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Project Title	Online Technologies for Construction SME's
Project Proposal	Document Sharing - Exploring Computer Aided Facility Management (CAFM) and Improving on Existing Systems and Processes

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1.0 Abstract

Implementing any new system or process can be a challenge for a single person/operative or for a large organisation. The subject of informatics is essentially the study of information. It can be the analysis of information in its most pure form, the analysis of how information is processed and the systems in place that allow for this analysis. Construction Informatics, *also known as 'construction IT' or 'communication and information technologies in construction' is an applied science that studies the construction specific issues related to processing, representation and communication of construction specific information in humans and software.* **[1]** Traditional methods of working used in the AEC industry have not always lent themselves very kindly to encouraging collaboration and efficiencies in work practices. Not only is collaboration an issue, but the fragmentation of industry and, in most cases, organisations. The lack of inter-organisational collaboration techniques may seem to people looking in on an organisations systems and processes from the outside, presuming that systems and processes are in place, to be challenges that can be easily overcome but this is not always as easy as it may at first seem. Take, for example, an attempt to implement a Building Information Modelling (BIM) strategy into a large University that has evolved over hundreds of years, and having naturally allowed work practices evolve through different technological ages. *For a BIM implementation strategy to succeed, it must be accompanied by a corresponding cultural transformation strategy. Cultural transformation is a greater challenge to the industry than any technological transformation resulting from BIM. It will require that building industry business partners regard one another differently than they do today – as true partners and collaborators with a mutual interest in a successful outcome, rather than as adversaries and potential future litigants.* **[2]**

Not only are these challenges present in the wider AEC industry, between companies competing against each other for business or, in fact, between those working together on projects, but they are also present internally within large organisations. In order for different organisations in the AEC industry to collaborate effectively and efficiently on, for example, a construction process schedule for a building project, collaboration between two or more organisations and their digital design software packages becomes not just important but vital if the full benefits of using a BIM workflow are to be realised. Workflows within different organisations can vary greatly. So too can workflows within a single organisation. When workflows vary, it can be assumed that the quality of digital information exchanged either between organisations or staff members within a single organisation will vary too. What one organisation, or indeed a member of staff of a single organisation, might regard as the best and most efficient process in which to collect, store and share digital information another may see the same process as a sub-standard practice that does not afford the recipient a seamless 'liquid flow' of the digital information produced. By developing rigid processes for data management an organisation cannot automatically expect members of staff collaborating on a single project to have undertaken the same process or to have an equal process that will allow this much sought after seamless 'liquid flow' and quality assurance of the digital information. There is a human side to informatics, a cultural challenge *per se*. There are many different aspects to informatics studies, including computational, *cognitive and social aspects* **[3]** therefore any new system or process may appear like a perfect solution on paper but could fail dramatically if the human and/or cultural challenges are not addressed effectively.

2.0 Introduction

The day-to-day management and running of facilities has moved from simply 'turning on the lights in the morning' to a more complex task of ensuring a building can function normally throughout its entire life cycle. Computer Aided Facility Management (CAFM) software has evolved into very complex, sophisticated and vital tools to aid and assist those responsible for the day-to-day management and running of a facility or building and to improve environments for staff and visitors. Nowadays it is much more beneficial to all concerned to take control of a facility prior to occupancy with as much information as possible in the form of digital databases rather than be handed a static 'Operation and Maintenance Manual' comprising of paper documentation to help support facility managers achieve their goals. (See Figs.2-001 and 2-002)

Fig. 2-001 – Traditional Operation and Maintenance Manual Handover

Source: Peter Mc Donnell (Student No. D12123482)

At the design stage of a building project a design team may work on details of the design relevant to them and compile this information into an O&M Manual for handover of a completed project by a required date. Traditionally this was considered acceptable, but with advancements in technology and in particular information and communications technology (ICT) we are seeing greatly improved and efficient ways to put this information at the fingertips of facility owners, operators and clients. Building Information Modelling (BIM) is a process of collecting, organising and managing data in a digital software environment for use in the full life cycle (design, build, operation and demolition) of a facility. (See Fig.2-003)

An approach such as using BIM to achieve better results like, for example, increased efficiencies, minimising duplication of data, reducing time taken to retrieve important information, improving decision making etc. can seem very daunting to some, particularly if a specific task has been undertaken in the same way for a long time. An existing employee might think "if something is not broken then why fix it?" but should this opinion be accepted by a facility owner if they are to hope to improve various elements of the operation of a valuable asset? Also, is it possible to improve on efficiencies if BIM was not implemented at the beginning of a facilities life cycle?

Information collected, organised and managed in a model can be used for a wide range of valuable and important everyday tasks and a review of existing and proposed Computer Aided Facility Management (CAFM) software tools can be seen as a possible solution to some, if not all, problems that occur when using traditional ways and thinking in relation to facility management.

Fig. 2-002 – Traditional Operation and Maintenance Manual Handover

Source: Peter Mc Donnell (Student No. D12123482)

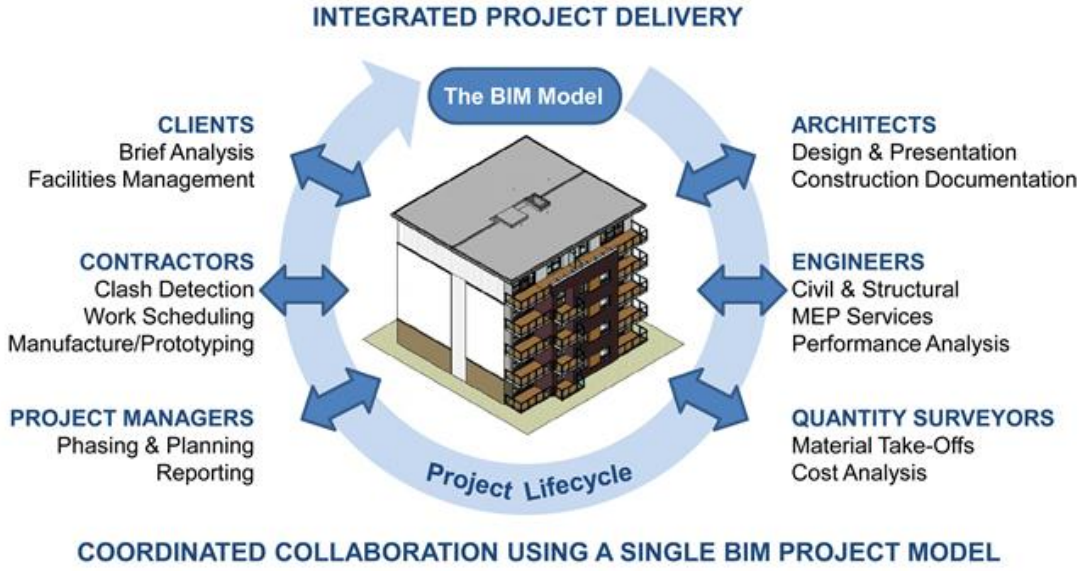


Fig. 2-003 – Building Information Modelling and Integrated Project Delivery Method

Source: ARCDOX Architecture|Documentation

2.1 Project Aim and Objectives

The main focus of this project will be to review the current organisational structure and existing systems and processes in place within a large university and to investigate solutions to particular problems with workflows and data storage techniques. While reviewing the existing way in which valuable data/information is collected, stored and shared within a large organisation and the issues associated with methods already in place, I will also review how a Small to Medium Enterprise (SME) might overcome the same issues and report on possible implementation strategies that could be undertaken or put in place to combat and remove these. *Measuring change brings the perception of value in line with actual value. When an organisation fails to measure progress in any change process, resistance to change is likely to increase throughout the organisation, even if the change is beneficial. We just don't remember how bad things were, so we don't see what the big deal is about where we are.* **[4]**

2.2 Project Structure

The project will be based around the existing CAFM tools available to a large university and analysis of problems with these by reviewing particular aspects of data/information collection, storage and sharing. The importance value of data will be assessed and potential issues such as data duplication and/or data loss reviewed to help evaluate how efficient and time consuming an existing workflow might be over a new improved workflow were it to be introduced into the organisation. For the purposes of this project it will be necessary to view the data to be analysed as having been gathered and stored over a long period of time and this data as having been 'historic' by nature rather than setting out on a data gathering exercise from the initial concept/design of a facility

As outlined in the 'Project Briefing' the main structure of this project will be as follows:

- Define the role of informatics in society in general and in AEC in particular
- Describe the strategic importance on the informatisation of the AEC sector
- Explain the potentials of construction informatics in general and of various specific application areas
- Discuss critically the specific problems of construction informatics

2.3 Project Conclusion

The project will aim to research and identify possible improvements to day-to-day data collection, storage and sharing methods used in a fully operational facility and outline benefits that may be achieved should new processes or systems be put in place. It is hoped that improvements in the existing methods can be reported and improved on if and when encountered.

3.0 Existing Organisational Structure

Presently, "*the Director of Buildings' Area in Trinity College Dublin are responsible for the development, operation and maintenance of the College's buildings, sites and facilities in support of the College's teaching and research activities*."**[5]** The College's activities are supported by the following duties undertaken by The Director of Buildings' Area (See Fig.3-001):

- Property/Estate Management
- Control and Service Sites and Shared Buildings
- Operate and Maintain Existing Buildings
- Provision and Management of Utilities
- Implement Physical Development Programme
- Secure Sites and Buildings
- Manage Development Planning
- Oversee the Construction Programme
- Maximise Potential of Sites and Buildings

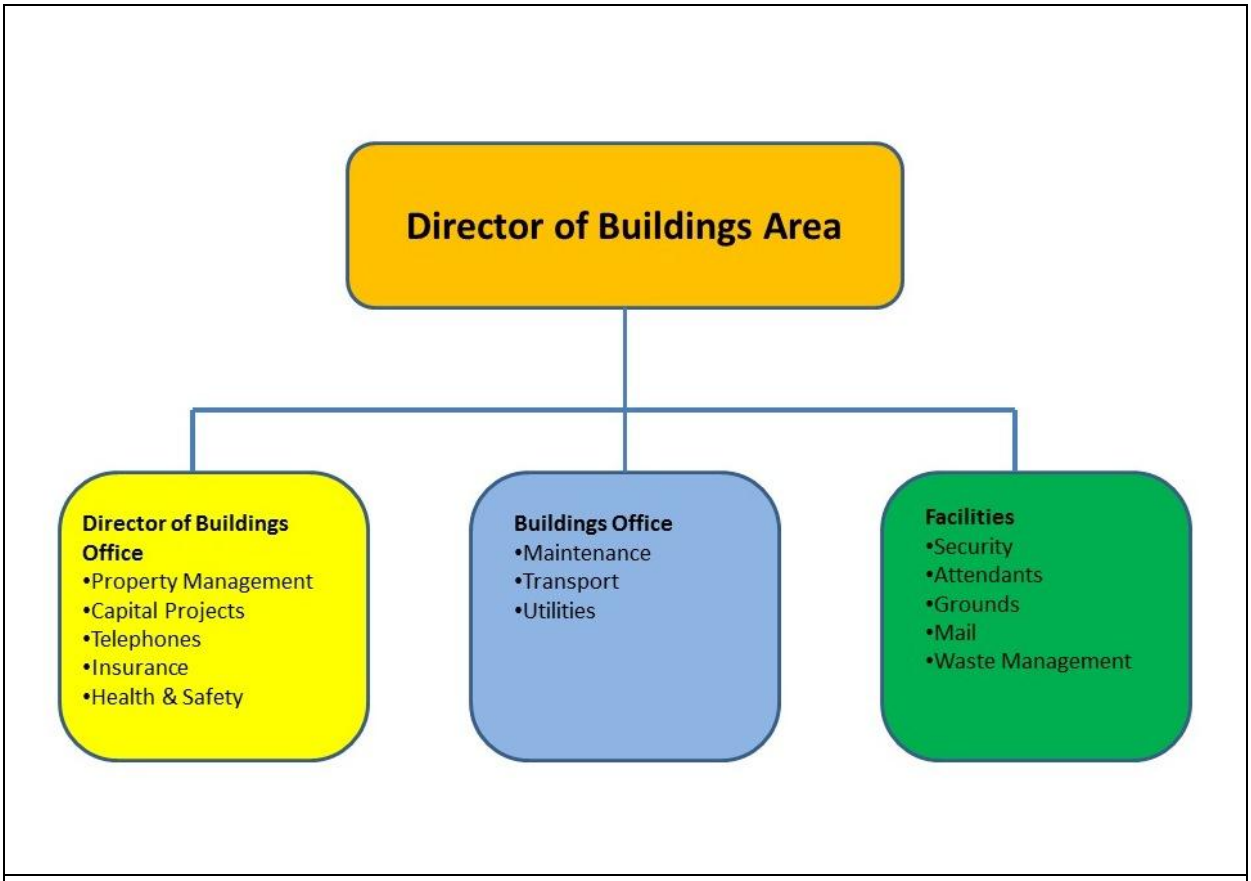


Fig. 3-001 – Existing Organisational Chart

Source: Director of Buildings' Office, The University of Dublin Trinity College

Reviewing the Organisational Chart above it is clear that The Director of Buildings' Area are responsible for and undertake a wide range of activities. These activities are split between three separate departments (Director of Buildings' Office, Buildings Office and Facilities) which have responsibility for undertaking particular elements which are seen to be relevant to each department.

The Director of Buildings reports to the Chief Operating Officer (COO) and the table below shows the existing staffing structure of the Director of Buildings' Area in The University of Dublin Trinity College (See Fig.3-002). Each individual function is undertaken by a group of staff or an individual. The natural flow of information should be downward, from the Chief Operating Officer (COO) to the Director of Buildings and then onward to Officers in control of each section.

