ABSTRACT

Computer aided facilities management (CAFM) systems are increasingly being utilised in facilities management. These systems may be database oriented, computer aided design oriented or independent of either as a web based system. CAFM systems are becoming synonymous with the concept of intelligent buildings (IB) which generally use a centralised monitoring and control system for building services. Such centralised data of intelligent buildings are being integrated with computer aided facilities management. The data itself needed to conform to a format standard such as common arrangement work section such as Integrated Database Background (IDB). Open standards and systems that conform to such IDB make it possible for systems to be integrated. In this paper Definitions of IB are investigated and some definitions embracing this open to effective change were polled using a questionnaire survey. The survey further investigated the extension of CAFM to intelligent buildings concepts and the opportunities that such integrated systems will provide to FM professionals. The results showed variation in the understanding of the concept of IB and the application of CAFM. The survey showed that 46% of respondents use CAFM system with majority agreeing on the potential of CAFM in delivery of effective facilities. However, following the many definitions of an intelligent building does not necessarily lead to technologies of equipment that conform to an open standard. This open standard and documentation of systems produced by vendors is the key to integrating CAFM with other building management systems (BMS) and further harnessing the application of CAFM for intelligent buildings.


INTRODUCTION

This implementation of information and communication technology is rapidly being deployed in Facilities Management (FM) to enable meeting human needs. Facilities Management Systems, are types of Information Technology systems (IT) providing the buildings, and more specifically designed Intelligent Buildings Management Systems (IBMS), with management system. The incorporation of intelligence by IT is making the facilities management much more innovative than the conventional FM. There are various researches undertaken to develop an intelligent building platform integrating Building Management Systems (BMS) and Facilities Management Systems (FMS) on local area networks as well as exploiting the World Wide Web (internet). IB integrates sensor and monitoring devices. This is enabled by data transmission through telephone lines, fibre optic cable or satellite uplinks. The data management systems that utilise process control and data communication to their best advantage are generically known as intelligent buildings (Clifford et al. 2007).

It is apparent that there is no one unified definition for IB concept (Himanen 2004). The only characteristic that all intelligent buildings have in common is a structured design to accommodate change in a convenient, cost-effective manner (Himanen 2003). There are no open system standards that are essential for IB and the implementation of CAFM to
effectively manage the systems. There is a difference in the definition of the intelligent building and the intelligent building concept.

It is difficult to define intelligence in Buildings but easier to describe it. A suggestion is made of an approach to describe for the use of computing, communication and control systems in construction to make lives easier, productive and procure an environment that is conducive to work and leisure. Other intelligent building concepts inculcate energy efficiency, security and communication. Some definitions dwell on the energy conservation measures of the building. This view tends to slant towards green buildings definition.

Himanen (2003) points out ‘There is no scientific definition available for the factors of the IB concepts. They are keywords, which describe common knowledge about intelligent building. The IB concept has not included the factor of intelligence according to Himanen (2003). The question of considering a building intelligent can be thought of in two different ways:

Firstly; building intelligence effectiveness. This is a measurement for the existence of building intelligence. The effectiveness comes from successful integration of the systems and control. There are features of intelligent buildings that become effective to numerous conditions encountered. Effectiveness from control can be implemented by a multiple agent system deploying information and communication technologies. Secondly; intelligent buildings built according to the intelligent buildings concepts. IB concept parameters such as: Life cycle costing, marketability, the adaptability to change and the wide range of service providers enhances marketability, working efficiency in meeting the purpose of the user so that equipment working efficiency is maintained with facilities management strategies and service-orientation, image of high technology, photovoltaic, structured cabling, information technology, productivity and construction process and structure, etc (Himanen 2004)

The complexity of understanding the concept of IB and its relation to CAFM is further exacerbated by finding an agreeable definition for FM. Facilities management like intelligent buildings is new and lacks a unified definition. This paper while raising the issues of myriad definitions for various concepts in FM, does not try to establish a unified facilities management definition for FM nor IB. The reasons for FM to effectively manage depend on delivery of contractual obligations when outsourcing. The maintenance strategy for this purpose, the use and selection of the CAFM system all contribute to such an end. This outsourcing service can be a bundle of services and total facilities management. A reason to have optimised use of CAFM software is so that it can automate a bundle of services.

