USE OF IT IN MANAGING INFORMATION AND DATA ON CONSTRUCTION PROJECTS – A PERSPECTIVE FOR THE IRISH CONSTRUCTION INDUSTRY

Alan Hore[1]

[1]School of Real Estate and Construction Economics, Dublin Institute of Technology, Bolton Street, Dublin 1, Republic of Ireland. E-mail: alan.hore@dit.ie.

ABSTRACT

The use of ICT in construction has been sporadic and piecemeal. Very significant inefficiencies and problems still exist in both paper transactions and non-integrated electronic solutions. Despite over two decades of significant advancements in ICT, the adoption of ICT Irish construction industry has been largely piecemeal. This paper will seek to highlight the key drivers, opportunities for the electronic support of the construction process together with currently available ICT applications to support the construction process. The paper will finally progress to reflect on the role of the Construction IT Alliance (CITA) in addressing the potential of ICT in the Irish construction sector.

1.0 INTRODUCTION

There are many millions of documents (such as drawings, specifications, bills of quantities, correspondence, schedules, programmes) currently exchanged on paper between practitioners in the Irish construction industry. It is commonplace that each of these documents are subsequently re-keyed, photocopied and filed, as they pass between different locations and computer applications (Hore and West, 2005a).

At present the extent of use of Information Communication Technology (ICT) in the Irish construction industry is relatively unsophisticated, mainly dependent on telephone, facsimile machines and networked personal computers. At the simplest level, the electronic transmission of business documents offers savings in paper and postage. By going a step further, businesses can make strides in communicating with their partners, at relatively low cost, through direct links between their computers (Hore and West, 2005b).

Competition from international firms as a result of increased globalisation has prompted a renewed focus on improving general performances within the construction industry, both in Ireland and in the United Kingdom (CICA, 1993; CICA, 1996; Building Centre Trust, 1999). Grant (1998) reflected on what was occurring in other industries,

with a focus on faster time to market, better quality and service and better control of risk and costs. The difference is that such changes have taken longer to affect the construction industry (Sun and Aouad, 2000). Market forces have put increased pressure on both construction industry practitioners and academia to try and identify the factors that stand in the way of achieving this performance improvement. A key question that is often asked is why, when other industries have successfully made use of ICT, construction has been so slow to do the same (Latham 1994; Egan 1998; Capron, 2000; Sun and Aouad 2000).

2.0 KEY DRIVERS FOR CHANGE

The nature of the construction industry is different to other industries, such as the manufacturing or retail sector, where processes and the working environment are well defined and controlled (Gann, 1996). The temporary nature and uniqueness of construction projects is reflected in one-off locations, one-off designs solutions and one-off project teams, which leads to a very fragmented communication platform (see Figure 1). This has lead to poor communication and inefficient information practices that have contributed to the emergence of dysfunctional supply chains (Love et al., 1999).

