	**Agreed action with panellist**
1	Labour savings due to automation of computation	Already covered in 'Reduction in evaluation time'
2	Cost saving due to elimination of computational errors and their subsequent correction	Added as 'Increased Quality through increased accuracy - (Elimination of errors through computer use)'
3	Packages of work can be conveniently archived for future reference	Added as 'Convenience of archiving completed work'
4	Work items can be communicated electronically for quotation without double handling the information i.e. converting to paper and back to electronic.	Already in Increased Quality through improved communication
5	Efficiencies are often benefit both Employer and Supplier / Contractor – a proper win-win	More a comment rather than a driver - however increased efficiency covers this.
6	Enhancing the efficiency, effectiveness and added value of the procurement capability to the Organisation	Already in 'Increased Quality through Increased efficiency', 'Process cost savings' and 'increased profit margins'

7	Developing and implementing new system capabilities 'best in class / best in breed' into procurement to improve performance and innovation	More a comment - capabilities broken down in questionnaire into the various drivers
8	Developing the technical skills, knowledge and expertise of procurement staff in all areas of e-procurement enabling procurement to deliver more to the bottom line.	Added as 'Develops the Technical Skills, knowledge and expertise of procurement staff'

TABLE 7: Results of Clarification stage on Additional Barriers

	Additional Barriers	**Agreed action with panellist**
1	Vested interests prefer to promote proprietary products and sideline cheap collaborative solutions	Covered with internal and external compatibility, and investment in compatible systems
2	Lack of publicity / public awareness of best practice solutions	Added as 'Lack of publicity / awareness of best practice solutions'
3	Lack of forum for exchange of ideas	Added as 'Lack of a Forum to exchange ideas'
4	Industry scepticism about efficiencies from IT and other out of date perceptions	Added as 'Perception of no business benefit to be realised'

These results were carried into the Delphi second stage questionnaire. The second stage questionnaires were split into three sections and the results shown in the following tables:

- Section A : To get consensus as to the removal or otherwise of the three barriers identified in the first round of questionnaires (Table 8)
- Section B : To get consensus as to the inclusion or otherwise of the additional drivers and barriers identified in the first round of questionnaires (Table 9)
- Section C : To see if the amalgamation of the drivers and barriers identified through consultations would be acceptable to all (Table 10).

TABLE 8: Barriers suitable for removal

No.	**Section A - Barriers suitable for Removal**	Reply 1	Reply 2	Reply 3	Reply 4	Reply 5	Outcome Ulschak(1983) 80% for consensus
A1	Staff Turnover	Include	Remove	Include	Include	Include	Include
A2	Slowdown in the uptake of Internet services since the DotCom bubble burst	Remove	Remove	Remove	Remove	Remove	Remove
A3	Religious Objections to the internet	Remove	Remove	Remove	Remove	Remove	Remove

TABLE 9: Additional Driver and Barrier assessment

	Section B - Additional Drivers and Barriers	1	2	3	4	5	**Median Value- (Green Test with mean, Red send to 3rd Round)**	**Mean Value (Green accept, Red Send to 3rd Round)**
B1 1	Increased Quality through increased accuracy (Elimination of errors through Computer use)	1	2	2	2	2	2	1.8
B1 2	Convenience of archiving completed work	1	2	1	2	1	1	1.4

B1 3	Develops the Technical Skills, knowledge and expertise of procurement staff	3	2	2	1	2	2	2
B2 1	Perception of no Business Benefit Realised	4	2	1	2	3	2	2.4
B2 2	Lack of publicity / awareness of best practice solutions	1	2	2	2	3	2	2
B2 3	Lack of a forum to exchange ideas	1	2	3	3	4	3	2.6

TABLE 10: List of Drivers and Barriers agreed for Combination

Original List of Driver(s) / Barrier(s)	Original Driver / Barrier Number	Agreed panel combination
• Process Cost Savings - (Tender / Purchase Process) • Transaction Administration Cost Savings • Reduced Administration Costs and Decrease in Costs through reduced staffing levels	1 (Table 1) 3 (Table 1) 4 (Table 1)	Process, Transaction and Administration Cost Savings
• Shortened Communication Cycle times • Reduction in time through improved internal workflow	10 (Table 1) 13 (Table 1)	Shortened Internal and External Communication Cycle times
• Lack of a widely accepted solution • Cost of assessment of systems to find correct system to fulfil tasks	4 (Table 2) 27 (Table 2)	Lack of a widely accepted e-procurement software solution

Consensus was reached and the findings from the Delphi process shown in the above tables combined to produce a confirmed list of drivers and barriers to e-procurement.

