Towards Ubiquitous Database Management Systems
A Case Study of E-Government Services in Selected Developing Countries

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Abstract: Ubiquitous Computing (UC) is a paradigm shift in computing and computing devices embedded in everyday appliances in the environment cooperates to provide information and services on behalf of their users. With the initiation of UC research has grown in community involving anthropologists, computing scientist and social scientist, working towards the realization of the UC dream. As envisaged by Marc Weiser, UC on mobile devices is starting to become an important player in the industry and its application is becoming common place, in service delivery. Although research has grown the state of relationship between design and research in business systems is under-investigated and little has been done. System design function is critical in system development for successful business systems. This paper investigates the relationship between research and design to give light on why it is critical. The paper aims to improve the illustrations on research and design factors and demonstrates the relationship by conducting a survey on countries which have successfully developed Ubiquitous Database Management System (UDMS) and applied best practices to develop UC in developing country settings to facilitate service delivery to users. The paper also claims that research views are shaped of what constitutes the value as created by design.

Keywords: Ubiquitous Computing, Ubiquitous Database, "unstated", customer-based, silicon-based, concrete forms, inconspicuous, UDMS.

Introduction

With the advent of UC there has been a growing interest in the research community involving anthropologists, computing scientist and social scientist, working towards the realization of the ubiquitous computing dream [1] [2]. Rapid expansion of information and communication technology, mobile communication devices and the Internet plays a critical role in people's lives. The technology devices and applications support offer numerous communication platforms. Computer devices have been used for various tasks and support an effective systematic work.

Research is a major tool used for generating knowledge which, in turn, is applied to design in order to realize business systems. However, the current research is not binding to design in business system development. Research identifies a problem to solve in some way, by having a wider understanding of context of knowledge in which that problem is set. Research takes responsibility of project conclusion. Research results into a contribution of a shared knowledge from reviewed document. The purpose is to find out how the idea of "unstated" contributions to knowledge or understanding might be worked out and made useful. Research on consumer responses elicited by business model design is in early stages, but limitedly constitute to the antecedents of communication behavior.

Design is necessary for expanding research into business related fields. Design impact on several businesses related concepts, communication methods, and quality of service, limited observed evidence is presented. While the importance of design is well documented particularly in design literature, experiential research on the impact of design is quite scarce in the marketing field. Design impact on the formation of brand knowledge is limited in study.

In respect to the above statements, to create the right environment for system development that is inclusive, as steps in system development process. There are not many existing references for evaluating effective system development that recognizes the significance the relationship. To overcome this limitation, the study examines this issue to improve the process and outcome of system development. The research is based on integrated systems that satisfy those served by it.

This paper presents a report conducted in countries which have successfully developed ubiquitous database management system so as to develop the same in developing countries settings for the purpose of facilitating service delivery to citizen. The paper claims that research views are shaped of what constitutes the value as created by design.

The remainder of the paper is structured as follows: Section 2 describes related works. Section 3 focuses on design of the research to be conducted. Section 4 focuses on case studies and gap analysis. Section focuses on the steps of the proposed solution. Section 6 focuses on recommendations and conclusions.

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2. Related work

The role of design in business system is a professional service of creating and developing concepts and specifications to optimize the function, value and appearance of systems. However, currently the design activity is as an involving compromise, choice, creativity and complexity in the new system development process. The role of design is not commonly delineated in representations of system development process. However, for the purposes of customer-based businesses paradigms, an understanding of customers and new market trends is driving the need to relate design to research before developing a new system.

2.1 Relationship between research and design

Design should be recognized to support organization system development. Design corrects misinterpreted information in the cooperation process that may contain unclear and superfluous information [16]. The role of design has been shifting by considering the complexity of the current systems that requires thorough presentation to reduce uncertainties associated with long delays, high costs, and insufficient attention. In addition, organizations are exploring means to solve the problem of unclear relationships to avoid consequences like financial losses, wasted time, and failed projects.

The value of design is well recognized and considered as a factor in economic theory. Design is a fundamental professional competence and that every design is aimed at changing existing situations into a better one. Design is a thought-process that underpins all kinds of professional activities. Designers use design to develop ideas and the ideas developed are used to record the designers' concepts and the formation of the concepts.

