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An Evaluation of Factors Affecting Information Systems Obsolescence

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ABSTRACT

The rapid progress of technology has resulted in an increased rate of obsolescence, especially in the field of information technology. Obsolescence involves many costs for organizations. However, the field of information systems obsolescence management is a relatively less researched area. The purpose of this study is to identify the factors affecting information systems obsolescence and provide guidelines for organizations to manage obsolescence. The factors affecting information systems obsolescence were identified from the literature and categorized into hardware, software and liveware obsolescence factors. The research was conducted using an online questionnaire distributed among IT managers in a sample of randomly selected companies in Sri Lanka. The data was analyzed using Partial Least Squares. Software and hardware obsolescence were shown to have a high impact on information systems obsolescence, with lower cost new hardware, business competition, incompatible hardware, no vendor support and technological advancements being the main factors of information systems obsolescence. Organizations should take these factors into account when making decisions regarding their information systems.

Keywords: *Information systems obsolescence, obsolescence management*

1. INTRODUCTION

Technology has progressed rapidly over the past few decades and this has provided people and organizations with many benefits. However, this progress has also resulted in an increased rate of obsolescence, especially in the field of information technology.

The Oxford English Dictionary defines obsolescence as "the state of being which occurs when an object, service or practice is no longer wanted even though it may still be in good working order." [4] Obsolescence is mainly categorized into technological, functional and logistical obsolescence [11]. Technological obsolescence is brought about when technology and related business decisions evolve. Older technologies cease to be used when newer technologies appear. Changing a component may lead to changing other components because the new components support different interfaces than the previous ones. Functional obsolescence occurs when the usefulness of a device is impaired because it cannot be upgraded or changed to meet new functional requirements. If replacement parts become unavailable, or if the cost of a new item is less than the cost of repairs or replacement parts, then products that break down or wear out may become obsolete. Logistical obsolescence is caused by the termination of supply or support arrangements due to supplier business decisions.

Organizations need to manage obsolescence so that they can know when they should upgrade or replace their information technology (IT) investments. For instance, if systems do not operate efficiently or cost effectively; if systems need an increasing number of updates to keep up with changes; or if competitors have gained an advantage by implementing newer technology, organizations may have to consider their IT systems as obsolescent and in need of replacement. Furthermore,

when IT systems are upgraded, the skills of the personnel using these systems also have to be updated.

Information technology investments are costly for organizations, and these investments should provide benefits to outweigh the costs. Organizations should be able to decide the optimal time to upgrade or replace their IT systems, and know when to provide necessary training for employees or recruit new employees to work with newer IT systems.

The increasing rate of obsolescence of information systems results in escalating costs for organizations in terms of keeping their systems up to date. Organizations also have to face the threat of competitors using newer technology to gain competitive advantage. Furthermore, organizations need to be aware of how long to effectively use their existing systems, rather than upgrading to the latest versions of hardware and software as soon as they are released. The field of information systems obsolescence management has had relatively little research conducted to-date [11].

Obsolescence factors defined in the literature are described in Section 2. Section 3 lists the factors of information systems obsolescence and presents the research model. The data collection and analysis are described in Section 4. Finally, Section 5 presents the conclusions and recommendations for organizations to manage information systems obsolescence.

2. LITERATURE REVIEW

An information system is defined as "any organized combination of people, hardware, software,

communications networks, and data resources that stores and retrieves, transforms, and disseminates information in an organization." [10]. Information systems obsolescence can be categorized into software obsolescence, hardware obsolescence and liveware (people) obsolescence.

2.1 Software Obsolescence

Software obsolescence occurs when software is rendered obsolete due to a number of reasons as stated below. The obsolescence of many commercial applications and operating systems depends on the "end of support" date, since the software becomes a security risk when security patches are no longer provided by the software vendors [11].

The reasons for software obsolescence can be listed according to the categories of obsolescence:

- Technological obsolescence: The reasons for termination of sales and support for software are due to the software no longer being sold by the original vendor, being unable to expand or renew licensing agreements, and the software no longer being supported by the original vendor and third parties under software maintenance agreements [11]. Software applications also become obsolete when they are retired from use and taken off the market due to technology advancements and decrease in product popularity [8].

- Functional obsolescence: The functionality of the software will become obsolete due to hardware requirements or other software changes to the system. Software vendors produce new software to run on improved hardware and make older software versions obsolete. Newer versions of software can also make other software obsolete [11]. Business strategies of organizations can change and the software changes in line with the new business strategies, causing functional obsolescence of the software [1].