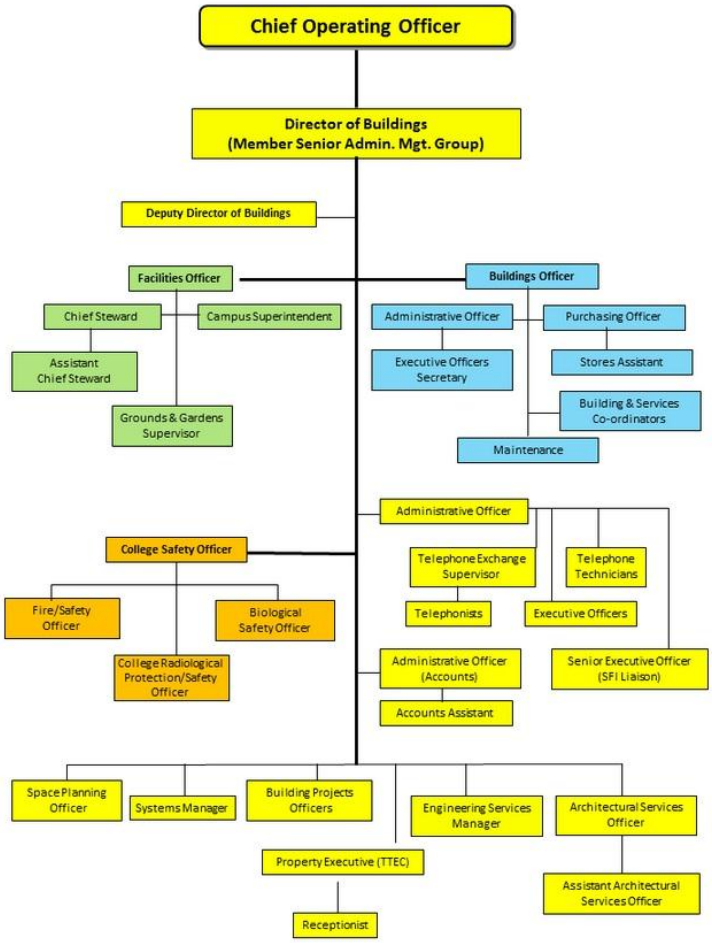


Fig. 3-002 – Existing Staffing Structure

Source: Director of Buildings' Office, The University of Dublin Trinity College

The Core Business of The University of Dublin Trinity College is education. Without students wanting to be educated there is no requirement for maintaining buildings, repairing elements contained within buildings or to provide heating/cooling and lighting systems to lecture theatres, laboratories, teaching spaces/classrooms etc. An organisation such as this cannot afford to lose sight of what their core business is, but at the same time an organisation cannot neglect to recognise the revolutions in communications and Information Communication Technology (ICT) that allow support activities a sufficient working environment in which to provide essential services. As a university evolves, naturally, over time, possibly hundreds of years, fragmentation of systems and processes can occur. By analysing these systems and processes that are in place it may be possible to reverse the fragmentation that has occurred and integrate new systems and processes to improve efficiencies, minimise waste and reduce, if not eradicate completely, issues such as duplication of effort and waste.

3.1 Director of Buildings' Office

The Director of Buildings' Office forms the 'Strategic' arm the Director of Buildings' Area. As was stated before this particular office undertakes a wide range of activities which could be anything from controlling site services and buildings to raising flags or tolling bells when exams commence each year.

An important part of the functions and responsibilities of The Director of Buildings' Office is the 'Operation and Maintenance of Existing Buildings' (Operate Telephone Service, Manage Insurance Claims, Operate Stationery Supply Service, Operate Central Photocopying Service, Provide Transport Service, Supply Heat, Light Power and Water Utilities, Maintain Fabric, Assist and Advise on Safety Matters, Service and Operate Mechanical and Electrical Plant etc.) but we will see in further sections of this report that there is some cross-over of responsibilities here that can lead to problems.

From the existing staffing structure of the Director of Buildings' Area (See Fig.3-002) it is worth noting that a Systems Manager is in place which will be beneficial should Computer Aided Facilities Management (CAFM) procedures and relevant new software tools be discussed and/or implemented.

A more detailed analysis of the Director of Buildings' Area duties (See Fig.3-001) is detailed below:

Functions and Projects

- Planning and Proposals (Higher Education Authority, Science Foundation Ireland, Benefactors etc.)
- Local Government (Planning and Development) Act
- Planning Permission and Consultation
- Environment Impact Assessment
- Procurement Under Government Contract Procedures
- Design Team Competition
- Full Design Consultation and Development (Planning Groups)
- Contact Administration
- Communications, Accounting and Cost Control
- Reporting and Project Analysis
- Handover and Begin Maintenance

Functions and Existing Programmes/Projects

- Routine Maintenance (Buildings)
- Routine Maintenance (Grounds)
- Backlog Maintenance
- Energy and Water Conservation
- Waste Management and Recycling
- Cleaning and Conservation
- Small Projects Programmes:
- Minor Works, Health and Safety, Universal Access and Small Capital Works
- Science Foundation Ireland (SFI)
- Programme for Research in Third Level Institutions
- Residential Accommodation and Facilities
- Departmental Improvements and Developments

Source: Director of Buildings' Office, Trinity College Dublin Website - http://www.tcd.ie/Buildings/

3.2 Buildings Office

The Buildings Office forms part of the 'Operations' arm the Director of Buildings' Area. Similar to the Director of Buildings' Office, the Buildings Office undertakes a wide range of activities but these are mainly focused around ensuring that The University of Dublin Trinity College can continue to operate on a day-to-day basis. "*The Buildings Office function is to provide an efficient and effective operation and maintenance service for the College Estate with the resources available for that service. Or put another way we try and keep the Estate (infrastructure, buildings and their systems) running and fix it when it breaks. A lot of the work we do is preventative where we try and fix things before they break."***[6]**

A more detailed analysis of the Buildings Office duties (See Fig.3-001) is detailed below:

Functions

- Help Desk
- Reactive Maintenance
- Planned Maintenance
- Plant Operation
- Minor Improvements
- Technical Advice
- Condition Monitoring
- Elemental Replacement
- Insurance Inspections
- Transport

Source: Director of Buildings' Office, The University of Dublin Trinity College

Interestingly, the first function on the list above is 'Help Desk' which is a good indicator of how basic Facilities Management (FM) is handled or 'managed' within the organisation. Users can contact the Help Desk when an issue arises, the Help Desk operator can log these issues and a system to distribute responsibilities for auctioning these logs can be put in place to ensure faults/problems are handled accordingly. *Many companies manage their FM work, in particular maintenance work, through help desk call centres. The process involves several parties: facilities users, call centre operators, contractors and FM managers. The facilities users are those people who use the building and its facilities to carry out business activities. When a fault occurs, the user will contact the help desk to report the fault. Helpdesk operators are responsible for logging the report and recording details of the fault. Contractors are responsible for carrying out the repair work. The FM managers are responsible for making decisions on contracts and whether a job needs to be carried out.* **[7]**

3.3 Facilities

The Facilities Office forms the final part of the 'Operations' arm the Director of Buildings' Area. Again, Facilities undertakes a wide range of services. "*The Facilities Staff report to the Facilities Officer and provide a range of general services to the College Community both on Campus and at off Campus sites.*"**[8]**

A more detailed analysis of the Buildings Office duties (See Fig.3-001) is detailed below:

Functions

- Security and Building Attendant Services
- Maintenance of Grounds, Gardens and Outdoor Sports Facilities
- Management of Waste/Recycling Facilities
- Mail and Central Photocopying Services

Source: Director of Buildings' Office, The University of Dublin Trinity College

Facilities are an integral part of the running of The University of Dublin Trinity College and it undertakes very important functions to ensure this continues. There is some cross-over in the maintenance area but as all three departments fall under the Director of Buildings' Area it is a manageable arrangement that has most likely evolved over time and remains in place today.

3.4 Information System Services

The main provider of computer systems and technologies in The University of Dublin Trinity College is Information System Services (IS Services). IS Service are "*responsible for the planning, delivery and support of the College's main computing facilities. This includes the College's network systems, web infrastructure, email and calendaring, management information systems, student computing facilities, some research infrastructure and High Performance Computing. IS Services also provides support for teaching and learning in a number of lecture theatres and seminar rooms on and off campus, and also provides a video capture/production service and a photographic service. Staff and students are provided with full IT support via the IS Services Helpdesk and a wide range of IT training is also available either online or face to face. The department also runs a Projects Office (ISS PO) for all IT projects in line with College Board policy and provides significant support to the College's enabling Strategy (e-Strategy). The department supports 25,000 users on the main campus and in 25 remote sites including two large hospital medical centres at St. James and Tallaght and support over 1,200 wireless access points and 20,000 fixed wired network points. The central point of contact for all services should be the IS Services Helpdesk where problems can be reported or advice sought."* **[9]**

One role that IS Services undertakes is research and innovation within The University of Dublin Trinity College. This knowledge and expertise could be useful to The University of Dublin Trinity College should any issues be encountered when undertaking this or any similar report into informatics and their use for functions such as document sharing.

3.5 Site Locations and Services

To give the readers of this report an idea of the size of the University of Dublin Trinity College campus and locations of the different departments mentioned in the report a map has been provided below (See Fig 3-003)

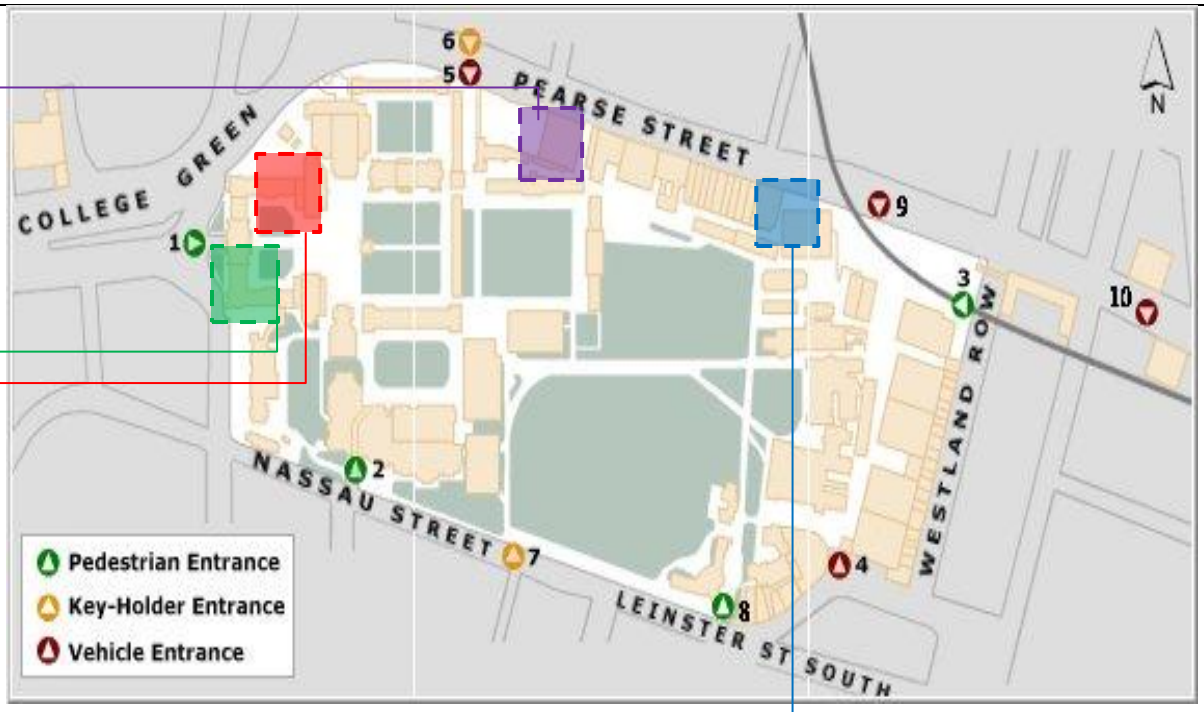


Fig. 3-003 – Trinity College Dublin Main Campus, Dublin 2, Ireland

Source: The Web Office, The University of Dublin Trinity College

Key:

Director of Buildings' Office (for more information See Section 3.1)

Buildings Office (for more information See Section 3.2)

Facilities (for more information See Section 3.3)

Information System Services (for more information See Section 3.4)

It is interesting to note that the three departments within the Director of Buildings Area (Director of Buildings' Office, Buildings Office and Facilities) are located in different parts of the main campus site. These three departments share essential core activities yet they are expected to operate efficiently while being located so far apart. Although Information System Services are not within this area, they could be of benefit should issues be found and require resolution/solving at some stage, and therefore it may be useful to have all of these departments occupy the same building in the future. The physical distance between these departments could lead to differences in ideas, information systems, processes, standardisation etc. and it is worth noting at this point of the report before the student goes into more detail on items such as these as well as those related to informatics, collaboration and integration amongst other things. One possible solution to improving efficiencies within an organisation is the introduction of Building Information Modelling (BIM) but there are many challenges to be overcome should this be the chose 'solution'.

4.0 Existing Software, Systems and Processes

There are numerous systems and processes in place within The University of Trinity College Dublin at present. Each separate department have individual servers which store digital information collected throughout the campus and satellite properties/sites.

4.1 Existing Software Tools

General Information Communication Technologies (ICT) systems enable users to interact with software tools for collection and sharing of this data. Operating systems are in place (Windows 8, Windows 7, Windows XP, Mac OS etc.) to ensure users can run these software tools on their computers while undertaking their daily duties. Some of the key software tools used within The University of Trinity College Dublin is set out below:

Section	Software/Application	Purpose of Use	Availability
01	Microsoft Outlook	Email, Calendar	All Users
	Microsoft Excel	Spreadsheets	All Users
	Microsoft Access	Database	All Users
	Microsoft Word	Word Processing	All Users
	Microsoft Sharepoint	Information Sharing and Collaboration	Limited Users
	Microsoft Project	Scheduling	Limited Users
	Adobe Acrobat	File Viewer	All Users
	Adobe Photoshop	Photo/Picture Editing	Limited Users
02	GVAS9 Live	Facility/Property Asset Management	Limited Users
	SoftCo	Document Management	Limited Users
	Zutec	File Storage/Archiving	Limited Users
	DropBox	Cloud Sharing/Storage	Limited Users
03	AutoCAD Architecture 2014	2D/3D Drawing Production	Limited Users
	Autodesk Revit 2014	Modelling	Limited Users
	Autodesk Design Review	Model/Drawing Viewer	Limited Users

Fig. 4-001 – (Selection of) Software/Application Tools in Use

Many of the software tools in use are standard applications with a number of specialised software tools available for specific purposes. The first selection of software tools (Section 01 Fig4-001) are used on a day-to-day basis for everything from communicating (via email) to scheduling meetings and organising room availability etc. The second selection of software tools (Section 02 Fig 4-001) are more specialised and are available to staff involved in accounting, project management, maintenance, scheduling etc. and are used in the daily facility management exercises undertaken by these members of staff. The third selection of software tools (Section 03 Fig 4-001) are again more specialised than the first section and are used by architects, engineers, space planners, project managers etc. for documenting drawings/layouts, refurbishment works and space calculations amongst a number of other functions. It is worth noting here that one particular software tool, Autodesk Revit, is a new application that is currently being used and tested for the possible use in a Building Information Modelling (BIM) process that is being considered by staff members familiar with this technology and the advantages it could provide to AEC industry professionals and the College as a whole.

4.2 Existing Computer Aided Facility Management (CAFM)

Over time it is realistic to view the facility management of any organisation as having evolved from simple paper documents and written dockets/orders etc. to more complex systems involving computers. Advances in technologies can take time to find their way into organisations for many reasons. Revolutions do not happen overnight. These reasons could be financial, cultural, knowledge (and possible lack of it) to name a few but each reason has its own set of barriers. Unfortunately if valuable information is not collected, stored and shared in a systemised way it can lead to problems such as data loss, duplication of information/effort, wastage and general inefficiencies. Just as any other large organisation can find it difficult to make the transition to a more streamlined and efficient Computer Aided Facility Management (CAFM) system, The University of Trinity College Dublin faces big challenges in its attempts to improve systems and processes already in place, some of which have just 'evolved over time'. Traditionally staff would use an 'asynchronous' method to collaborate on facility management using tools such as email to communicate activities that need to be undertaken. By moving to a 'synchronous' method of collaboration by using shared applications for CAFM, for example, real time and 'live' information can be made available to key members of staff while they are either in front of their computers, at meetings or out 'in the field' undertaking other duties. A selection of software tools (not all) currently used on site are outlines in the following sections.