The designs become the aids for the progression of a problem solution and play an essential part in knowledge acquisition and representation. The ability to read or produce designs appears to be ideal to develop the gathered architectural expertise. Design is a means to an end a tool to help solve problems, create new ideas and assist communications (15). It is the easiest and most widely used direct mean to highlight the research work. Designs cover design solutions and are critical for identifying the conflicts and possibilities. It is a dialogue between the designer and what the designs suggest.

Most architects use concrete forms to help them develop ideas. Designers approach problems by creating a tentative solution, prior to understanding the problem. He proposes that the environment provided by the object to be created is an integral part of the designer's thinking process and the location for the complex ideation [2]. A valid research contribution to knowledge may not be precisely disseminated by the researcher without designing it.

2.2 Ubiquitous Computing and Database System

Ubiquitous Computing is a new frontier in the world of computing conceived in 1991 by Marc Weiser and his colleagues at Xerox PARC; having observed that silicon-based information technology was far detached from the environment. In his seminal paper [10], Marc Weiser argued that the idea of a "personal" computer is misplaced, and that the vision of laptop machines, dynabooks and "knowledge navigators" is only a transitional step toward achieving the real potential of information technology. To Marc such machines were operating in their own world and cannot truly make computing an integral, invisible part of the way people live their lives. Marc Weiser also notes in [10] that "The most profound of technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it." Weiser thus put forward a vision of future computer systems where "Computers themselves vanished into the background" and thus becomes inconspicuous. The vision initiated Ubiquitous Computing.

UC is thus a paradigm shift in computing where computing devices embedded inconspicuously in everyday appliances in the environment cooperate to provide information and services on behalf of their users. UC is thus a "calm technology" residing in an environment where the computing devices are context aware, and proactively provide services to and on behalf of their users [11]. These devices, as described by Weiser, "are invisible and come in different sizes, inch-scale machines, foot-scale machines and yard-scale displays [10]". Among other characteristics, ubiquitous computing is thus said to be computing anywhere, and anytime, as well as computing without conscious effort, computing with a sense of super-realism and computing that is context-aware, with the user's point of view central to the computing process. Ubiquitous Database is a kind of Ubiquitous Computing that places data everywhere [16] [7]. [6] are of the view that Ubiquitous Computing, particularly UDMS, enables us to have access to real world information from sources that hitherto were impossible to get, and to control various everyday objects that hitherto could not be controlled, by embedding computing devices in them [4].

[3], notes physical integration and spontaneous interoperation as the two main characteristics of UDMS, arguing that much of the vision, as expounded by Mark Weiser and others, either deals directly with or is predicated on them. [13], introduced a new concept, "convenience", as a characteristic of UC technology, even though it has not gained currency in the literature. They present convenience as a multidimensional construct and proposed a conceptual framework for assessing the convenience of services, drawing on [1], who argues that "the concept of convenience has includes time, place, acquisition, use and execution".

3. Research design

3.1 Statement of Problem

The realization of the Marc Weiser's dream of Ubiquitous Computing is an on-going research problem in research labs across the world. The view that ubiquitous computing will enable us to have access to real world information from sources that were impossible to access, and to control daily objects that we could not control, is a view that we subscribe. The problems to address include:

- Focus on users instead of agencies in service provision
- Facilitate inclusion of marginalized society.
- Set up contact point integrated system for users
- Access to services, anytime, anyplace

3.2 Objective and Scope of the Study

- Review globally benchmarked integrated systems
- Delineate best practices in developing integrated systems in developing countries
- Develop an integrated assessment framework and a ubiquitous database architecture

- Perform e-readiness analysis for integrated systems in Ethiopia, Ghana and Kenya

3.3 Methodology and Approach

The research is conducted by:

- Underrate a desktop research on UC and Databases.
- Review cases of success stories and adopt best practices from Canada, Taiwan and South Korea to develop Readiness Assessment Framework (RAF).
- Carry out gap analysis, based RAF established.
- Developed ubiquitous database architecture

4.0 Case Studies and Gap Analysis

4.1 Introduction

The creation of user centered communication platform is a necessary condition for strategically positioning a country to meet squarely the emerging new paradigm that will supposedly change the practices of enterprises and the way they will deliver services in the 21st century. A user centered communication platform will not only play a key role in expanding national competitiveness, but will also empower the user in terms of their interaction with business enterprises, such as access to services and information.

