DEVELOPING A SOFTWARE APPLICATION FOR BUILDING MAINTENANCE REPORTING SYSTEM IN MALAYSIA PUBLIC UNIVERSITY

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DEDICATION

This thesis is dedicated to my parents, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task could be accomplished if it is done one step at a time.

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ABSTRACT

Building maintenance is a complex operation that requires the right skills, experience and technology to manage a building premise. Technology utilisation, such as mobile technology is very important for accurate information to be accessed by the right person in charge at the right time and place. Thus, this study aims to establish an information delivery system of context-awareness applications for building maintenance of public universities in Malaysia based on user requirement and maintenance workflow. A total of eighteen public universities were chosen in the process of reviewing the development and current practice of building maintenance. Next, the current tools and technologies for building maintenance were examined and based on this information, the requirements of building maintenance in relation to context-aware information were identified. The identification was made by comparing several workflows from government agencies, universities and published journals to obtain common elements for establishing a standard building maintenance report for context- awareness. The validation of the establishment standard was done by employing semi- structured interviews with user-centred design method that emphasised user requirement and its context elements. To ease the validation process, a prototype of mobile technology for building maintenance reporting system known as i- Maintenance was developed. It was found that there were six common stages for establishing the standard building maintenance report and the concept of "on-the-go Maintenance" was well accepted with 80% respondents agreed, 80% respondents agreed that context-aware technology had potential value and contained extra features, whereas 85% respondents agreed on the workability and user friendliness of i-Maintenance. The weakness of building maintenance reporting system that engaged with the context-aware technology was the unstable cellular phone signals. However, what was interesting about this technology was that specific information would be delivered individually to the specific person in charge. Finally, it can be concluded that the concept of supplying specific information and services to the building maintenance manager has become technically and financially feasible because of the capability of integrating mobile devices, context-awareness, data, voice and positioning technologies.

ABSTRAK

Penyelenggaraan bangunan adalah operasi kompleks yang memerlukan kemahiran, pengalaman dan teknologi yang tepat untuk mengurus premis bangunan. Penggunaan teknologi, seperti teknologi mudah alih adalah sangat penting supaya maklumat yang tepat dapat diakses oleh individu yang bertanggung jawab pada waktu dan tempat yang diperlukan. Oleh itu, kajian ini bertujuan untuk mewujudkan sistem penyampaian maklumat aplikasi menggunakan *context- aware* untuk penyelenggaraan bangunan universiti awam, di Malaysia berdasarkan keperluan pengguna dan carta kerja penyelenggaraan. Sebanyak lapan belas universiti awam telah terlibat dalam proses kajian pembangunan dan amalan semasa penyelenggaraan bangunan. Kemudian, alat dan teknologi terkini untuk penyelenggaraan bangunan ditentukan berdasarkan maklumat kajian tersebut. Keperluan penyelenggaraan bangunan berkaitan dengan maklumat yang sesuai dengan *context-aware* juga dikenal pasti. Pengenalpastian dibuat dengan membandingkan beberapa carta kerja dari agensi kerajaan, universiti dan jurnal yang diterbitkan untuk mendapatkan elemen umum bagi membangunkan laporan penyelenggaraan bangunan piawai bagi *context-aware*. Pengesahan piawai dilakukan secara temu ramah separa berstruktur dengan kaedah reka bentuk berpusatkan pengguna yang menekankan keperluan pengguna dan elemen *context-aware*. Untuk memudahkan proses pengesahan, prototaip teknologi mudah alih untuk sistem pelaporan penyelenggaraan bangunan yang dikenali sebagai *i-Maintenance* telah dibangunkan. Didapati enam peringkat umum untuk membuat laporan penyelenggaraan bangunan piawai dan konsep *"on-the-go Maintenance"* telah diterima dengan baik dengan 80% responden bersetuju bahawa teknologi yang *context-aware* mempunyai nilai potensi dan mengandungi ciri-ciri tambahan, sementara 85% responden bersetuju dengan fungsi dan persekitaran mesra pengguna *i-Maintenance*. Konsep penyediaan maklumat dan perkhidmatan khusus kepada pengurus penyelenggaraan bangunan telah didapati berdaya maju dari sudut teknikal dan kewangan kerana kemampuan mengintegrasikan peranti mudah alih, *context-aware*, data, suara dan teknologi penentuan lokasi. Akhir sekali, segala kelebihan ini menjadi peranan penting untuk memajukan sistem maklumat berkaitan pengurusan penyelenggaraan bangunan dan ianya juga boleh digunakan bagi mana-mana cabang dalam industri pembinaan.

