

6 AWARENESS OF INFORMATION STANDARDISATION IN THE UK CONSTRUCTION INDUSTRY: A PRELIMINARY SURVEY BY THE SIENE NETWORK

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Abstract:

The Network on Information Standardisation, Exchanges and Management in Construction (SIENE) was launched to streamline information standardisation and interoperability in the construction industry. SIENE is represented by academia and industry from UK and overseas. Its main objective is to benchmark UK performance in information standardisation with the rest of the world.

The paper deals with the results of a preliminary survey conducted by SIENE in the UK construction industry on awareness of information standardisation. Forty members of the Construct IT, Centre of excellence in UK were selected as the initial target audience for the survey.

The paper discusses the different information standards, which are available and presents a synthesis of usage and awareness of information standards in the UK construction industry. It highlights how the construction industry could benefit by adopting information standards while providing an account of the barriers that prevent the adoption of standards.

It is expected to broaden the study by exploring the status quo with regard to information standardisation in other countries through the overseas members of the network to benchmark UK performance.

Keywords: *Information standardisation, interoperability, awareness*



INTRODUCTION

The Network on Information Standardisation, Exchanges and Management in Construction (SIENE) was launched in March 2000 to streamline information standardisation and interoperability in the construction industry. It is an international network consisting of academics and industry practitioners from UK and overseas. The project is funded by the Engineering and Physical Sciences Research Council (EPSRC) under the Innovative manufacturing Initiative (IMI). The main source of knowledge gathering is through workshops conducted in the UK. The website of SIENE ([Http://www.scpm.salford.ac.uk/siene](http://www.scpm.salford.ac.uk/siene)), also provides opportunity for the members and other participants to network. SIENE's main objective is to explore current research being undertaken in the area of information standardisation and overall interoperability and to benchmark UK performance with the rest of the world. It investigates potential business benefits of adopting information standards and barriers that prevent the adoption.

Information sharing and exchange in other industries such as banking, retail and manufacturing has been fairly widespread. The construction industry has shown a slow response to it mainly due to the industry's complex interrelationships between different participants (Grilo, 1998). However the past few years have recorded notable developments in this field mainly due to pressures imposed by clients, who desire more productive work and demand more value for money. Egbu (1999) has pointed out that some government initiatives have intensified efforts towards supporting the rate and direction of innovation in construction. Production of three major reports from 1994 – 1998: the Latham report (1994), the UK technology foresight report (1995) and the Egan report (1998) has fuelled the intensification of effort in this direction. Funding for SIENE under IMI as mentioned earlier, has also been initiated as one of many programmes to support innovation in construction.

At one of SIENE's workshops, it was noted that firms in the construction industry did not have a clear understanding of business benefits that could be gained from information standardisation and interoperability. Therefore it was the view of the SIENE members that enlightening the industry with the benefits and barriers in adopting information standards will induce them to make long-term commitments towards adopting standards. Through elaborate discussions at the workshops and follow up meetings, the benefits and barriers of information standardisation were documented. It was also proposed to conduct an industrial survey in UK on the awareness and usage of information standards.

The paper attempts to disseminate:

- The results of the workshop on benefits and barriers and;
- The preliminary results of the industrial survey conducted on usage and awareness of information standards

The rest of the paper is structured as follows: First the different types of standards covered in this paper will be introduced which will be followed by the benefits and barriers of adopting information standards. Next the details of the industrial survey will provide an insight into the current status of the industry in relation to awareness of information standards. The final section of the paper deals with the conclusions and the way forward.

TYPES OF INFORMATION STANDARDS:

The paper deals with the following technologies for information standardisation and their applications in the construction industry. The results of the industrial survey also deal with the usage and awareness of the following information standards.

- Exchange of structured business data [Electronic Data Interchange (EDI)]
- CAD based exchange of files using DXF and DWG standards (traditional method)
- Product or Object Based exchange of information – STEP and the development of Industry Foundation Classes (IFC) in construction.
- Exchange of electronic documents based on Extended Markup Language (XML) and web standards.

Review of literature on the above-mentioned standards; demonstrate how they could be applied in the construction industry.