2.2.6 Conclusions from the Verification Process

The aim of using the verification process was to obtain a confirmed list of drivers and barriers to construction e-procurement which was agreed upon by representatives from all sections of the construction industry. Consensus was found and these findings have been used to produce an instrument for ranking drivers and barriers to Construction e-procurement (Table 11 Final list of Drivers after completing the Verification Process and Table 12 Final list of Barriers after completing the Verification Process). The verified drivers and barriers were grouped into 6 different bands by the authors relating to: General, Cost, Time, Quality, Cultural, Infrastructure, Security, Legal, and Compatibility for further analysis.

TABLE 11: Final list of Drivers after completing the Verification Process

No	Drivers from Literature and Delphi Process	Banding
1	Process, Transaction and Administration Cost Savings	Cost
2	Service / Material / Product Cost Savings	Cost
3	Increasing Profit Margins	Cost
4	Strategic Cost Savings	Cost
5	Enhanced Inventory Management	General
6	Shortened Overall Procurement Cycle Times	Time
7	Shortened Internal and External Communication Cycle times	Time
8	Reduction in time through greater transparency (Less objections)	Time
9	Reduction in Evaluation Time	Time
10	Reduction in purchasing order fulfilment time - Contract Completion	Time
11	Reduction in time through increased visibility	Time
12	Increased Quality through increased competition	Time
13	Increased Quality through Benchmarking (Market Intelligence)	Quality
14	Increased Quality through increased visibility in the supply chain	Quality
15	Increased Quality through increased efficiency	Quality
16	Increased Quality through Improved Communication	Quality
17	Gaining Competitive Advantage	General
18	Increased Quality through increased accuracy (Elimination of errors through Computer use)	Quality
19	Convenience of archiving completed work	General
20	Develops the Technical Skills, knowledge and expertise of procurement	General

	staff	

TABLE 12: Final list of Barriers after completion of the Verification process

	Barriers from Literature and Delphi Process	Banding
1	Upper Management Support / Lack of Leadership	Cultural
2	Other Competing Initiatives	Cultural
3	Resistance to change	Cultural
4	Lack of a widely accepted e-procurement software solution	Cultural
5	Magnitude of Change	Cultural
6	Lack of a national IT policy relating to e-procurement issues	Cultural
7	Lack of Flexibility	Cultural
8	Bureaucratic dysfunctionalities	Cultural
9	Complicated procedures and extended relationships	Cultural
10	Lack of technical expertise	Cultural
11	Staff turnover	Cultural
12	Company access to the internet	Infrastructure
13	Insufficient assessment of systems prior to installation	Infrastructure
14	Security in the process - Data transmission to the wrong person	Security
15	Confidentiality of information - unauthorised viewing	Security
16	Prevention of tampering with documents - changes to documents	Security
17	Data transmission reassembly - incorrect reassembly of data transmitted in packets	Security
18	Partial Data Display - incomplete documents provided	Security
19	Lack of pertinent case law	Legal
20	Different national approaches to e-procurement	Legal
21	Proof of intent - electronic signatures	Legal
22	Clarity of sender and tenderer information	Legal
23	Enforceability of electronic contracts	Legal
24	Information technology investment costs	Assessment Costs
25	Internal and External interoperability of e-procurement software	Compatibility
26	Investment in compatible systems	Compatibility
27	Reluctance to 'buy-into' one off systems	Compatibility
28	Perception of no Business Benefit Realised	General
29	Lack of publicity / awareness of best practice solutions	Cultural
30	Lack of a forum to exchange ideas	General

These lists of drivers and barriers to construction e-procurement were placed into a web-based questionnaire for the survey phase of the research.