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LIST OF ABBREVIATIONS

3D	-	Three Dimension
4D	-	Four Dimension
AI	-	Artificial Intelligence
BAS	-	Building Automation System
BEAM V2	-	Bersih Elektrikal Awam Mekanikal Versi 2
BEM	-	Board of Engineers Malaysia
BERNAMA	-	Pertubuhan Berita Nasional Malaysia
BIM	-	Building Information Modelling
BS EN	-	British Standard European Norm
BSFB	-	Bahagian Senggara Fasiliti Bangunan
BSI	-	British Standards Institution
CAD	-	Computer Aided Design
CAFM	-	Computer Aided Facility Management
CIDB	-	Construction Industry Development Board
CMMS	-	Computerised Maintenance Management System
COBOL	-	Common Business Oriented Language
CSL	-	Computer Science Laboratories
Custcare	-	Customer Care
DRN	-	Dasar Perumahan Negara
eFACT	-	Electronic Complaints and Feedback System
EMMUS	-	European Multi Media Usibility Services
EPKP	-	Elektronik Permohonan Khidmat Pembangunan
FMO	-	Facility Management Office

GLC	-	Government Linked Company
GPS	-	Global Positioning System
HCI	-	Human Computer Interaction
I/O	-	Input Output
ID	-	Identity Document
IRTMM	-	The Intelligent RealTime Maintenance Management
IT	-	Information Technology
JKR	-	Jabatan Kerja Raya
JPAK	-	Jawatankuasa Pengurusan Aset Kerajaan
KBSMEDIA	-	Knowledge Based System Media
KPI	-	Key Performance Indicator
MAFM	-	Malaysian Association of Facilities Managers
MAINCAST	-	Maintenance Forecasting
MAS	-	Malaysia Airline
MATLAB	-	Matrix Laboratory
MOE	-	Ministry of Education
MSQL	-	Mini Structured Query Language
NAFAM	-	National Asset & Facility Management Convention
NAPIC	-	National Property Information Centre
PDA	-	Personal Digital Assistant
PHP	-	Hypertext Preprocessor
PPM	-	Planned Preventative Maintenance
PWD	-	Public Work Department
RAD	-	Rapid Application Development
RDBMS	-	Relational Database Management System

RFID	-	Radio Frequency Identification
RISM	-	The Royal Institution of Surveyors Malaysia
SDLC	-	Software Development Life Cycle
SEGAK	-	Sistem Senggara Asset Kerajaan
SERFIN	-	Translated into English Maintenance Experience Communication on Internet
SIRIM	-	Standard and Industrial Research Institute of Malaysia
SPACE	-	Simultaneous Prototyping for an Integrated Construction Environment
SPATA	-	Sistem Pengurusan Aset Tidak Alih
SQL	-	Structured Query Language
TAM	-	Total Asset Management
TMA System	-	The Maintenance Authority System
TNB	-	Tenaga Nasional Berhad
TP1M	-	Tabung Perumahan Satu Malaysia
TPPM	-	Tabung Penyelenggaraan Perumahan Malaysia
UCD	-	User Centered Design
UiTM	-	Universiti Teknologi Mara
UKM	-	Universiti Kebangsaan Malaysia
UM	-	University Malaya
UMS	-	Universiti Malaysia Sabah
UNITEN	-	Universiti Tenaga Nasional
UPM	-	Universiti Putra Malaysia
UPSI	-	University Pendidikan Sultan Idris
USD	-	United States Dollar
VRML	-	Virtual Reality Modeling Language

Xerox PARC - Xerox Palo Alto Research Center

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Investment in building maintenance was vast worldwide, contributing nearly 50% of the total revolution of the construction industry (Lateef, 2009). The construction sector in Malaysia accounted for a gross output value of RM 204.4 billion in 2017, compared to RM 177.9 billion in 2015, with a yearly growth rate of 7.2% annually (Hauashdh et al., 2020). Malaysia is a prosperous country that is thriving in all kinds of property investments, the total residential properties of current stock as far as the third quarter of 2019 were found about 5,692,646 units (National Property Information Centre, 2019). Overall, the number of buildings in Malaysia was huge and ascended in both the private and public sectors (Lateef et al., 2010). As reported by the National Property Information Centre (NAPIC) in 2019, the performance of Malaysian market property had registered at the modest enhancement in 2019 which about 328,647 transactions worth RM141.40 billion were documented, interpreting an increment of 4.8% in figure and 0.8% in value in as compared to 2018. Most of the sub-sectors observed growth in activity, for examples, residential property market (6.0%), commercial property market (7.2%), Industrial property market (3.8%) and Agriculture (2.0%). The growth of such activities incurred in management issue as poor building maintenance practices was still common in Malaysia, and buildings were not maintained efficiently in the public orprivate sector due to several issues such as knowledge, skill of workers and application methods (just to name a few).