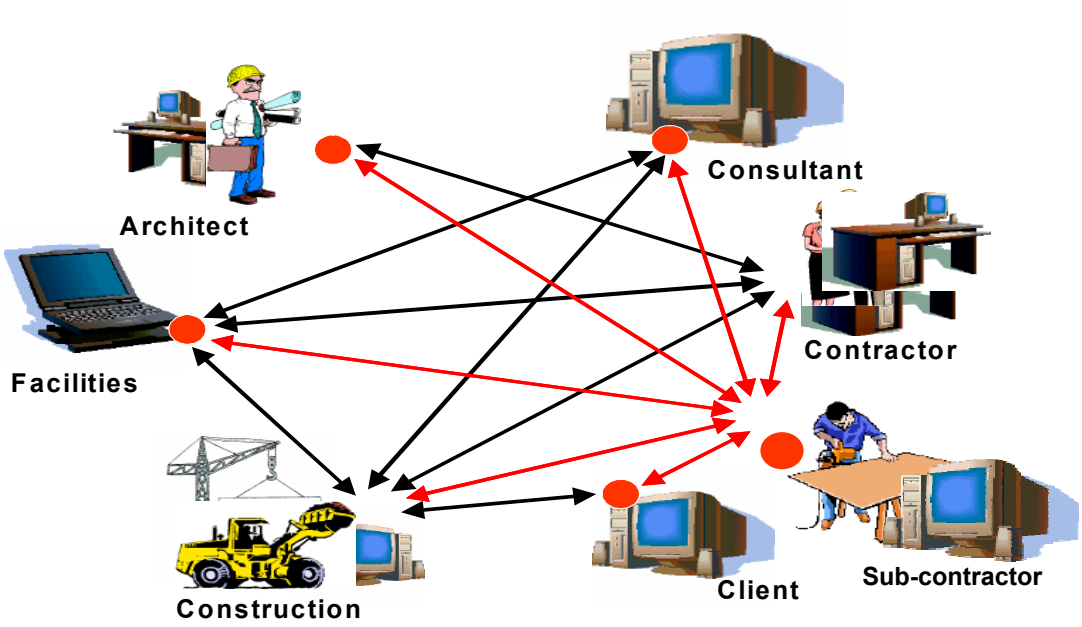

Figure 1. Fragmented nature of the construction industry (Sarshar et al., 2000)

This, in turn, has created challenges for the application of ICTs in the Irish construction industry. It is now becoming accepted that the preferred communication model for managing information on a construction project should be based on a central project model, through which, all the information is disseminated (Figure 2). A common tool used is a project extranet.

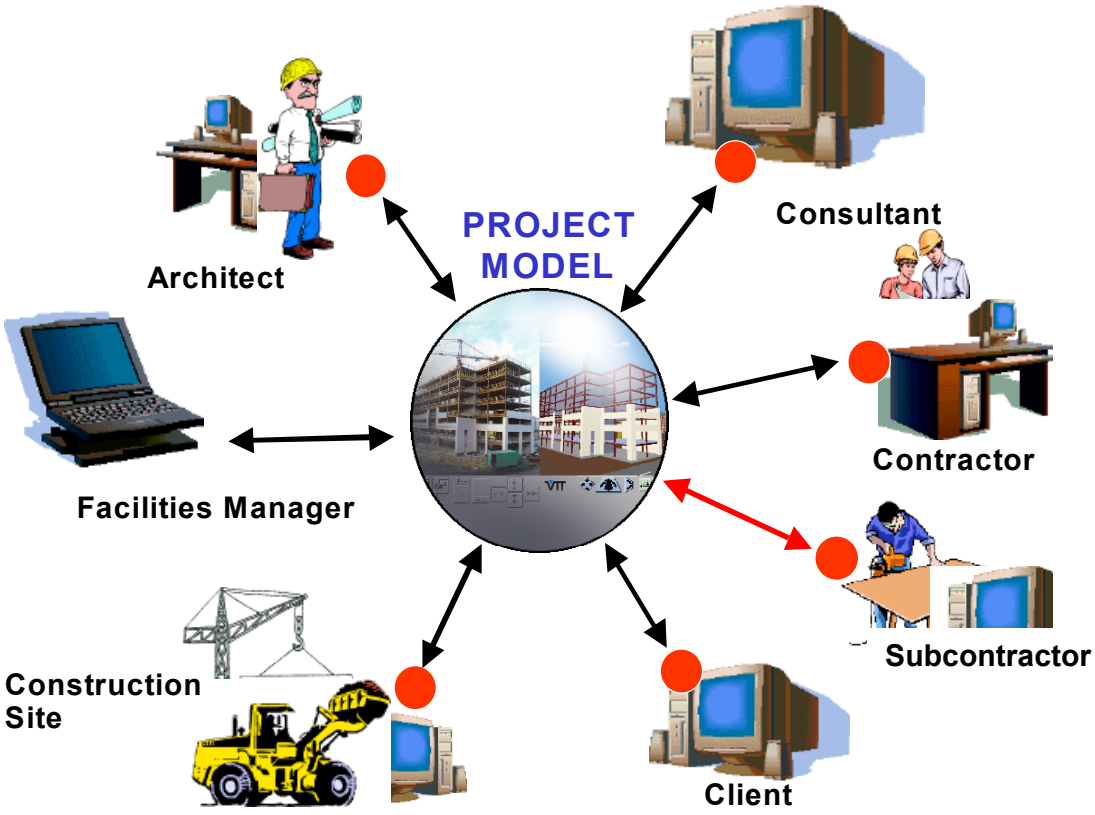

Figure 2. Preferred communication model for construction (Sarshar et al., 2000)

3.0 OPPORTUNITIES FOR ELECTRONIC SUPPORT IN CONSTRUCTION

Construction sectors in many countries around the world are increasingly recognising the importance of ICT. ICT is improving the capability and efficiency of specific aspects within the construction process. It also has the potential to vastly improve communication

throughout the construction process (see Figure 3) through electronic dissemination of information.