4.3 GVAS9 Live

Take, for example, the existing CAFM software tool (GVAS9 Live) used on site for managing properties and maintenance amongst other things (timesheets, asset registry, stock taking, contact registry/records etc.). This live database is accessible to a selected group of staff members who enter information into a database that can be shared amongst other key members of staff:

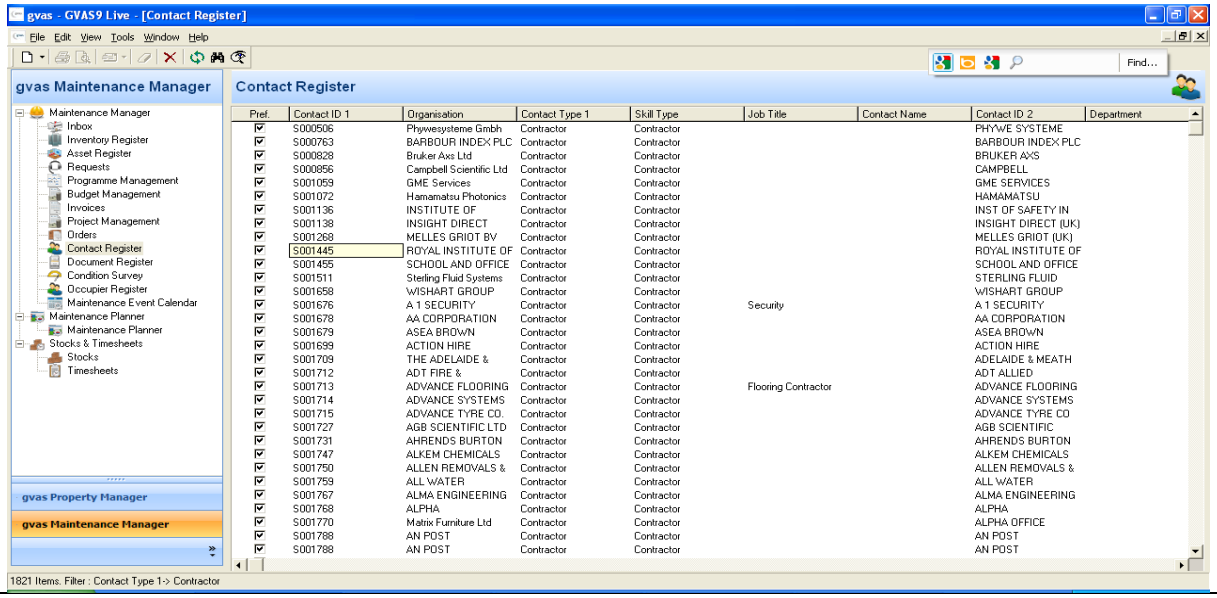


Fig. 4-002 – Existing CAFM Software Tool

Source: Director of Buildings' Office, The University of Dublin Trinity College

This valuable information could be made available to all members off staff rather than a select few, although data entry could be controlled, and reduce time taken in retrieval of already stored on a database. The centralised information can then be accessed while at a computer or mobile making it 'real time' and improve efficiencies for all staff. GVAS9 Live offers three core solutions (Property Manager, Estate Director and Maintenance Manager and serves *the corporate occupiers, estate managers and facilities managers, within*

both the public and private sectors. Based on robust Microsoft technology, gvas *has been developed using component based architecture that is quick to implement, flexible and cost-effective to maintain.* **[10]** Further exploration of this existing CAFM software tool (GVAS9 Live) shows that there are some issues with access to information contained within it (See Figs. 4-003 and 4-004)

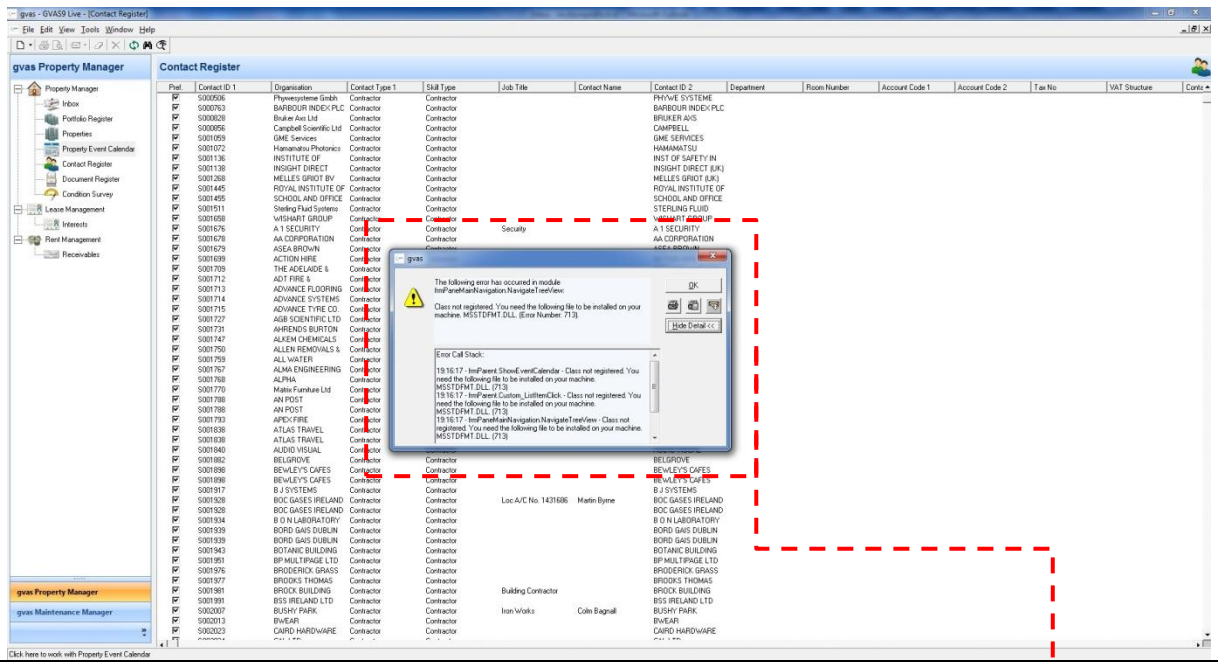


Fig. 4-003 – Existing CAFM Software Tool Information/Access Issues

Source: Director of Buildings' Office, The University of Dublin Trinity College

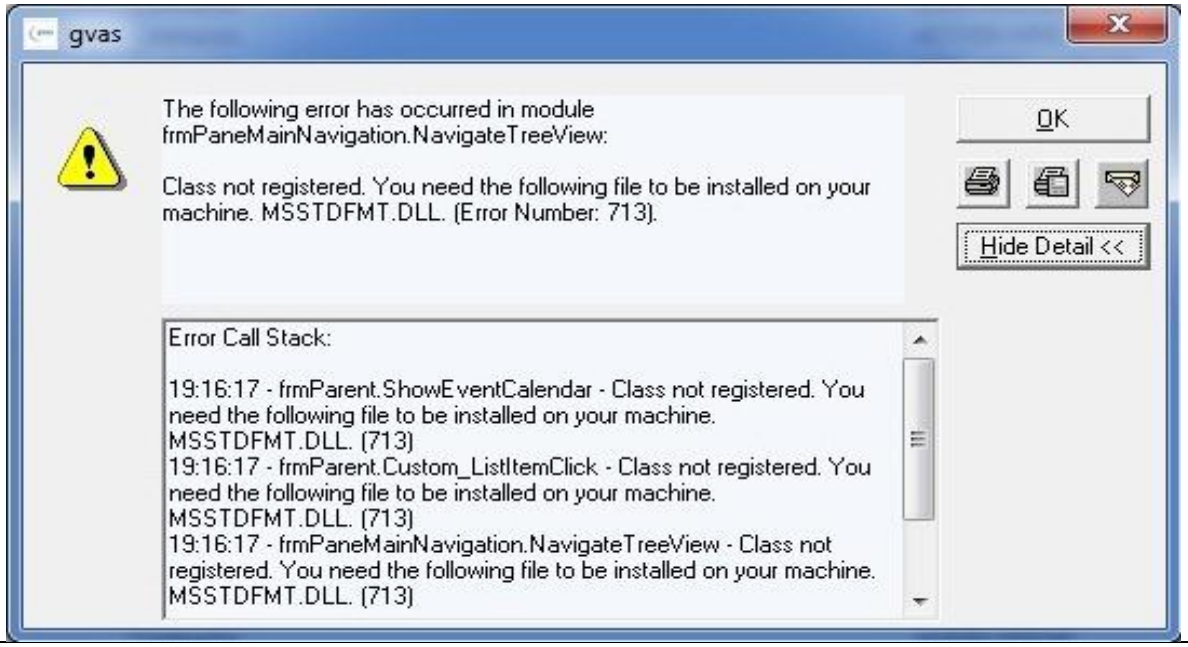


Fig. 4-004 – Existing CAFM Software Tool Information/Access Issues

Source: Director of Buildings' Office, The University of Dublin Trinity College

Missing or not yet installed registry/driver files restrict access in some cases. This can be easily solved and again and improve efficiencies for all staff.

4.4 SoftCo

Electronic document management is a vital part of business in this communication age. The inefficiencies of paper need to be reduced or eliminated completely. It is not an overall solution to have digital versions of valuable documents as the poor management of electronic documentation can lead to other issues (duplication etc.) but putting in place a document management system is one step towards streamlining processes within an organisation. The existing document management software tool in place is SoftCo. *SoftCo document management solutions help gain control over paperwork. Once captured and scanned, a confusing paper trail is replaced with an electronic business workflow that is easy to track, escalate and manage. Electronic files and emails are automatically indexed and archived. End-to-end visibility improves business intelligence, delivers on-time reporting and full auditing. You always know who created a document, where, when and how it was modified, and ultimately, where it is securely stored.* **[11]** (See Fig. 4-005)

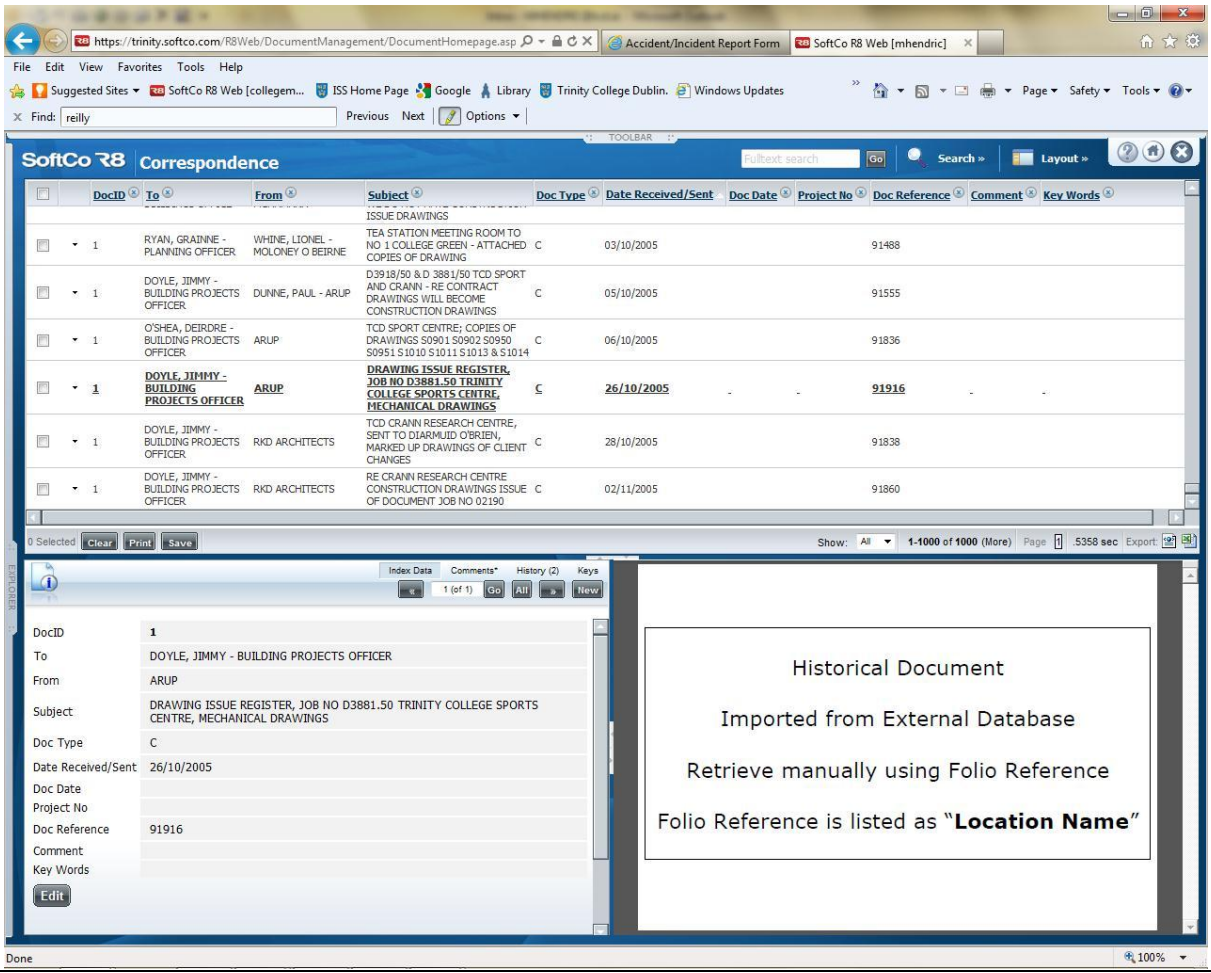


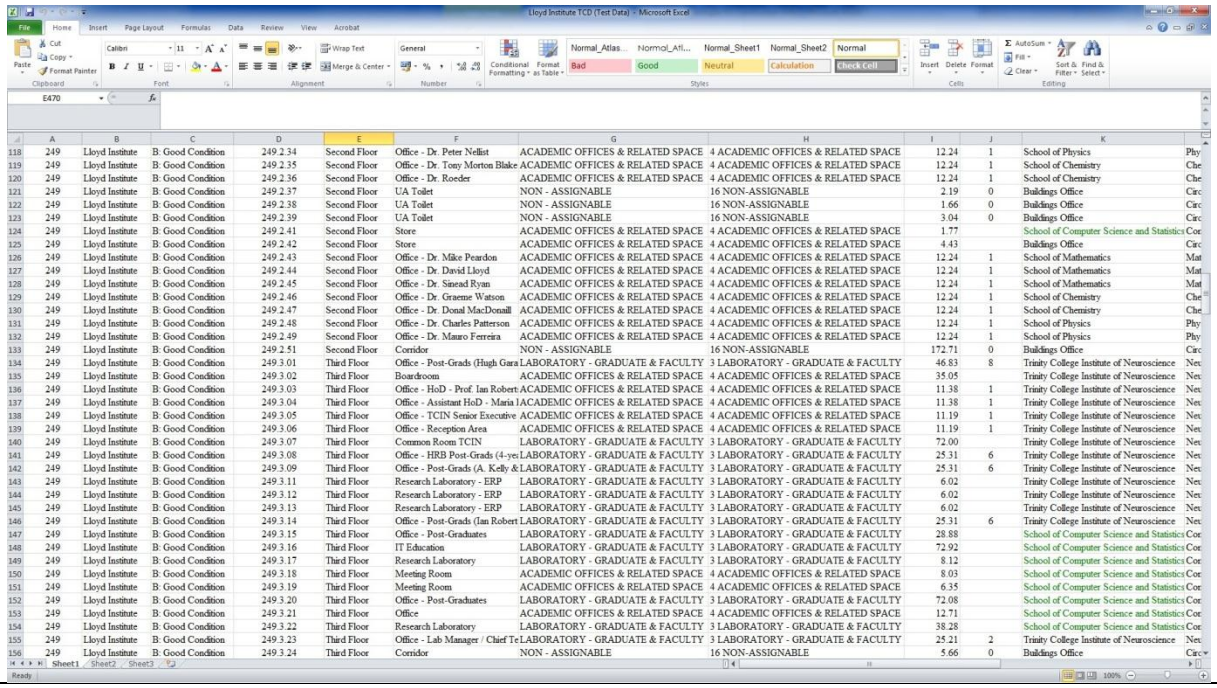
Fig. 4-005 – Existing CAFM Software Tool

Source: Director of Buildings' Office, The University of Dublin Trinity College

By eliminating entry times and automating processes such as archiving emails and scanning of paper documents productivity can be increased, version control on documents can be improved, time taken to access digital information can be reduced and general improvements on controlling information flows can be achieved. SoftCo can not only be localised and managed 'in house' but a cloud solution is also available as is the case here.

