Embracing Our Smart World by Enhancing Information Technology for Office Buildings

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ABSTRACT

Aging technology will devalue the economical life of commercial buildings, especially in a highly competitive global environment. Thus, reengineering the information technology (IT) system of commercial buildings will become imminent to escalate its property values, marketability, and productivity/production of the occupants. This study is aimed to investigate the extent of IT, encompassing telecommunication services and network facilities that can be advanced to meet the above reengineering purpose, through action research of case studies in Hong Kong. The potential problems, difficulties and processes in IT upgrading will be examined and analyzed to evaluate the probable benefits at times before and after such IT are improved. Quantitative method via structured questionnaire will be dispatched to major users of the target case buildings, then follow with statistical analysis to assess the overall reengineering implications before and after such IT upgrading, to shed some light in paving the way forward for modernizing aged commercial buildings.

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BACKGROUND

Roberson et al., (2013) contend that the technology for office automation and Internet has fundamentally been changed during the facility planning of Facility Management (FM). The traditional telecoms network for telephony is not adequate to cope with the new trend of business (Lindmark et al., 2006). Nowadays the business requires a fast and reliable with wide bandwidth telecommunication network to accommodate in the organization (Granda et al., 2015). Furthermore, the development of wireless devices is among the most dynamically improving areas of the Information Technology (IT). With the new wireless IT solutions, remote communication can be supported more efficiently and flexibly than earlier with only wired networks.

FM is a special application area for these equipments where the demand for remote communication devices is extremely high because there might be long distances among together working people and devices (Eckhardt et al., 2015). In addition, the automation systems are mainly used to manage only buildings but in some cases, the supported FM activity has been extended to outer areas of the property. The application of wireless elements could be much more comfortable and cost efficient than any wired solution for managing large facilities, but the FM service quality can also be increased extremely. The IT hardware development has only affected the processes remarkably that belong either to the Facility or Building Automation Systems (FAS/BAS).

In the 1980s, Hong Kong undergoes many changes to establish its financial centre in Asia. Most developers have changed to invest in commercial buildings. However, the commercial buildings, which built in 80's, are having basic design facilities such as heating, ventilation, and air-conditioning (HVAC), lighting, lift system, security control, fire safety systems, closed-circuit television (CCTV), alarming system etc. These facilities are adopting wired cable to communicate with its control center such as CCTV using coaxial cables connected to the monitor/recorder system, control valves of HVAC which controlling the chilled water having the copper cables connected to the operator panel etc. Yet they are not fully integrated together, whilst not having a centralized system to better manage with other systems. Besides the communication networks, another driving forces are the office automation, increasing office productivity, and better control building's operating and running costs. Gouin and Cross (1986) has explained the conditions that lead to the emergence of intelligent buildings (IB). The conspicuous factor is the occurrence of "information economy".

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The effect of the internet revolution on the building simulation could not be undermined. A broad range of simulation software applications has become available for a variety of building performance assessments over the latest two decades. The two key aspects dominate this evolution process: (1) attaining an increased level of quality assurance and (2) offering efficient integration of simulation expertise and tools in the overall building process. Wang and Xie (2002) has assessed the possibilities of integrating FAS/BAS. The personal digital assistant (PDA) can be widely used in supporting FM. Citrin and Gross (1996) mention that PDA is introduced in facility maintenance supporting system to store and correct the collected information in the field.