In order to meet users and private business needs, user centered communication initiative is critical for transparency and effectiveness. The platform will expand user and private enterprises use of Information Technology.

Enterprises worldwide are preparing for the arrival of the emerging user centered communication paradigm. For instance, the US passed user centered Act in 2000, England created "UK Online" and Singapore implemented an e-Citizen initiative. Beyond establishing computing systems and infrastructure in enterprises to support services, developing world enterprises are setting strategic goals to overhaul business process and to change the mindset of employees, as well as citizenry, about enterprises.

In a similar vein Korea and Canada, having built two of the most advanced information networks in the world, embarked upon and completed two of the most successful citizen centered initiatives in the world. As a result Korea and Canada, instituted successful user centered initiatives, are striving to make services convenient and accessible, through business process re-engineering and the use of IT.

These success stories are testimonies to the assertion that the establishment of a successful user centered communication platform impacts positively on a nations competitiveness as it eliminates bureaucracy, and improves the overall efficiency of the enterprises. Thus, it goes without saying that developing user centered communication plan is no longer an option for enterprises, but necessary steps they must take.

The next section examines the user centered communication. Canada and South Korea identified initiatives with the objective of identifying critical factors for their success and based on that develop a framework for assessing the readiness of developing countries for creating user centered communication platforms.

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4.4 Case Studies - Frontiers of Ubiquitous Computing

For 30 years, the power of microprocessors increased and the increase applies to some other technological parameters like storage capacity and communications bandwidth. The trend means that computers will become considerably smaller, cheaper, and more abundant, hence become ubiquitous. They are also finding their way into everyday objects, resulting in the creation of "smart" things capable of accessing the Internet and its varied resources to optimize the purpose, and cooperate with each other.

Ubiquitous computing paradigm foresees seamless integration of communicating and computational devices and applications (e.g., smart sensors, wireless networks and mobile agents) embedded in all parts of our environment, from our physical selves, to our homes, our offices, our streets and so forth. However, the benefits will only be realized if security issues are appropriately addressed.

UC means new devices, sensors, and protocols throughout society, and thus new sources of consumer data. The new data sources, along with new means of individual identification, constitute a personal privacy concern: what should and should not be done with personal data..

Three knowledge visualization techniques namely: factor analysis, pathfinder networks and context-based ontology are UC related [5]. The comparison of the techniques showed that application of ubiquitous computing in health care is the most popular research and PFNet provide a broader view UC [16].

4.4.1 Case 1: *Korea – Reducing the digital divide*

A study conducted by a researcher in Korea recognized that there is a big gap between developed and developing countries in regard to UC. As such it is believed that developing countries can learn from the developed countries so as to reduce the digital gap as Korean did. The Korean government reduced the digital gap by updating, adding and enhancing a toolkit to support the developing countries [9]. The methods of implementing this were identified based on personnel experiences and knowledge. A SWOT analysis was conducted, followed by the implementation of management development processes, and then monitoring and evaluation process which was focused on users. Korea republic adopted a centralized development strategy which has become their foundation for economic development.

4.4.1 Case 2: *Japan - Ubiquitous Computing for Commerce*

Japan initiated digital money payment systems that use Sony's FeliCa near-field communication smartcard technology [8]. The approach incorporates heavy dependence on IT-based Japanese reluctance to make credit card payments over the Internet or via telephones opened the way for Japanese convenience stores to provide third-party payment services, which required substantial IT

infrastructure. They followed a alliances, a range of services and products, and telematics rather than PCs.

4.4.2 Case 3: *Taiwan - Ubiquitous Mobile Database for Java Phones*

This is a Taiwan case focusing on designing of a ubiquitous interface agent based on the ontology technology and interaction diagram with the backend information agent system [12]. Taiwan investigated ubiquitous interface agent with the Bluetooth wireless technique and related interaction diagrams under cloud computing environments. The system parts included the ubiquitous interface agent as the client device; the Bluetooth wireless technique as a connecting technology; and the backend information agent system providing cloud computing. This environment is suitable for cloud computing for extensively and seamlessly entering related web information agent systems through modern mobile equipment.