4.5 Microsoft Excel

This spreadsheet software is well known to the vast majority of computer/ICT users worldwide. It allows users to run analysis, calculations, tables etc. by utilising cells to input data and organise it in such a way that complicated formulae can be used to generate results for review. It is a valuable tool for most offices in the age of ICT. Microsoft Excel is a data model that has immense value to any user inputting or extracting information from it. (See Fig. 4-006)



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126	249	Lloyd Institute	B: Good Condition	249.2.43	Second Floor	Office - Dr. Mike Peardon	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	12.24	1	School of Mathematics	Mat
127	249	Lloyd Institute	B: Good Condition	249.2.44	Second Floor	Office - Dr. David Lloyd	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	12.24	1	School of Mathematics	Mat
128	249	Lloyd Institute	B: Good Condition	249.2.45	Second Floor	Office - Dr. Sinead Ryan	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	12.24	1	School of Mathematics	Mat
129	249	Lloyd Institute	B: Good Condition	249.2.46	Second Floor	Office - Dr. Graeme Watson	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	12.24	1	School of Chemistry	Che
130	249	Lloyd Institute	B: Good Condition	249.2.47	Second Floor	Office - Dr. Donal MacDonall	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	12.24	1	School of Chemistry	Che
131	249	Lloyd Institute	B: Good Condition	249.2.48	Second Floor	Office - Dr. Charles Patterson	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	12.24	1	School of Physics	Phy
132	249	Lloyd Institute	B: Good Condition	249.2.49	Second Floor	Office - Dr. Mauro Ferreira	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	12.24	1	School of Physics	Phy
133	249	Lloyd Institute	B: Good Condition	249.2.51	Second Floor	Corridor	NON - ASSIGNABLE	16 NON-ASSIGNABLE	172.71	0	Buildings Office	Circ
134	249	Lloyd Institute	B: Good Condition	249.3.01	Third Floor	Office - Post-Grads (Hugh Gara	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	46.83	8	Trinity College Institute of Neuroscience	Neu
135	249	Lloyd Institute	B: Good Condition	249.3.02	Third Floor	Boardroom	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	35.05		Trinity College Institute of Neuroscience	Neu
136	249	Lloyd Institute	B: Good Condition	249.3.03	Third Floor	Office - HoD - Prof. Ian Robert	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	11.38	1	Trinity College Institute of Neuroscience	Neu
137	249	Lloyd Institute	B: Good Condition	249.3.04	Third Floor	Office - Assistant HoD - Maria I	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	11.38	1	Trinity College Institute of Neuroscience	Neu
138	249	Lloyd Institute	B: Good Condition	249.3.05	Third Floor	Office - TCIN Senior Executive	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	11.19	1	Trinity College Institute of Neuroscience	Neu
139	249	Lloyd Institute	B: Good Condition	249.3.06	Third Floor	Office - Reception Area	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	11.19	1	Trinity College Institute of Neuroscience	Neu
140	249	Lloyd Institute	B: Good Condition	249.3.07	Third Floor	Common Room TCIN	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	72.00		Trinity College Institute of Neuroscience	Neu
141	249	Lloyd Institute	B: Good Condition	249.3.08	Third Floor	Office - HRB Post-Grads (4-yea	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	25.31	6	Trinity College Institute of Neuroscience	Neu
142	249	Lloyd Institute	B: Good Condition	249.3.09	Third Floor	Office - Post-Grads (A. Kelly &	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	25.31	6	Trinity College Institute of Neuroscience	Neu
143	249	Lloyd Institute	B: Good Condition	249.3.11	Third Floor	Research Laboratory - ERP	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	6.02		Trinity College Institute of Neuroscience	Neu
144	249	Lloyd Institute	B: Good Condition	249.3.12	Third Floor	Research Laboratory - ERP	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	6.02		Trinity College Institute of Neuroscience	Neu
145	249	Lloyd Institute	B: Good Condition	249.3.13	Third Floor	Research Laboratory - ERP	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	6.02		Trinity College Institute of Neuroscience	Neu
146	249	Lloyd Institute	B: Good Condition	249.3.14	Third Floor	Office - Post-Grads (Ian Robert	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	25.31	6	Trinity College Institute of Neuroscience	Neu
147	249	Lloyd Institute	B: Good Condition	249.3.15	Third Floor	Office - Post-Graduates	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	28.88		School of Computer Science and Statistics	Cor
148	249	Lloyd Institute	B: Good Condition	249.3.16	Third Floor	IT Education	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	72.92		School of Computer Science and Statistics	Cor
149	249	Lloyd Institute	B: Good Condition	249.3.17	Third Floor	Research Laboratory	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	8.12		School of Computer Science and Statistics	Cor
150	249	Lloyd Institute	B: Good Condition	249.3.18	Third Floor	Meeting Room	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	8.03		School of Computer Science and Statistics	Cor
151	249	Lloyd Institute	B: Good Condition	249.3.19	Third Floor	Meeting Room	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	6.35		School of Computer Science and Statistics	Cor
152	249	Lloyd Institute	B: Good Condition	249.3.20	Third Floor	Office - Post-Graduates	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	72.08		School of Computer Science and Statistics	Cor
153	249	Lloyd Institute	B: Good Condition	249.3.21	Third Floor	Office	ACADEMIC OFFICES & RELATED SPACE	4 ACADEMIC OFFICES & RELATED SPACE	12.71		School of Computer Science and Statistics	Cor
154	249	Lloyd Institute	B: Good Condition	249.3.22	Third Floor	Research Laboratory	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	38.28		School of Computer Science and Statistics	Cor
155	249	Lloyd Institute	B: Good Condition	249.3.23	Third Floor	Office - Lab Manager / Chief Te	LABORATORY - GRADUATE & FACULTY	3 LABORATORY - GRADUATE & FACULTY	25.21	2	Trinity College Institute of Neuroscience	Neu
156	249	Lloyd Institute	B: Good Condition	249.3.24	Third Floor	Corridor	NON - ASSIGNABLE	16 NON-ASSIGNABLE	5.66	0	Buildings Office	Circ

Fig. 4-006 – Microsoft Excel Space Planning/Building Atlas

Source: Director of Buildings' Office, The University of Dublin Trinity College

Space planning functions within The University of Trinity College Dublin are currently undertaken using Microsoft Excel. Room areas are calculated from drawings available on servers within the organisation and transferred manually onto spreadsheets. It is obvious how fragile this exercise has the potential to be. Any experienced user of ICT will know that the data is only as valuable as the source from which it was taken. The drawings used to quantify space calculations are used to charge departments rent for rooms, laboratories, offices etc. that they occupy. Unfortunately the information gathered from drawings requires that the latest version of these drawings are available and live. The information gathered using Autodesk Architecture 2014 is not bi-directional, meaning that a change on a plan is not automatically reflected in the data model contained within the spreadsheet. One solution to this problem is ensuring that this information remains bi-directional, or to put it simply, that any change on a drawing or spreadsheet is automatically updated on each 'model' so, for example, if a room area on a drawing is changed this is automatically updated on the spreadsheet and vice versa. At present, Autodesk Revit 2014 contains room schedules that are embedded within the models themselves and it is hoped that this software can be used in the future to overcome a very standard and basic problems such as this. Space Planning is examined more in Section 5.0 (Existing Workflows)

4.6 Existing Processes

Managing data and methods of data entry within an organisation is very important in order for that information to remain real and valuable. Users of digital information need to trust it to ensure that they can undertake their duties and provide accurate data to any person who requires it. Information is valuable as is the undertaking of retrieving, compiling and sharing information. Setting in place protocols to enable users of valuable information is key to an organisations success. Take, for example, one user within an organisation gathering information and storing this on a server which is accessible to another user within the same organisation. Unless this data is structured and control is put on how it is stored, another user may not trust it and could, in effect, undertake the exercise of gathering the same information again. This is a real problem for all organisations, not just The University of Trinity College Dublin.

There are numerous bodies in existence that will assist an organisation in standardising processes in order to maintain a value on data. One of these is The International Organisation for Standardisation (ISO) who develops standards to *give state of the art specifications for products, services and good practice, helping to make industry more efficient and effective. Developed through global consensus, they help to break down barriers to international trade. A management system describes the set of procedures an organization needs to follow in order to meet its objectives. In a small organization there may not be an official system, just 'our way of doing things'. Often 'our way of doing things' is not written down, instead it is in the head of the staff. However, the larger the organization the more likely it is that there are written instructions about how things are done. This makes sure that nothing is left out and that everyone is clear about who needs to do what, when and how. When an organization systemizes how it does things, this is known as a management system.* **[12]** It would be a rarity to find any experienced ICT user that has not heard of the ISO 9000 Quality Management system.

Unfortunately, many processes currently used within The University of Trinity College Dublin have simply evolved over time, such as may be the case with a smaller organisation. Failing to introduce a standardised process or, 'way of doing things', and the absence of written and documented protocols and standards leads to misinformation being available to all staff. Misinformation is of no value to any member of staff. Information needs to flow seamlessly from one user to another. Data should be shared but should also be structured so that it can be used over and over again, edited, and reused/distributed as needed.

5.0 Existing Workflows

As the previous section outlined, and just like processes in place within the organisation, workflows have been allowed evolve over time so that, in effect, workflows are relevant to individual users and are not part of the overall organism that is the organisation. Fragmented workflows lead to staff working within 'silos' and therefore resulting in information being untrustworthy, unreliable and realistically valueless. Organisations need to ensure that workflows are in place so that data gathered remains valuable.

Take the space planning element of the organisation as has been described previously in this report (See Section 4.5 Microsoft Excel). We will look more at this process in the Section 6.0 (Existing Data Management) but for the purpose of outlining issues that present themselves on a daily basis the table below shows a workflow that presents problems to users (See Fig. 5-001)

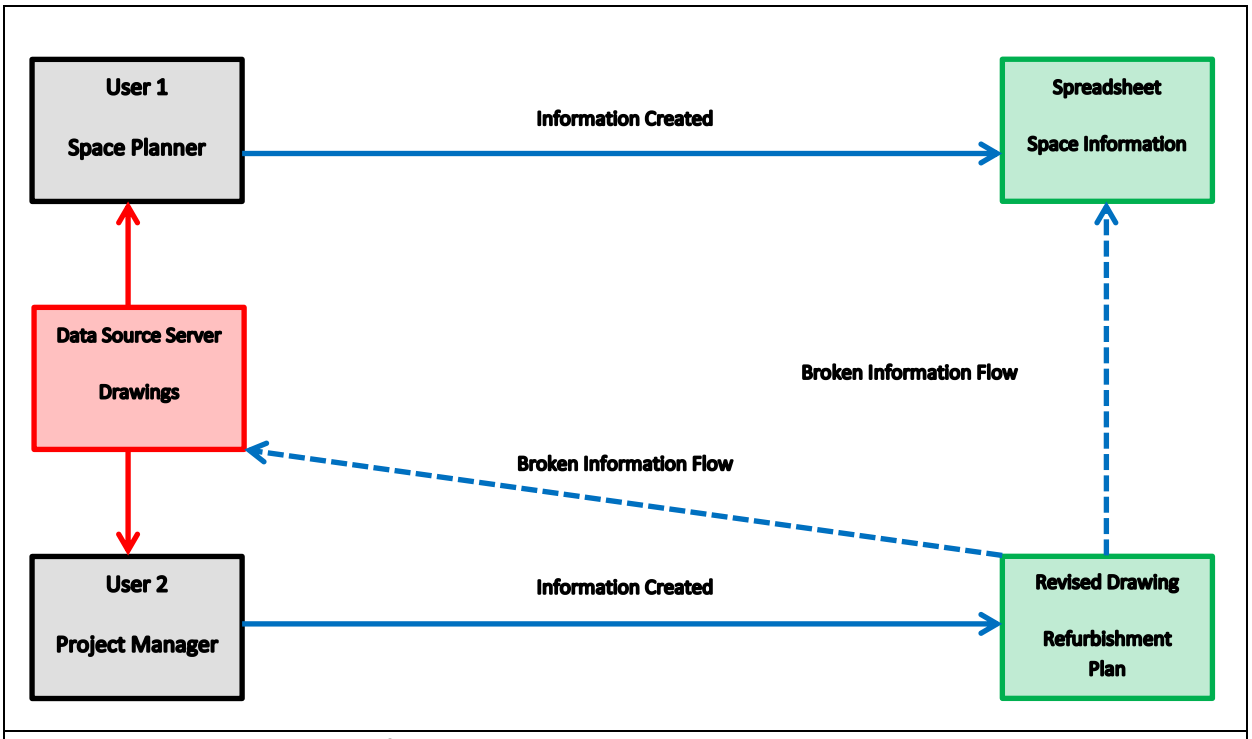

Fig. 5-001 – Space Planning Workflow Issue

Source: Peter Mc Donnell (Student No. D12123482)

The fragility of the existing system is apparent as failure of a Project Manager to upload their revised drawing onto the data source (server) means that the Space Planner does not have accurate and real information available to them. The Space Planner can take this information and charge incorrect rates of rent to the occupier of the space meaning the real possibility that a department could be over or under charged for the space they occupy. Although this is a very simplified example of problems that can occur it presents a visual of the challenges faced by staff when undertaking their duties. This example assumes that there is only one data source available to both users but this issue and the possibility of more than one data source will be examined in Section 6.0 (Existing Data Management). It is also worth noting that similar issues are present for a wide range of responsibilities of The Director of Buildings' Office area and are not just limited to space planning.

