EFFECTS OF MOBILE COMPUTING ENABLED LABORATORY INFORMATION SYSTEM ON PERCEIVED PERFORMANCE OF GEOTECHNICAL FIELD WORKERS

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To my beloved Parents

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ABSTRACT

Increasing demand of earthworks like reservoirs, tunnels and both offshore and onshore structures has forced geotechnical laboratories to increase their productivity and performance at organizational as well as individual level. In this modern era of digitization and mobility, mobile computing technologies (MCT) have grown to a juncture where these can facilitate in revamping organizational mobile work processes. Though geotechnical work involves substantial amount of mobile work processes like sample collection from the field, execution of in-situ tests and exchange of information for real time mobile tasks, but the potential of mobile computing technologies has not been effectively exploited predominantly due to lack of availability of customized integrated mobile information system. To fill this gap, this study investigated the requirements of tasks and respective functionalities provided by MCT. Based primarily on the theory of task-technology fit (TTF), a perceived performance conceptual model was developed. This model was aimed at finding the effect of mobile computing on performance of field workers through first establishing a fit between geotechnical tasks and MCT. To statistically test and validate this conceptual model, quantitative research methodology was adopted by employing survey questionnaire as a research instrument for data collection and using Partial Least Squares Structured Equation Modeling (PLS-SEM) for analysis of data. Based on analysis of results, all identified mobile work support functions were found useful for interdependent and time critical tasks while mobile data processing feature was only found effective for location sensitive tasks. Secondly, it was also empirically supported that once fit between task requirements and technology features is found effective; it creates substantial influence on the perceived performance of geotechnical mobile workers.

ABSTRAK

Peningkatan permintaan kerja-kerja tanah seperti takungan, terowong dan kedua-dua struktur luar pesisir dan daratan telah memaksa makmal geoteknik untuk meningkatkan produktiviti dan prestasi mereka di organisasi dan tahap individu. Dalam era moden digital dan mobiliti, teknologi pengkomputeran mudah alih (MCT) telah berkembang ke peringkat di mana ia boleh membantu staf menyusun semula proses kerja mudah alih organisasi. Walaupun kerja-kerja geoteknik melibatkan sejumlah besar proses kerja mudah alih seperti pengumpulan sampel dari lapangan, pelaksanaan ujian in-situ dan pertukaran maklumat untuk tugas-tugas mudah alih masa sebenar, tetapi potensi teknologi pengkomputeran mudah alih tidak tidak diambilkira secara optima kerana kekurangan sistem maklumat mudah alih bersepadu. Untuk mengisi jurang ini, kajian ini menyiasat keperluan tugasdan fungsi yang disediakan oleh MCT. Berdasarkan kepada teori tugas-teknologi patut (TTF), sebuah model konsep prestasi tanggapan telah dibangunkan. Model ini bertujuan untuk mencari kesesuaian dan kesan pengkomputeran mudah alih pada prestasi pekerja lapangan berdasarkan tugas-tugas geoteknikal dan MCT. Untuk mengesahkan model konsep ini, ujian statistik dan kaedah penyelidikan kuantitatif telah diterima pakai dengan menggunakan soal selidik sebagai instrumen kajian untuk pengumpulan data dan menggunakan kuasa dua terkecil separa berstruktur Persamaan Model (PLS-SEM) untuk analisis data. Berdasarkan analisis keputusan, semua fungsi sokongan kerja mudah alih dikenalpasti berguna untuk tugas-tugas yang kritikal melibatkan saling kebergantungan dan masa; manakala ciri pemprosesan data mudah alih hanya didapati berkesan untuk tugas-tugas sensitif lokasi. Kedua, ia juga secara empirik disokong bahawa apabila keperluan tugasan dan ciri-ciri teknologi yang didapati adalah berkesan, ia mewujudkan pengaruh yang besar ke atas prestasi tanggapan pekerja mudah alih geoteknikal.