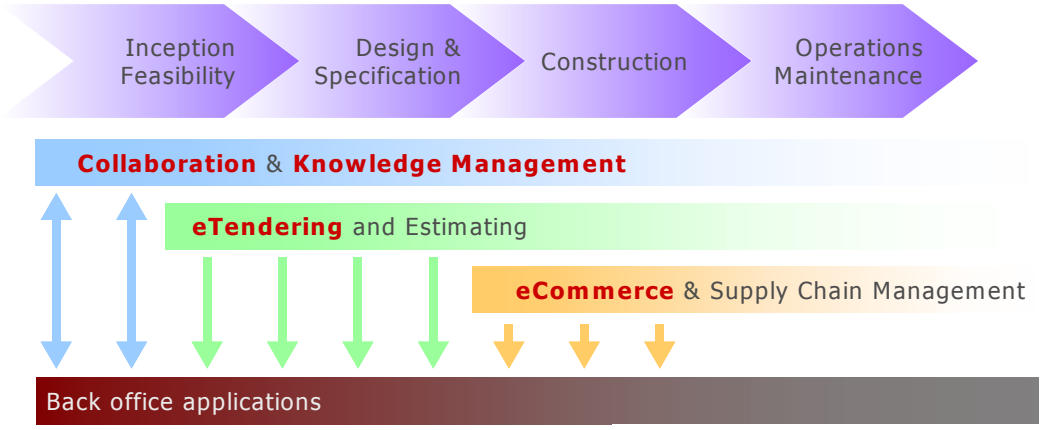

Figure 3. Illustration of how ICT can support the construction process

ICT should support the entire construction process from inception through to the operational maintenance of the building asset. The idea of a project model that supports improved co-ordination and management of information throughout the project life cycle is gained increased recognition. ICT is improving the capability and efficiency of specific aspects within the construction process. Figure 4 illustrates the application of available technologies throughout the project life cycle.

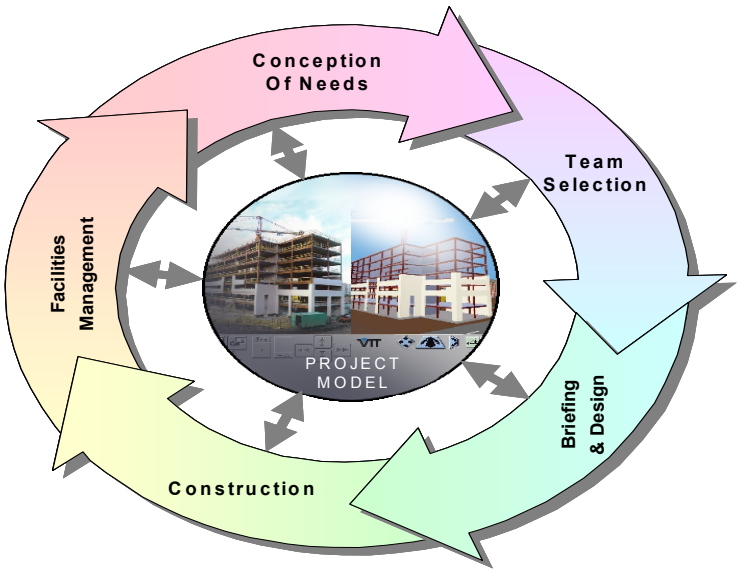

Figure 4. Project model for construction (Sarshar et al., 2000)

3.1 Overview of available construction applications

The UK 'Construct IT Bridging the Gap' Report (DoE, 1995) examined the use of ICT in the construction industry and concluded ' Software applications are available to support most aspects of a construction project. They have been designed largely as solutions to specific problems. Applications are particularly strong in design and analysis'. This conclusion is supported by an extensive list of construction IT applications complied by the Construction Industry Computing Association (CICA) in the UK. Its software directory lists some 1600 programs from over 500 software houses for use in design, construction and maintenance of buildings (CICA, 2003). For the purposes of this paper, these programs are grouped into six categories.

