July 2011

The Awareness Of ICT Implementation For Materials Management In Construction Projects

N. B. Kasim

Faculty of Technology Management, Business & Entrepreneurship Department of Construction and Real Estate Universiti Tun Hussein Onn Malaysia (UTHM) 86400 Parit Raja, Johor Darul Takzim, MALAYSIA, narimah@uthm.edu.my

Peniel Ang Soon Ern

Faculty of Technology Management, Business & Entrepreneurship Department of Construction and Real Estate Universiti Tun Hussein Onn Malaysia (UTHM) 86400 Parit Raja, Johor Darul Takzim, MALAYSIA, peniel.ang@gmail.com

Follow this and additional works at: <https://www.interscience.in/ijcct>

Recommended Citation

Kasim, N. B. and Soon, Peniel Ang Ern (2011) "The Awareness Of ICT Implementation For Materials Management In Construction Projects," *International Journal of Computer and Communication Technology*: Vol. 2 : Iss. 3 , Article 3.

DOI: 10.47893/IJCCT.2011.1088

Available at: <https://www.interscience.in/ijcct/vol2/iss3/3>

This Article is brought to you for free and open access by the Interscience Journals at Interscience Research Network. It has been accepted for inclusion in International Journal of Computer and Communication Technology by an authorized editor of Interscience Research Network. For more information, please contact sritampatnaik@gmail.com.

The Awareness Of ICT Implementation For Materials Management In Construction Projects

N. B. Kasim *

Faculty of Technology Management, Business & Entrepreneurship
Department of Construction and Real Estate
Universiti Tun Hussein Onn Malaysia (UTHM)
86400 Parit Raja,
Johor Darul Takzim, MALAYSIA
Email: narimah@uthm.edu.my

* Corresponding author

Peniel Ang Soon Ern

Faculty of Technology Management, Business & Entrepreneurship
Department of Construction and Real Estate
Universiti Tun Hussein Onn Malaysia (UTHM)
86400 Parit Raja,
Johor Darul Takzim, MALAYSIA
Email: peniel.ang@gmail.com

Abstract: Construction materials usually constitute a major portion of the total cost in a building construction project. Despite the potential benefit of ICT, convincing construction organisations to embrace its use and implementation has proved a difficult task. This research seeks to identify the implementation of ICT in construction materials management processes and to investigate on the acceptance of contractors for ICT transformation to the materials management in construction projects. In relation to that, current constraints that are found hindering the acceptance of ICT in materials management processes are also identified. A triangulation research approach which consists of standard derived questionnaires, semi structured interviews with class A contractors and review of previous research were conducted. The findings from this research reveal that the implementation of ICT in the materials management for construction projects in Malaysia is at early stage. Microsoft Excel Spreadsheet and handheld devices are found to be the common ICT tools adopted in the materials management processes. Meanwhile, there is only an average level of acceptance towards the transformation of ICT implementation in the construction materials management. The main barrier is found to be the cost involvement at the initial stage or overall implementation of ICT in the materials management processes. Finally, it can be concluded that there is a lack of awareness towards the ICT implementation of materials management in the construction projects.

Key words: Construction projects, Materials management, ICT, Transformation, Triangulation

1 Introduction

Materials management functions include planning and taking off materials, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution [1]. Almost 60% of the total working capital of any industrial organisation consists of materials costs [2]. Materials management can only produce what it should with the right quantities of the right material at the right time [3]. Thus, any improper handling and managing of materials will cause a huge effect on the total project cost, time and quality.

Information and Communication Technology (ICT) is a wide-ranging term that includes all technologies for the manipulation and communication of information. For instance, the internet is widely used for electronic mail (e-mail) and electronic commerce (e-commerce) including electronic invoicing, payments and receipt of materials process [4]. Apart from that, more sophisticated solutions of ICT based technologies are emerging such as wireless communication, bar-coding and radio

frequency identification (RFID) for tagging technologies. Thus, an appropriate implementation of ICT could facilitate more effective and productive materials management processes.