4.5 Comparison of E-readiness index

The E-Readiness Index is a composite index derived from component readiness indices like infrastructure index, mobile phone subscription index, and human resource competence index. As illustrated in the Table 1 there is a direct relationship between the E-readiness and the infrastructure index; and the mobile phone subscription. The comparatively very good infrastructure of South Korea with high level customer connectivity is reflected in the high E-Readiness index. Thus it takes good infrastructure and equipping users with the terminals to access the platform for service delivery.

Table 1. Comparison of E-readiness

Criteria/ Parameter	Components Metrics	Canada	Korea	Ethiopia	Ghana	Kenya
Level of Bureaucracy	Single/Integrated Point of Contact	Low	Avg	High	High	High
Governance and Leadership Readiness	Policy framework Business contingency Service Managers	High	High	Low	Low	Low
User Readiness	Accessibility Social Culture, language, Literacy Disability Economic Digital divide Limited public Access	High	High	Low	Low	Low
Trust Concerns	Privacy and Security Confidentiality Privacy Authentication PKI	High	High	Low	Low	Low
Competency Readiness	Qualified Personnel Permanent/Outsourced Contract Negotiation Skills Relationship Management Contract Admin Skills	High	High	Low-Avg	Low-Avg	Low –Avg
Technology Readiness	Hardware System/Application S/W Communication/Network Infrastructure Internet Penetration Legacy Systems	High	High	Low	Low	Low
	Availability of Prof. Skills Web Tech & Portal Design PKI	Avg-High	Avg – High	Low-Avg	Low-Avg	Low-Avg
Legal Readiness	Electronic Business Transaction Law Right of access to information Bill Electronic Payments Law Legality of notification, Mgt	Avg	Avg	Low	Low	Low
Codes & Standards	Harmonized Codes and Standards	High	High	Low	Low	Low

Table 1 illustrates an E-Readiness Framework developed to assess the E-readiness of selected developing countries namely: Kenya, Ethiopia and Kenya, using Canada and South Korea as benchmarks. As indicated, whilst the level of bureaucracy of Ethiopia, Ghana and Kenya are high compared to those of Canada and South Korea, their government and leadership readiness, customer readiness, trust concerns, competency readiness, technology readiness, legal readiness and codes and standards are low.

The countries have to improve the IT skills and competency of service personnel as well citizens and business clients to effective service delivery. They have to improve the IT skills and competency of the service, personnel, and citizens for business clients to run effective service delivery. Moreover, the public services of these countries need to reform organization structure and conduct business process re-engineering to minimize the high bureaucracy and red-tapism in their civil services.

5.0 Steps in the Proposed Solution

There is globalization and trends in the market. No country can escape the effect of these trends, considering that the natural resources are also scarce and the countries must develop nationally. A responsible nation should be able to protect the peoples' lives by implementing UC by creating governance whereby markets and society cooperate with the government to solve social problems. In addition, stakeholders must be made to understand the concepts, goals, requirements, limits, contents of UC. The concepts meaning of change corresponds to Information Technology (IT) development and the innovation done by government.

5.1 Stages of UC Action Plan

UC lowers delivery costs in worldwide groups by enhancing communication and allowing interactions. However, the decrease is constrained by infrastructure cost and individual behaviors, activities and interaction practices.

UC is a set of related parts making the entire system [9]. Resources of all kinds flow across the system parts inform of input, throughput, output, and feedback. The entire system is accessible to the outside environment. UC is to achieve seamless integration between systems and the implementation covers research, design, development and deployment as shown in Table 2.

Table 2: Stages of UC Action Plan

Stages	Building Blocks	Actions
Research	Team, awareness	1. Define mission and goals. 2. Identify benchmarking countries. 3. Determine network policies. 4. Develop social awareness. 5. Form political leadership
	Form agencies	1. Create agencies. 2. Identify partners: committees, leadership
	Explore environment	1. Natural and human gaps. 2. Political and administrative barriers. 3. Communication and network gaps
	Referencing	1. Past successful cases. 2. Successful countries
Design and development	Vision and mission	1. Define mission and vision statements. 2. Strategize targets
	Develop framework	1. Develop administrative framework. 2. Rank the targets. 3. Create targets units
	Develop strategy	1. Conduct major reforms. 2. Empower the people. 3. Define users
	Administer significant issues	1. Human, financial, and technological resources. 2. Develop policy and regulations. Understand stakeholders. 3. Determine management methods
	Develop the system	1. Identify ISP. 2. Reengineer business processes. 3. Develop the system
Deployment	Evaluate the system	Monitor and evaluate the system
	Operate the system	Operate, maintain and manage information resources
	Get feedback	1. Determine public relation to system use. 2. Get users feedback. 3. Implement feedback to enhance the system

5.2 Organizational Structure & Business Process Re-Engineering

It is recommended to the various countries to first and foremost conduct organizational restructuring of service delivery. This will bring change in business processes, and make the service amenable to the diffusion of information technology into the service. It will reduce the work flow chain and consequently reduce the level of bureaucracy. This is by creating a single service contact point.