- Business and information management
- Computer aided design and visualisation
- Building engineering applications
- Computer aided estimating
- Planning, scheduling and site management
- Computer aided facilities management

Business and information management

The construction process is information intensive with a large volume of information generated and consumed by all participants involved. Electronic Document Management (EDM) software can create an environment within which disparate forms of information can be linked together, in the context of a project or organisation, to achieve easy access and control.

Businesses of all types have to review their processes in the light of new technology and to maintain their competitiveness, and construction is no exception. Greater integration business departments is leading to the use Enterprise Resource Planning (ERP) software to link the various facets of an organisation, such as, purchasing, accounts, planning, estimating, plant, salaries, human resources, contracts, marketing etc.. One such example is the product supplied by the Construction Industry Software Solutions (COINS).

Knowledge Management (KM) is any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance in organisations (Scarborough et al, 1999). The process of capturing, consolidating, disseminating and reusing knowledge within an organisation is the way it gains competitive advantage and builds an innovative and successful organisation (Kanter, 1999). ICT can be used to capture and distribute information and knowledge throughout an organisation in a structure manner.

Construction projects always involve the collaboration of a multi-disciplinary project team located in different parts of a country. Some may be resident on site, others located in an office. The advent of the Internet has greatly enhanced the operational scope of collaboration tools. There is now a wide-range of ready-made tools aimed at supporting projects where participants are potentially widespread. Examples include, Buildonline, 4Projects, BIW Technologies, Sarcophagus, Business Collaborator etc.

There are established technology tools used in everyday business processes, including fax machines, fax/modem cards, Internet fax and e-mail. Leenders et al (2001) described a number of "off-the-shelf" eBusiness packages available in the market. Notwithstanding the software selected by the main contractor, behind the scenes of today's construction purchasing departments, there is a consortium of individual suppliers that use different software applications, characterised by poorly synchronised electronic information handling (IT WG, 2002).

Electronic Data Interchange (EDI) has become the preferred way of compressing and transmitting data between a buying firm and its suppliers in many sectors (Leenders et al, 2001). There are however, many limitations in the use of EDI such as cost, the width of connectivity with a business supply-chain, by use of Value-Added Networks (VANs) and dedicated EDI servers. In the early twenty-first century, one dilemma for those with well-developed EDI systems is whether or not they should migrate to a Web-based system. The growing use of eXtensible Mark-Up Language (XML) technologies will enable automated electronic communication between the buyer and supplier in transmitting order, receipts and payments. XML received WWW recognition in February 1998 (Leenders et al, 2001). Other technologies that will play a key role in the re-engineered process includes Enterprise Resource Planning (ERP) software such as that provided by SAP and Oracle; Auto-ID Technologies such as bar-coding; On-line

supplier catalogue capability and Pen computers or Personal Digitiser Assistants (PDAs).

Computer Aided Design and Visualisation

Computer Aided Design (CAD) software is widely used by design professionals, with AutoCAD having the largest share of the CAD market (Howard, 1998). Other popular CAD packages include Microstation, ArchiCAD, MiniCAD, FastCAD, etc. These CAD programmes have replaced the traditional drawing board in the production of design information. 2D CAD systems have dramatically improved the drawing process. 3D modelling can enable designers to investigate the buildings internal spatial system and its relationship with the surrounding environment. Visualisation and animation systems, like 3D Studio, Graphisoft, Revitt and ArchiCAD, can produce photo-realistic, static and moving images so that clients can view the final appearance of the building at the design stage. Virtual Reality (VR) technically now allows the user to integrate with the design model and experience the building in simulated reality situations.

Building Information Modelling (BIM) is an innovative new approach to building, design, construction and management. BIM keeps critical design information in digital forms making it easier to update and share design information. It also creates real-time, consistent relationships between digital design data with the use of innovative parametric modelling technology techniques. Autodesk Architectural Desktop and Autodesk Building Systems are examples of software currently available.

Building Engineering Applications

Over the past two decades, a range of building engineering applications have been developed for energy analysis, HVAC design, structural analysis, lighting simulation, etc. The benefits of these applications are that they allow designers to evaluate alternative design solutions in order to achieve the optimum design. They also help to ensure that the design complies with building regulations. Software packages such as CADLink from Cymap and the HEVA Comp package both offer a comprehensive range of software options for energy, lighting and building services design.