Electronic Data Interchange (EDI)

EDI is the direct transfer of structured business data such as payments, receipts, requisitions etc, between firms by electronic means. EDI has been very successful in a number of industries that have very high transaction volumes (e.g. banking, retail and manufacturing industries). Impact of EDI on construction has been limited to exchange of one or two types of information with very limited integration and largest users of EDI in the construction industry have been builder's merchants, material suppliers and manufactures. (Grilo, 1998). However it was also found that many of these firms were using EDI as a mechanism to have links with firms from outside the construction industry. Generally automobile manufacturing firms use EDI to transact with their supply chain partners and their suppliers are sometimes forced to change their systems to comply with the standards or lose their share in the market to competitors who have better systems of integration.

File Transfer using DXF and DWG Formats

These are traditional file formats of most CAD packages. Traditionally participants in the construction industry who used CAD based software to design building and civil engineering structures used DXF and DWG file formats to transfer design details and drawings electronically. However there was very little integration brought about by these electronic file transfers, but this form of exchange marked the beginning of information sharing and exchange in the construction industry. Problems encountered in file transfers based on these traditional methods necessitated standards to be developed. The need to seek universal standards for information sharing and exchanges made some researchers in construction venture across other industries to search for best practices in information standardisation. The drive for information standardisation in construction has also formed various interest / research groups in many parts of the world.

Standard for Exchange of Product Model Data (STEP) and Industry Foundation Classes (IFC)

The development of product models such as IFC in construction has been influenced to a great extent by successful adoption of STEP in many other industries. Work on STEP started in 1984. It is concerned with the transfer of product data mainly in manufacturing and retail industries. (Wix et al, 1999). Although STEP considered the construction industry under its team 12 in their organisation, developments in object modelling in the construction industry were spearheaded by the International Alliance for Interoperability (IAI). IAI, specifies how physical objects such as doors, windows, walls etc., and abstract concepts such as space, organisation etc., in a constructed facility should be represented electronically through its development of Industry Foundation Classes (IFC) ([Http://www.bre.co.uk/iai](http://www.bre.co.uk/iai)). IFC represent a data structure, which facilitates sharing data across applications giving each professional in the construction industry the opportunity to define their own view about the objects. Software is being developed based on the universal IFC specifications to create specific applications in the construction industry. For example a fan object created in one application (e.g. by an architect) can be exchanged with and used in another IFC compliant application (e.g. by an electrical services engineer), which enables application integration.

There are three possible ways to share data using IFC: ([Http://www.bre.co.uk/iai](http://www.bre.co.uk/iai))

- Exchange of files by email or physical medium. (files attached to emails or in diskettes).
- Using shared databases.
- Use of software interfaces.

Presently most software applications share information using physical files. As mentioned earlier, CAD files which are according to DXF and DWG could be transferred between different users according to this method. Data could also be transferred and shared using a database. The main thrust of IFC development is in the area of software interface development for information sharing and exchange.

Extensible Markup Language (XML) and Web Standards

XML integrates data from different sources that are dispersed and exist in a variety of formats. XML markup maintains the intelligence of the data all the way through a processing chain. Therefore data can be retrieved from several sources, combined and customised and sent to another level for processing. The difference between IFC and XML is mainly on the volume of information handled. The former is about sharing project information in large volumes whereas the latter concerns transactions in smaller volumes. According to the World Wide Web Consortium (W3C), developments in XML started in 1996 and it became a W3C standard in 1998. Since XML is a W3C technology, it is license free; therefore software can be built around it without paying any fees. Several research groups have been involved in the development of XML, in the construction, but in terms of regions there are two main groups who are heavily involved in the development process. The group in United States is known as aecXML and the group in Europe is known as bcXML (under the eConstruct project). Both aecXML and bcXML have thus become web standards. In both cases, it is recognised that there is diversity in national and local regulations which give rise to conflicts in information flows in different regions.

The current Internet language, HTML only supports free form data exchange. Under the eConstruct project it will develop the Internet so that XML based structured information could be exchanged between architects, engineers, suppliers, contractors and sub contractors. Therefore the web standard developed called bcXML could facilitate information exchanges within the European construction industry using the Internet as a common platform for user access. Work on the eConstruct project is currently progressing. ([Http://www.econstruct.org](http://www.econstruct.org)).