6.0 Existing Data Management

Data management within any organisation is vital to ensuring it remains operational and, from a business sense, competitive. Data needs to be stored in a way that makes it accessible at all times. The collection of data is also a vital part of data management and decisions on where to store data are just as important as how it has been collected.

Servers are a normal way of organising data over a large computer network. Servers operate in a client server architecture where users connect to a centralised server which can be programmed to perform certain tasks or typically store information. For example, the server in use within The Director 0f Buildings' Office contains licences for accessing various software tools enabling staff members to use these particular software tools to perform their daily duties while limiting the need for every user to have a 'stand-alone' licence on their local computer/hard drive. We can, in theory, think of the internet as one giant server containing all of the information that we have available to use. Of course, the information available on the internet is not all stored on one server but it is a good way of understanding where the information we access is stored. Different types of servers are available for use in storage of data (file server), email (mail server), internet (web server) etc.

A server is located in each department of The Director of Buildings' Area (Director of Buildings' Office, Buildings Office and Facilities). The main 'file server' is located in the Director of Buildings Office with separate computers dedicated to storage of data located in Buildings Office and Facilities (See Fig 6-001)

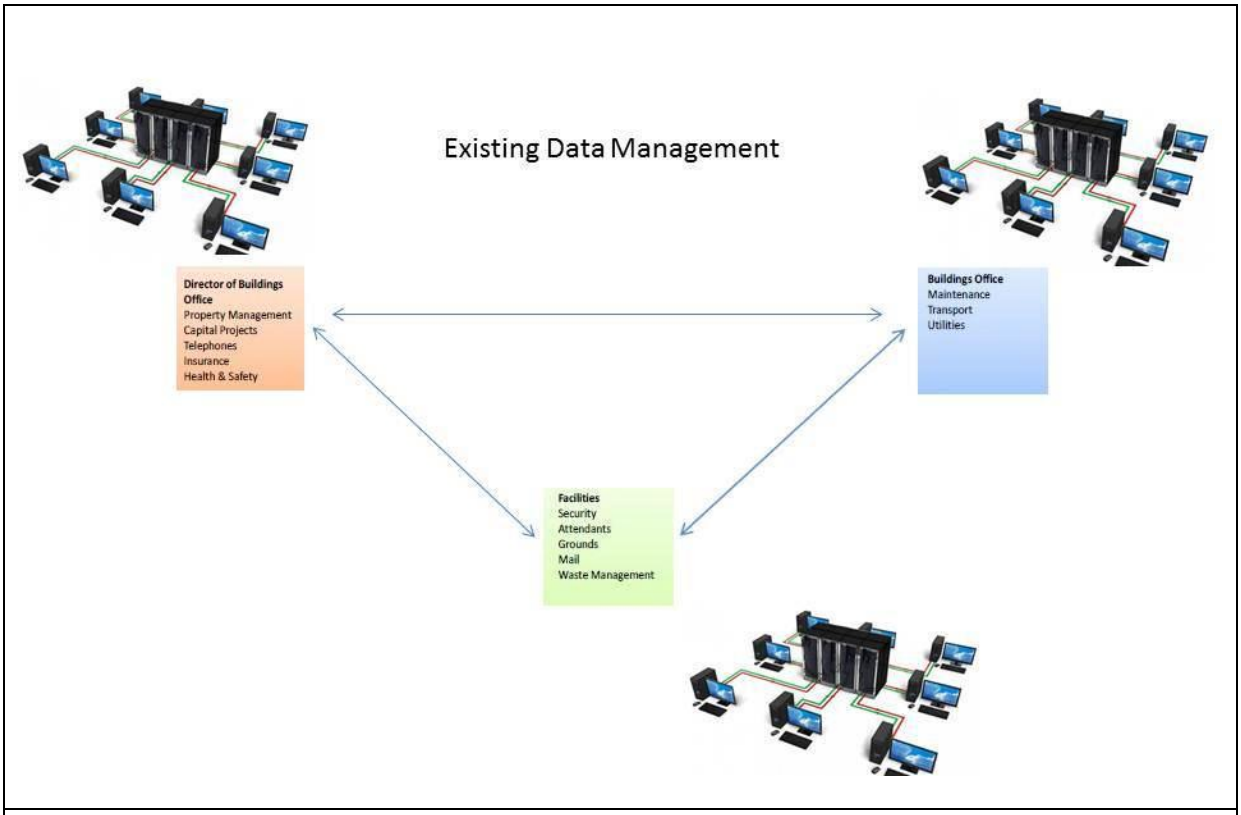

Fig. 6-001 – Existing Servers and Data Storage

Source: Peter Mc Donnell (Student No. D12123482)

Problems with this existing set up will be explored more in Section 7.0 (Identification of Problems Encountered)

Archiving and retrieval of data related to drawings (atlas/space planning and projects) and correspondence within The Director of Buildings' Area also utilises a cloud based solution in the form the software tool outlined in Section 4.4 (SoftCo). This indexed, cloud based system, should to allow for easy retrieval of information when and where it is needed (See Fig 6-002)

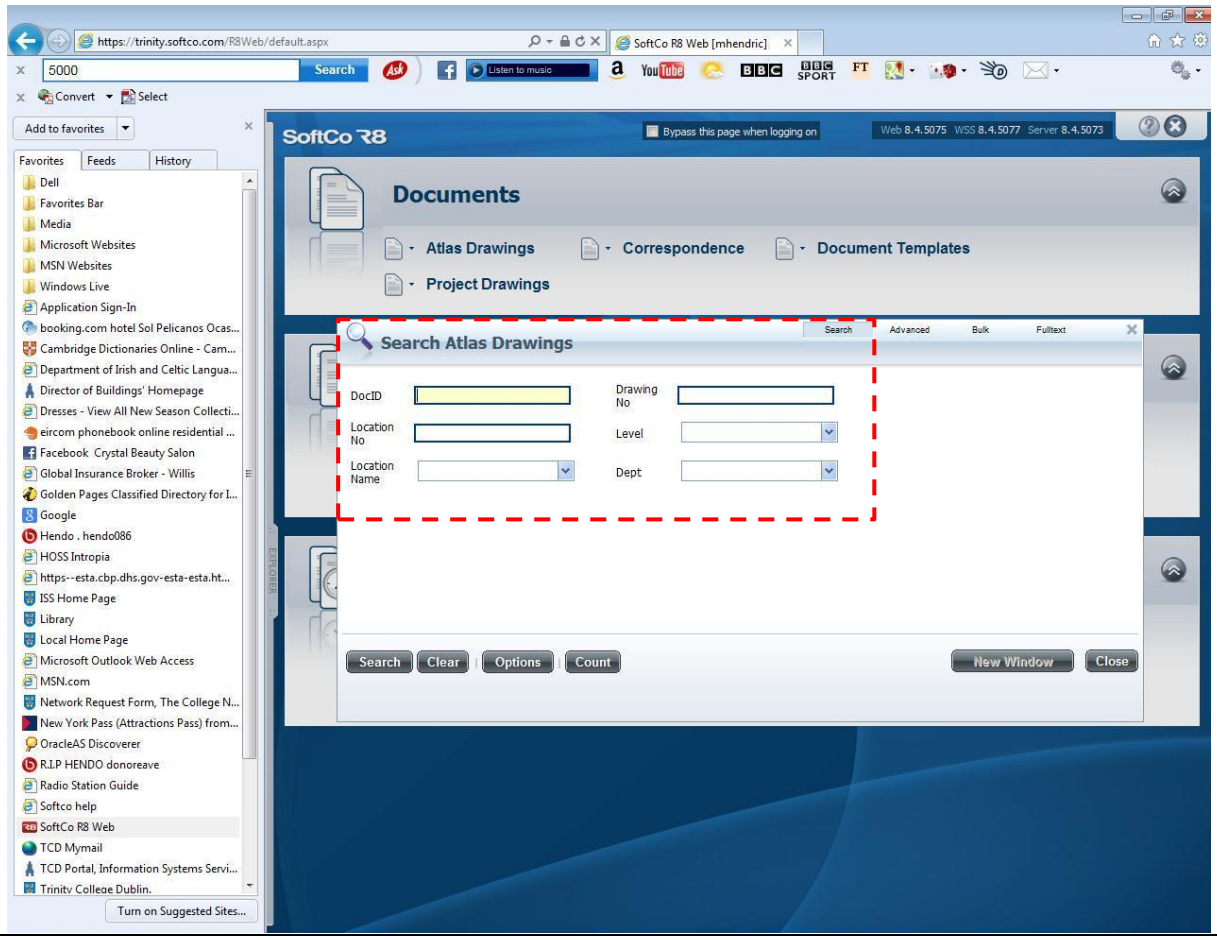

Fig. 6-002 – Existing CAFM Software Tool

Source: Director of Buildings' Office, The University of Dublin Trinity College

This system requires human input to ensure all information remains up to date at all times. It should, if used correctly, protect against duplication and other inefficient practices within the organisation. A control over paperwork will reduce time taken to search for documents that have been physically scanned by a user and 'uploaded' onto the cloud server. Allowing users to have visibility on documents that have been scanned should result in increased productivity for staff.

Collection of this information, in this case, is not automated as the SoftCo. Software tool is not integrated into the existing CAFM software tool (GVAS9 Live) used on site. Instead, staff members collect data as they work through their work duties and scan what they chose to. It is noticeable from the image above (See Fig. 6-002) that some information, in this case Atlas Drawings, has not been scanned and are therefore as a result not available in the SoftCo cloud based data management system.

7.0 Identification of Problems Encountered

Having spent time detailing the existing data management and workflows of the organisation it became clear how the fragmented system could cause users problems. In theory, the system(s) that have been set up should increase efficiencies and productivity; however, it was found that this was not the case in most instances.

In order to establish the nature of staff members work, staff members knowledge of ICT, software tool usage, data management systems access and to gain information of data collection, storage and sharing methods a BIM 'Survey of Needs' was created in order to attempt to accurately analyse and identify the good and the bad of the existing data management system(s). Analysis of Problems Encountered and Review of Systems/Processes/Workflows/Data Management etc. will allow for a strategy for delivering improvement to be implemented (Section 9.0 Implementation of Data Management Tools and Strategies)

7.1 BIM Survey of Needs

The survey consisted of 31 questions and was sent via email to all relevant staff (total 150no.) with these staff given sufficient time to respond. In all, 45 responses were collected indicating a 30% response rate. As this was quiet a large survey, a selection of the questions asked, responses gathered and graphical illustrations of these are provided below (See Figs. 7-001 to 7-006) while the following link can be used to access the survey and results gathered from this survey online:

