The usage of Automation System in Smart Home to provide a Sustainable Indoor Environment: A Content Analysis in Web 1.0

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Abstract

The fast development in computer and various mobile devices have bought changes to our living environment. Pressing a button to open the door of flat when we are in office is no longer purely imagination in cartoons or films. More importantly, home automation as such provides us an alternative solution to reduce the usage of energy, save costs and convenience. This paper reviews the advantages of home automation smart home in Hong Kong and Australia from industry perspective with the help of content analysis.

Keywords*: content analysis, sustainable development, smart home, knowledge sharing, Australia, Hong Kong*

1. Introduction

Information in documents linked by hypertext on the World Wide Web is now often referred to as “Web 1.0” [25]. The birth of Web 1.0 accelerated the availability of various appliances and devices in home that could automate and process information for specific services required in modern home environment [29]. Smart Home, which is also known as intelligent buildings, automated homes or integrated home systems, [31] is able to acquire and apply knowledge about its inhabitants and their surroundings so as to adapt and meet the goals of comfort and efficiency [29], devise intelligent homes according to the users’ needs, providing a better home life experience [27]. They can be found at every corner of the world [8]. The smart home technology, which incorporate electronic devices, was originally used to control the on and off of HVAC, heating and lighting as well as fire safety system and security through a central computer [5, 31]. The past decade has seen significant advancement in consumer electronics. Various ‘intelligent’ appliances such as air-conditioners, home security devices, cellular phones, home theatres etc. are set to realize the concept of a

smart home. They have given rise to a Personal Area Network in home environment where all these appliances can be monitored and interconnected using a single controller [39]. Smart home also monitors the activities of the occupant of a home, operates devices in a predefined patterns as the users require [31] and provides solutions to energy saving and reduction. The Advanced Metering Infra-structure, for example, sends time-varying electricity price messages to smart meters located in residents' houses. Smart meters issue instructions to smart appliances placed in houses based on these message and communicate with the appliances to accomplish the power usage adjustment for the purpose of energy management and improvement in power efficiency [19]. Another smart home technology provider, E Element [10]'s smart home design, consists of control panel for environment, appliance, lighting and security (Figure 1). Apart from the abovementioned functions, smart home also brings much benefit to those handicapped patients and elderly people. For example, West Lothian Council (WLC) in Scotland creates smart housing to support community care of patients [20], the using.net enables the physician as well as the elderly's relatives to view the status of the elderly by viewing the real-time status and actions performed by the elderly with time and date log. Once the vital data is captured from the elderly remotely, the physician can determine the necessities of transferring the patient to the hospital or subscribing a medicine for him [30]. Other smart homes function both as energy saving tools or tools which aid those who could not otherwise live independently. The Portsmouth smart homes project, for example, identifies appropriate technology to create energy efficient dwelling which supports the disable occupants to achieve an independent life. It also effectively manages the resources with minimum life-time costs [5].

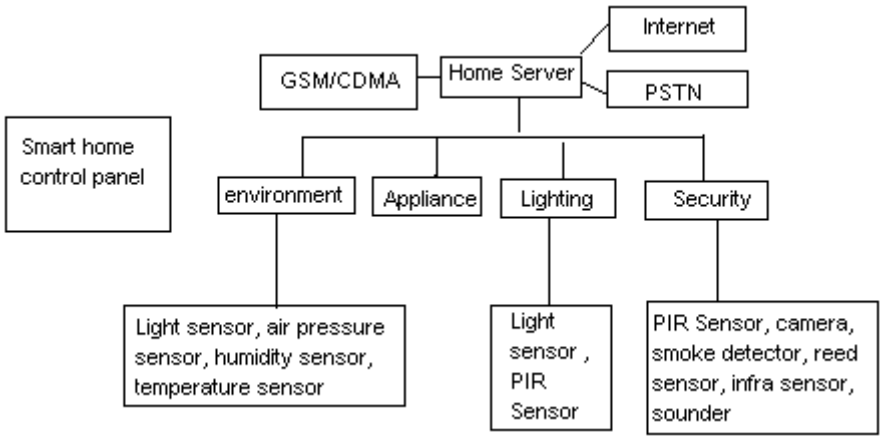

Figure 1. The use of Smart Home Control Panel [10]