Literature pertaining to traditional methods of information exchange and new developments in information standardisation has been reviewed to present the latest technologies available for construction firms. However it is the view of SIENE members that most firms are unaware of the benefits of standardising information exchanges. The listing of the benefits of information standardisation and the barriers will help the construction firms in deciding to make long term commitments. The next section briefly explains and lists out benefits and barriers of information standardisation.

BENEFITS AND BARRIERS OF INFORMATION STANDARDISATION

The benefits and the barriers of information standardisation were discussed at the second SIENE workshop held at University of Loughborough in July 2000. Fourteen members representing industry and academia participated in the workshop. The members were able to discuss the current use of information standards, their benefits and barriers. The benefits and the barriers could be listed out as follows ([Http://www.scpm.salford.ac.uk/siene](http://www.scpm.salford.ac.uk/siene)):

Benefits

- Savings in time and costs due to elimination of re-work during design and construction phases. Similar data is keyed once and accessed by many parties who operate different applications in a project. Clash detection mechanisms, which are being developed, will prevent conflict of information between different users.
- Improved integration and communications within, project teams results in productivity increase.
- Quicker and more efficient building-up of project team relationships as the standards, which are being followed are common.
- Efficient working of distributed virtual project teams being enabled due to extensive communication links and standards.
- Reduction of software development costs, as software developers have to comply with agreed standards.
- Quality of decision-making and organisational learning improved due to re-use of knowledge.
- Greater (human) focus on the critical issues due to the high potential for automation of appropriate tasks.
- Greater operational flexibility and confidence enhances the ability to cope up with added tasks than ever before.

Barriers

- Uncertainty surrounds the legal position regarding exchange and sharing of information and is therefore delaying industry take up.
For example in exchanging drawing data, the lines in the drawings can be shown differently on received drawings than on the sent version, text fonts and size can differ, units can be interpreted differently on different systems etc., (AEC3, 1999).
- Communication of the need for standardisation is poor in the industry and there exists a lack of initiative by top management in tackling the cultural changes necessary within businesses, to adopt standards.
- Short-term project focus and varying client requirements are limiting standard solutions being introduced across businesses.
- The company size is also proving a limiting factor. (Implementing standards in SME's is relatively easy compared to large companies in terms of large volumes of procedures that are in place)
- Some technical issues serve to obstruct standardisation. E.g. computer hardware and software between supply chain partners may not be compatible to implement standards. Therefore businesses' existing IT infrastructure limits ability to change and invest in new systems.
- Companies do not have a mature set of business processes on which information standardising systems can be based. Understanding of this vital need is lacking in the industry.

The members argued that the industry lacks a proper understanding of the subject and is unaware of benefits available through standardisation. Therefore it was suggested that a survey should be carried out encompassing a wider cross section of the industry to investigate the awareness and usage of information standards. Corrective measures can be implemented based on survey results. The next section discusses preliminary results of the industrial survey.

THE AWARENESS AND USAGE OF INFORMATION STANDARDS IN THE INDUSTRY

The Industrial Survey

A questionnaire was designed to investigate the awareness of information standards in the construction industry of UK. It was decided to select forty members of the Construct IT, Centre of Excellence, UK as the initial target audience for the survey. The selected sample consists of contracting organisations, consultancy firms, IT companies and a few other firms and institutes. Twelve questionnaires were returned with a return rate of 30%. Among the companies, which responded to the questionnaire survey, there were seven contracting companies, four consulting companies and an industry data exchange service provider.

Contact personnel in the companies for the questionnaire survey were either the top management or senior management in their respective IT departments, therefore their level of knowledge expected to provide responses was acceptable for the purpose of validity of the survey results. The questionnaire obtained responses based on the following subheadings

1. Awareness of any business benefits of adopting information standards
2. Extent of priority in adopting information standards.
3. Willingness to invest on information standards.
4. The organisation having the necessary procedures to adopt information standards
5. Familiar standards
6. Adopted standards
7. Problems faced in adopting the standards
8. Approx. time taken to adopt the standards
9. Actual business benefits.
10. Future standards contemplated.
11. Sources of collecting information on standards.
12. Familiarity of websites dealing with information standards.
13. Major drivers for adopting information standards

The questionnaire and the analysis of responses under the above sub headings are included in the appendix.