Wireless fidelity (Wi-Fi), also known as the technology of IEEE 802.11, is widely used in Local and Metropolitan Area Network (LAN/MAN) systems (Ngan et al., 2015). Subsequently, more supporting devices are extensively developed such as mobile phone-based smartphone, PDA-based smartphone, PDA, handheld PC, tablet PC, and laptop PC etc. These devices increase the mobility of support in enhancing FM. The Wi-Fi is a fixed network for mobile devices connecting to the service point, whereby server farm and relative equipment, such as transceivers and receivers, will be set to form the wireless network. Figure 1 shows a typical network diagram for a simple Wireless Local Area Network (WLAN) design that engage Wi-Fi technology in an office area.
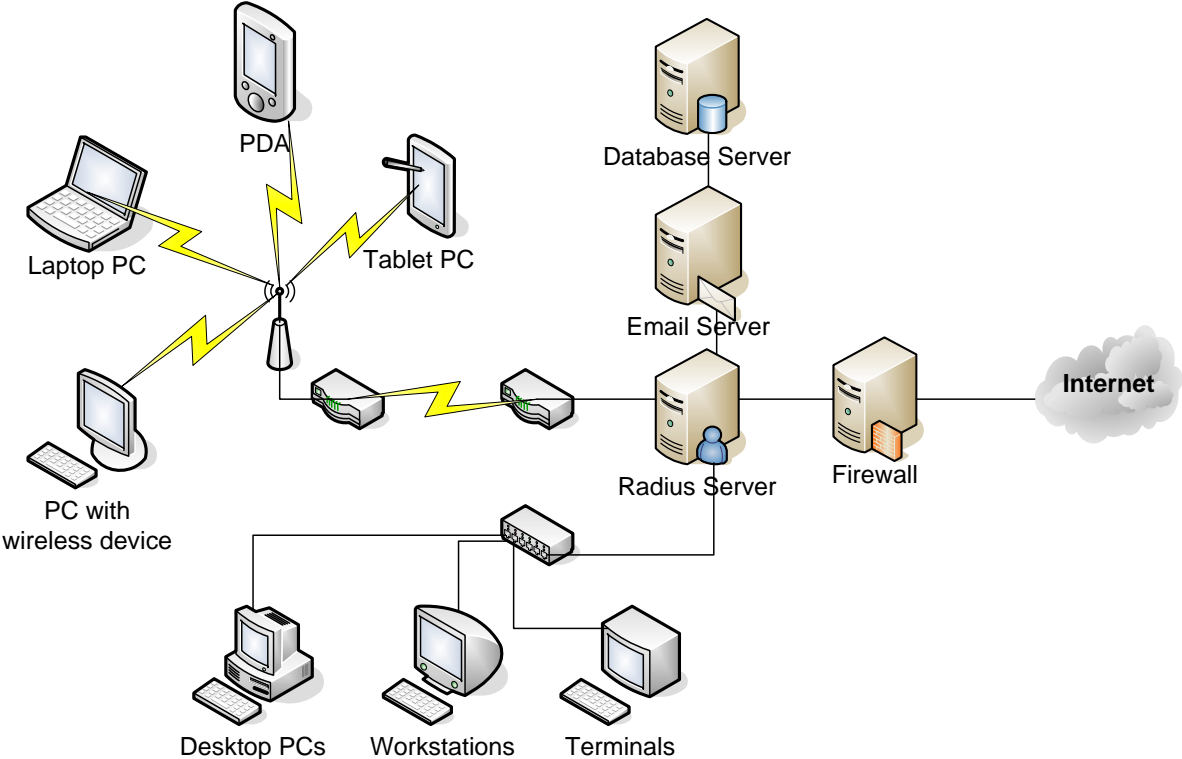

Figure 1 WLAN network diagram

Thompson (2004) explains that the wireless and internet technologies have been rapidly advanced in the past decade. The availability of cheap Ethernet-based networking hardware and PC technology (driven by the huge office IT market coupled with the explosion of Internet) has made Ethernet an attractive proposition for control and monitoring systems. Additionally, the advent of low cost mobile telephone technology and wireless interconnect for PC and electrical goods are driving interest in the adoption of this technology in other areas. The application of Ethernet and wireless technologies for on-board systems, remote operational monitoring, testing and control are evolving.

1. INTELLIGENT BUILDINGS (IB)

Most people refer IB as a building integrated with something "smart" in order to automate some manual functions, such as automatic analyze the temperature, adjust the level of lighting, determinate the fresh air volume etc. to accommodate human comfort inside the building. Gouin (1986) concludes that IB involves: (1) providing efficient building management tools for owner, and (2) sophisticated electronic communications tools for tenants. An IB is one equipped with the telecommunications infrastructure that enables it to continuously respond and adapt to changing conditions, allowing for a more efficient use of resources and increasing occupant comfort and security. It integrates most of the major building systems, such as HVAC, fire safety, security, and energy/lighting management systems within a BMS. For example, in the case of a fire, the fire alarm communicates with the security system to unlock the doors; the fire alarm system will also communicate with the HVAC system to regulate the flow of air to prevent the fire from spreading, as well as the communication technologies for voice, data and office automation. These systems are controlled by a central computerized management system (CCMS). The intelligent building is a flexible and adaptable building that helps tenants to meet their goals and support occupant functions (Langston, 2002).