- Logistical Obsolescence: Access to software is limited or terminated due to digital media obsolescence, formatting, or degradation [11].

2.2 Hardware Obsolescence

Obsolescence affects all types of computers, including laptops, servers, and personal computers. It also affects computer components and peripherals such as processors, memory, printers, and scanners.

Over the past 20 years, hardware costs have been reduced by one-half every two years while the density and speed of hardware has doubled [6].The price and computing power are greater in new computer models than older models [6]. The value of older computers is affected by the fact that new computers are cheaper and have better performance. The specifications of new computers can be improved by technical change. These improvements in new computers can depress the value of older computers by making them obsolete. Older computers can become obsolete because they are incompatible with new operating systems or software or do not have hardware that becomes standard in new models, although they are able to do existing tasks in an acceptable manner. Technological change in hardware manufacturing has significantly lowered the cost of Random Access Memory, speed, and hard disk space. The lower costs of computer hardware encouraged software engineers to write programs that are more demanding on the hardware. The limited capabilities of older computers do not allow the newer software to run well [6].

Hardware obsolescence can be categorized according to the types of obsolescence. The availability of more technologically advanced hardware will create technological obsolescence of existing hardware. Software upgrades that do not execute correctly on existing hardware will be a factor that creates functional obsolescence of hardware. When replacement parts cannot be obtained, this causes logistical obsolescence of hardware [11].

2.3 Liveware Obsolescence

Liveware obsolescence occurs in the form of skills and knowledge of computer hardware and software becoming obsolescent. The extent of liveware obsolescence can be observed by the quantity of training and certifications available for people to learn new hardware and software [13].

The productivity of end users and information systems specialists is affected by skills obsolescence. IT professionals must always upgrade their professional knowledge and skills because their existing intellect will become obsolete in a few years [13]. As new technology changes, the roles of IT professionals will be constantly changing and they must be able to adapt and be willing to learn new skills.

2.4 Obsolescence Management Problem

The costs associated with obsolescence events are not tracked by organizations [8]. The overall consequences of not developing obsolescence management strategies are difficult to measure due to this reason.

Other than the topics of "information or digital preservation" or termination of sales and support, little attention has been paid in literature to software obsolescence [11]. Most organisations employ a reactive approach to software obsolescence management, such as factoring in unspecified additional integration efforts or vendor communication [8]. Software obsolescence is tracked and managed by only a few system development and support organisations. Concurrently managing software and hardware obsolescence through systems engineering approaches is rare. Obsolescence data and information on software are not shared by any formal organisations [11].

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3. METHODOLOGY

The factors affecting information systems obsolescence and the factors affected by information systems obsolescence were initially identified through the literature review. An expert survey was conducted to verify the applicability of the factors in the Sri Lankan organizational context and identify any other relevant factors of information systems obsolescence. The expert survey panel comprised of four top-level information technology managers in Sri Lankan organizations and academia. The factors were verified through a detailed discussion on the views and opinions of the panel of experts and a final list of factors was compiled.

3.1 Factors Affecting and Affected by Information Systems Obsolescence

3.1.1 Software Obsolescence Factors

The factors affecting software obsolescence are,

Technology advancements - Vendors create new software due to technology advancements. Organizations upgrade or replace their existing software with the newer software, leading to the obsolescence of the existing software [8].

Low product popularity - Software applications are retired from use and taken off the market by vendors due to decrease in product popularity [8].

No vendor support - Vendors of software applications do not provide support for older versions. Lack of vendor support would cause organizations to change their software because they would not be able to obtain necessary updates, technical assistance, and other support [8].

Competition in business environment - Competition in the business environment will cause organizations to replace or upgrade their existing software in order to meet the new challenges brought on by competition [1].

Changes in Business Strategies - The business strategies change and the software changes with the new business [1].

Mergers and acquisitions - Mergers and acquisitions cause the software used by a business to be changed (Expert survey). The acquired organization may have to change its existing software if it is not compatible with the software that is in use in the acquiring organization.

New operating systems - Newer operating systems may not support older application software. This would require the application software to be changed or upgraded [13].

New application software - Newer applications may not run efficiently or at all on older operating systems. Therefore the operating system would have to be upgraded [13].

Different software versions - Different versions of the same application software may be incompatible. This would require the organization to discontinue the use of one incompatible version, usually the older version [13].