The Intelligent Building Management System is separate from or integrated with the CAFM system. There are various developments on the IB platform including integration on projects. The building management system would communicate with the CAFM system e.g. to generate work orders or report alarms. The Intelligent Building Management System is about the building controls being all accessible from a common user interface, from which planning tasks as to routes through the building and action tasks such as calling the lift can be implemented. The software task is where the CAFM system is integrated with the IBMS in managing of massive event reporting. This is accomplished by creating a data base that contains statistical information about the property ranging from general floor area to office space of specific individuals located in the building. Some Computer aided facilities management systems (CAFM) include asset registers and a separate database integrated with the CAFM.
Both Himanen (2003) and Finch (2004) made reference to a correlation being made with intelligent buildings and value contribution in that some building made clear and distinctive statements about its organisation creating a brand. But branding has been maligned for producing inefficient and costly buildings (Finch 2004). This is where facilities management comes into play in the strategic management of non-core activities relating people, process and place. The appropriate strategic management would ensure the provision of space at the lowest cost and occupation at the highest density.

Finley et al (1991.) presents a generic definition of the concept of intelligent building: An intelligent building is a single building or a complex of buildings which offers a coherent set of facilities to both the building managers and to the occupants (tenants). Unlike Himanen (2003), Finley et al (1991.) do not use convenient mathematical formulae to capture the goal of intelligent buildings (Finley et al. 1991). It is argued that FM professionals are just beginning to acquire an understanding of the multi-facet factors involved in creating ergonomic work, recreation, and living environments. There should be a whole new rethinking of what a facility and services provided are, how it should be acclimatized and illuminated and the kind of furniture needed.

**CAFM AS A CONTRIBUTING FACTOR TO THE BUILDINGS BEING INTELLIGENT**

Computer-Aided Facilities Management (CAFM) are tools for organising and managing various activities within the facilities assets such as; client contract whereby the client is aware of the equipment, locations and services catered for; material, stock, purchases and equipment replaced for repairs; procurement, the subcontractors service and management; service, the services rendered in accordance to service level agreement and other reactive maintenance; work history carried out on equipment; and the strategy used to manage the assets with the engineering instructions to do so at a schedule. CAFM ranges from a simple space management tool to a range of applications (Keller and Keller 2004) such as: maintenance & operations, facility budgeting & accounting, construction & project management, space inventory & management, architectural & interior planning, space forecasting, telecommunications and cable management, lease & property management, and furniture & equipment management.

The application of CAFM is becoming synonymous with the concept of intelligent buildings. Like any other social phenomenon, an intelligent building (IB) as a concept has various meanings articulated in various constituencies of interests and profession (Elmualim et al. 2006) and hence open to facets of interpretations. It is argued that IB as a concept is better described by listing criteria for building quality (solutions) rather than by a list of high-tech installation (Himanen, 2004). Himanen (2003) definition of IB has not included the factor of intelligence. Contrary to Himanen’s (2003), intelligent is the word for having mental ability. In IB this mental ability is replaced with software agents such as CAFM, which give buildings the ability to make decisions through a fuzzy logic controller. The fuzzy logic controller (FLC) based on fuzzy logic provide a mean of converting a linguistic control strategy based on expert knowledge into an automatic control strategy.

A new wave of intelligent systems began to dominate the office buildings with the introduction of structured cabling. An intelligent building is one which has an information communication, network through two or more of its services systems. It is automatically
controlled, guided by predictions based upon knowledge of the building and usage maintained through an integrated data base (Wong et al. 2005).

CAFM systems are commonly database oriented systems with knowledge of the building which could integrate with the knowledge based system for predicted control. CAFM systems contribute to the business of facilities management and organisations. Benefits to various organisations included; the advantages of sharing data with other departments; faster processing time i.e. reduced management time; cost savings; reduced crisis management; reduced error; reduced personnel; better control of information; increased product quality; and helping to avoid penalty clauses. The idea of connecting, integrating or opening facilities management and building automation systems, in order to achieve unified software architecture by extending the functionality of a standard management tool capable of handling FM and building control networks, is essential in practise (Himanen 2003, Thomoson and Plouffe 1999).