Generally, the construction industry in Malaysia has lagged behind other industries in embracing ICT. It was found that although the professionals are quick to assimilate computerisation into their construction processes, the contractors and builders are still far from the adoption of ICT [5]. In the international construction industry, Turkey and other countries faced similar challenges in the area of communication and loss of information [6]. Accordingly, the implementation and practice of ICT in materials management will strongly ease unnecessary lost and increase productivity in any projects. Thus, there is clearly a need to explore on the existing ICT implementation of the contractors while studying the availability for ICT to be implemented. Other than that, current constraints that are hindering the acceptance of ICT in materials management processes will also be identified.

The purpose of this research is to study the awareness towards the adoption of ICT for materials management in construction projects. Therefore, we need to look into the implementation of ICT in materials management processes in construction projects. Apart from that, it is essential to also look into the acceptance of contractors towards the transformation of ICT implementation in materials management processes. Thus, there is a need to explore on the area of materials management, the issues relating to materials management problem and the implementation of ICT in materials management.

2 Materials Management

Materials management is defined as a coordinating function responsible for planning and controlling materials flow [3]. In a detailed view, materials management is a planned procedure that comprises the purchasing, delivery, handling and minimisation of waste with the aim of ensuring that requirements are met [7]. Materials management is an essential function that improves productivity in construction projects. Hence, the efficient use and management of material have an important influence on a company's profit and can avoid delay in construction [8].

In this study, materials management are categorised to 5 processes, namely planning, procurement, logistics, handling, stock and waste control processes.

2.1 Planning

Materials planning includes quantifying, ordering and scheduling. It is stressed that planning is especially significant in terms of increasing productivity, profit, and facilitating the timely completion of construction projects [9]. Hence, productivity will suffer if the material planning process is not executed properly.

2.2 Procurement

Procurement is described as the purchase of materials and services from outside organisations to support the firm's operations from production to marketing, sales and logistics [10]. As such, a detailed material schedule and co-ordination of the procurement and order of material are important in assuring material availability [11].

2.3 Logistics

Generally, logistics is a concept that emphasises movement and it may include planning, implementing, and controlling the flow and storage of all goods from raw materials to the finished product to meet customer requirements [12]. There is evidence that the routing of materials is one of the main points which affect cost and time during construction projects [13].

2.4 Handling

Materials handling is described as a broad area that encompasses virtually all aspects of all movements of raw materials, work in process, or finished goods within a plant or warehouse [10]. Nearly 50 % of the production cycle time in many industries is spent on handling materials. Due to that, poor material handling may result in delays leading to the idling of equipment [14].

2.5 Stock and Waste Control

Stock control is classified as a technique devised to cover and ensure all items are available when required. Stock control can include raw materials, processed materials, components for assembly, consumable stores, general stores, maintenance materials and spares, work in progress and finished products [15]. It is of great importance that the bulk of construction materials delivery requires proper management of stock control.

Meanwhile, construction activities can generate an enormous amount of waste [16] and materials waste has been recognised as a major problem in the construction industry [17]. However, tighter materials planning can reduce waste and can directly contribute to profit-improvement and productivity [18].

Each processes stated above plays an important role for an effective materials management. However, there are materials management issues that have not yet been tackled effectively. The following section will highlight on the current materials management problem faced in the construction industry.

3 Materials Management Problem

It is gathered that current manual materials management and control procedures are unsatisfactory as they are labour intensive, inaccurate and error prone. The implication leads to waste and surplus of materials, delays, decrease in productivity and lack of up-to-date and real-time information [19].

Interestingly, many problems related to management surface amongst local contractors even in developing countries. The problems normally vary in nature and intensity but are usually related to the inefficient management of construction resources including materials, labour, plant and subcontractors [14].

Few main materials management problems were being identified in the construction industry in the UK and are summarised as below [20]:

- Lack of site storage space
- Problems with tower crane distribution
- Problems on logistic of materials
- Small loading area
- Problem with one site access point
- Difficulty in delivery of materials on site during aircraft operation
- Operation limitation due to security considerations
- Inadequate loading area at consolidation centre
- Problems with congestion time at loading area

A survey in the construction productivity in Iran reveals the major causes of the lack in productivity boils down to the improper deposited material, improper material handling, improper material application and improper material deliveries [21]. Due to the fact that the problems in materials management will be never ending, it is plausible that ICT may be the answer to overcome the challenge of materials management in the construction industry. The dilemmas faced in materials

management can be overcome by adapting ICT-enabled solution that can help support the effective management of materials activities.