https://www.surveymonkey.com/s/WFMZKGF

https://www.dropbox.com/sh/rvbvxisuct7ivgu/hEHDRWhvw5

- **BIM Survey of Needs – Question 9**

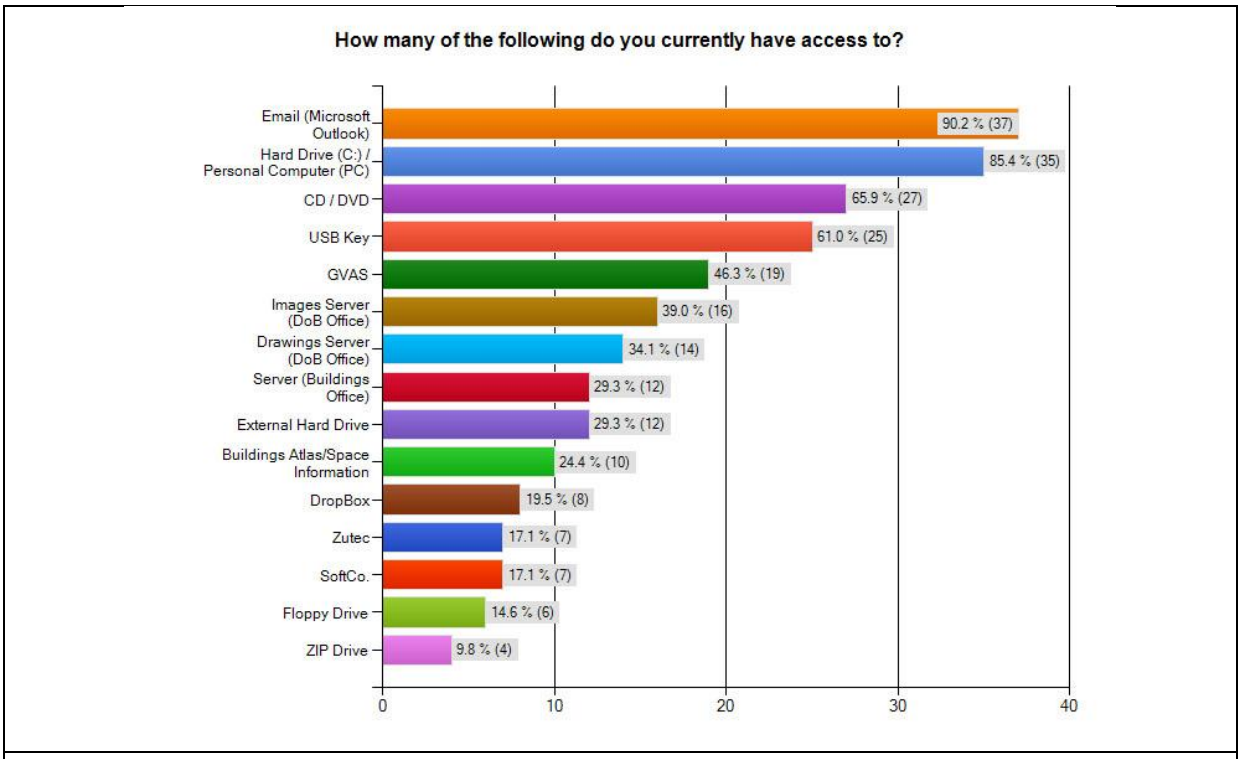

Fig. 7-001 – Q.9 BIM Survey of Needs – Access to Data Management Tools

Source: Peter Mc Donnell (Student No. D12123482) / Survey Monkey

- **BIM Survey of Needs – Question 10**

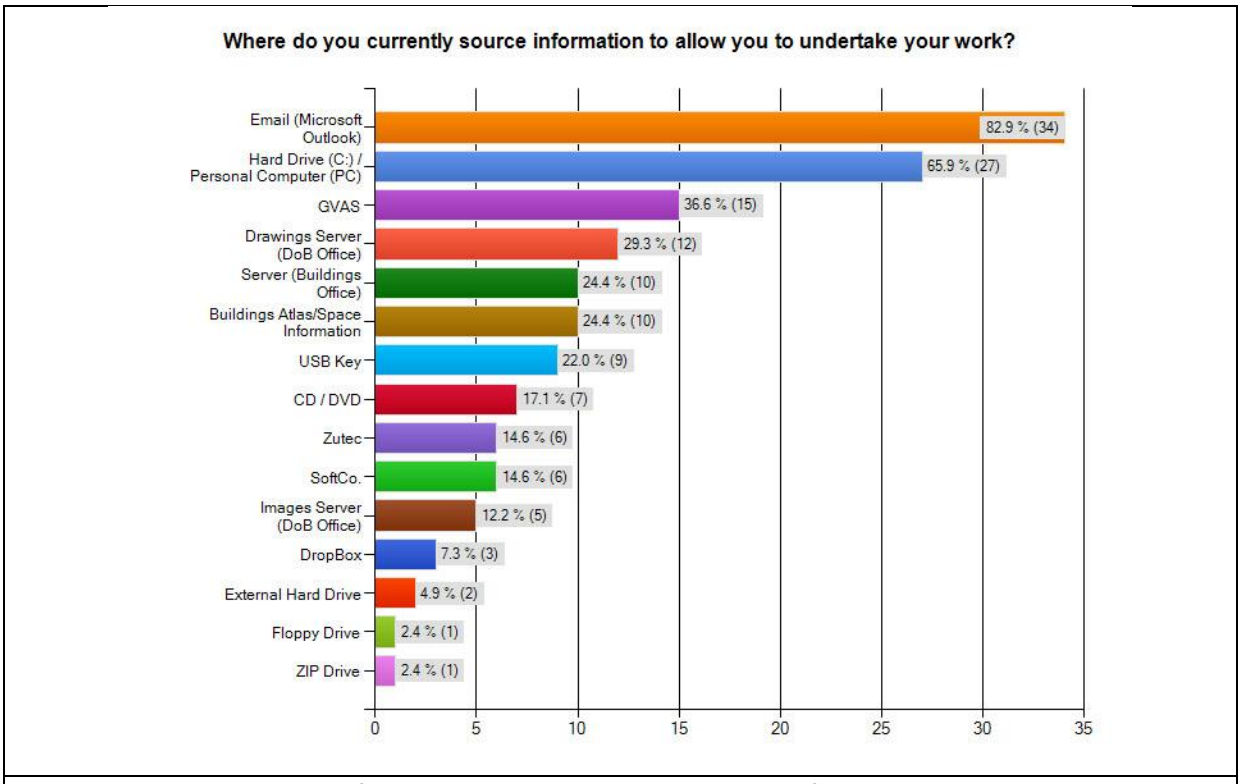

Fig. 7-002 – Q.10 BIM Survey of Needs – Access to Data Management Information Sources

Source: Peter Mc Donnell (Student No. D12123482) / Survey Monkey

- **BIM Survey of Needs – Question 11**

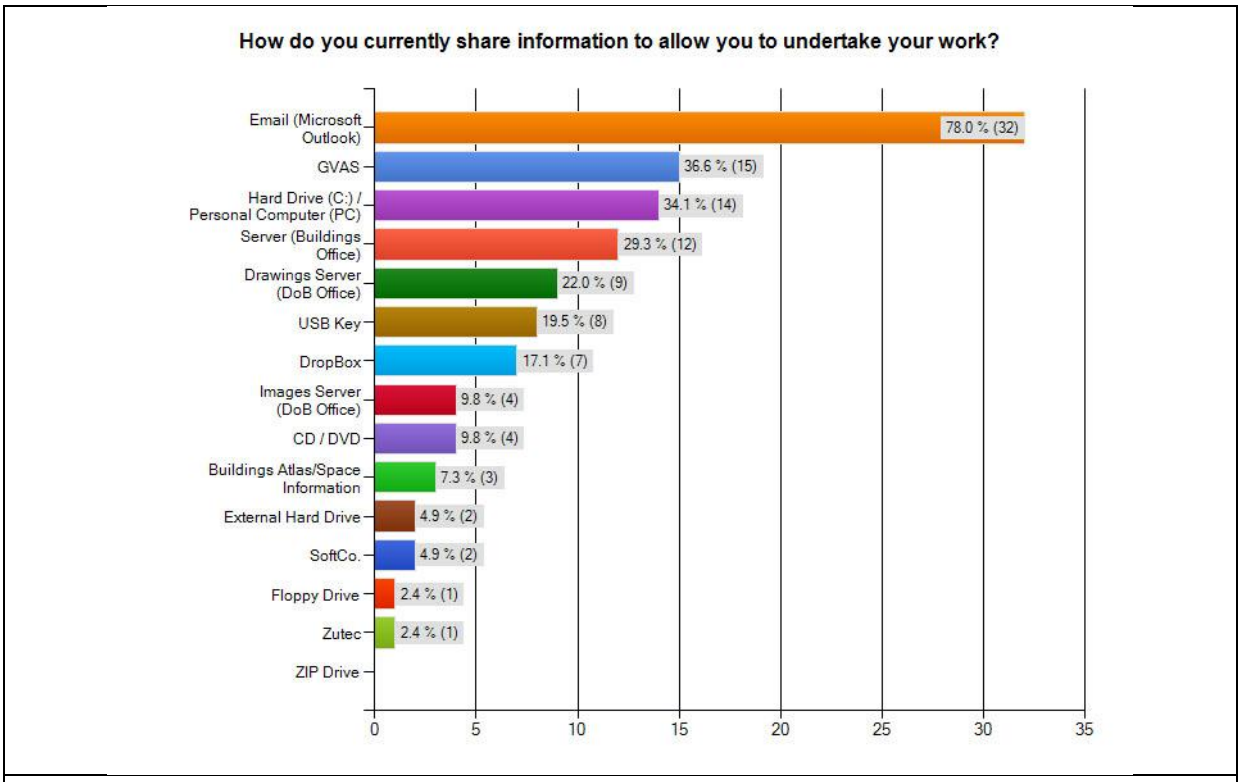

Fig. 7-003 – Q.11 BIM Survey of Needs – Sharing and Data Management Information Sources

Source: Peter Mc Donnell (Student No. D12123482) / Survey Monkey

- **BIM Survey of Needs – Question 12**

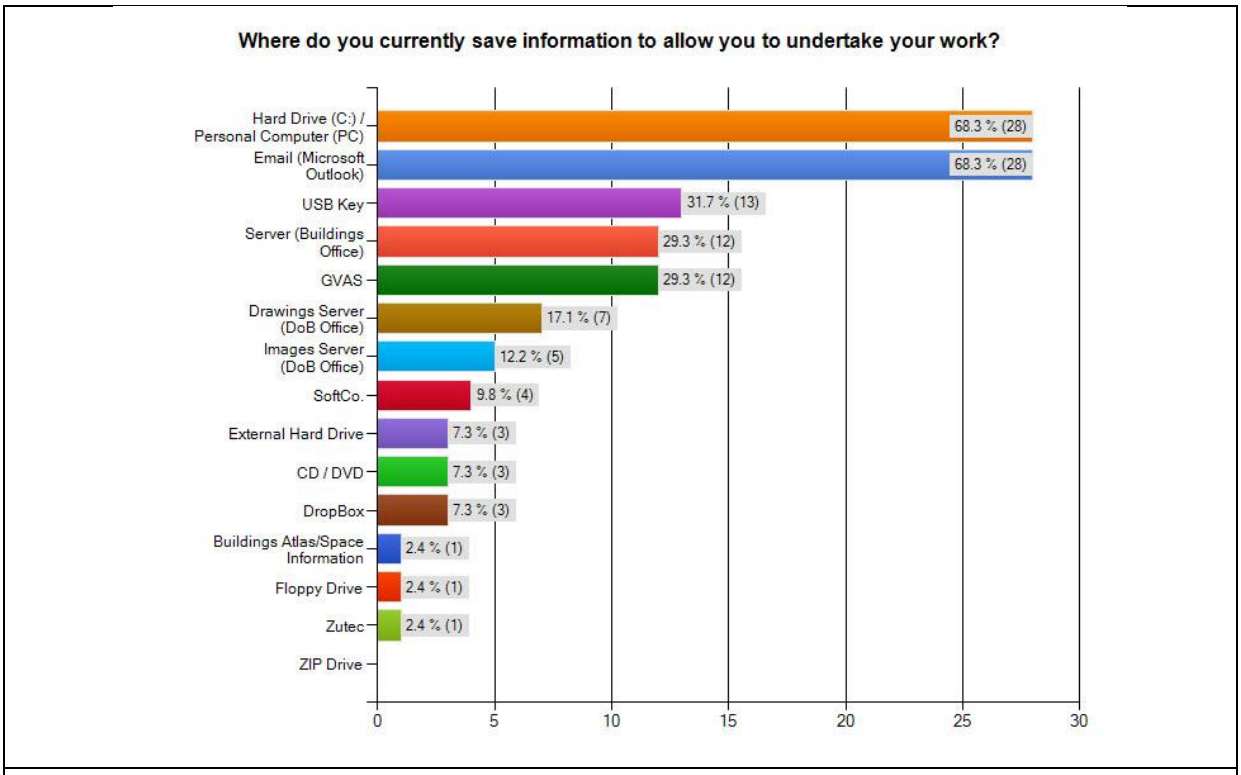

Fig. 7-004 – Q.12 BIM Survey of Needs – Saving to Data Management Information Sources

Source: Peter Mc Donnell (Student No. D12123482) / Survey Monkey

- **BIM Survey of Needs – Question 29**

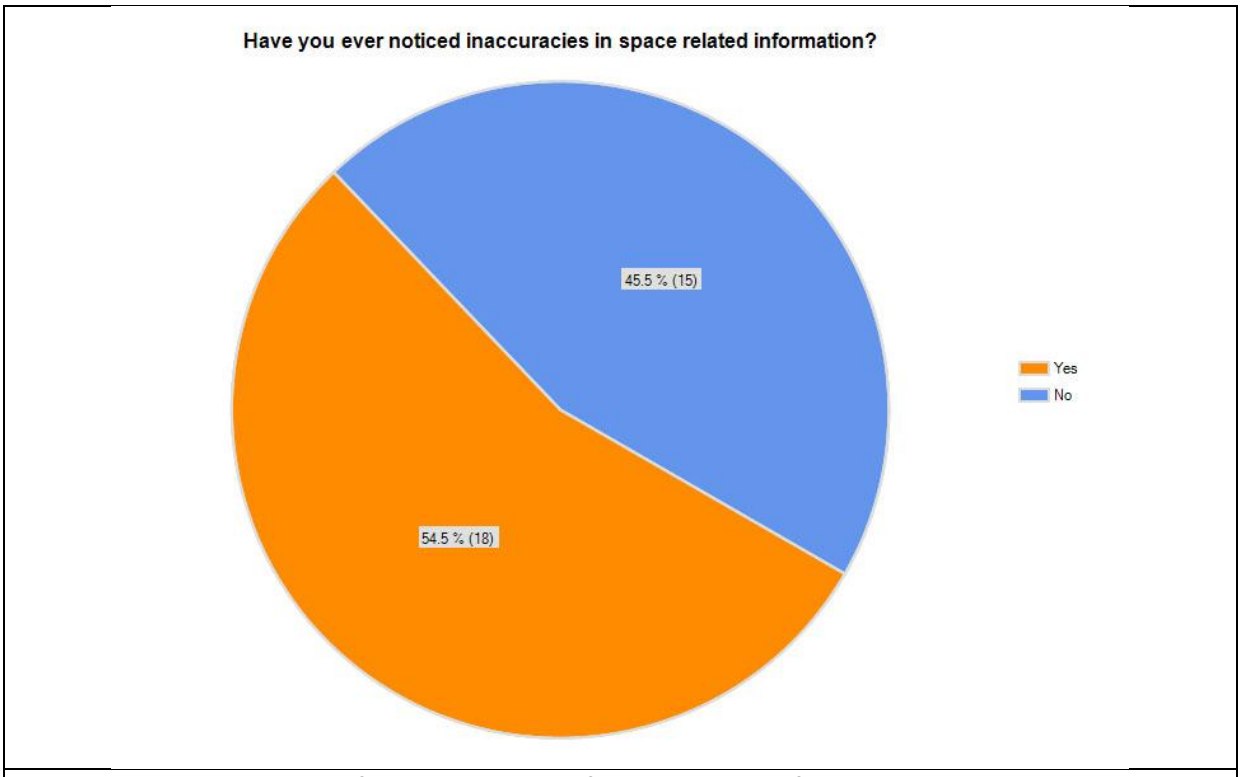

Fig. 7-005 – Q.29 BIM Survey of Needs – Accuracy of Space Planning Information

Source: Peter Mc Donnell (Student No. D12123482) / Survey Monkey

- **BIM Survey of Needs – Question 30**

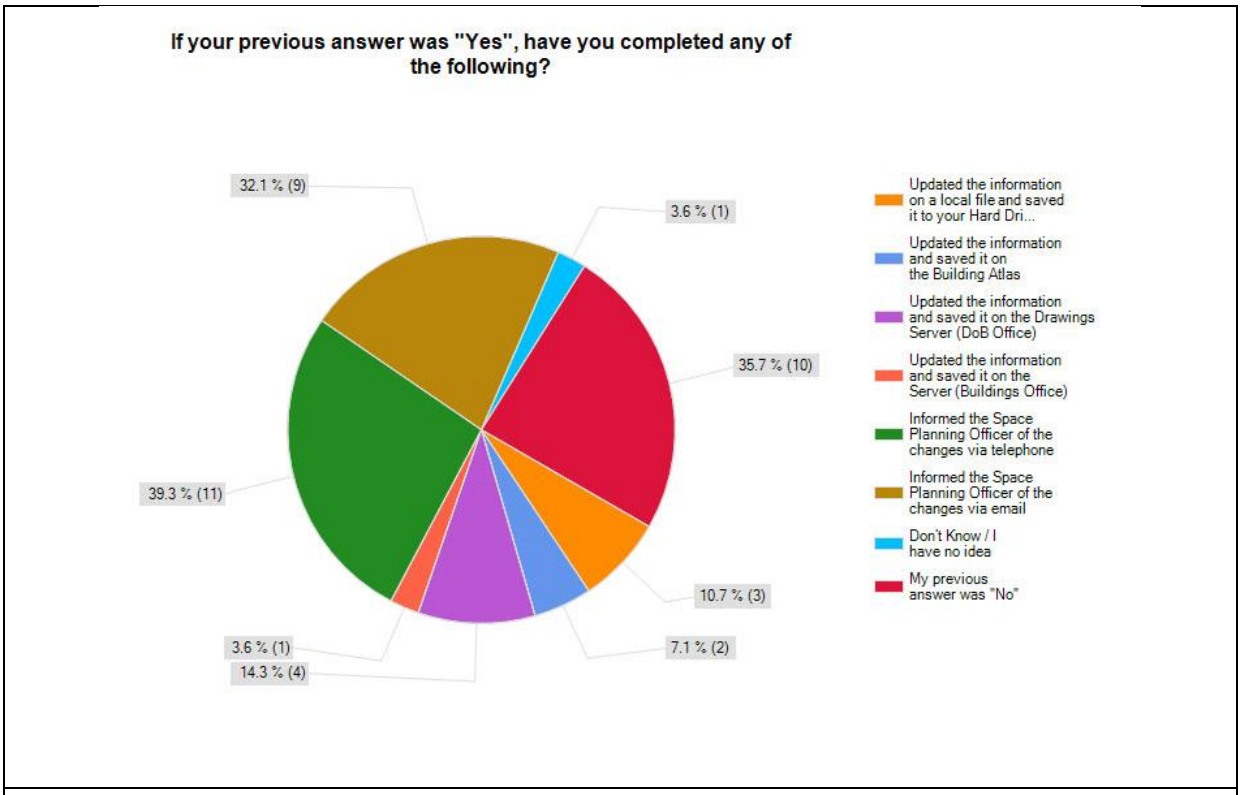

Fig. 7-006 – Q.30 BIM Survey of Needs – Updating of Inaccurate Space Planning Information

Source: Peter Mc Donnell (Student No. D12123482) / Survey Monkey

Focusing one elements of data management as set out in the previous questions from the BIM 'Survey of Needs' particular problems in the following sections of the report.