2. Sustainable Development

There is no point of arguments that our ecosystems are complex, adaptive, characterized by multiple basins of attraction, historical dependency and complex dynamics. The management of such systems presents fundamental challenges which become difficult as the putative controllers, i.e. humans are essential parts of the system and thus the essential parts of the problem. The most important is the importance of experimentation, learning and adaptation [26]. Over the past few decades, climate change has become a more and more severe global challenge [13]. How to adapt the change is one of the major issues. Some of the scholars stress the importance of sustainable development in climate change. The Brundtland Commission defines sustainable development as development which meets the present generation without depriving the needs of future generations to meet their own aspirations and needs [4]. Sustainable development strives to achieve the goal of environmental protection, economic and social development [1, 21, 22, 24]. Within our building envelops, smart home technology helps us achieve the goal of sustainable development.

Table 1. Elements of sustainability in Agenda 21 [2]

Element	Criteria
Economic sustainability	Growth, development and productivity
Social sustainability	Equity, empowerment, accessibility, participation, sharing, cultural identity and institutional stability
Environmental sustainability	Eco-system integrity, carrying capacity and biodiversity

3. Knowledge Sharing

To enhance smart home development, knowledge sharing among the major stakeholders such as smart home technology suppliers and users are important. Knowledge is the basic element and a key strategic resource for firms to acquire intangible capabilities and assets. Some scholars consider it as an important element in firm growth. Knowledge sharing is an indispensable part of organizational activities [3] as growth in knowledge work and knowledge workers requires not only the ability to find and access information and knowledge, but also the ability to share this asynchronously and synchronously in terms of time and location [28]. The process of knowledge sharing bridges the individual and organizational knowledge, improving the absorptive capacity and innovation capacity and thus leading to sustained competitive advantage [3]. Recently, the concepts of innovation,

knowledge management, and technological capability are widely dwelled upon by enterprises. The existence and sustainability of the enterprises and their entities in an ever-changing business environment is based on the efficient utilization and implementation of these factors. Moreover, the ability of enterprises to manage change depends on the establishment of sensible relations with systematic collection of knowledge, their environment and management of their operations by analyzing the knowledge obtained [14].

4. Web 1.0

The cyberspace interacts with urban space, disrupts and collapses conventional boundaries and enclosures. People move from one place to another becomes increasingly virtual than physical. Bodies which coordinate multiple conversations and tasks now oscillate between semi-private and private modes of communication [23]. Whilst previous generation depends on face-to-face, modern organization share knowledge via website, Web 1.0 of various smart home organizations is one of the very good channel. Furthermore, mobile internet emulates the success of fixed internet [23]. With the cloud storage services, which provides online storage services for data owners over the Internet, it is expected that another great change in smart home development will occur in the near future [40].

5. Research Method and Results

By using the keyword smart home in Hong Kong in Google and Yahoo, the major Web 1.0 search engines, relevant websites for companies which supply smart home in Hong Kong are located. After that, content analysis will be used. The term ‘content analysis’ did not appear in English until 1941 as printed mass media increased in the US at the beginning of the 20th century, so did quantitative newspaper analysis, the end result of many efforts to create simplistic and scientifically objective methods of analyzing news articles. Until the end of the Second World War, these methods were widely used in the study of texts from journalism, political speeches, and propaganda among other applications. Subsequently, the methods were taken up by other fields including psychology, anthropology, history, and linguistics [38]. The first descriptions on content analysis dated from the 1950s and are predominately quantitative but it has been expanded to include interpretations of latent content over time. Qualitative content analysis slowly emerges. In such case, similar information is grouped into similar categories [15] so as to create systematic and objective criteria for transforming written text which can be analyzed for symbolic content of communication [32].

The results of the data search show the practitioners' view on the major merits bring by the smart homes in Hong Kong include convenience / comfort (HKC, E Element, Hometouch, Smart Living), cost reduction (Hometouch) and power saving (E Element). The major smart home system elements include energy management (E Element, HKC, Smart Home Automation Designer), green source of energy (E Element) and mobile remote control (Hometouch, Smart Living).