2. BUILDINGS OF INTELLIGENCE

Becker, Tennessen and Young (1995) show that employees are working away from the traditional office, they are working under different schedules, and their work requires new ways of communicating. New technologies are being developed which support the need for new ways to communicate. These technologies, such as the fax machine, cordless telephones, voice and e-mail, beepers and pagers, conference call capabilities, and videoconferencing have been developed to enable today's more mobile worker - as well as employees who work in the same place but regularly communicate with colleagues in the same company located in different buildings, sites, and cities - to support various forms of remote communication.

BAS is a platform for systems integration. By applying the innovative technologies, the building environment and functionality can be improved and operating cost reduced. It provides a single platform to control multiple systems, such as lift, lighting, HVAC,

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access control, fire safety, communication, car-park monitoring and facility management service, and has the ability to perform energy saving on the job scheduling and optimizing on the facility start/stop function. It also capable for remote access by any pre-registered with secured key exchanged devices means convenient operation and maintenance.

3. INTEGRATION OF SYSTEMS

The following list illustrates the most important/possible roles of network units in Facility Information Management Systems (FIMS).

1. Devices without controlling other equipments:

- Collect input signals for the system

- Perform output signals e.g. to control the temperature in a heating system or to display the contents on the screen of a mobile device.

2. Controlling and decision supporting devices:

- Perform data processing and evaluation tasks

- Automatic decisions: Create output signals without human influence for the controllable network units.

- Automatic decision supporting. In these cases the system gives suggestions based on the collected inputs. In some controlling units, if the administrators have confirmed the suggested actions, the controlled signals can be generated. Sometimes the actions will be started manually like in such cases when the actions are performed by the employees and not by output peripheries.

3. Other roles:

- Data storing, archiving

- Database synchronization in networks with more databases

Honeywell (2016) classifies the Automation and Control peripheries as follows:

- Environmental and Combustion Control (ECC)

- Fire Solutions Group

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- Industrial Measurement and Control

- Security

- Sensing and Control

- VCSEL (Vertical Cavity Surface Emitting Laser)

4. RESEARCH METHOD

The study is targeted to realize the implications of the fast growth telecommunication market and IT hardware development in FM; with concentration on modifying the collected information in FIMS for easing decision making processes. Several types of hardware are adopted in facility related information systems such as BAS. With the continuous development of these devices and networks, new generations of sensors and control units could be used in FAS. Firstly the types of FM wired and wireless hardware devices and networks are classified. Thereafter the advantages and disadvantages of the new FM related wireless solutions are observed including those complex systems that can either support the tasks of monitoring, controlling or data collection. The planned communication method, the division of data processing, storing and presentation among the devices in the network helps in determining the architectural structure of the information system.

The centralized system architecture has yet several benefits. This is not the only available alternative anymore, since the more distributed networks are built if more intelligent peripheries and computers (PCs, laptops, PDAs, mobile devices, etc.) are to be connected together on the network. These hardware devices can be used for data processing, presentation or information storing purposes. In wireless systems the installation and operation costs could be highly reduced and these solutions support connection among physically moving/movable network points, even in cases of long distances. Networked database software solutions with the possibility of offline working can be used also in those systems and situations where the network is not permanently available. In offline mode local databases will work and support the locally running application. After the network connection has been restored, the information system should synchronize the local and central (or other local) databases. The impacts of the hardware development are investigated for each FM processes to determine which FM areas are influenced more remarkably and which ones are less affected.

A survey is designed to identify the market trend of IT networking services. The technology is fast growing over the past decade. Most of the communication methods are changed such as widely applied Internet in business. E-mailing becomes an essential tool to communicate among business processing, evolution on overwhelmingly IP telephony (from traditional PABX to IP network), including image transmission during

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making a call etc. To backup these kinds of innovative evolution is by means of technology.

5. CASE STUDY - BUILDING PERFORMANCE ANALYSIS

A target commercial building located in H.K. Island, which was built in 1985, is identified. It has 32-storey including 111 parking spaces for 26 tenants' use.