7.2 Problems Encountered – Access/Sourcing Information

Focusing one elements of data management as set out in the previous selection of questions from the BIM 'Survey of Needs' particular problems in the area of data sourcing were observed (See Figs. 7-001 and 7-002). From the responses/graphs provided it is clear that there are limits on numbers of staff members who have access to the central server. Failing to allow access to all staff to one centralised repository of data results in alternative methods of storing data being used by staff (USB Keys, External Hard Drives, Local Hard Drives etc.) 34.1% of staff who responded to the survey have access to the main 'Drawings' server. This results in fragmented data storage and access leading to data being duplicated and version control become a real issue. Sourcing information is also an issue, as we see 65.9% of staff who responded to the survey source valuable data from their local (C:) drive. This means that although this information is available, it is limited to the person(s) who have access to this computer. Other staff members rely on these users to share information with them using different methods available to them (See Fig. 7-003)

7.3 Problems Encountered – Sharing Information

Sharing information is also an issue, as we see 34.1% of staff who responded to the survey believe that a legitimate way to share information is via their local (C:) drive. Again, this information is limited to the person(s) who have access to this computer (See Fig. 7-003). As well as this, 29.3% of staff who responded to the survey use a separate computers dedicated to storage of data located in Buildings Office (See Fig 6-001) for 'sharing' of information although this particular information source is only available to the same percentage of staff (Se Fig. 6-001) which would indicate that there is limited sharing actually happening in this instance.

7.4 Problems Encountered – Saving Information

Saving information follows on from the previous two sections where problems encountered with access to, sourcing and sharing of data/information were observed. 68.3% of staff who responded to the survey believe that an efficient way to save information is via their local (C:) drive. Again, this information is limited to the person(s) who have access to this computer (See Fig. 7-004) resulting in data sharing being limited. There is also a quiet large amount of usage of USB use within the Director of Buildings' Area (31.7%) which can lead to data loss should these valuable files/data sources not be returned to the central server. There is also the possibility that version control can become a real problem.

7.5 Problems Encountered – General

A selection of problems and issues encountered are set out below:

- Data Flow
- Data Sharing
- Data Saving
- Data Collection
- Data Entry
- Data Duplication
- Data Integrity
- Data Fragmentation
- Data Retrieval
- Duplication of Effort
- Lack of Standardised Documents
- Lack of Protocols/Guidelines
- Lack of User Manuals
- Limited Knowledge Transfer
- Incorrect use of Central Server (for data)
- Number of 'Servers' in operation (for above)

It is clearly evident that there are a large number of problems with current practices in The Director of Buildings' Area. This report will outline possible solutions to these (Section 9.0 Implementation of Data Management Tools and Strategies)

7.6 Problems Encountered – Space Planning

As outlined in Section 5.0 (Existing Workflows) space planning is one important element of the responsibilities of The Director of Buildings' Office, amongst many others. As we have reviewed this particular undertaking previously it is worthwhile to look at the responses gathered from the BIM 'Survey of Needs' to identify problems with space planning. Users have identified that there are particular inaccuracies with space planning information that is available to them (See Fig. 7-005). This could be for a number of reasons, but reading through Section 7.0 (Identifications of Problems Encountered) again in its entirety and it is not difficult to understand why this may be so. It is not to say that these issues are limited to just space planning but there appears to be a systematic failure with collection, storage and sharing of data within the organisation. Particular interest is paid to the next set of results (See Fig. 7-006) where the absence of standard protocols and/or guidelines on how to repair inaccuracies that might be observed lead to further deepening of the problems that exist already. Once data inaccuracies are discovered, a selection of methods are used for 'updating' the inaccurate information including updating the information and saving it to a local (C:) drive (10.7%), updating the information and saving it to the Building Atlas spreadsheet (7.1%), updating the information and saving it to the Drawings Server (14.3%), updating the information and saving it to the Buildings Office Server (3.6%). The 3.6% of updates that occur on the Buildings Office Server account for a total of 1 staff member, however, this could realistically be 1 too many staff members. Only 71.4% of staff members updated the Space Planning Officer (by telephone or email) to allow the correct person responsible for space planning issues update the information as it should be. However, as there are no set guidelines for doing so it is difficult, and unfair, to place any blame at any individual set of staff members for doing so as a lack of control, protocols or guidelines means that situations such as this are common practice. If we were to review, to select just one item, how space functions within The University of Trinity College Dublin are currently undertaken (Section 4.5 Microsoft Excel) and how drawings and control of versions are managed within The Director of Buildings Area this would show that there are solutions available but that they will require 'buy in' from all concerned as well as up skilling and training in the use of existing software and possible new software that could be introduced. It would be relatively easy to set in place a test case to review existing Computer Aided Design (CAD) software in use, Autodesk Architecture 2014, and instead use a Building Information Modelling tool such as Autodesk Revit 2014 to reduce or hopefully eliminate altogether these problems. This report has already mentioned the possibility of this being a viable solution (Section 4.5 Microsoft Excel).

8.0 Strategies to Overcome Problems Encountered

Identifying the correct strategy to overcome the problems encountered will not be any easy task but The University of Dublin Trinity College can look to similar organisations such as The Pennsylvania State University or Xavier University to research what institutions such as these have done to combat problems with data entry, decision making, tight schedules etc. on new building projects but these do not address the issues that are existing with buildings and associated information that exists already. Work practices and work flows have evolved over time within the organisation, leading to staff working in isolation, in silos, and failing to appreciate the value of the data that they are in possession of. Traditionally, data would be collected in an inefficient and non-productive way but what are the options available to an organisation of this size when looking to streamline work practices, eliminate duplication and waste? It is important that the organisation ask important questions of itself in order to gain some insight into how to achieve better data sharing and CAFM:

1) **Data Collection**

- How is valuable data relating to a facility/building collected?
- Can this data be collected in a more efficient way?

2) **Data Access/Sourcing**

- How is valuable data relating to a facility/building accessed or sourced?
- Can this data be accessed or sourced in a more efficient way?

3) **Data Storage**

- How is valuable data relating to a facility/building stored?
- Can this data be stored in a more efficient way?

4) **Data Sharing**

- How is valuable data relating to a facility/building shared?
- Can this data be shared in a more efficient way?

5) **Data Saving**

- How is valuable data relating to a facility/building saved?
- Can this data be saved in a more efficient way?

Implementing building information modelling is much more of a business decision than a technical one. BIM is an enabling technology with the potential for improving communication among business partners, improving the quality of information available for decision making, improving the quality of services delivered, reducing cycle time, and reducing cost at every stage in the life cycle of a building. But while it opens the door to these possibilities, it does not make them happen. The technology must be deployed as part of a comprehensive business strategy in order to be successful. Many business processes and workflows must change to take full advantage of the technology. **[13]**

By far the most important yet least addressed aspect of implementing BIM is the corresponding changes of business practices needed to optimize the opportunity afforded by BIM, whether the practice in question, such as integrated project delivery, requires the cooperation of business partners or is entirely internal to your firm. The aspects of business process reform that should be considered as part of any BIM implementation effort include:

- *Greater electronic information exchange to reduce or eliminate manual data entry whenever possible*
- *Reduction of cycle time whenever and wherever possible to reduce or eliminate low-value or no-value tasks such as processing Requests for Information, preparing shop drawings, or measuring existing conditions*

  ……..
- *Reorganisation of business processes to enable more tasks to occur concurrently rather than sequentially*

  ……..
- *Automated, real-time monitoring and analysis of operating systems and equipment to achieve and maintain optimal performance*

These changes are only partly about technology. BIM and related technologies may enable these reforms to occur but the fundamental issue is how we use information to improve the way we do business. **[14]** The term *'information'* is an interesting one. What is the difference between it, data and knowledge? Information keeps cropping up but can we define it? *The term information is often used loosely to cover data, information and knowledge, and it is necessary to distinguish between these.*

- *Data is (or are) collections of facts, measurements or statistics*
- *Information is organised or processed data that is timely and accurate*
- *Knowledge is information that is contextual, relevant and actionable*

Data is what we tend to have too much of and, although necessary for management or for operating any computer system, it needs to be carefully selected for its timeliness and accuracy, thus becoming information. **[15]**

Innovative organisations take risks and are not afraid to look at emerging trends (such as Computer Aided Facility Management) in order to improve work practices by increasing the levels of collaboration already present within the organisation, and reduce the fragmented workflows that are present and causing considerable damage to valuable data. Thinking about Construction Informatics is not a risk, it is common sense. By studying the information already available, processes by which it was collected, stored and shared and organisation and workflows used by staff to allow them to undertake their work duties any organisation can identify the correct strategy to allow them to achieve their goals.

8.1 Traditional Information Collection v Building Information Modelling Intelligent Information Input

The previous sections describe in detail the traditional processes and systems used within the organisation, but what about new processes and systems that might be emerging?

Building Information Modelling is a process of collecting, organising and managing data in a digital software environment for use in the full life cycle (design, build, operation and demolition) of a facility. The information collected, organised and managed in a model can be used for 3D visualisation purposes, simulations and analysis of projected performances of a facility, assist in design decisions, improve efficiencies and co-ordination, scheduling and life cycle operations such as the maintenance of plant/equipment and refurbishment of individual areas of a completed facility in later life. Advancements in Building Information Modelling (BIM) technologies and software mean that design teams can now work more collaboratively, particularly in the early stages of a building's design, which should lead to better analysis of design decisions, improved problem solving and decision making. *A strategy that depends on such profound understanding of the entire building life cycle by all participants in the life cycle is doomed to fail. What is important, rather, is that anyone involved in any part of the life cycle of a building – from the geotechnical engineer analysing a building site to the renovation or demolition contractor – recognise that the tasks they perform and the information they create are a small part of a very long sequence or cycle of tasks. Anyone can readily understand and appreciate that any building information they create might be of value to someone else for some other purpose, even if they have no idea exactly how, when, why or by whom. Systems-minded building industry professional regard the information they create with an attitude of stewardship rather than ownership. They are mindful that their possession of the information is temporary and that it is of potential value to someone else after it is no longer useful to them. They organise, compile and maintain information in the most structured, integrated, and accessible manner possible. They view information as a tangible asset and a living resource.* **[16]**

A suggestion of what the University of Trinity College Dublin could do is look at the following possible solutions to existing problems:

- Cloud Storage
- Remote Access Live Data
- Standardisation
- Open Platforms (IFC)
- Computer Aided Facility Management (CAFM)
- Culture/Mindset Change

Some people may be surprised that these are not all technology based but there are cognitive and social aspects to Construction Informatics. An organisation can put all of the technology it wants in place but failure to address the human side of informatics will inevitably lead to failure to produce the desired improvements. Communication (and how we do it) and the platform upon which we communicate are key. If an organisation of the size of The University of Dublin Trinity College was to choose to take the first suggestion from this list, Cloud Computing, what would we think would be the benefits that could be achieved over a more traditional process of information collection and what would be the risks involved.

8.2 Cloud Computing

By allowing an organisations workforce to create and share information in one central location, the organisation will encourage collaboration and integration of workflows resulting in increases productivity and efficiencies within it. By providing one central database, on a cloud server for instance, each member of staff in different departments can collaborate easier and automate some elements of their traditional work practices, such as space planning. Some elements of existing work practices are fragmented but having different storage and information sources invites this. (See Fig. 8-001)

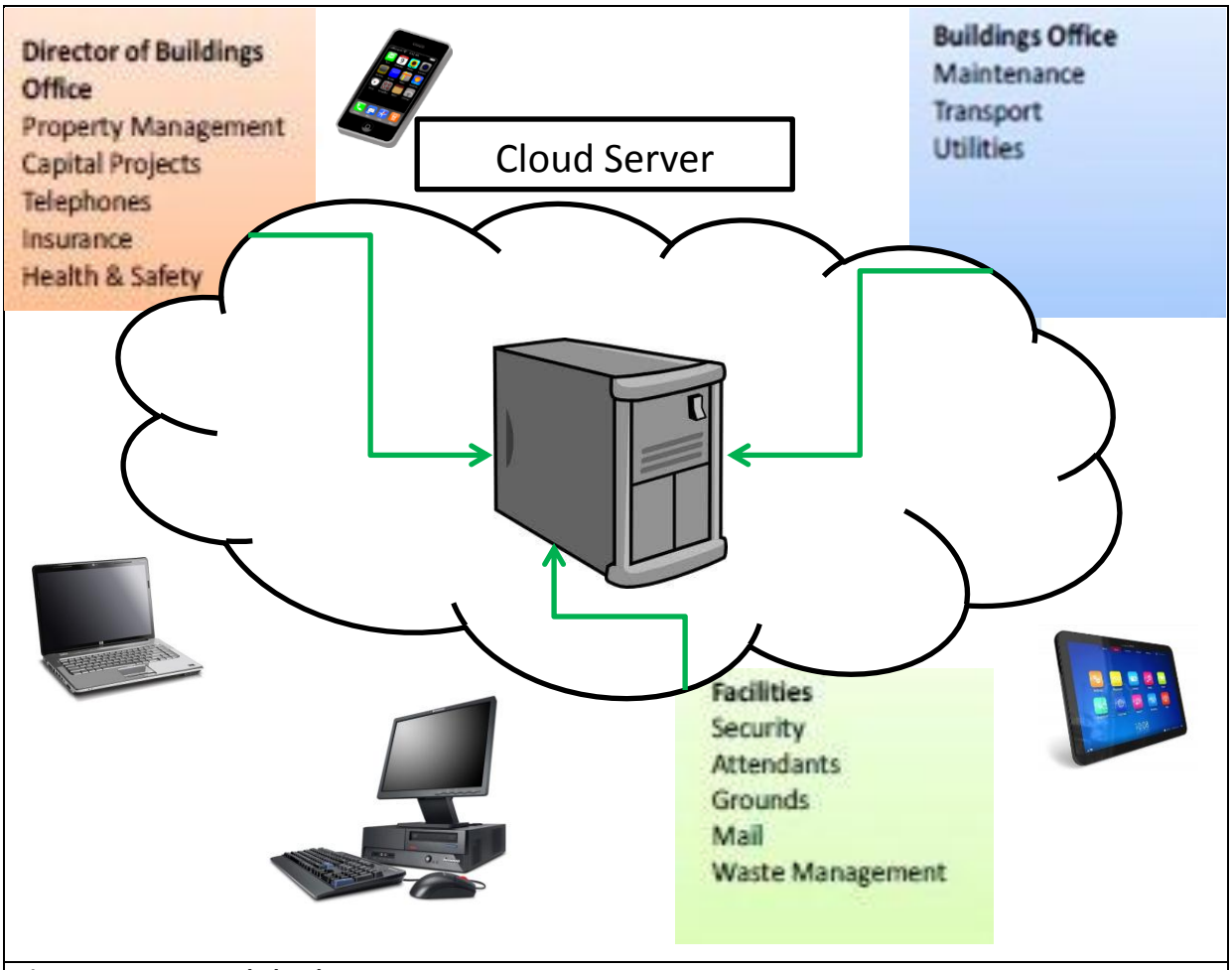

Fig. 8-001 – Proposed Cloud Server

Source: Peter Mc Donnell (Student No. D12123482)