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LIST OF ABREVIATIONS

CBR	----	California Bearing Ratio
GPS	----	Geographic Positioning System
IS	----	Information System
IT	----	Information Technology
LIMS	----	Laboratory Information Management System
MCT	----	Mobile Computing Technology
MLIMS	----	Mobile Computing enabled Laboratory Information Management System
MWSF	----	Mobile Work Support Function
PLS-SEM	----	Partial Least Square- Structured Equation Modeling
SCPT	----	Seismic Cone Penetration Test
TAM	----	Technology Acceptance Model
TTF	----	Task Technology Fit
UCS	----	Uniaxial Compressive Strength

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CHAPTER 1

INTRODUCTION

Geotechnical engineering examines the behavior of earth materials. Its application areas include civil engineering, military, mining, petroleum and other fields related with on surface construction as well underground exploration. In recent years, it has been witnessed a trend of rapid pace of earthworks like reservoirs, offshore structures, tunnels, deposition of hazardous waste, oil platforms and onshore structures, etc. This in effect is creating pressure on geotechnical laboratories to revamp their business processes especially with the usage of cutting edge technologies.

1.1 Problem Background

For industries involving large amount of field work, Information technology (IT) acts as a conduit for dispersed information as well as human resources (Loudon, 2000). It is believed that use of IT has the potential to make significant contribution in providing effective interaction between stakeholders, minimizing cost, increasing productivity and performance and thus creating a competitive edge for an organization (Petiz, Ramos, & Roseiro, 2007).

Geotechnics business processes comprises of numerous stages during which vast variety of information is fetched and dispatched between physically dispersed people and business units. A complete geotechnical investigation and

analysis consists of an adequate program of field sampling, laboratory testing, and engineering analysis and evaluation, with the results presented in report form. Major activities involved in a typical geotechnical project are conducting field investigations, geologic surveying and mapping, preparation of preliminary boring log using the field results, conducting the subsurface investigation, performing in-situ tests, coordinating with all stakeholders and determining and conducting laboratory tests for the collected samples. Estimated duration and cost of each activity varies based on the level of complexity, constraints and assigned resources.

These wide varieties of tasks require swift acquisition of accurate data and coordinated exchange of information and resources. This resultantly necessitates use of IT (Medved, Medak, & Pribicevic, 2009). Examples of different IT applications for geotechnical professionals include Geographic Information System, Electronic Document Management System, Digital description of borehole logs, Geotechnical Modeling, Laboratory Information Management System and E-Work Orders and Digital Analysis of Seismic Cone Penetration Test (SCPT) data (Cheung 2007; Jaksa et al. 2009; Yoo 2013).

With mobile devices increasingly becoming powerful capable to perform all sorts of tasks for which traditionally computers used to be relied upon, so called handheld devices like smartphones and tablets etc. are pushing the boundaries of capacity. Therefore, for businesses involving substantial field work, this paradigm shift has introduced field-based computing perspective, which is particularly more compelling now because of the introduction of more reliable and economical mobile computing technology. Mobile solutions developed for field technicians and inspectors can replace paper-based site information gathering required for geotechnical investigations with an innovative and easy to use electronic data acquisition and logging mechanism (Yoo, 2013). Existing mobile technologies employed in geotechnical industry include Rugged Mobile Devices, mobile mapping system and other general purpose mobile applications like Geographic Positioning System (GPS) etc.

For field service organizations, mobile computing has the potential to decrease data entry workload by 85%. This saving in time can further be coupled with fewer data integrity issues. Other worth mentioning benefits of MCT are improved managerial effectiveness, increased operational efficiency and real time information access and task dispatching (Goswami, 2013).