Computer Aided Estimating

Controlling costs is one of the most important requirements during a construction project. To achieve this, contractors and subcontractors must first produce an accurate cost estimate to establish the tender price. Today, there are sophisticated computer software packages such as Esti-mate, Manifest, which allow project managers to assist in the production of project estimates and keep track of project spending.

Many of these programmes can assist in the quantity take-off in the production of bills of quantities. Examples of such software includes, Buildsoft, Masterbill, CATOPro etc. Modern cost estimation programs can be integrated with CAD programs and linked data for labour, materials and plant. The advantage is that cost data does not need to be re-entered thus improving the speed of estimating and avoiding errors.

Planning, scheduling and site management

It is a common misconception that computers are of little help on a building site. In fact computer systems can assist site personnel to plan, co-ordinate and generally to become more efficient in the administration of the project. Apart from the widespread use of planning packages such as, Power Project and Microsoft Project, there are solutions from Primavera, COINS and the growing interest in web-based collaboration tools.

An additional area that is rapidly expanding is in the use of mobile technology. Mobile technologies enable physical separate hardware devices to connect and share data. Developments in this technology have led to the amalgamation of mobile computing devices and mobile communications protocols, with Personal Digitised Assistants (PDAs) now available with integrated mobile connectivity or via a separate mobile phone, through either a wired or wireless connection such as Bluetooth. This provides the mobile user with the ability to upload and download data from anywhere that a mobile signal is provided. An example of an recent initiative in the UK focusing on mobile computing is construction is the ‘Construction Opportunities for Mobile IT’ (COMIT).

Computer Aided Facilities Management

Facilities Management (FM) is a relatively new phenomenon which emerged in the early 1980's. It reflects the wide recognition of the importance of building operations and maintenance and the impact they have on the life cycle cost of a building. The software available for FM has developed from a combination of CAD and database management systems. CAD is often used to provide data on departments and location of individuals, together with their services. Special routines enable blocking and stacking studies to be carried out to explore alternative layouts or to reflect on organisational change. The database is the most important part of FM software as it holds data on people and their services.

3.2 Importance of integration

There is a proliferation of ICT applications developed by a wide range of software houses. They use their own data formats, which are not compatible with each other. As a result, data cannot be exchanged electronically between them. In recent years there is an increasing awareness of the need for integrated construction processes and a number of research centres are investigating related issues world wide (US: Construction Industry Institute; Finland:VTT; UK: ConstructIT; Ireland: CITA. During the past two decades, advances in object oriented programming, databases systems and project data modelling technologies have provided a solid platform for integration (Sun and Bakis, 2000). Standards are currently being developed by the International Alliance for Interoperability (IAI) for the integration of software (Sun and Howard, 2004).

4.0 CONSTRUCTION IT ALLIANCE LTD

While much research has been carried into the uses of Information Technologies in construction in certain countries such as the USA, UK and Scandinavia, this area has largely been overlooked by Irish research institutions. Although much of the international research and work of these national centres is of use to Irish firms, the lack of specific research and an equivalent organisation prior to 2001 was regarded as a contributory factor in the slow progress towards harnessing the potential of IT in the Irish

construction sector. Recognising that a number of countries had already established centres to identify and promote best practice in use of IT in construction (such as Construct IT in the United Kingdom), an early goal of CITA's was to investigate whether a similar approach could be taken by the Irish construction sector.

The Construction Information Technology Alliance (CITA) has operated until now as a research project in the Dublin Institute of Technology, Bolton Street. The Alliance was formally incorporated on the 10th November 2005. Membership is currently in excess of 110 corporate members. The organisation has had many achievements including 10 conferences, bi-monthly newsletters, an informative website and eight special interest groups.

The objectives of the Alliance strategy are:

- To inform the Irish construction sector of relevant IT developments.
- To establish and disseminate best practice in the use of IT in the Irish construction sector.
- To encourage IT related research and training collaboration between the Irish academic sector and the leading firms in the Irish construction sector.
- To establish and maintain links with relevant national and international organisations.
- To encourage the strategic use of IT by the leading firms in the Irish construction sector.