5.1 Electricity

The electricity supplied by the H.K. Electric Company Ltd (HEC) to the building is 380/220 volts, 3 phase, 4 wire (including 3 phase & neutral), and alternating current system at a frequency of 50Hz. The electricity supply is backed up by one 400kVA emergency generator. The busbars for tenant power supply is operated individually from the meter/switch room. A plug-in unit with fuse is installed at meter room to tee-off power from busbar. The distribution board (MCCB board) and all HEC's meter tenants are positioned inside the meter room. Authorized person only is allowed to monitor and count the power consumption of each tenant.

An emergency generator set is provided to support, as standby electricity power for the building. It is put into operation in case of power supply failure from HEC. The generator set is capable of sharing and starting simultaneously the following life safety and essential systems:

- Fire services system & control panel

- Sump pump system

- Sprinkler system

- Firemen's lift

- Essential lighting for entire building

- Security system

5.2 Closed Circuit Television System

CCTV system is offered to monitor the whole building and provide a secure condition for occupants. Cameras are in placed inside lifts, main entrance, all exits, car park and critical areas. All cameras have been wired to the CCTV console inside control room of the building management office.

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5.3 Telecommunications

For this building, three telecommunication companies have developed their respective services. It can provide choice for occupants to take their advantages. Therefore, a vertical trucking has fully been installed inside the data cable duct. Besides, optical fibre will become the main transmission cable in future, which has high reliability with superior quality in data transmission rate and capacity.

5.4 Fire Services System

The following installations are provided according to Hong Kong ordinances and regulations.

- Emergency lighting & exit signs

- Emergency generator

- Fire alarm system

- Fireman's lift

- Fire hydrant/hose reel system

- Audio/visual advisory systems

- Fire detection system

- Automatic actuating devices

- Sprinkler system

- Portable hand-operating appliances

- ventilation/air conditioning control system

For all plant and mechanical rooms, the smoke detection and portable hand-operated fire extinguisher have been provided.

6. OUTCOMES AND ANALYSIS

This survey reveals that 59% building tenants do not outsource any part of their network and have no plan to do so. Among those IT professionals surveyed, 23% contract out some of their network management functions, and 13% for all of them (Figure 2). The organizations caution more over outsourcing comes as the global IT and network outsourcing business continues to thrive.

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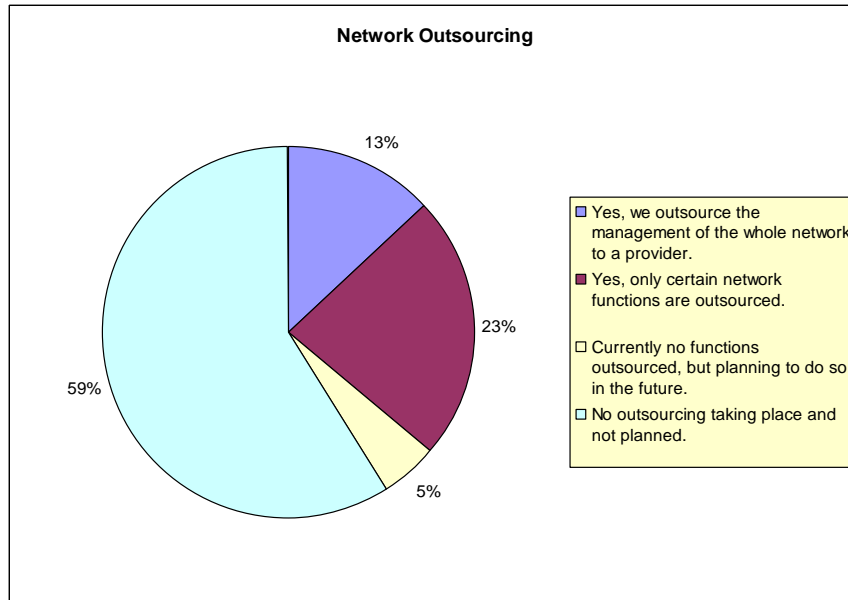Istanbul, Turkey, May 6–11, 2018

Figure 2 Network Outsourcing Status

The big four networked applications are email, voice, video-conferencing and enterprise resource planning (ERP) respectively, as shown in Figure 3. Of those surveyed, 82.1% indicate that they deploy email on their own network. However, the remaining respondents are using the internet email like Yahoo mail, Google mail, Hotmail etc, as their primary communication channels. The video-conferencing is running at a close third to voice. 38.8% respondents contend that they carry voice, while 37.5% nominate video-conferencing, owing to the pressures on business to cut travel budgets, especially for firms with location around the region. The most popular one is using IP network to delivery the video image rather than the technology of Integrated Service Digital Network (ISDN). Despite the strong concerns expressed over security, a tiny 4.5% respondents prefer to run backup and recovery applications in their own network via the data communication link to delivery the data to backup computer system.