4 ICT Implementation In Materials Management

Information Technology (IT) can be defined as the use of electronic machines and programmes for the processing, storage, transfer and presentation of information. Communication technology is today an important part of IT [3]. Together; they make up for the term ICT. Mobile devices range from Laptop computers, Notebooks, personal digital assistants (PDA), portable data terminals (PDT), tablet personal computers to smart phones. Today, these devices have increased in style, functionality, capacity, application areas, features, usability, etc. Apart from that, Radio Frequency Identification (RFID) is also used in materials identification on construction projects in order to reduce the level of confusion regarding materials delivery from suppliers, and the relevant location at the jobsite [22].

Accordingly, firms are recognising the benefits of automating the materials handling process, including increased productivity, better space utilisation, higher customer service levels, reduced operating expenses and improved flow of materials [23]. For instance, integrating promising information technologies such as RFID technology, mobile devices-PDA and web portals can help improve the effectiveness and convenience of information and material flow in construction supply chain control systems. Previous researches have proven that adoption of ICT is essential in order to overcome the materials management problems inherent within the construction industry. Moreover, it is found that the effective implementation of ICT has the huge potential to bring about significant improvements.

However, in regard to the adoption of ICT for building project management in the Indian construction industry, mobile internet had been used only by 15% of the surveyed organisations for project management. It was even more apparent that RFID and bar-coding had not been used by any of the surveyed organisations for materials management [24]. Apparently, this low acceptance to ICT adoption contradicts with the findings above. Despite the advancement of technologies designed to facilitate materials management processes, it appears that a resistance towards effective implementation of ICT still exist in the current construction world. Consequently, it has deterred the construction industry from moving rapidly forward [25].

The challenges existing in the current materials management chain has clearly raised the importance to explore on the awareness of the players in the construction industry towards the adoption of ICT in the management of materials. Thus, a constructive research methodology was derived to study on the related issues stated in this paper.

5 Research Methodology

The triangulation research approach, which is the combination of both the qualitative and quantitative methodologies were adopted in this research. This research has the advantage of gaining a stronger research design and achieving more valid and reliable findings. As such, semi-structured interview, questionnaire survey and literature reviews were the methodologies conducted to carry out the objectives of the research. Accordingly, it is believed that a deeper and more detailed quality of information could be obtained with interview opted as the methodology instrument whereas questionnaire survey could cover a broad range of the study in fulfilling both objectives.

All questionnaire and interview respondents were of Class A contractors, which is the highest contractor classification in Malaysia. The survey was done in the state of Johor which is the southern area of the Peninsular Malaysia. Apart from that, the data analysis was conducted with research instruments such as the Statistical Package for Social Science (SPSS) software, Microsoft Excel Spreadsheet and the Matrix Table. The survey aimed to explore the extent of ICT implemented in the

materials management processes and the acceptance towards increased adoption of ICT in materials management.

6 Result

The result of the study were recorded from the 18 questionnaire respondents and 5 interview respondents. The questionnaire survey studied on the implementation of ICT in materials management processes whereas the interview investigated on the acceptance of contractors toward ICT implementation in materials management.

6.1 Implementation of ICT in Materials Management Processes in Construction Projects

The findings reveal that most respondents widely used common ICT tools such as Microsoft Excel Spreadsheet and hand-held devices, with each having the highest percentage of 44.4% respectively. The highest mean of 4.33 is recorded by the adoption of hand-held devices. Meanwhile, RFID is least adopted with the lowest mean of 2.44. (Refer Figure 1)

Figure 1: Mean of ICT Adoption in Materials Management of Construction Projects

Next, this survey sought to determine the benefits of ICT implementation in materials management. Recorded with the highest mean of 4.17 are advantages of 'increased efficiency and productivity' and 'a higher customer service level created'. The lowest mean is 3.56, representing the benefit of lowered operational costs. (Refer Figure 2 and Table 1)

Figure 2: Mean of Benefits of the Implementation of ICT in Materials Management

No.	Benefits of the Implementation of ICT in Materials Management	Mean
1	Paper work can be eliminated	3.67
2	Operational costs lowered	3.56
3	Cycle times reduced	3.94
4	Increased efficiency and productivity	4.17
5	Higher customer service levels	4.17
6	Better space utilization	4.00
7	Employee satisfaction	4.00
8	Integrated supply chain	3.78
9	Ensure the availability and quality of material	4.00
10	Ensure the right time and place of material delivery	3.89
11	Reduction of errors and rework	3.89
12	Reduction of time overrun and material waste	3.89