3.1.2 Hardware Obsolescence Factors

Hardware obsolescence is affected by the following factors:

Technology advancements - Technology advancements give rise to new hardware. This hardware is marketed as being more efficient than existing hardware. Therefore, organizations would replace their existing

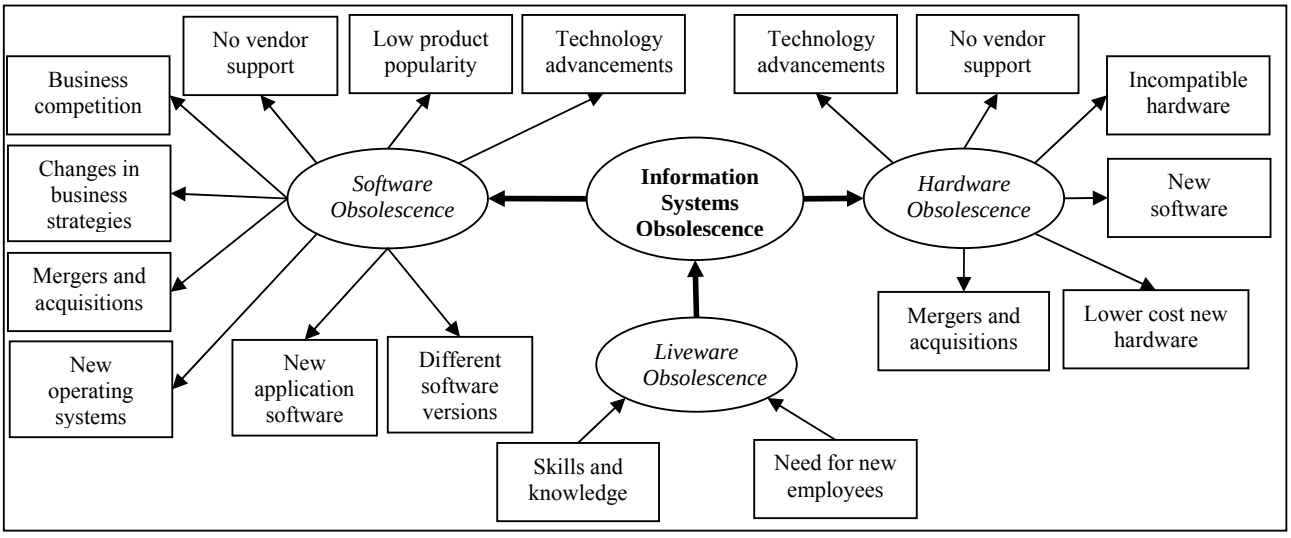

Fig 1: Research model

hardware with the new hardware [1].

No vendor support - Spares to support in-service hardware become unavailable because some component is no longer in production or is no longer in demand by the marketplace. Therefore the entire hardware unit may have to be replaced by the organization, in case a component malfunctions [1].

Incompatible hardware - New hardware is incompatible with old hardware components. This would require the older hardware components also to be replaced [13].

New software - Software upgrades require an increased specification computer for the software to run efficiently. Older hardware systems may not be able to handle the requirements of the new software and have to be replaced [1].

Lower cost new hardware - Hardware replacement costs are sometimes lower than costs to upgrade specific components. This would mean that entire hardware systems would be replaced, rather than upgrading the required components (Expert survey).

Mergers and acquisitions - Organizations may have to change their hardware systems due to major changes in the business environment, such as mergers and acquisitions [1].

3.1.3 Liveware Obsolescence Factors

The following are the liveware obsolescence factors.

Skills and knowledge - Employees require training when new software applications or operating systems are introduced to the organization, because they have to acquire the new skills and knowledge to operate the systems. If they do not update their skills and knowledge, they will become obsolescent [13].

Need for new employees - When new information systems are introduced organizations may hire new employees to operate these systems. This may cause the existing employees to become obsolescent if their skills and knowledge are not up to date [13].

3.2 Research Model

Fig. 1 illustrates the research model representing the factors affecting and affected by information systems obsolescence. The rectangles in the figure represent the factors or observed variables. The ovals represent the components of information systems obsolescence or latent variables. An arrow pointing from an oval towards a rectangle (from a component of information systems obsolescence/latent variable to a factor/observed variable) means that the factor affects the component of information systems obsolescence. e.g. Technology advancements affect software obsolescence. The arrows pointing from one oval to another oval mean that software obsolescence and hardware obsolescence affects information systems obsolescence, and liveware obsolescence is affected by information systems obsolescence. An arrow pointing from a rectangle towards an oval represents a factor being affected by the component of information systems. e.g. Skills and knowledge is affected by liveware obsolescence.