Analysis and Discussion

Although 92% of the firms were aware of the benefits of information standardisation, the level of priority attached to it varied from very low to very high with three firms pointing out that their organisations give a very high priority to information standardisation among other agendas of the organisation. The companies surveyed, belong to different sizes but 92% of them stated that they are willing to invest in adopting information standards. This shows their extreme enthusiasm in adopting standards irrespective of the firm size. Ten of the firms have already adopted at least one type of standard. File exchanges using DXF format was the most popular (as expected) among the standards already adopted. Seven firms have already adopted DXF for file exchanges and have realised that there are various integration problems involved in using it. Four firms were already engaged in EDI. Only a single firm has embraced the IFC in the CAD software that they use. But XML and web standards have been adopted by 4 firms and 5 firms respectively. However the level of adoption of XML and web standards is not clear from the questionnaire survey. It requires an in depth study to reveal more details about the level of adoption of the standards. The actual adoption of various standards among the companies is shown below in fig 1.

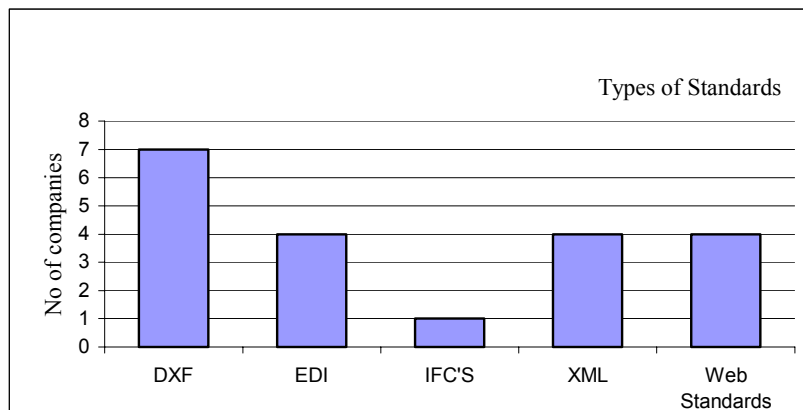


Fig 1 - Adoption of Information Standards

Six firms mentioned that they have gained actual business benefits out of adopting information standards. The benefits, which they mentioned in their responses, are as follows: (in no particular order)

1. Reduced discussion time.
2. Simplified project implementation
3. Easier information flow between supply chain partners
4. Improve the quality of production information available to site teams.
5. Reduction in wastage and abortive effort. E.g. £600,000 savings to client on an £18 million project.
6. Increase in the speed of sharing design data.
7. Provided a platform for open information exchange across the construction industry.

It was the view of 58% of the firms, that the lack of motivation among the supply chain partners was a major barrier in implementing information standards. Standards have to be implemented throughout the supply network for the benefit of all the parties. The message has to be communicated to all parties in a firm's supply network. Six firms believed that they don't have the proper procedures in place for the information exchanges to take place. This is a problem that has to be addressed along with the development of standards, as lack of proper internal procedures will make the developed standards difficult to implement.

About 75% of the respondents stated that the latest details on information standards are collected through competent employees of the organisation, who have access to the Internet and who are sent on training programmes, workshops and conferences on a regular basis. Seven firms cited technical literature as a source of obtaining information on information standards. However the inadequacy of refereed journal articles or academic research on this subject is quite evident as only a single firm listed them as source of information. Either the employees don't have access to these materials or they are sparsely available. A few companies noted that the following websites provided them with the latest details on information standardisation:

1. aecxml ([Http://www.aecxml.org](http://www.aecxml.org))
2. BASDA
3. bcxml ([Http://www.bcxml.org](http://www.bcxml.org))
4. CITE ([Http://www.cite.org.uk](http://www.cite.org.uk))
5. IAI ([Http://www.bre.co.uk/iai](http://www.bre.co.uk/iai))
6. STEP
7. CEFACT / EDIFACT
8. eCenter, UK.
9. RIBA (Classification)

A very high percentage of the respondents to the survey (83%) consider adopting information standards as a major contributor for achieving competitiveness and profitability, which are organisational goals. However demands by individual and corporate clients also impact to a great extent (67%) in adopting information standards. Some firms have commented that they closely monitor developments in IFC, XML and web standards to be able to adopt them as soon as they are available on software platforms.