3. DETAILED WEB-BASED SURVEY OF QUANTITY SURVEYING ORGANISATIONS

Hussey and Hussey (1997) define a questionnaire as 'a list of carefully structured questions, chosen after considerable testing, with a view to eliciting reliable responses from a chosen sample with the aim to find out what a selected group of participants do, think or feel'. This phase of the study of e-procurement in construction required responses from representatives in various parts of the United Kingdom where it would have been physically and economically impossible to conduct face-to-face interviews. A web survey provided the ability to contact and obtain responses from individuals from each country in the UK, namely: England, Scotland, Wales and Northern Ireland. The flexibility and speed of this method of data collection has led to it being recognised as one of the most extensively-used surveying techniques (Monette et al, 1998).

A list of all Quantity Surveying organisations was compiled using the web-based Royal Institute of Chartered Surveyors (RICS) directory. Each organization was contacted by telephone to confirm their e-procurement experience and willingness to partake in the survey. If these conditions were met, an individual in the organisation was then assigned to complete the survey.

The list contained 483 names across the United Kingdom. Figure 3 and Table 13 show the numerical breakdown across England, Scotland, Wales and Northern Ireland. The results of the phone questionnaire relating to e-procurement use are also described. The percentage of the total responses possible from the sample that completed the survey was denoted percentage valid response.

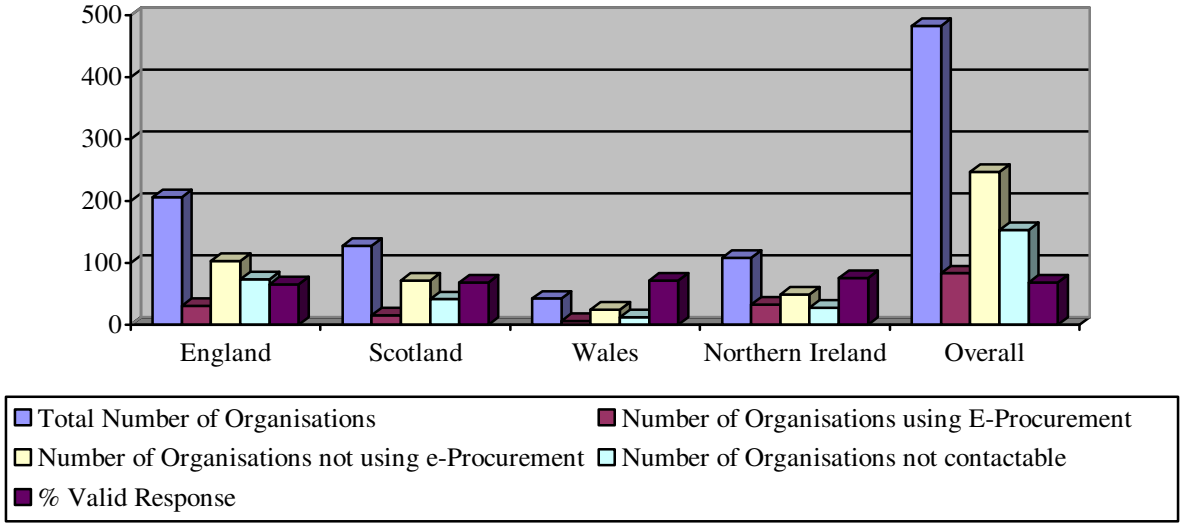

FIG. 3: E-Procurement use from main survey.

TABLE 13: UK wide Surveyors sample breakdown showing e-procurement use

Location	Total Number of Organisations	Number of Organisations using E-Procurement	Number of Organisations not using E-Procurement	Number of Organisations not contactable, no longer trading or no one available for comment	% valid response
England	206	30	103	73	65%
Scotland	127	15	71	41	68%
Wales	42	6	24	12	71%
Northern Ireland	108	32	49	27	75%
	483	83	247	153	68%

Limesurvey™, a system similar to Solomon (2001), was used on the Internet to conduct the survey in 2008. This software package collected the responses through a web-based interface and stored these in an on-line MySQL™ database. Data collected was exported directly into SPSS™ for analysis.

3.1 Sample Group for Web-based Survey

The identified organisations that carry out e-procurement were requested to complete the web-based questionnaire. Figure 4 and Table 14 provide details of the sample for web-based survey.