The benefits of this cloud server will be allowing staff to access reliable information from anywhere at any time (on a number of different devices such as laptops, computers, smart phones and tablets etc.) while reducing time taken to source and access valuable data. Think of this in relation to what we have seen with the existing organisational structure and ways of doing things (See Section 7.0 Identification of Problems Encountered) and ask if a cloud based solution could improve the existing model. *Cloud computing is not a specific technology or a particular software solution. Instead it is an umbrella concept for different methods to share resources over computer networks……* **[17]**

There are also some other very important questions to ask before a decision on any strategy is made, including amongst others the use of cloud computing. Access to the cloud is vital, keeping sensitive information confidential, licensing of applications used to interact with information, performance of the cloud etc. There are also specific requirements to enabling cloud computing and achieving the benefits from it.

The 5 'S' Requirements of Cloud Computing are:

- Security
- Simplicity
- Scalability and Standards
- Scalable Service Orientated Architecture (SOA)
- Semantics

If the information already available to staff was made available on a cloud server, and a structured platform with specific application put in place to feed this data, one element of work that would benefit would be space planning.

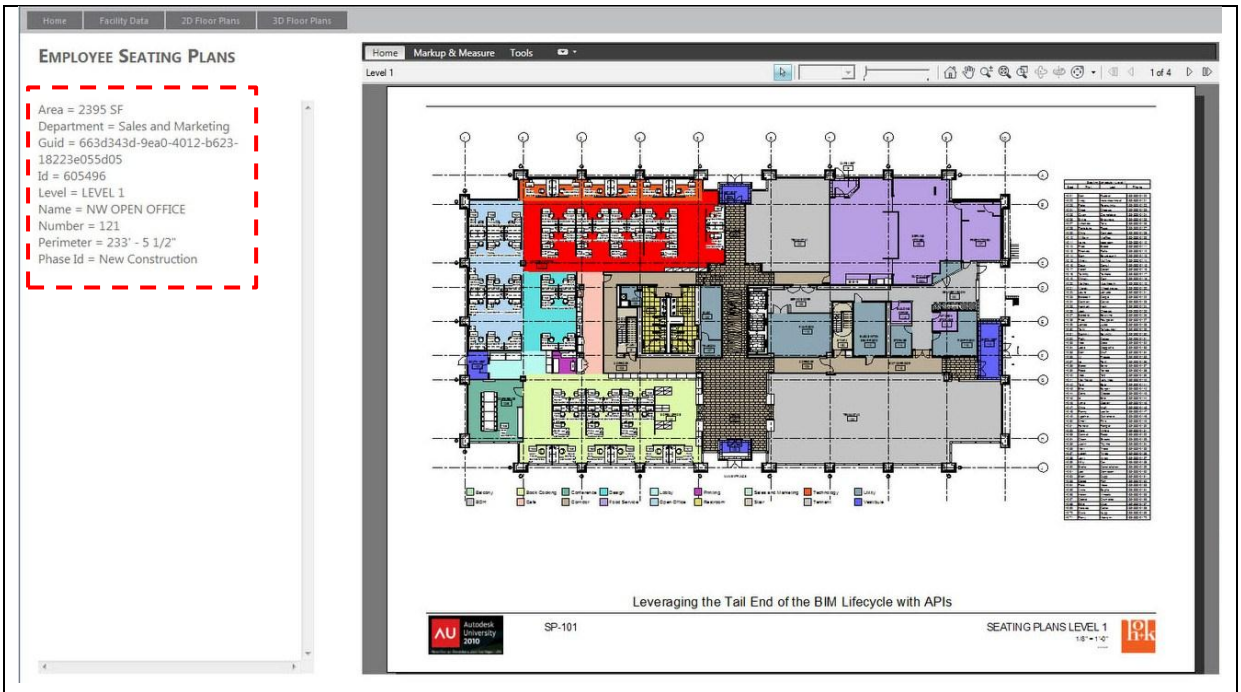

Fig. 8-002 – Space Planning and CAFM with Autodesk Revit

Source: Autodesk University

Data already contained within 2D CAD drawings, excel spreadsheets and on various other documents could be used more intelligently, collated and organised on a cloud server and, in this case used with Autodesk Revit (See Fig. 8-002) to allow more staff access to it and keep data live and in 'real time'.

9.0 Implementation of Data Management Tools and Strategies

The implementation of a new data management strategy needs to happen while business within the organisation continues and the organisation itself remains operational. It is unrealistic to think that an existing workflow or process within a business will stop at close of business one week and be replaced with a new improved workflow or process at the beginning of the following working week. Use of pilot project(s) would help is assessing if a new data management strategy will have the desired effect. *When doing a pilot project, it's always best to do a dry run and make sure the tools and processes are in place to succeed. This may be as simple as giving the designer a small design task that showcases the desired BIM applications.* **[18]**

The implementation should following only after asking a serious of questions:

- How efficient are current practices?
- Will CAFM Tools be of any benefit?
- Who, if anybody, would benefit from CAFM implementation?
- Will BIM be of any benefit?
- Who, if anybody, would benefit from BIM implementation?
- Is organisational restructuring required?
- Are there cultural or mind set issues to be overcome?

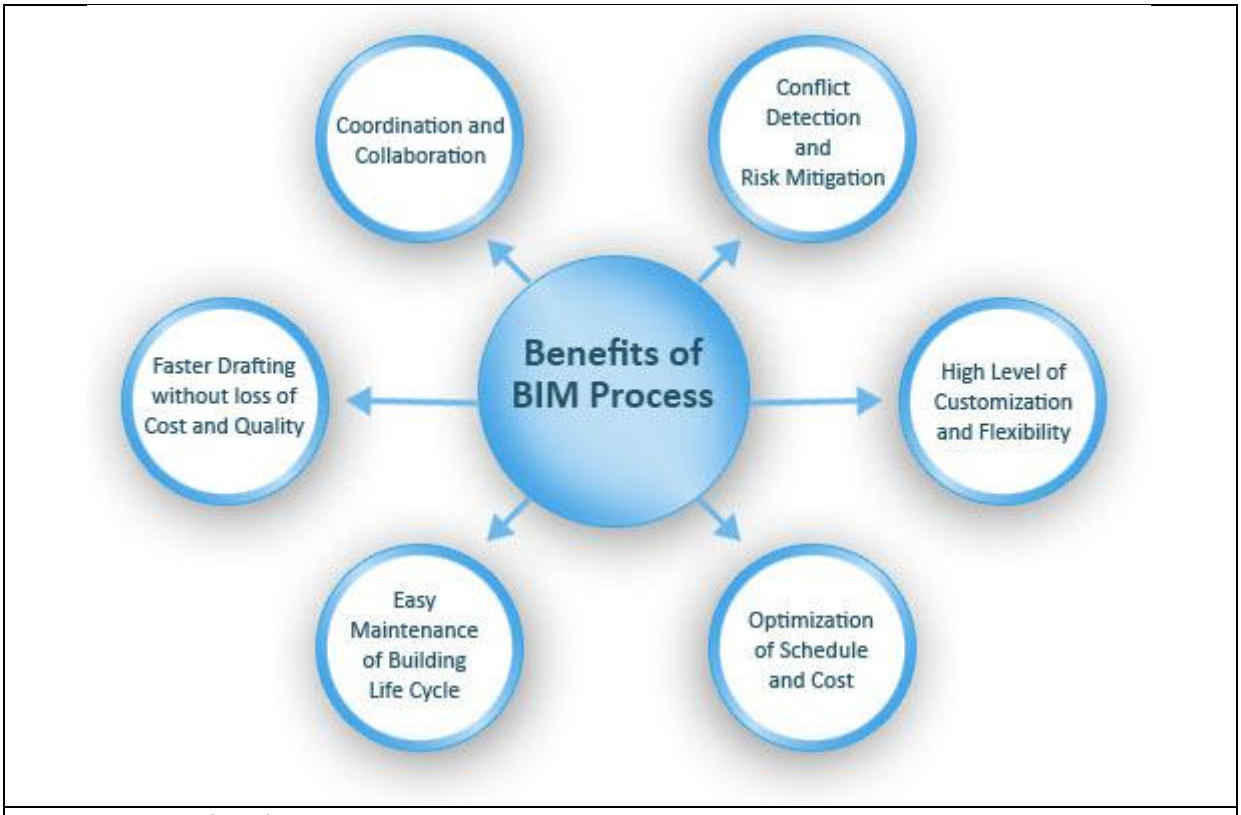

Fig. 9-002 – Benefits of a BIM Process

Source: Peter Mc Donnell (Student No. D12123482)

The University of Dublin Trinity College must begin with the final 'end goal' mind. *Strategic planning helps ensure an organisation is ready for the implementation of a new process or technology with planned resources. If implemented correctly, it can promote collaboration within an organisation and greatly reduce the chances of failure.* **[19]**

10.0 Conclusion

This report has looked at a large organisation, how it currently collects, stores and shares valuable data and how improvements to this might be made. A smaller organisation would have fewer barriers to implementing new systems and processes but would still need to do so in a carefully structured way. Strategies for planning and implementing the new systems and processes would have to be carefully planned if they were to succeed. Any SME would need to know what it is exactly that they want from the new systems and processes, be it BIM or not. It would need to not only look at the technology aspects of existing information systems but also the social aspects, *Construction informatics is an applied science that studies the construction specific issues related to processing, representation and communication of construction specific information in humans and software.* **[20]** Failing to address different levels of ICT skills amongst an SME's staff could lead to less collaboration among staff members when one person cannot trust another person's data and may be inclined to not wish to collaborate to a level that would see the desired improvements being realised by a new system or process.

By using a pilot project to test a new system and process an SME can protect itself from the possibility of it failing and old practices being returned to. An SME should, in theory, be less fragmented that a large organisation. This should mean that a pilot project can be easier to put in place and run, then reviewed to check if the desired improvement s were realised. A limit on the number of different software tools in use would also reduce the chance of interoperability issues to arise. Where different software tools are used, a standardised format for data exchange, Industry Foundation Class (IFC), could be agreed upon before the pilot project commenced and staff could be encouraged to input data into datasets that could be exported and imported into any different software tools that were in use. The SME could ask for an external business partner for assistance in testing out the new system or process by using this open platform for data exchange. An IFC can support the transfer of data between different software tools used within different organisations. When the data is imported/exported it can be checked for data loss at each end, or for general differences in the quality of the information that was imported/exported when each stakeholder receives it.

The SME's chosen strategy for implementing the new system and process for working will have a better chance of success and the maximum benefits will be achieved if all aspects of the organisation are researched before the chosen strategy is put in place. *E-business strategy defines how organisations connected with external partners as well as how organisations operated within management activities, processes and systems (Zeng and Li, 2008). It enables organisations to promote the alignment of business and IT infrastructure in order to derive the maximum benefit from their investments in technology According to Chaffey (2009), without a clearly defined e-business strategy, the following problems mat result:*

- *Missed opportunities: because of a lack of evaluation of opportunities or insufficient resourcing of e-business initiatives;*
- *Inappropriate direction in e-business development: having no long-term consideration of e-business development and without clearly defined objectives;*
- *Limited integration: at only a technical level potentially resulting in "silos" (e.g. separate organisational team with distinct responsibilities that do not work in an integrated manner with other teams) of information in different systems; and*
- *Resource wastage: due to duplication of e-business development in different functions and limited sharing of best practice.*

Therefore it is important for all organisations to define an appropriate e-business strategy to guide its e-business implementation and support the overall corporate strategy. **[21]**

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[4]*Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors and Real Estate Managers, Dana K.Smith, Michael Tardif (2009) – Chapter 3 Page 86*

[5] *Trinity College Dublin Website - http://www.tcd.ie/Buildings*

[6] *Trinity College Dublin Website - http://www.tcd.ie/Buildings/servicesandmaintenance.php*

[7] *Understanding I.T. in Construction, Ming Sun and Rob Howard (2004) – Chapter 7 Page 135*

[8] *Trinity College Dublin Website - http://www.tcd.ie/Buildings/facilitiesandsecurities.php*

[9] *Trinity College Dublin Website - http://www.isservices.tcd.ie/*

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[12] *International Organisation for Standardisation Website - http://www.iso.org/iso/home.html*

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[15] *Understanding I.T. in Construction, Ming Sun and Rob Howard (2004) – Chapter 2 Page 26*

[16] *Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors and Real Estate Managers, Dana K.Smith, Michael Tardif (2009) – Chapter 2 Page 34*

[17] AEC Bytes, Debunking the Myths About BIM in the "Cloud", AEC Bytes View point #61 July 2011

[18] *BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers and Contractors, Second Edition, Chuck Eastman, Paul Teicholz, Rafael Sacks, Kathleen Liston 2007 – Chapter 4 Page 189*

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11.3 Software Tools and Applications

The following software was used or researched while undertaking this project:

Autodesk

- Revit 2014

http://www.autodesk.com/products/autodesk-revit-family/overview

- AutoCAD Architecture 2014

http://www.autodesk.com/products/autodesk-autocad-architecture/overview

- Design Review

http://usa.autodesk.com/design-review/

Microsoft

- Sharepoint

http://office.microsoft.com/en-ie/sharepoint/sharepoint-2013-overview-collaboration-software-features-FX103789323.aspx

- Excel

http://office.microsoft.com/en-ie/excel/

SoftCo

- Document Management

http://www.softco.com/

GVA

- GVAS9 Live

http://www.finobj.com/gvas/