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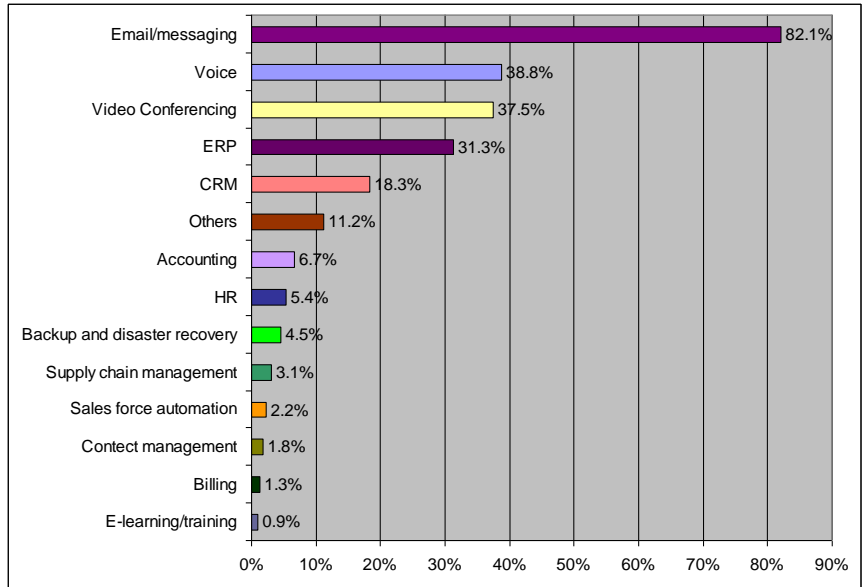Istanbul, Turkey, May 6–11, 2018

Figure 3 Various network applications

From Figure 4, there are 43% respondents dealing with three carriers or more, and 30% dealing with two.
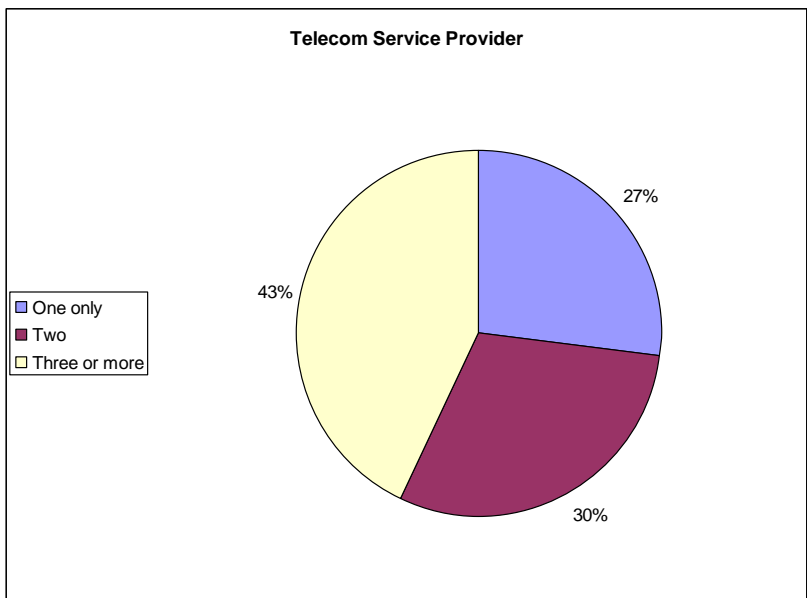
Figure 4 No. of telecom service providers