As some Quantity Surveying organisations have offices in all four parts of the UK, four English organisations suggested that the Belfast/ Northern Ireland office could be used to complete the survey, consequently the number of English organisations was reduced by four.

Similarly, three organisations in Scotland, two in Wales and one in Northern Ireland requested that their England based office complete the web-based questionnaire. Three multidisciplinary organisations in England and one in Wales, although originally on the RICS list as Quantity Surveyors, chose to be termed as consultants and were not retained on the list in their respective areas.

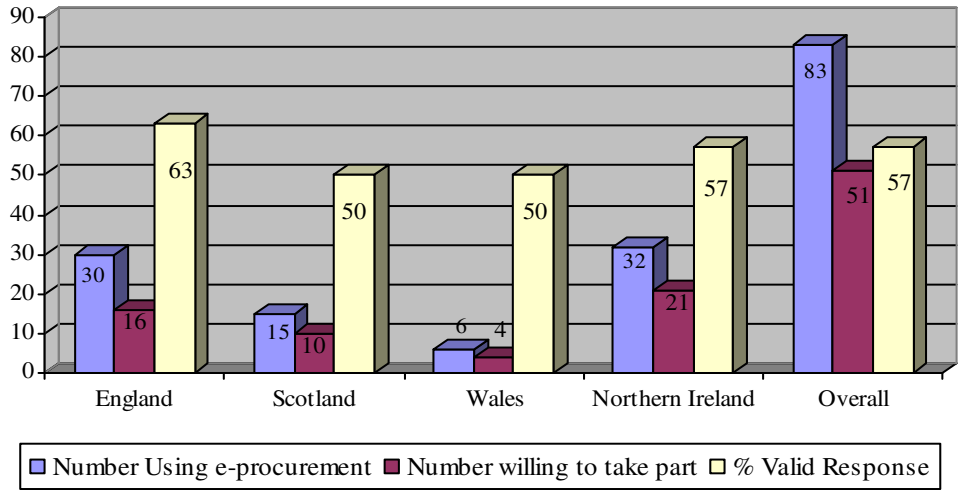

FIG. 4: Respondents to Main Survey

TABLE 14: Main Survey Surveyors validity percentages

Location	Number using E-Proc.	Number willing to take part in the Web-based survey	% of complete sample from phone survey stating willingness to complete	Number of Organisations who completed the Web-based survey	% valid response
England	30	16	53%	10	63%
Scotland	15	10	75%	5	50%
Wales	6	4	67%	2	50%
Northern Ireland	32	21	66%	12	57%
	83	51	61%	29	57%

These results show that a good level of response was achieved; it is above the 50% threshold suggested for external validity (OIG, 1997).

3.2 Analysis of Driver Results for e-procurement from Quantity Surveyors Perspective

Table 15 shows how Quantity Surveyors across the UK ranked the drivers for e-procurement identified through the verification process. After entering an importance ranking of 1 to 5 against each driver, the average of the results entered by the respondents produced an overall ranking for e-procurement. The data analysed to produce the ranking contains the individual responses from England, Scotland, Wales and Northern Ireland. Table 15 contains the drivers in rank order according to Overall Results and shows the average importance of each (Ave.Imp.). The column 'Rank A' denotes the overall ranking results for the combined sections of the United Kingdom. The column denoted 'Ave.Imp.A' gives the overall average importance of each driver when the results from all the regions/countries of the United Kingdom are combined. The column 'Rank B' denotes the segregated England results and the column denoted 'Ave.Imp.B' gives the average importance of each driver for all Quantity Surveying organisations from England. The column 'Rank C' denotes the segregated Scottish results and the column denoted 'Ave.Imp.C' gives the average importance of each driver for each Quantity Surveying organisation from Scotland. The column 'Rank D' denotes the segregated Welsh results and the column denoted 'Ave.Imp.D' gives the average importance of each driver for each Welsh Quantity Surveying organisation. The column 'Rank E' denotes the segregated Northern Ireland results and the column denoted 'Ave.Imp.E' gives the average importance of each driver for each Northern Ireland Quantity Surveying organisation.