Himanen (2003) stated that integrated facilities management is the combination of the intelligent buildings with facilities management although a definition that Himanen has not accepted. However CAFM systems are generally split into two groups, modular and integrated systems. The CAFM software named integrated FM do not particularly emphasise on intelligent buildings, they merely produce modules of CAFM that can be integrated. An example of the point is the incapacity of most software to help make strategic decisions on when to recommend replacement of an asset.

Recently advanced CAFM systems have been chosen for their reporting capability such as the MTA Ultra sys. The separate software MTA report builder can query the Ultra sys CAFM system. These non-integrated structured query reporting modules and intelligent building technologies have been used for monitoring, diagnosis and management of potential maintenance problems. However condition assessment surveys can be treated separately from the CAFM system. The cost of these surveys pushes up the running cost of the facilities. Normally the budget for the facilities management system is separate from the condition survey budget. For this reason the condition assessment surveys can only be treated separately rather than via CAFM.

CAFM differ from conventional Building Energy Management Systems (BEMS) in that BEMS are tools for diagnosing, monitoring and causing actuations to assets particularly related to energy services and consumption in a building. With intelligent building and open standards conformity the BEMS is able to function to higher effective levels. The function can be performed by the CAFM querying the BEMS or by form of integration. CAFM systems that were integrated with Computer Aided Design (CAD) have proved effective. Keller and Keller (2002) evaluates the strategic use and implementation of CAFM systems arguing that a number of users only use CAFM operationally and not strategically. This is similar to the proposal to research the optimised usage of CAFM systems. Strategic thinking is all about anticipating and managing change, to predict future facility needs and develop strategies that will enable timely responses (Keller and Keller 2004).

This integrated facilities management has not found its way to the commercial market as yet. The implementation of an integrated facilities management system is possible but because of the complexity of the functionality of such a large system and the co-ordination of multi-vendor systems easily leads to fault situations (Bozany 2006). The reasons for the predicted fault situations are encountered by Bozany (2006) and Thompson and Plouffe (1999). If the designers specify an open standard for vendors, this would help narrow down the faults
However, there has been no true integrated CAFM system seamlessly linking CAD graphics, non-graphic data, and raster images from multiple heterogeneous computer systems through an integrated database (IDB) for use throughout the life cycle of a facility (Teicholz 1992).

The many non-technical impediments to the implementation of integrated systems make it difficult for the implementation of an optimised CAFM system. The factors that have driven an increase in the use of CAFM include the need for: reduced maintenance and logistics costs, improved equipment availability, and protection against failure of mission critical equipment (Lebold, and Thurston 2001). A complete CAFM system comprises a number of functional capabilities: sensing and data acquisition, signal processing, condition and health assessment, diagnostic, prognostics, and decision reasoning. In addition, a Human Computer Interface (HCI) is required to provide user access to the system. The implementation of such a system usually requires the integration of a variety of hardware and software components. There are a broad range of system level requirements such as communication and integration with legacy systems, protection of proprietary data and algorithms, a need for upgradeable systems, implementation time and cost limits.

Standardization of specifications within the community of CAFM users will, ideally, drive the suppliers to produce interchangeable hardware and software components. A widely adopted non-proprietary standard will result in a free market for CAFM components. The potential benefits of a robust non-proprietary standard include: improved ease of upgrading for system components, a broader supplier community resulting in more technology choices, more rapid technology development, and reduced prices (Lebold and Thurston 2001).

RESEARCH RESULTS AND DISCUSSION

The aim of this work was to identifying statements to define intelligent buildings, evaluating an acceptable theory and identifying a list of CAFM systems on the market and those used by intelligent buildings. The questionnaire was devised to be polled by a non-probability group of participants. The sample chosen for the study were members of a professional institution Facilities Management group. Initially a pilot study was conducted on FM firm personnel. This was to assess the clarity of the instructions, weather any topics had been left out. Comments from the personnel were also sought. Initially invitations to participate in the survey went out. Then the agreed questions were Emailed to members of the intelligent building group who expressed they were willing to participate. In support of this study questions were polled to deliver quantitative results with regards to determine the category, size and budget of the participants’ organisation. This in addition to question about the role of CAFM systems in effective management of intelligent systems within buildings, identifying a list of CAFM systems on the market and those used by intelligent buildings. The result of the questionnaire survey presented in the paper is based on 15 responses.