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Notwithstanding cost is a major factor in any decision to converge networks, as in Figure 5, there are 15% respondents deem that lower cost is a crucial factor to drive deployment of a converged IP network.
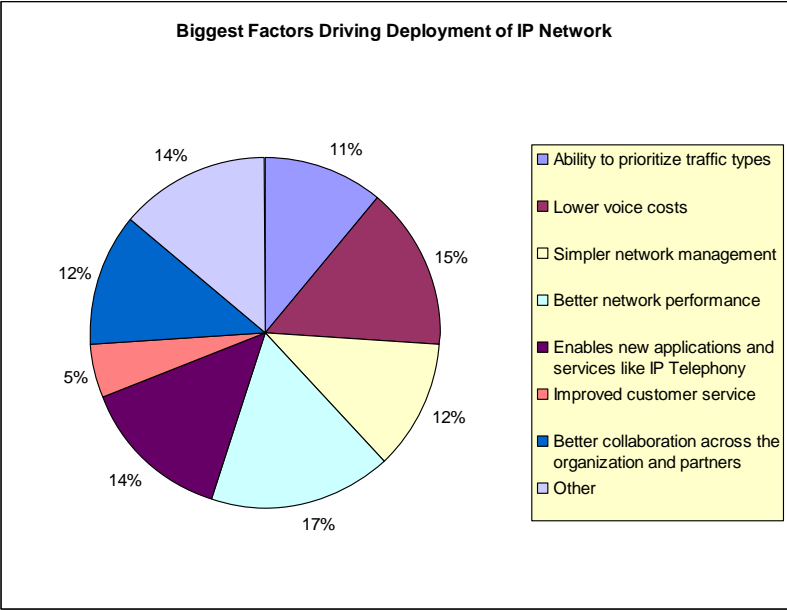

Biggest Factors Driving Deployment of IP Network

Legend:
- Ability to prioritize traffic types
- Lower voice costs
- Simpler network management
- Better network performance
- Enables new applications and services like IP Telephony
- Improved customer service
- Better collaboration across the organization and partners
- Other

Figure 5 Factors driving deployment of IP network

In view of the economic growth, most organizations, with 43% of surveyed companies, are willing to spend 10%-25% extra money to improve the telecoms and network technologies in coming 2 years. (Figure 6).

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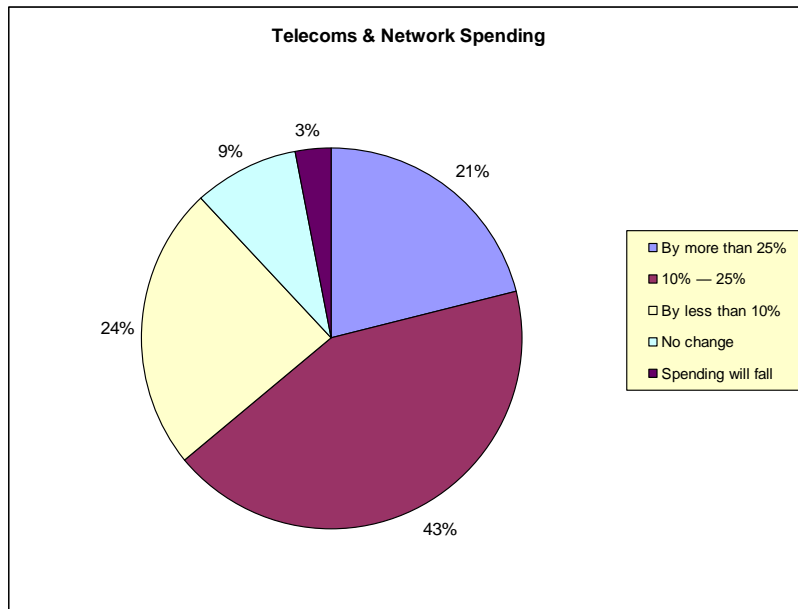
Telecoms & Network Spending

Figure 6 Projected expenditure on technology improvements

7. SUGGESTIONS

According to the classification by Hamer (1988), the following FM processes should be distinguished:

- Technical Work Management

- Space Management

- Status documentation

- Human Resource Management

- Contract Management/Occupant Management

- Inventory

- Property Management/Portfolio Management

- Fire protection

- Security/Access Control

- Network Management

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The portfolio and technical work management are the most important areas in FM, as further illustrated from below.