TABLE 15: Surveyors Rank Order for Drivers for e-procurement

	Overall Results		England		Scotland		Wales		Northern Ireland	
Drivers in rank order	**Rank A**	**Ave. Imp. A**	**Rank B**	**Ave. Imp. B**	**Rank C**	**Ave. Imp. C**	**Rank D**	**Ave. Imp. D**	**Rank E**	**Ave. Imp. E**
Process, Transaction and Administration Cost Savings	1	4.20	1	4.29	7	3.33	1	5.00	1	4.50
Increased Quality through increased accuracy (Elimination of errors through Computer use)	2	3.80	3	3.86	1	4.66	18	2.00	3	3.50
Convenience of archiving completed work	2	3.80	2	4.00	1	4.66	15	3.00	12	3.00
Increased Quality through increased efficiency	4	3.67	7	3.28	1	4.66	4	4.00	3	3.50
Increased Quality through Improved Communication	5	3.60	4	3.71	6	4.00	18	2.00	3	3.50
Shortened Internal and External Communication Cycle times	6	3.53	8	3.14	1	4.66	4	4.00	7	3.25
Increasing Profit Margins	7	3.40	6	3.43	9	3.00	1	5.00	7	3.25
Service / Material / Product Cost Savings	8	3.33	5	3.57	17	2.00	4	4.00	2	3.75
Shortened Overall Procurement Cycle Times	9	3.20	12	2.86	5	4.33	4	4.00	16	2.75
Reduction in Evaluation Time	10	3.13	9	3.00	9	3.00	4	4.00	7	3.25
Gaining Competitive Advantage	11	2.93	15	2.57	7	3.33	18	2.00	11	2.93
Reduction in purchasing order fulfilment time - Contract Completion	11	2.93	14	2.71	12	2.66	4	4.00	7	3.25
Strategic Cost Savings	13	2.86	9	3.00	19	1.66	1	5.00	12	3.00
Develops the Technical Skills, knowledge and expertise of procurement staff	14	2.80	12	2.86	12	2.66	4	4.00	18	2.50
Reduction in time through increased visibility	14	2.80	20	2.14	9	3.00	4	4.00	3	3.50
Reduction in time through greater transparency (Less objections)	16	2.66	18	2.29	12	2.66	4	4.00	12	3.00
Enhanced Inventory Management	17	2.60	9	3.00	20	1.33	4	4.00	18	2.50
Increased Quality through Benchmarking (Market Intelligence)	17	2.60	16	2.43	15	2.33	4	4.00	16	2.75
Increased Quality through increased visibility in the supply chain	19	2.46	18	2.29	17	2.00	15	3.00	12	3.00
Increased Quality through increased competition	20	2.333	16	2.43	15	2.333	15	3.00	20	2.00

Overall the most important driver for UK Quantity Surveying Firms are 'Process, Transaction and Administration Cost Saving' with 'Increased Quality through increased accuracy (Elimination of errors through Computer use)' and 'Convenience of archiving completed work' ranking a joint second.

Only in Scotland did 'Process, Transaction and Administration Cost Savings' not rank as the top driver for e-procurement. The Scots ranked four of the drivers equally as the most important drivers. These were 'Increased Quality through increased accuracy (Elimination of errors through Computer use)', 'Convenience of archiving

completed work', 'Increased Quality through increased efficiency' and 'Shortened Internal and External Communication Cycle times'. This could be due to the small number of completed survey returns from Scotland as there were only five respondents.

English Quantity Surveying organisations ranked 'Convenience of archiving completed work' as their second most important driver.

'Strategic Cost Savings' and 'Increased Profit Margins' were ranked joint top in Wales. Again, because of the small number in the Welsh sample group could mean that these drivers cannot be separated.

Cost savings were the main reason in Northern Ireland that e-procurement would be adopted with 'Process, Transaction and Administration Cost Savings' and 'Service / Material / Product Cost Savings' ranking first and second, respectively.