CONCLUSIONS AND THE WAY FORWARD

It was noted that current developments in information standards in construction have centred on the traditional file transfer formats and to a lesser degree on EDI. The latest developments such as IFC, XML have not impacted much on construction firms as a lot of work is currently in progress in many countries. However firms have realised (based on a sample of 12 firms) the potential of information standards and what benefits they can accrue out of them and some firms keep a close eye on the developments so that they can adopt them as soon as the standards are available. A very high percentage of the firms have also realised that without having proper internal procedures (which could be extended to proper project procedures) adopting standards will not be a meaningful exercise.

It is expected to do a more in-depth research on this subject by conducting few case studies on construction firms, which will help to paint a picture in the construction industry on status of information standardisation. The firm that realised a major business benefit (£600,000 saving on an £18 million project), which was mentioned earlier, has already expressed their willingness to provide more information on the project to conduct a case study. It is also expected to widen the scope of the study to investigate the status in other countries. Such a detailed comparative study will enable SIENE to perform a benchmarking exercise on the status in information standardisation in the UK construction industry.

REFERENCES

1. AEC3 (1999), "Applying IT strategies in the AEC / FM industry, discussion paper.
2. Egbu, C. (1999), "Innovations in construction – lessons learned from four innovative organisations", in Baldry D. and Ruddock L (Eds), Proceedings of the COBRA 1999, September 1999.
3. Grilo, A. (1998), "Development of electronic trading between construction firms", PHD thesis (unpublished).
4. [Http://www.bre.co.uk/iai](http://www.bre.co.uk/iai)
5. [Http://www.econstruct.org](http://www.econstruct.org)
6. [Http://www.scpm.salford.ac.uk/siene](http://www.scpm.salford.ac.uk/siene)
7. Wix, J., Bloomfield, B. and Amor, R. (1999), "Development and adoption of standards for interoperability: Business benefits of standards for information exchange and sharing", BRE 48/99.

□ Appendix – The Questionnaire

Questionnaire on Awareness and Usage of Standards for Information Exchanges in Construction

Name of the Contact Person: (Prof./Dr./Mr./Ms.):

.....

7 Designation:.....

Name of the Company:

Address: Tel:

..... Fax:

.....Postcode: Email:

Please tick (√) the appropriate box wherever applicable

1. What is the category, which best describes the type of your organisation?

Contracting

Consulting

Client

Supplier

Other

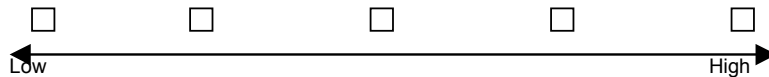
Please state:

2. Is your organisation aware of the benefits of adopting standards for data / information exchanges?

Yes

No

3. What is the extent of the priority that your organisation attaches in adopting information standardisation? (Please tick the appropriate box on the sliding scale)



4. Is your organisation willing to invest in adopting standards?

Yes

No

5. Does your organisation have the necessary procedures in place to adopt information sharing?

Yes

No

6. Please select the type / s of technologies for information standardisation which the organisation is familiar with.

DXF

EDI

STEP

IFC's

CORBA

- XML
- Web Standards
- Question not relevant to our organisation

7. Please Select from the list below the type / s of technology / ies for information standardisation that your organisation has already adopted and the relevant year/ s of adoption.

Year

- DXF —————▶
- EDI —————▶
- STEP —————▶
- IFC's —————▶
- CORBA —————▶
- XML —————▶
- Web Standards —————▶

If you have selected at least one option in Question 7 above please answer question 8, 9, 10, 11 and 12, if not go to question 13.

8. What problems did your organisation face in adopting the standards?

- Lack of training
- Legal and copyright issues
- Very high costs
- Lack of emphasis by supply chain partners
- Other
- Did not face any problems

Any Additional Comments:

.....

4. Briefly explain the steps taken by your organisation to overcome the problems (if any).

.....

.....

5. How long did it take for the organisation to implement the standards, which you have mentioned in question (7) above?

- 0 – 6 months
- 6 – 12 months
- more than 12 months

11. Did your organisation gain any business benefits from implementing standards?

- Yes No

12. If so briefly explain below the benefits that your organisation gained from adopting the standards. (If possible please support your answer with financial figures)

.....
.....

13. Please select from the list below the type of standards that your organisation is intending to adopt in the near future and the projected year / s of the adoption taking place.