In Australia, environmental protection is one of the major goals (Smart Home Product, Smart home solutions, Clipsal Smart Home), enhances quality of life / convenience / comfort (Clipsal Smart Home, Digital Smart Home, Digital Smart Home, Smart Home Systems, Nous House, Eco Centric Energy, Envious Technology) and increase property value (Eco Centric Energy, Nous House). The smart home systems elements usually include the water management (Smart Home Solution), energy management device (Smart Home Solution, Smart Home Systems, Nous House, Eco Centric Energy, Envious Technology).

As compared to Hong Kong, Australia practitioners consider smart home as an important factor which improve quality of life and it is also a valid selling point which increases the property value. Nevertheless, both of the two places' smart home providers agree the importance of automation in smart home lies on sustainable development. Generally speaking, these companies' suggestions on the advantages of smart home can be categorized into:

1. Social (convenience, comfort, quality of life *etc*);
2. Economics (cost saving, efficiency);
3. Environment (water saving, energy saving, environmental protection, green energy supply).

Furthermore, both of the two places lack of initiative in providing home automation which conserve water (there is only one company which provide water conservation tool but none in Hong Kong). Nevertheless, it is one of the major concerns in sustainable development. The results of Hong Kong and Australia's smart home can be found in the following tables.

Table 2. Smart Home Solutions provided by Private Companies and Merits of Smart Home (author's research)

Company	Advantages of smart homes	Smart homes systems elements
HKC [16]	HKC Home Automation solutions embrace a digital lifestyle which brings us 4C, i.e. care, connectivity, comfort, convenience in an intelligent living.	The products include HKC Pro 300+ and HA Express. The HKC Pro300+ is a professional complete Home Automation solution for estate developer and HA Express is a wireless Home Automation Solution to control curtain, lighting, and AV devices for individual end-users.
E Element [10]	A Smart Home can provide people a safe, comfortable, power-saving and convenient life by enabling intercommunication among all the household appliances which includes TVs, security system, computers, lights, entertainment system and HVAC (air conditioning, heating, ventilation). They can be controlled by a smart home control panel installed at home or through Internet, GSM/CDMA and PSTN networks.	The products include energy harvesting, supervisory control and data, acquisition, solar tracking system, solar installation system, wind turbine pitch control, home solar power system, inverter for Grid-Conn, wind turbine monitoring system, solar micro inverter and smart meter.
Hometouch [17]	The use of intelligent building technology delivers the economies of scale which reduces cost. It improves the ease of use and convenience of the smart home system.	The iPhone and iPad apps allow the home occupant to integrate the iPhone with smart control solution, they can then become remote controllers to control lighting, curtain , LCD etc. Other products include curtain controller and Villa Type Visitor Panel.
Company	Advantages of smart homes	Smart homes systems elements
Smart Home Automation	N/A	CCMS Systems & HVAC System Design, building efficiency & energy

designer [33]		management, acoustic Design & Consultant, automation system design & consultant, lighting control system design & consultant
Smart Living [37]	Smart home brings us extra comfort, convenience, and efficiency at home, saves much occupants' time	With customized home broadband network and automation systems, occupants can control home settings such as curtains, lighting, entertainment products and surveillance systems, etc. via HKT's eye Tab or a customized remote control at home, or even via a tablet or a smartphone when occupants are on the move.

Table 3. Smart Home Automation in Australia (author's research)

Company	Advantages of smart homes	Smart homes systems elements
Smart Home Product [34]	Smart Home Products supports the protection of our fragile environment and are actively taking steps to help preserve our planets resources for the next generations to come.	Home automation systems control venetian blinds, roller blinds, flyscreen products, vertical blinds, exterior blinds, interior rugs, drapery, drapery accessories
Smart Home Solutions [35]	1) Reduce environmental impact: by controlling window furnishings to maximize natural highlighting, ventilation or shade, by ensuring systems are active only when needed, or by activating watering systems only as needed during the cooler hours, energy and water usage can be reduced. 2) Improve quality of life: a smart home takes care of heating, cooling, lighting, and watering. The indoor environment can be maintained at	Home automation systems controls multi-room audio and video, home theatre, energy and water management, home security and access control, home lighting control, home networking, home communications, structured cabling