Figure 1 gives the category of Organisations of the respondents. The survey participants were from a large cross section of industry serving their organisations in the majority as non-core business services providers. This accounts for over 58% of all the participants. 14% (one quarter of the services percentage) is accounted for by the local Government this includes the Police services, Fire brigade and local councils. The remaining sectors Financial, Consultancy, Public and Manufacturing Industrial are equally represented by 7% each. This shows the organisations in majority, are outsourcing the function of facilities management with service providers.
1) Which of the following best describes the main activity of your company?

- Consultancy: 7%
- Services: 58%
- Manufacturing: 7%
- Public Sector: 14%
- Local Government: 7%
- Financial/Financial Services: 7%

Figure 1: Category of survey respondents

67% of the respondents indicated none of their buildings are intelligent buildings. The majority (40%) identified a single intelligent building they were responsible for. 30% of the sample identified 2-4 intelligent buildings, these respondents were Facilities managers and Maintenance managers within mechanical and electrical service. This group were positive to the use of CAFM as a vital FM. 10% of the sample that identified 5-7 intelligent buildings, which were the same number of building they were responsible but their functions were related to building and construction. The mechanical and electrical services were not part of the job function so this 10% do not use CAFM systems. Those that identified 10 plus intelligent buildings (20%) were representatives of Maintenance and Operations managers.

Figure 2: Identification of intelligent buildings

The results showed 46% use CAFM systems for intelligent buildings. This include the respondents that have identified one intelligent building in their portfolio. The majority 54% do not use CAFM systems for intelligent buildings.
Figure 3 gives the CAFM system used by respondents. The figure indicates that Archibus users are 18% of the sample that use CAFM for intelligent buildings. Maximo users are also 18% of the sample but only half the number of this proportion use CAFM for intelligent buildings. None of the 9% that use Concept have CAFM for intelligent buildings. The majority of this sample 55% is bespoke and other CAFM system users. Not all but a good proportion of the majority also use CAFM for intelligent buildings.

Figure 3: CAFM system by users

Other results showed 38% of the sample use an integrated CAFM system, two thirds of this proportion use CAFM on intelligent buildings. This indicates 13% of the samples are the users of a particular CAFM which can also be used on intelligent buildings. 42% of the sample link the information provided for in the CAFM to any other data bases. With regard to the potential of successful application of CAFM to effectiveness of the FM function the majority of the respondents (64%) strongly agrees or agrees to the statement. This fortifies the potential of integration at management level of the systems of CAFM for intelligent buildings.

CONCLUSIONS

Intelligent buildings are generally viewed as systems composed of a number of distinct yet interfacing subsystems and components such as: a computer and telecommunications system, an alarm/security system, an energy regulatory system management and control system, electrical and communications wiring infrastructure, a command and control centre, an electric power supply system guaranteeing continuous uninterrupted power supply and a utilities system (water, sewage and drainage).

It is evident that there is no scientific definition available for IB concepts. They are keywords which describe common knowledge about intelligent building. A questionnaire survey was conducted to evaluate the understanding of IB concepts as well as CAFM application and their potential for the effectiveness of the FM functions. There are myriad of definitions for the term Intelligent Buildings which generally refer to the application of digital technologies in the design process, and management of building assets. The results of the survey showed that 46% of the respondents do use CAFM systems on intelligent buildings. 36% of the
samples do not agree that a successful CAFM system is vital for the effectiveness of the FM function. As the management skills used in place of CAFM are inconclusive. Indeed there are opportunities to exploit digital technologies integrated into CAFM to enable effective assets and facilities management. This call for the provision of such digital technologies and CAFM tools in an open standard to delivery cost effective and efficient facilities.

REFERENCES