4. DATA COLLECTION AND ANALYSIS

The data was collected through an online questionnaire, in order to increase the ease of distribution of the questionnaire and directly reach the participants. The questionnaire was sent to IT managers of 65 randomly selected companies in Sri Lanka, in the areas of apparel, banks, finance and insurance, manufacturing, telecommunication, information technology, and services. A total of 31 responses were received, giving a response rate of 48%. 19.4% of the respondents were from the apparel sector. The banks, finance and insurance sector comprised of 22.6% of the total. Manufacturing, information technology, and services sectors were each 16.1% of the survey sample. The remaining 9.7% of responses were from the telecommunication sector.

The statistical tool used for data analysis was Structural Equation Modelling using Partial Least Squares (PLS). PLS is a well-established technique for estimating path coefficients in structural models and has been widely used in various research studies [2], [5]. PLS is designed to explain variance, i.e., to examine the significance of the relationships and their resulting R^2, as in linear regression. Using Ordinary Least Squares as its estimation technique, PLS performs an iterative set of factor analyses combined with path analyses until the difference in the average R^2 of the constructs becomes insignificant [12]. Once the measurement and structural paths have been estimated in this way, PLS applies either a jackknife or a bootstrap approach to estimate the significance (t-values) of the paths. Neither of these PLS significance estimation methods require parametric assumptions. PLS is thus especially suited for the analysis of small data samples and for data that does not necessarily exhibit the multivariate normal distribution [3], [12]. PLS estimates the parameters in such a way that will minimize the residual variance of all the dependent variables in the model.

The PLS data analysis was done using the software package Smart PLS (Version: 2.0.M3).

4.1 Reliability and Significance of the Results

The typical approach to reliability assessment is the Cronbach α coefficient, which ranges from 0 to 1. The Cronbach α values are above 0.7 for hardware obsolescence, software obsolescence and information systems obsolescence, which are acceptable for capturing the dimensions [9]. The composite reliability of hardware, software and information systems obsolescence, as shown in Table 1, exceeded the threshold of 0.7 recommended by [9]. The R^2 values for the constructs are also significantly high (greater than 0.7).

The outer loadings should be greater than 0.5 to be significant. According to the calculations, all hardware obsolescence factors except mergers and acquisitions (0.405) are significant. The liveware obsolescence factor need for new employees (0.443) is not significant. For software obsolescence, all factors except mergers and acquisitions (0.398), new operating systems (0.463) and incompatible software (0.414) are significant.

Table 1: Scale reliability and composite reliability measurements

	Cronbach Alpha	Average Variance Explained	Composite Reliability	R^2
Hardware Obsolescence	0.8563	0.6030	0.8970	0.9427
Information Systems Obsolescence	0.9020	0.4426	0.9184	0
Liveware Obsolescence	0	0	0	0.7037
Software Obsolescence	0.7831	0.3863	0.8414	0.9153

If the cross-loading values for the measurement items are greater for its assigned construct, compared to any other construct, then the measurement items correlate with the constructs. From the calculations, all measurement items except mergers and acquisitions (software obsolescence factor) and new operating systems correlate with the constructs.

Since the PLS method makes no prior distributional assumptions, traditional significance tests and estimation of confidence intervals for the path coefficients cannot be done. However, the bootstrapping estimates of mean, standard errors and t-statistic can be used to test the significance of the structural coefficients [3]. The bootstrapping technique is used in this research. Table 2 gives the values obtained by running the bootstrapping technique for samples of 17, in 80 iterations. At the 0.05 significance level, the hypothesized paths of the constructs are considered to be significant (t-value is greater than 1.96), according to the calculated data.

Table 2: Total effects
(Mean, standard deviation, t-values)

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	Standard Error (STERR)	T Statistics (|O/STERR|)
IS→ Hardware	0.971	0.974	0.010	0.010	99.507
IS → Liveware	0.839	0.837	0.079	0.079	10.571
IS → Software	0.965	0.970	0.014	0.014	68.006

When considering the t-values of the measurement items, in the hardware obsolescence construct, all paths except mergers and acquisitions (t-value: 1.74) are statistically significant at the 0.05 significance level. The factor need for new employees (t-value: 0.31) in the liveware obsolescence construct was not statistically significant. Mergers and acquisitions (t-value: 1.49) and different software versions (t-value: 1.64) are the only measurement items that are not statistically significant in the software obsolescence construct. These four factors were removed from the research model and the validated model was again tested using PLS. In this model all t-values of measurement items except the skills and knowledge factor (t-value: 0.00) of liveware obsolescence were statistically significant. Therefore, this factor too was removed and the model was tested again using PLS. The t-values in the final validated model (Fig. 2) were all statistically significant.