3.3 Analysis of Barrier Results for e-procurement from Quantity Surveyors Perspective

Table 16 shows how Quantity Surveyors across the UK ranked the barriers to e-procurement identified through the verification process. The average of the results entered by the respondents produced an overall ranking for e-procurement. The data analysed to produce the ranking contains the responses from England, Scotland, Wales and Northern Ireland. Table 16 contains the barriers in rank order according to Overall Results. The column 'Rank A' denotes the overall ranking results for the combined sections of the United Kingdom. The column denoted 'Ave.Imp.A' gives the overall average importance of each barrier when the results are combined. The column 'Rank B' denotes the segregated England results and the column denoted 'Ave.Imp.B' gives the average importance of each barrier for each English Quantity Surveying Organisation. The column 'Rank C' denotes the segregated Scottish results and the column denoted 'Ave.Imp.C' gives the average importance of each barrier for each Scottish Quantity Surveying Organisation. The column 'Rank D' denotes the segregated Welsh results and the column denoted 'Ave.Imp.D' gives the average importance of each barrier for each Welsh Quantity Surveying Organisation. The column 'Rank E' denotes the segregated Northern Ireland results and the column denoted 'Ave.Imp.E' gives the average importance of each barrier for each Northern Ireland Quantity Surveying organisation.

TABLE 16: Surveyors Rank Order for Barriers for e-procurement

	Overall Results		England		Scotland		Wales		Northern Ireland	
Barriers in rank order	**Rank A**	**Ave. Imp. A**	**Rank B**	**Ave. Imp. B**	**Rank C**	**Ave. Imp. C**	**Rank D**	**Ave. Imp. D**	**Rank E**	**Ave. Imp. E**
Prevention of Tampering with Documents - changes to documents	1	3.86	10	3.43	1	4.33	10	3.00	1	4.50
Reluctance to 'Buy-into' one off systems	2	3.53	1	4.28	3	3.67	10	3.00	22	2.25
Enforceability of Electronic Contracts	3	3.46	10	3.43	3	3.66	1	4.00	9	3.25
Proof of intent - electronic signatures	3	3.46	10	3.43	5	3.33	1	4.00	6	3.50
Insufficient assessment of systems prior to installation	3	3.46	5	3.86	2	4.00	10	3.00	19	2.50
Confidentiality of Information - unauthorised viewing	6	3.40	13	3.28	9	2.67	10	3.00	2	4.25
Lack of a widely accepted e-procurement software solution	6	3.40	13	3.28	16	2.33	1	4.00	2	4.25
Lack of a national IT policy relating to E-Procurement Issues	6	3.40	7	3.57	21	2.00	1	4.00	4	4.00
Resistance to change	6	3.40	2	4.00	9	2.67	1	4.00	13	2.75
Security in the process - Data transmission to the wrong person	10	3.33	13	3.28	16	2.33	1	4.00	4	4.00
Internal and External interoperability of e-procurement software	11	3.26	2	4.00	16	2.33	27	2.00	10	3.00
Investment in compatible systems	11	3.26	2	4.00	7	3.00	10	3.00	22	2.25

Lack of publicity / awareness of best practice solutions	13	3.13	7	3.57	9	2.67	10	3.00	13	2.75
Data Transmission reassembly - incorrect reassembly of data transmitted in packets	14	3.06	17	3.14	16	2.33	10	3.00	6	3.50
Partial Data Display - incomplete documents provided	15	3.00	19	3.00	9	2.67	27	2.00	6	3.50
Lack of technical expertise	15	3.00	5	3.86	24	1.67	10	3.00	19	2.50
Lack of Flexibility	17	2.93	7	3.57	28	1.33	10	3.00	10	3.00
Information Technology Investment Costs	18	2.86	19	3.00	5	3.33	1	4.00	24	2.00
Bureaucratic dysfunctionalities	18	2.86	13	3.28	21	2.00	10	3.00	13	2.75
Magnitude of Change	18	2.87	17	3.14	21	2.00	1	4.00	13	2.75
Upper Management Support / Lack of Leadership	21	2.60	19	3.00	9	2.67	10	3.00	27	1.75
Lack of Pertinent case law	22	2.53	25	2.43	9	2.67	10	3.00	19	2.50
Other Competing Initiatives	23	2.40	28	2.28	7	3.00	10	3.00	24	2.00
Clarity of Sender and Tenderer Information	23	2.40	25	2.43	24	1.67	10	3.00	13	2.75
Lack of a forum to exchange ideas	25	2.33	28	2.28	28	1.33	10	3.00	10	3.00
Different national approaches to e-procurement	26	2.26	30	1.71	16	2.33	1	4.00	13	2.75
Perception of no Business Benefit Realised	26	2.26	22	2.86	24	1.67	27	2.00	27	1.75
Complicated procedures and extended relationships	26	2.26	24	2.57	24	1.67	10	3.00	24	2.00
Company Access to the Internet	29	2.22	25	2.43	9	2.67	10	3.00	30	1.25
Staff Turnover	30	2.13	22	2.86	28	1.33	27	2.00	29	1.50