Table 1: Description to Benefits of the Implementation of ICT in Materials Management

Next, this analysis is done to study the extent of ICT implementation for the materials management processes. The materials management process that has the highest mean (4.17) of ICT implementation is in the planning process. The process with the lowest mean of ICT implementation is in the stock and waste control, which records at 3.44. With the moderate and high scores of mean, there is a high possibility that the adoption of ICT is basically widely used in the 5 materials management. (Refer Figure 3)

Figure 3: Mean of ICT Adoption in Identified Materials Management Processes

In addition, the key elements of the ICT tools are divided into 2 categories which are the normal ICT and sophisticated ICT tools. The division of categories are purposed to identify the acceptance level of the respondents in the complexity of ICT tools. The findings reveal a higher level of acceptance for normal ICT tools (54%) whereas the remaining 46% are for sophisticated ICT tools. (Refer Figure 4).

Figure 4: Percentage of Acceptance of Sophisticated and Normal ICT Tools

The last subject to be analysed in the questionnaire is regarding the reasons of resistance towards implementing ICT in a heavier scale in materials management. The main reason of resistance is due to the exceptional high cost of specialist software, with the highest mean of 4.39. On the other hand, the lowest mean of 3.06 represents the reason of no acceptance of employees. (Refer Figure 5)

Figure 5: Main Reasons for Barriers To ICT Transformation in Materials Management

6.2 Acceptance of Contractors Toward ICT Implementation in Materials Management Processes

This paper also reports on an exploratory study involving interviews with 5 Class A contractors. 12 semi-structured questions were directed and their responses are summarised as below.

Firstly, all 5 respondents emphasised on the basic ICT implementation of Microsoft Word and Microsoft Excel in their materials management processes. Besides that, 2 out of the 5 respondents consider Microsoft Project and Microsoft Access as their main ICT tool. Generally, ICT tools such as the usage of laptop, computer, and mobile phone are common for all respondents. Meanwhile, only 2 respondents utilised the handheld device which is the walkie-talkie in materials management at the construction site. The use of PDA is considered a main ICT tool for materials management by 3 respondents and only 1 respondent implements wireless service (Bluetooth and WiFi) in the processes of materials management.

Next, planning and procurement materials management processes are considered by 4 respondents as needing the highest investment of ICT implementation. As such, 2 respondents regarded logistics process as needing the highest investment in ICT implementation.

It is gathered that all respondents acknowledged the need to further develop ICT transformation in their materials management processes. 1 respondent plans to adopt bar-coding and PDA while another agreed on the need to improve in the implementation of Microsoft Project; handheld devices; wireless service; GPS; more usage of management software and integrated system. In addition, another

respondent highlighted the need for further initiative in the materials control and planning, especially in the forming of an integrated network system. Moreover, a need to further involve PDA in materials management is recognised by another respondent. The last respondent wanted the increased adoption of Microsoft Access, Microsoft Project and management software.

Accordingly, all respondents directed the main barriers of ICT implementation to the high cost involvement and the expertise inadequacy of their staffs. Besides that, another respondent mentioned the challenge of training workers to adapt to ICT whereas 2 respondents discussed about the uncertainty of the return of investment. Other than that, 2 more respondents included the supplier to be one of the main barriers as not being able to cope with and provide their service to the ICT transformation in materials management processes.

Lastly, in regard to the extent for ICT adoption in the near future, all respondents commented that it should be executed phase by phase as time is needed for adjustments in handling of materials.

7 Discussion

This section evaluates on the findings from the questionnaire and interview surveys. The discussion is performed in relation to the 2 objectives of this research paper.

7.1 *Implementation of ICT in Materials Management Processes in Construction Projects*

Generally, the main tools that are implemented in the materials management processes are the Microsoft Offices and handheld devices. In Malaysia, the applications of Microsoft, walkie-talkie and mobile phone are widespread in the construction industry. However, the usage of PDA is only common for mega projects whilst bar-coding and RFID is totally nonexistent. One possible explanation behind the limited usage of ICT tools might be the lack of awareness to the benefits in ICT implementation among the contractors. Moreover, contractors handling small to average projects might doubt for a good return of investment, thus conferring to the lowest usage of ICT as possible.