Knowledge on the significance of appropriate building maintenance and management system became the fundamental supporting factor to the facilities of facility management in Malaysia (Syed Mustapa et al., 2008). The decision for building maintenance requires various types of knowledge created by different members of construction teams, such as maintenance records, work orders, causes, and knock-on effects

of failures. The facility department usually handles maintenance records involving various fields such as architecture, surveyor, engineer, and administrative personnel that deem proper fundamental management team.

There were five fundamental management problems in administrating Malaysian state-owned properties, which were the lack of appropriate unit or department in charge of the property within a ministry, shortage of expertise, insufficient proper strategies, inadequacy in proper management procedures and insufficient usage of IT (Abdullah et al., 2011; Khalid et al., 2019). These problems affected everyone by increasing the health and safety risks, reducing economic competitiveness, ineffective maintenance strategies, reduced value of the nation's built assets, and urgency to enhance funding in maintaining the built environment. In most situations, this thorough inefficacy will eventually generate demands for "contemporary" buildings and engineering works, even when appropriate facilities managed by the asset manager.

Asset managers were the individuals in charge of handling the important maintenance, repair, and renewal works. It was their duty to improve the expenses and enlarge the value of the properties over their life cycle. Moreover, asset managers had to make numerous complicated decisions concerning the repairing works of their current building properties economically, using a few devices, as examples, the literature or smart computer software, to aid them in making decisions (Hooper et al., 2009; Love & Matthews, 2019). Integrating computer technology with facilities information could enhance the asset manager performance.

Integrated information system generated room for implementing mobile information and service conveyance for construction management (Boddy et al., 2007; Chu et al., 2018) and building maintenance (Cha et al., 2018). Instead of integrated information, decision-makers also required a detailed and updated view of their project information as a part of their business planning (Rajegopal et al., 2007). Indeed, communication and visibility were the crucial aspects for a successful administration process, thus allowing the business to sustain a constant perspective of the issues throughout the length and breadth of the organisation.

The growth and advanced development of mobile communications recently has changed the way people and organisations communicated and interacted. It had revolutionised the built environment by adjusting to how the information was transmitted and perceived (Löfgren, 2007; Park et al., 2016; Šuman & Pšunder, 2008). The advancements in mobile communication technologies, including wireless technology (Aziz et al., 2006; Ferrada et al., 2014; Kim et al., 2008; Skibniewski & Jang, 2006) and global positioning system (GPS) technology (Andoh et al., 2012; Lu et al., 2007). have brought a great impact towards the construction industry. Besides, these applied sciences have also enhanced the acceleration of information progress and collaboration (Demian &Walters, 2014; Kirisci et al., 2004), increased the efficacy and usefulness of the information and communication technology (ICT) (Leung et al., 2008; Vähä et al., 2013) and reduced the cost of information transfer. The ICT was also a fundamental element of building maintenance which abled to enhance the efficiency, effectiveness and accountability of the people who managed buildings (Talamo & Bonanomi, 2015). The use of ICT in building maintenance could help prolong the lifespan of the building by providing the proper and advanced maintenance approaches.

1.2 Problem Statement

Malaysia is proud of its ability to provide world-class infrastructure, but it falls short when it comes to building maintenance. Defects and damage in new buildings, commercial buildings, and infrastructure, particularly those developed by the government, are frequent problems arising in building maintenance management (Nawi et al., 2017). It can be seen in various statements appearing in research papers which indicated that the country is facing problems in managing its property assets and facilities, especially relating to building defects, maintenance, abandoned projects, lack of expertise, inappropriate work culture, and a below-par quality system among others (Hashim et al., 2015; Hong, 2008; Isa et al., 2016; Suffian, 2013; Zainol et al., 2014).

Since building maintenance is a fundamental practice in facility management that supported the longevity of a building, the increasing costs of maintenance practices is a challenge for the facility management professionals as building maintenance decisions often comprised complex and conflicting criteria. (Besiktepe et al., 2020). Where as, building maintenance and repair was listed among the most typical functions of facilities management activities (Alexander, 2013; Booty, 2009; Falorca et al., 2014; Langston & Lauge-Kristensen, 2013; Raposo et al., 2011) and it needs the involvement and contributions from the researchers in order to respond to the current situation (Alexander, 2013; Falorca et al., 2014). Globally, the financing investment of building maintenance was enormous as it represented almost 50% of the overall turnover of the construction (Lateef et al., 2010). In the Malaysia scenario, the allocation sum for upgrading, renovating and maintaining various facilities were increasing as stated under the Tenth Malaysia Plan (2011 – 2015) in which the government had allocated the sum of USD120m, which then increased greatly in the Eleventh Malaysia Plan (2016-2020) to USD963 mil (Shah Ali, 2009) which include ICT technology in building maintenance towards the development of smart cities.