Overall the most important barriers for UK Quantity Surveying Firms are 'Prevention of Tampering with Documents - changes to documents', followed by 'Reluctance to 'Buy-into' one-off systems'. The latter is ranked as the most important barrier in England. This shows that multiple systems for multiple clients have proved to be a major barrier to the implementation of e-procurement in the past. The adoption of an industry wide system would overcome this barrier. Eadie et al (2007) found that in the Northern Ireland study for e-procurement from a contractor perspective that security was one of the major barriers. This is further borne out by the findings of this study where overall the protection against changing documentation is ranked top from a Quantity surveyors perspective.

In England, Quantity Surveyors ranked 'Resistance to change', 'Internal and External interoperability of e-procurement software' and 'Investment in compatible systems' jointly as the second most important barriers to e-procurement in construction.

In Northern Ireland, 'Confidentiality of Information - unauthorised viewing', and 'Lack of a widely accepted e-procurement software solution' are jointly ranked second. Again from a Northern Ireland perspective the Quantity Surveyors have agreed with the findings of the earlier Eadie et al (2007) study of contractors. The latter of these two barriers may soon be resolved with both the government organisations and the Royal Institution of Chartered Surveyors (RICS) promoting BravoSolutions as an industry-wide way forward (BravoSolution, 2008).

4. SUMMARY OF CONCLUSIONS

This paper aimed to produce a complete list of verified drivers and barriers to construction e-procurement. A list of 21 drivers and 31 barriers were compiled using an extensive literature review on general e-procurement drivers and barriers from other domains (Table 1 and Table 2). A domain expert group verification process was devised to verify the applicability of these general drivers and barriers to e-procurement in the construction industry. The Delphi method was used by a group of industry experts to achieve consensus on the composition of

a verified list of drivers and barriers to e-procurement. A verified list of 20 drivers and 30 barriers were presented in Table 11 and Table 12.

The second objective of this paper was to investigate and compare the perception of Quantity Surveying organisations as to the importance of each of these drivers and barriers to construction e-procurement. This resulted in a ranked list of drivers and barriers produced and compared according to each region/country with UK (Table 15 and Table 16).

The most important driver for UK Quantity Surveying Firms is 'Process, Transaction and Administration Cost Savings' with 'Increased Quality through increased accuracy (Elimination of errors through Computer use)' and 'Convenience of archiving completed work' ranking a joint second. This confirms the findings of the Northern Ireland Contractor pilot study, Eadie et al (2007) where 'Price reduction in tendering' was ranked as the most important driver from a contractor perspective. This shows that both Quantity Surveyors and Contractors agree on this being vital to the successful implementation of any e-procurement system.

'Increased Quality through increased accuracy' was an additional driver identified through the validation process which was not investigated in the Northern Ireland Contractor study but shows the importance of using computerised methods to achieve a better quality product. Hore et al (2006) suggested a move toward e-tendering as a way of improving quality and decreasing the risk of costly mistakes.

The most important barriers for UK Quantity Surveying Firms are 'Prevention of Tampering with Documents - changes to documents', followed by 'Insufficient assessment of systems prior to installation' and 'Confidentiality of Information - unauthorised viewing'. These two barriers are included in the 'Unsure as to the Legal Position of e-procurement' ranked top in the Northern Ireland Contractor study (Eadie et al, 2007) therefore confirming that the findings of that study apply to both contractors and Quantity Surveyors.

Further work is being carried out to evaluate cross-discipline comparison of views on ranking of drivers and barriers to e-procurement within the construction industry and to develop a capability maturity model to assess organisations level of maturity in e-procurement.

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