Accordingly, materials planning and procurement are the main ICT-embracing processes. It is apparent that these processes are seen as the most critical start up point of a project, hence the greater extent of ICT adoption. Another possible explanation might be other processes such as materials logistics and handlings require a greater investment in ICT tools such as bar-coding tools for tracking materials.

The findings have demonstrated that Microsoft Excel and Microsoft Project are the most common ICT tools in the current industry's practice. They are perceived as the less costly ICT tools that contractors could afford investing in. However, bar-coding and RFID are tools under the category of sophisticated ICT tools. These tools are hardly adopted by any of the respondents in their materials management. Nevertheless, among the benefits cited by the respondents are the improved material flow and the convenience of tracking and identification of materials. With the availability of bar-coding and RFID, the monitoring of materials management will be effective, thus improving the materials flow and tracking.

7.2 *Acceptance of Contractors Toward ICT Implementation in Materials Management Processes*

Arguably, many respondents suggested that the under development of ICT is not the main reason for the challenge currently faced by the construction industry. Even if there were ICT systems available in full scale for the materials management, the respondents doubted their users' competency. Indeed, ICT implementation can only be effective if the users are trained and willing to adapt to the change in technology upgrading. Instead, the respondents argued that the main cause of the challenge to the industry lies on the government policy that does not encourage a competitive environment within the

industry. Apparently, players in the industry may find it hard to come out of their comfort zone if the government does not challenge the competitiveness of quality and management in the industry.

In general, all the respondents agreed on the need to develop future initiatives in the implementation of ICT in materials management. However, the level of acceptance for ICT transformation in the normal or sophisticated ICT tools is merely near to average. This shows a certain degree of reluctance to improve in their performance and quality of products. One reason may be due to the contractors sticking to the norm of applying conventional building methods. Other than that, there may be an over-reliance on the un-skilled labor workers and lower educated supervisors. These workers do not need acquire high wages, but as a result it may be a hindrance in implementing ICT in full scale.

Next, the respondents were of the same mind that an increased introduction of ICT is fundamental for the materials management processes. Though there were doubts and uncertainties towards the status quo of the construction industry in Malaysia, yet they saw the importance in the area of cost effectiveness and in materials handling. For an instance, RFID is appropriate for various construction applications, and provides cost savings through increased speed and accuracy of data entry.

Meanwhile, the respondents contended that the main barriers towards the transformation of ICT are the high cost involvement whether in the maintenance or overall materials management implementation. As a matter of fact, the exceptional high cost of specialist software is also a main hindrance to the increased adoption of ICT. These findings are consistent with a survey in Malaysia that evidently proves that the awareness of implementing ICT exists but the cost of investment prohibits companies from adopting the technology. It is stated that big companies could afford ICT investment while most of the small companies find its adoption or upgrading process unaffordable [26]. Hence, cost will always remain as a barrier as long as ICT is not seen as a guarantee that will bring security to the future of the construction company.

8 Conclusion

Based on the first objective in studying the implementation of ICT in materials management, the main tools that are widely adopted by the respondents are the Microsoft Offices and handheld devices. Subsequently, planning and procurement are the materials management processes considered needing the highest investment of ICT implementation. Evidently, bar-coding and RFID are tools that are hardly adopted in the materials management of each respondent's company.

Next, the second objective led to the study of the acceptance for ICT transformation in the materials management processes. There is a call for future initiatives in the implementation of normal and sophisticated ICT tools in materials management despite the fact that there was just an average level of acceptance. Nevertheless, ICT transformation was deemed vital especially in the area of cost effectiveness and in materials handling. On the other hand, the main reasons of resistance towards the increased level of implementing ICT in materials management are due to the high cost involvement whether in the maintenance or overall implementation. In addition, the exceptional high cost of specialist software is also a barrier to the upgrading of ICT implementation.