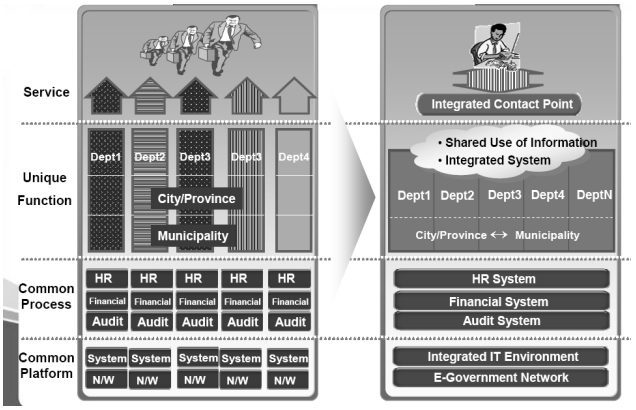

Figure 1. Typical framework of service delivery

Figure 1 illustrates a typical framework of service delivery before developing integrated proposed framework for service delivery for Ethiopia, Ghana and Kenya. The existing frame has several access points to service delivery. This results in a redundant database content and breeds inefficiency and high bureaucracy in accessing services. In the proposed framework, a user or business entity will only need to access one integrated contact point to access any kind of service. This reduces work flow chain and trips to transaction. It harmonizes codes and standards, systems and application software and database of users' service.

5.2 Technological – Ubiquitous Database Architecture

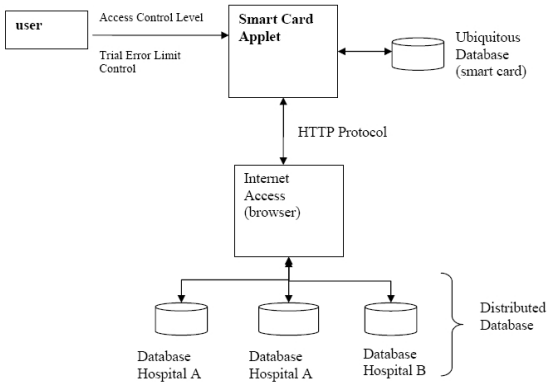

Figure 2. Ubiquitous Database Architecture

The Ubiquitous Database Architecture is based on the Client Server Concept. Apart from organizational restructuring the database for integrated services need to be

redesigned to accommodate the needs of the emerging paradigm of ubiquitous computing and ubiquitous database management system. The following database architecture and design shown in Figure 2 is recommended for the development of Ubiquitous E-Healthcare as Ubiquitous Computing service for Ethiopia, Ghana and Kenya client server concept. It has a client side hosted on a smartcard, and a server hosted on a desktop. In view of the limited resources, processor and memory of the smartcard, is very difficult to implement the full functionality of a rich DBMS on it. The function of DBMS is therefore divided into a host PC and on the smart card.

The part on the host is a preprocessor that transforms a query language into primitive commands. In addition, it takes charge of the management of schema based view and transaction roll-backing. On the other hand, the part on the smart card is a command processor that executes primitive commands that create, read, write and delete data objects. Executions are controlled and both parts are connected through an encrypted Internet communication.

Relational database design model is recommended. Listed is the entity relationship design for the proposed E-Healthcare system, capturing the schema for patients and health facilities (hospitals and clinics), diseases, etc as shown in Figure 3.