	ideal lighting levels and temperature by using natural lighting and warmth so as to achieve win-win goal of comfort and convenience. Moreover, such well-designed system is simple to use, and flexible to adapt to user's changing demand.	
Company	Advantages of smart homes	Smart homes systems elements
Smart Home Solutions (Con't) [35]	3) Economic benefits: incorporating technology for water and energy management into a home automation system is not only a more sustainable approach, but also leads to a substantial savings on power and water bills. Smart Meters can further save energy by using off-peak power wherever possible. With higher energy ratings through schemes like NABERS, efficiency increases a home's value.	
Digital Smart Home.net.au. [9]	Smart home integrates all of the home's systems via smart wiring or structured cabling package. A home automation system simplifies the use of digital services and devices: from the push of a button, located on any easily operated smart device such as iPhone or iPad, a home automation touch screen or even a smart light switch, various systems at home, such as cooling, lighting and telephone can be turned on.	Automation systems control home security, audio, theatre, heating and cooling, entertainment, lighting, telephone, computers & networking.
Company	Advantages of smart homes	Smart homes systems elements
Smart Home	Smart home creates the perfect living	C-Bus is a microproces-

Systems [36]	by allowing most home functions to be simply operated from a single panel, a remote control unit or even mobile phone. With a Clipsal C-Bus automation system enable our home becomes a smart home, providing an enhanced lifestyle of entertainment, convenience, comfort and security.	sor-based control and management system for Buildings and Homes. It is used to control lighting and other electrical services such as pumps, Audio Visual Devices, Motors, etc. Whether simple ON/OFF control of a lighting circuit, or variable (analogue) type control, such as electronic dimmable fluorescent ballasts, C-Bus can be used to easily control virtually any type of electrical load [7].
Clipsal Smart Home Technology [6]	A smart home provides superior comfort, convenience, security and energy savings through intelligent control of lighting and electrical devices.	C-Bus, Wiser home control turns on air conditioner from mobile phone on the way home, or checks everything is turned off over the Internet during work. StarServe distributes entertainment centre, audiovisual and high tech devices to rooms at home with StarServe data, StarServe video, StarServe Audio. Multi-Room Audio allows us to listen to favorite music in any part of the home. Simply connect equipment such as an iPod or MP3 player to the system and distribute the audio to the desired area at home.
Company	Advantages of smart homes	Smart homes systems elements

Nous House [18]	Start home enhances convenience, security, comfort and entertainment, value of the property.	There is a wide range of home automation with iPhone, iPad, Android or other iDevice to control the home's lighting, air-conditioning, pool, blinds, fans, complete audiovisuals.
Eco Centric Energy [11]	Smart home reduces planning, installation and wiring costs. It also enables the integration of new functions at any time and realizes intelligent automation, e.g. lighting and heating control during absence. This saves energy costs and protects our environment and reduces carbon footprint. It also provides simple operation and monitoring and hence lowers the running costs, efficiently manages the facility and achieves optimum building maintenance. Smart home also offers a great deal of individual comfort, Increases safety and security. Thereby, increasing the home value.	ABB i-bus® KNX is a universally applicable system for smart home and intelligent building control where all devices (the lighting control and regulation, shutter control, regulation of heating, ventilation and airconditioning, security and monitoring, central automation, energy and load management, audio/video functions, remote control/remote maintenance) can communicate with one another via a single bus cable.
Envious Technology [12]	It enhances our lifestyle and allows us to extract the full potential and efficiency at home.	With INSTEON, lights, heater, appliances, air-con and other electrical devices can operate together and we can control our home via internet or smartphone app.

6. Conclusions

The global climate change forces us to reconsider the important elements inside our home. Recent advances in technologies foster the rapid development of automation devices for smart home users [29]. This paper finds that the major advantages of smart home include comfortable housing and cost reduction. Energy saving device remain the major elements in

smart homes. As compared to Australia, smart home suppliers in Hong Kong mainly focuses on energy saving and have not yet included water management.

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