References

- [1] Bell, L C. and Stukhart, G. "Attributes of materials management systems." *Journal of building industry: Main causes and prevention.* *Journal of Construction Engineering Construction Engineering and Management.* 112(1). 14-22, 1986
- [2] Dey, P. K . "Re-engineering materials management : A case study on an Indian refinery." *Business Process Management Journal.* 7. 394-408, 2001
- [3] Arnold, J. R. and Chapman, S. N. "Introduction to Materials Management." 5th Ed. New Jersey: Prentice-Hall. 10 (2004)
- [4] Harris, F. and MacCaffer, R. "Modern Construction Management." London: Blackwell Science (2001)
- [5] New Strait Times "Leverage on ICT in Construction Industry." 13 May. Malaysia, 2007

- [6] Sarshar M. and Isikdag, U. "A survey of ICT use in the Turkish construction industry," *Journal of Engineering, Construction and Architectural Management*. 11 (4). 238-247, 2004
- [7] Illingworth, J. and Thain, K. "Material Management is it Worth It?" *Technical Information Service, The Chartered Institute of Building ASCOT*. 93. 1-5, 1998
- [8] Abdul-Rahman, H. and Alidrisyi, M. N. "A Perspective of Material Management Practices in a Fast Developing Economy: the case of Malaysia." *Construction Management and Economics*. 12. 412-422, 1994
- [9] Wong, E. T. T. and Norman, G. "Economic evaluation of materials planning systems for construction." *Construction Management and Economics*. 15. 39-47, 1997
- [10] Lambert, D. M., Stock, J. R. and Ellram, L. M. "Fundamentals of Logistics Management." United States: McGraw Hill. 20, 96 (1998)
- [12] Ademeso, O.S. and Windapo, A. O. "Relationship between Material Management Approach and Scheduled Project Completion Time." In COBRA. "Conference The construction and building research of the Royal Institution of Chartered Surveyors." Dublin Institute of Technology, 2008
- [12] Pheng, L. S. and Chuan, C. J. "Just-in-time management in precast concrete construction: a survey of the readiness of main contractors in Singapore." *Integrated Manufacturing Systems*. 12. 416-429, 2001
- [13] Varghese, K. and O' Connor, J. T. "Routing large vehicles on industrial construction sites." *Journal of Construction Engineering and Management*. 121 (1). 1-12, 1995.
- [14] Gopalakrishnan, P. and Sundaresan, M. "Materials Management: an integrated approach." New Delhi: Prentice-Hall. 189, 240 (1977)
- [15] Prabhu, V. and Baker, M. "Materials Management." UK: McGraw-Hill, (1986)
- [16] Teo, M. M. M. and Loosemore, M. "A theory of waste behaviour in the construction industry." *Journal of Construction Management and Economics*. 19(7). 741-751, 2001
- [17] Formoso, C. T., ASCE, L. S. M. , De Cesare, C. and Isatto, E. L. "Materials waste in building industry: Main causes and prevention." *Journal of Construction Engineering and Management*. 128(4). 316-325, 2002
- [18] Datta, A. K. "Materials Management: Procedures, text and cases." Rev. Ed. New Delhi: Prentice-Hall. 6-7, 1992.
- [19] Navon, R. and Berkovich, O. "An automated model for materials management and control." *Journal of Construction Management and Economics*. 24 (6). 635-646, 2005
- [20] Kasim, N. B., Anumba, C. J. and Dainty, A. R. J. "Improving materials management practices on fast-track construction projects." In: Khosrowshahi, F (Ed.), 21st Annual ARCOM Conference, 7-9 September 2005, SOAS, University of London. Association of Researchers in Construction Management, 2, 793-802, 2005.
- [21] Zakeri, M., Olomolaiye, P., Holt, G. D. and Harris, F. C. "A Survey of constraints on Iranian construction operatives' productivity." *Journal of Construction Management and Economics*. 14. 417-426, 1996.
- [22] Jaselskis, E. J., Anderson, M. R, Jähren, C. T., Rorriguez, Y. and Njos, S. "Radio-Frequency Identification Applications in Construction Industry." *Journal of Construction Engineering and Management*, 121 (2) 189-196, 1995
- [23] Andel, T. "Automatic Data Identification: For your own good." *Transportation and Distribution*. 34 (10). 76-88, 1993
- [24] Ahuja V., Yang J., Shankar R. "Study of ICT adoption for building project management in Indian Construction Industry". *Automation in Construction*. 1-9, 2008
- [25] Ang, P. "Implementation of ICT in Materials Management in Construction Projects". Degree Thesis, University Tun Hussein Onn Malaysia, January 2009
- [26] The Star Publications. "Construction Companies Urged To Adopt ICT". *Business*. 20 August, 2009