The importance of the factors that affect information systems obsolescence can be identified by listing the t-values of the factors in descending order. In the final validated model the factors that affect information systems obsolescence in order from greatest to least are as follows:

a. Lower cost new hardware (Hardware obsolescence)
b. Business competition (Software obsolescence)
c. Incompatible hardware (Hardware obsolescence)
d. No vendor support (Hardware obsolescence)
e. Technology advancements (Hardware obsolescence)
f. New software (Hardware obsolescence)
g. Low product popularity (Software obsolescence)
h. Technology advancements (Software obsolescence)
i. No vendor support (Software obsolescence)

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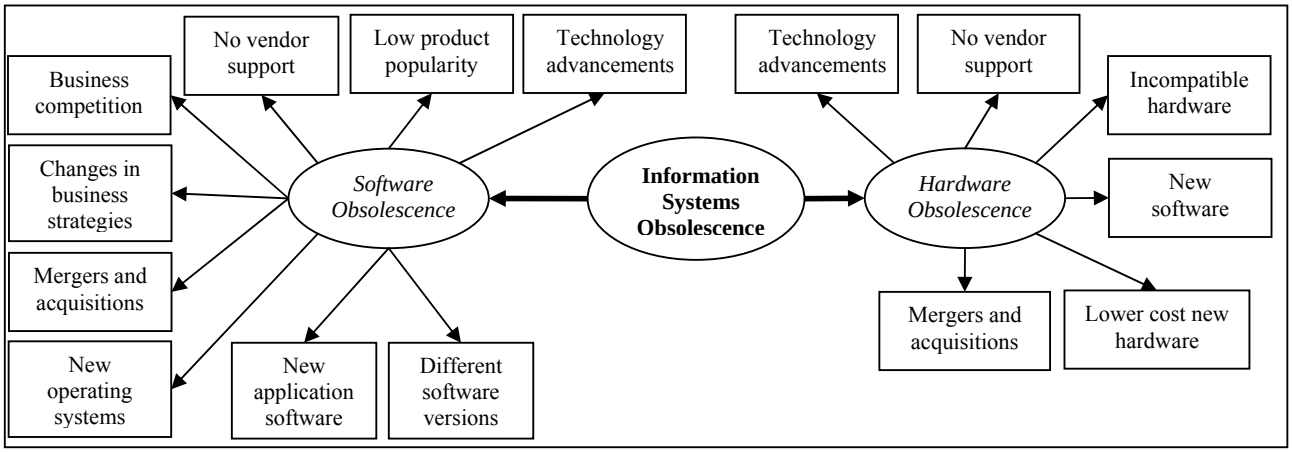

Fig 2: Final validated research model

j. New application software (Software obsolescence)
k. New operating systems (Software obsolescence)
l. Changes in business strategies (Software obsolescence)

5. CONCLUSIONS AND RECOMMENDATIONS

According to the research findings, organizations need to consider information systems obsolescence, taking into account software and hardware obsolescence factors. The most important factor to be considered is lower cost new hardware, which is the greatest factor in hardware obsolescence. Even though the existing hardware is functional, if a hardware component needs to be upgraded, organizations tend to replace entire hardware systems due to the decreasing costs of new hardware. Organizations would have to do a cost-benefit analysis before replacing the hardware in this manner. The main factor that affects software obsolescence is business competition. Organizations need to consider whether their software applications are adequate to meet the current business competition, and upgrade their systems accordingly. If not, they may lose out on their market shares and profits.

When hardware components are being upgraded, incompatibilities may arise between the new hardware and the existing old hardware. This fact should be taken into consideration by organizations. The research that has been conducted on hardware obsolescence, as mentioned in [1], [6], [11], and the guidelines provided through this existing research could be useful for organizations to mitigate the risk of hardware incompatibilities. For example, using standard hardware components, and having agreements with hardware vendors could help minimize the hardware obsolescence risk.

No vendor support is a factor that affects both hardware and software obsolescence. Agreements with vendors could help organizations mitigate the risks of this factor of obsolescence.

Introducing new software could lead to hardware obsolescence. This fact should be taken into consideration when upgrading software or introducing new software. If possible, the software should be selected which meets the current hardware specifications, due to the fact that it would be a waste of hardware resources if the existing hardware has to be replaced before its time, and also if the software is installed on hardware with insufficient capabilities, the software will not run efficiently.

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