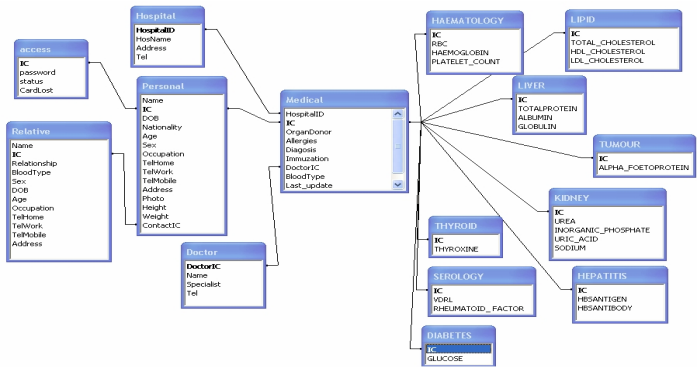

Figure 3. Database Design

6.0 Recommendation and Conclusion

Based on the gap analysis following are suggested:

1. Level of Bureaucracy: To improve business process it is necessary to focus on reducing bureaucracy level by creating a Single/Integrated Point of Contact for customers.
2. Technology Readiness of Ethiopia, Ghana and Kenya are very low compared to the benchmarked countries. Effort is to invest in hardware, system software, communication & network infrastructure to facilitate service delivery.
3. Skilled Professional Manpower: Avail skilled professional in area of Web Tech, Portal Design and PKI. It is important to provide a variety of types of technologies to facilitate the implementation of e-government
3. Prepare users ready by changing cultural concerns like culture language, economic status and literacy barriers.
3. The government to prepare laws for accessing transactions

Conclusion

- UC and UDMS redefine the key aspects of user relationships
- Businesses focus on user needs and provide reflective services
- UC enhances social action innovative, novel organizational and new business models
- For security authentication to information is a must
- Develop systems which are context aware and location specific.
- Develop laws for cyber G2C and G2B transactions
- Gather ideas and designs to capture and store
- Focus is on cultural concerns in technology development to sustain the society

7.0 References

[1] L.G. Brown, Convenience in services marketing, Journal of Services Marketing (1990) (1), pp. 53–59. Full Text via CrossRef

[2] Hanks & Belliston. (1992). DRAW ! A visual approach to thinking, learning and communicating Gedenryd, H. (1998).

[3] Tim Kindberg, Armando Fox, System Software for Ubiquitous Computing, Pervasive Computing, IEEE 2002

[4] Kimio Kuramitsu, Ken Sakamura, Ubiquitous Database in Mobile Commerce, ACM, New York, USA, 2001

[5] [1]Maria R. Lee, and [2]Tsung Teng Chen, "Trends in Ubiquitous Multimedia Computing", International Journal of Multimedia and Ubiquitous Engineering Vol. 4, No. 2, April, 2009

[6] Hong Joo Lee, Choon Seong Leem, A Study on Value Chain in a Ubiquitous Computing Environment, Lecture Notes in Computer Science, Springer, Berlin, 2005.

[7] Eric Jui-Lin Lu, Yung-Yuan Cheng, Design and Implementation of a Mobile Database for Java phones, 2010.

[8] Scott D. Mainwaring and Wendy March Bill Maurer "From meiwaku to tokushita! Lessons for digital money design from Japan", 2008.

[9] Hee Joon Song, e-Government in developing countries, lessons learned from Republic of Korea, 2003.

[10] Weiser M, The Computer of the 21st Century, 2005.

[11] Weiser M., Hot Topics: Ubiquitous Computing, IEEE Computer, Vol.26, (1993).71-72

[12] Sheng-yuan Yang[1],Chun-Liang Lsu[2], Dong-Liang Lee[3], "An Ontology-supported Ubiquitous Interface Aagent for Cloud Computing – Example on Bluetooth Wireless Ttechnique ith Java Programming", Proceedings of the Ninth International Conference on Machine Learning and Cybernetics, Qingdao, 2010.

[13] Cheolho Yoon, Sanghoon Kim, Convenience and TAM in a ubiquitous computing environment: The case of wireless LAN, 2007.

[14] Kim, B. Y., & Kang, B. K. (2008). Cross-functional cooperation with design teams in new product development. International Journal of Design, 2(3), 43-54

[15] Zainal, Anazida, Kamat, Maznah, Kadir, Rasidah, Mat Din, Mazura Ubiquitous Database in Mobile healthcare. Project Report. Universiti Teknologi Malaysia Fulltext, 2005.

[16] Hanks & Belliston. (1992). DRAW ! A visual approach to thinking, learning and communicating.