Year

- DXF _____>
- EDI _____>
- STEP _____>
- IFC's _____>
- CORBA _____>
- XML _____>
- Web Standards _____>
- Not yet contemplated in adopting standards

14. Name the sources from which your organisation collects information on adopting standards

- In-house staff
 - Referred Journals
 - Technical Literature
 - Supply Network
 - The internet
 - Workshops and Conferences
 - Other
Please state
 - No sources available
-
.....
.....

11. If it is relevant please explain the dissemination process (with respect to adopting data standardisation) within your organisation.

.....
.....

12. Is your organisation familiar with any web sites, which deal with information standardisation?

- Yes No

13. If your answer to question 16 is “yes”, please mention the web sites below. (If there is more than one answer please rank the web sites according to the order of importance)

.....
.....

14. According to your opinion what drives (or what will drive) your organisation in adopting information standardisation?

- Increase Productivity and profitability of projects
- To become more competitive in the industry
- The supply network
- Clients
- The fear of being left behind
- Other

Please state

.....

.....

.....

NOTES TO APPENDIX

Note 1 - Types of Standards covered in the questionnaire

- 1 - DXF
- 2 - EDI
- 3 - STEP
- 4 - IFC
- 5 - CORBA
- 6 - XML
- 7 - Web standards
- 8 - Not Applicable

Note 2 - Sources of collecting information on standards

- 1 - In-house staff
- 2 - Refereed journals
- 3 - Technical literature
- 4 - The supply chain
- 5 - The Internet
- 6 - Workshops and conferences
- 7 - Other
- 8 - No sources available

Note 3 - Major Drivers for adopting information standards

- 1 - Increase productivity and profitability of projects
- 2 - To become more competitive in the industry
- 3 - The supply chain
- 4 - Clients
- 5 - The fear of being left behind
- 6 - Other

APPENDIX - Analysis of Data

Company Heading	1 Company A Cont	2 Company B Cont	3 Company C Cont	4 Company D Cons	5 Company E Cont	6 Company F Cons	7 Company G Cont	8 Company H Cons	9 Company I Cons	10 Company J Cont	11 Company K Cont	12 Company L Other
1. Awareness of business benefits of adopting information standards	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
2. Extent of priority in adopting information standards. (1 - 5) - Very Low to Very High	4	2	5	5	1	4	N/A (2)	2	3	4	2	5
3. Willingness to invest on information standards	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
4. The organisation having the necessary procedures to adopt information standards	Y	N	N	Y	N	Y	N	Y	N	Y	Y	Y
5. Familiar standards (see note 1)	1, 2, 6	3, 4, 7	2, 6, 7	1, 2, 4, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 6, 7	2, 6	1	1	1, 2	1, 2, 3, 4	2, 4, 6, 7
6. Adopted standards (see note 1)	1, 2	7	6, 7	1, 2, 4, 6, 7	1, 6, 7	none	none	1	1	1, 2	1	2, 6
7. Problems faced in adopting the standards	supply chain	high costs, supply chain	supply chain	supply chain	supply chain	N/A	N/A	lack of training, supply chain	no problems faced	supply chain	no problems faced	no problems faced
8. Approx. time taken to adopt the standards	0-6 months	> 12 months	> 12 months	0-6 months	0-6 months	N/A	N/A	0-6 months	no comment	6 - 12 months	6 - 12 months	0-6 months
9. Actual business benefits	Y	Y	Y	Y	Y	N/A	N/A	N	no comment	Y	no comment	Y
10. Future standards contemplated (see note 1)	none	2, 6	none	none	none	no comment	6	none	7	6, 7	2, 4, 6	2, 4, 6
11. Sources of collecting information on standards (see note 2)	1, 4, 5, 6	1	1, 4, 6	2, 3, 5, 6	1, 3, 6	1, 3, 6	1, 6	3, 5, 6	1, 3, 5, 6	3, 4, 6	1, 3, 6	1, 3, 4, 5, 6
12. Familiarity of websites dealing with information standards	N	N	N	Y	Y	N	N	Y	N	Y	Y	Y
13. Major drivers for adopting information standards (see note 3)	1, 4	5, 6	1, 2, 3, 4	1, 3, 4	1, 3, 4	1, 2	1, 2	1, 3, 4	6	1, 2, 3, 4	1, 3, 4	1, 3, 4, 5