The Alliance is principally funded by membership subscriptions. Membership has been increasing incrementally since May 2001. Current membership numbers have reached 115. CITA depends a great deal on the network of Special Interest Groups (SIGs) formed by members. Members are encouraged to get involved in developing new interest groups or by joining established groups. It is intended that the findings of these groups will be published and will encourage further research. The SIGs that are currently in operation are as follows:

- SIG 1 - Materials Procurement
- SIG 2 - Layering convention for CAD drawings
- SIG 3 – Knowledge Management
- SIG 4 - Collaboration Tools

- SIG 5 - eTendering
- SIG 6 - Object Modelling
- SIG 7 - Education and Research
- SIG 8 – QS CAD User Group
- SIG 9 – Mobile Computing

The progress of each of these SIGs has been varied. The following is a summary of the progress of some of the more active groups at the time of writing this paper

SIG 1 – Material Procurement

Electronic purchasing aims to overcome the administrative and communication problems with the many millions of trading documents (such as invoices and orders) currently exchanged on paper in the construction industry. Within CITA, a special interest group was set up to look specifically at the administration of ordering, delivering and invoicing of building materials using currently available IT.

To date this group has been carrying out a pilot project, of which Phase 2 is almost complete. The pilot team of Ascon Limited and WT Burden (PVF) Limited are currently working with COINS and O2 in the testing of the electronic message system. In 2006, the results of this project will be available and CITA aims to help drive the dissemination of this technology within the industry.

SIG 2 – CAD Layering

The lack of any broadly accepted standard for the layering of CAD drawings has been an ongoing problem, which has hampered the effective use of IT within the Irish construction design sector. CITA's special interest group in this area has worked since 2002 to promote a more standard and structured procedure for electronic transfer of CAD information between design team members.

CITA are currently working on maintaining a register of users of the CAD Layering Standard, via logging requests that are made through our website. A more aggressive promotional campaign for the standard is planned for 2006, where CITA plans to work closely with such members such as the Construction Industry Federation, RIAI, Society

of Chartered Surveyors, CIOB, Department of the Environment Local Government and Heritage, Department of Education and Science, Local Government Computer Services Board and many of its private practice members.

SIG 5 - eTendering

CITA's special interest group in this exciting area have to date carried out three electronic mock tenders. The final mock tender was deemed a great success and the group was invited by the Department of Finance through the National Public Procurement Policy Unit (NPPU) to join the eTender Postbox pilot team.

At this point the group are planning a large scale eTendering survey that will be administered jointly by CITA and the National Building Agency in 2006.

SIG 8 – QS CAD User Group

The Quantity Surveyor profession is continually changing and little research is available in the effective use of existing CAD technology in cost estimation and cost management. CITA set up an interest group to develop guidelines for the effective use of AutoCAD by Quantity Surveyors in the management of construction costs. Having run a number of courses in this area, an online survey on the relationship between CAD and the role of Quantity Surveyor in building measurement is planned for 2006.

5.0 CONCLUSION

It is clear that ICTs have the potential to improve processes and solve specific problems in the construction sector. There are a number of innovative ICT applications currently emerging, among them virtual design and engineering, e-Commerce in the supply chain, consumer-focused construction processes, and electronic facilities management. In many cases, however, these are still at a very early stage of development. In addition, it is particularly important that new applications are taken up by SMEs, which means that the focus has to be on making them more user-friendly and cost-effective.

A key factor for increasing the use of ICT in construction which has emerged very clearly is the importance of establishing shared information standards, since these form

the basis of effective e-collaboration practices. In addition, there needs to be a greater awareness of the potential benefits of this technology in order to stimulate the demand side.

If new ICTs and applications are to take hold in the construction industry, there must be a sufficient number of people skilled to use them. It is therefore vital to make new technologies more widely accessible by providing appropriate training to potential users, especially SMEs. E-learning programmes comprising training on ICT use and vocational training should assist in raising the skills level within the sector.

It is clear that a great deal of inefficiency exists in the mainly paper-based process deployed predominantly in the construction industry. The key causes of this inefficiency include a fragmented industry, the temporary nature of construction, the uniqueness of construction and a dependence on a single-project model. This has lead to poor communication and inefficient information practices that have contributed to the emergence of dysfunctional industry.

Co-operation is needed between research centres globally, in particular into assessing the value of ICT investment. If the recent controversy over Government spending on ICT projects has shown anything, is that it is very easy for things to go awry when implementing an ICT project. When investing in ICT, companies need to ensure that there is a proper method or process in place by which to measure the return on the investment and the impact of the technology on the organisation as a whole. Although it may not be possible to accurately measure all the benefits achievable from an ICT investment, establishing a framework will give one a better picture of whether the money spent has been worthwhile or not.

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