7.1 Documentation of property status

The status documentation can be supported either by using computer-integrated FM (CIFM) and BAS or with Document Management solutions. The information system should store the results of the data/pattern collection for later presentation and/or data processing. The status monitoring techniques can be separated in the following groups which are for each stored input and output signs:

- If the results are collected automatically by the input/measurement units in the system. Using short pattern sampling times, it can result a real-time monitoring solution. The collected information can be used to start human or automatic prevention steps or reactions by controlling the output device.

- If the results are not collected automatically, it usually means human data collection. In these cases several IT techniques can be used to make the data collection easier and to fix the errors of the entered information. The devices or the software are able to add some additional information automatically when the user fills a form and stores its content in the database. In these cases the additional information comes from some input sensor in the system.

7.2 Managing Human Resources

Generally the hardware devices are in placed to the system, the needs for workers is less, but sometimes the maintenance of new monitoring and controller devices require well trained worker to perform. Hence, the application of remote technologies implemented are no real benefits for the HR related affairs since they are mostly done in offices where the information system can be accessed using wired local networks however in the latest few years the more new LAN solutions use wireless technology such as Wi-Fi systems.

7.3 Managing Contracts & Occupants

Managing contracts and occupants are such processes that can be rarely supported by special hardware. Typically software is used for these purposes. Software tools can also alert if the deadlines are close. It can send messages even by e-mail or just to show the message on the screen maybe with some alerting sound. The alerting systems could be also used to perform automatic restrictions like e.g. if a tenant doesn't pay, his authorities will be restricted for certain time period.

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7.4 Controlling Security & Access

It is well known that the security solutions were heavily influenced by IT hardware and software developments. IT has been used widely in security systems for a long time. Additionally this field has achieved most of its results before the age of the wireless devices however the wireless solutions should meet different security criteria than wired systems. Typical wired security systems are working in the banking sector and others in prisons. The computerized security information system should be distinguished from the protected process. Different persons have the authority to enter in the information system than into a given restricted area of the facility. The wireless technology has evolved new possibilities for the crackers as well. It means some extra risks to those at wired networks. In this case the transmissions can be observed or sent e.g. from mobile terminals, not only from terminals with fix positions. For mobile devices, there are also solutions that can provide appropriate security level for the transmission. Yet, if such a mobile device will be used for bad purposes, the allocation of the current/and maybe also moving accessing position could be much harder than e.g. in wired systems with fix access points.

Earlier the Key Management was supported practically only with a simple database where the user key and area authorizations are registered with the issued keys that can be easily supported with simple software while facilities that use electric card based access systems are equipped with special IT hardware. Fortunately these e-solutions are widely used and several implementations have been finished successfully even in those areas where the security risk is not extremely high, sometimes also in the non-profit sphere. Some of these systems can be used to determine the current positions of the users in the managed area too. These systems should alert if there have been too many wrong attempts in a short amount of time.

7.5 Managing Network

It is hard to find such a result in the improvement of electric and digital networks that is not used during facility network implementations, including wired and wireless, local and public network solutions. Earlier those problems that require very much and fast counting are usually processed on special hardware devices, but currently most of these problems can be solved remarkably cheaper with fast software on common computers and multipurpose microcontrollers. The trend is that with the increasing of the counting speed earlier hardware solutions could be replaced with cheaper software solutions. Lighting systems usually use high voltage networks in most of the facilities.

There are some industrial plants where the pipelines and other networks represent more than 50% of the real estate's value. These networks can be controlled and monitored in BAS with computers and networks. BAS usually use electric cables to receive signs and control the system. It is normal that, in facilities with more individual sanitary systems, parallel cables of different systems can be found. The whole system could be cheaply

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implemented using an integrated system with one cable or pipeline in every direction that are currently duplicated.

8. CONCLUSION

In this study, the influence of technology development towards FM processes are analyzed and qualified. The functions of network units in facility information systems are categorized. The important types of input and output devices are presented, whilst the new trend of IT technology developments are introduced, such as Wi-Fi, wireless device, IP6 etc. In accordance with the above findings, it is considered to remove the old cables and accommodate the new optic fibre as the vertical backbone cabling system; and consider to upgrade the facilities for centralized operation in a single location to upgrade the building monitoring on performance and preventive measures; to render it more competitive in a modern society.

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