However, despite all the benefits of MCT for geotechnical work processes, productivity improvements have remained nominal. This implies that mere technological advancements and their innovative features are not sufficient to bolster the acceptance of new system and its impact on performance of its users (Berghaus & Back, 2014). Stieglitz, Lattemann, & Brockmann (2015), in their research, have also found that as field workers do not form a coherent group therefore they require a customized system for their work support. To fill this gap of mismatch between task requirements of field workers and technology features, this research aims to find the potential fit between task requirements of geotechnical workers and core features of MCT. Impact of this fit is consequently examined on performance of geotechnical field workers.

1.2 Research Question

This research study will examine the impact of mobile computing enabled laboratory information system on the perceived performance of geotechnical field workers via first analyzing the fit between tasks and technology characteristics. Thus the main research question is formulated as

"How mobile computing enabled laboratory information system affects geotechnical field workers' perceived performance"

To address the above stated research question, this study will investigate following research questions:

i. What are the field worker's task characteristics and major mobile support functions of mobile computing technologies in the context of geotechnical work processes.

ii. What is the conceptual perceived performance model for geotechnical field workers?

iii. How statistically valid is the conceptual perceived performance model.

1.3 Research Objectives

This study aims to achieve the following objectives

i. To conduct a literature review on field worker's task characteristics and major mobile support functions of mobile computing technologies in the context of geotechnical work processes.

ii. To develop a conceptual perceived performance model for geotechnical field workers.

iii. To statistically test and validate the conceptual perceived performance model.

1.4 Scope of the Study

The scope of this dissertation was limited in many ways. First, survey based research investigating the impact of the fit of mobile work support functions and geotechnical field workers tasks on perceived performance of geotechnical field workers and intention to use mobile work support functions was conducted in geotechnical testing laboratories working in Johor, Kuala Lumpur and Selangor as in Malaysia these regions are witnessing an increased trend of all types of construction on soft ground and hill sites mainly because of depleting competent

land in these areas (Yean-Chin & Chee-Meng, 2009). Second, this research study concentrated on geotechnical laboratories' field staff working as field supervisors as well as professionals whose jobs are related to working in field either for collecting samples pertaining to soil investigation, site assessment and foundation designs from the field and shipping it to a laboratory for tests or doing in-situ tests i.e. at site testing after collecting samples.

1.5 Justification for this research

This research augments in the knowledge pool of IS theory and model in two fold.

i. This research builds a generic framework to gauge the impact of the perceived usefulness of mobile computing enabled Laboratory Information Management System (LIMS) in a geotechnical testing laboratory on the performance of field workers.

ii. Secondly, it addresses many future research questions voiced by different IS researchers e. g. Gebauer et al. (2010) and Zhang et. al. (2011) had urge for conducting a large-scale empirical research to test of the Task Technology Fit model for assessment of the performance impact of mobile technologies at the operational level, while Ahearne et al. (2008) in his research recommended extending Task Technology Fit (TTF) model with contextual constructs. Ladd et al. (2010) has identified need for investigation of impact and transformation ignited by mobile computing technologies on field workers of organizations. Similarly Fischer & Smolnik (2013) has pushed for shift of research focus from application development to gauging the potential impact of MCT on individuals and organization level.

1.6 Importance and contributions of this study

The outcomes of this research will add both theoretical IS knowledge as well as it will help practitioners to use the findings and outcomes of this study as a guideline for development, implementation, selling or purchasing a system for identical settings.

1.7 IS Theories Underpinning This Research Study

As this research is primarily related to adoption/acceptance of technology along with its impact on performance, therefore nucleus of this dissertation is different IS theoretical frameworks upon which proposed research model is built. This research study uses Task Technology Fit (TTF) model as the core model while considering the problem statement some construct have been selected from the Technology Acceptance Model (TAM). Details about these ground setting models are explained in great detail in the second chapter.

1.8 Chapter Summary

An overview of the dissertation has been presented in this introductory chapter. In the beginning, background of the problem domain, mobile computing and relevant IS research is briefly described. On those bases, research question and research objectives have been stated along with justification and research significance.

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