Undoubtedly, ICT can provide organisations with powerful strategic and tactical tools that, if properly applied and used, can help them promote and strengthen their competitiveness (Aziz et al., 2016). ICT enables the firm to better manage their business processes through new and improved business models and increase their supply chain and outreach activities interaction (Shelbourn et al., 2012). Therefore, the demand for improved workplace quality of life (QOL) had prompted ICT Programmers to create a variety of software/tools in Facilities Management (FM) (Aziz et al., 2016).

The application of ICT in facilities management is necessary compared to the conventional method in supporting the maintenance practices in building permises that include public universities. The important aspects that need to be improved are; the facility assessment, diagnosis, and decision-making processes. The continuous development of current ICT-based system resources is part of the basis for forming an effective framework, which will then be used to support the improvement in maintenance management practices (Ismail, 2018). In general, the ICT could help

optimise and innovate the current FM processes, models, and services.

Many stakeholders in maintenance management practice had gained benefit from using ICT in carrying their work such as engineers, technical staff, administrators, and policy makers, which helps make an informed decision specifically on the maintenance, repair, and renewal of an asset. Informed decisions depend on reliable data, solid engineering principle and acknowledged economic values. If reliable data and efficient decision-supporting tools should be employed, the rate of maintaining, repairing andrestoration could be lowered, and the services would be well-timed, with fewerinterruptions. These enhancements will potentially lower the cost by increasing the efficiency and effectiveness of administrating assets and infrastructures.

Therefore, this study aims to establish an information delivery system of context-aware applications for building maintenance in Malaysia. This was done by investigating the challenges and understanding user requirements, maintenance workflow, and relevant frameworks amongst the maintenance managers in managing the assets and infrastructure. Accordingly, eighteen public universities were selected as sample cases for data collection purposes, including two phases of data collection. It started with investigating user requirements through semi-structured interview and document review, followed by system development methodology. It is crucial to collect the field data, which would help develop an appropriate software application that could perfectly accommodate the user needs. The following section will discuss the research significance pertaining to this study.

1.3 Significance of the Research

The extensive utilisation of smartphones in work, mobile learning and emergency services had envisioned an expanding market for new applications (Grant & Barbour, 2013; Murata et al., 2019; Thurnher et al., 2006). It was well-understood that utilising mobile information and communication technologies (ICT) was crucial

in administrating projects as the right information needed to be conveyed to the correct individual at the precise time and at a specific place (Bowden et al., 2006; Ismail, 2018).

Mobile ICT, through its applications, could be customised to users' demands if they were context-aware (using technology that can ascertain the users' real goals by estimating any relevant additional information provided for the purpose). Context-awareness was aimed to utilise the information in the customs context by complying with the style of the devices that corresponded to any situations in a suitable medium (Dey & Abowd, 2000; Masango et al., 2016).

Thus, changes in the distinctive forms of context-aware information will lead to various operations introduced by the applications, as if an individual would react to similar signs. It has been suggested as a possible phase in the future of technological enhancement as it offered a lot of potentials (such as in intelligent environments, flexible user interfaces and more adaptable use of devices) (Häkkilä, 2008) by considering the specific natures of mobile devices, in which they will set up an appropriate platform of context-aware application enhancement.

This study was steered by the requirement to analyse the relevance of context-aware mobile technologies for building maintenance management. This study focused on a contemporary communication model for building managers by providing relevant information at a particular time in a distinguished place through mobile devices. The transfer of context-specific information and services to the building managers might increase their governance capabilities by supplying personalised information and services according to their current context. It is often argued that providing personalised information to the managers will help them make an informed decision and prevent an information overload (Roetzel, 2019); thus increasing the effectiveness and efficiency in their decision-making and service delivery.

1.4 Research Aim

To establish an information delivery system of context-aware applications for building maintenance in Malaysia based on user requirement and maintenance workflow.

1.5 Research Questions

The following research questions which related to the research have been identified as follows:

1) What is the current state of building maintenance in Malaysian public universities?

2) What are the current tools available for building maintenance work in Malaysian public universities?

3) What are the requirements of professional parties in developing the tools for maintaining buildings?

4) What are the user requirements for effective building maintenance practicesin Malaysia?

5) How can the current mobile technologies enhance the information delivery related to building maintenance in Malaysia?

1.6 Research Objectives

The objectives of the research are:

1) To review the development and current practice of building maintenance

in Malaysian higher education facilities.

2) To determine the current tools and technologies for building maintenance practices.

3) To identify the requirements of building maintenance in relation to context-aware information delivery system.

4) To develop functional specifications of a context-aware information services delivery system for building maintenance.

5) To develop a proof-of-concept prototype system according to the developed specification using a combination of ICT tools.

The research programme and methodological approach for this study will be discussed in the next section.

1.7 Research Programme

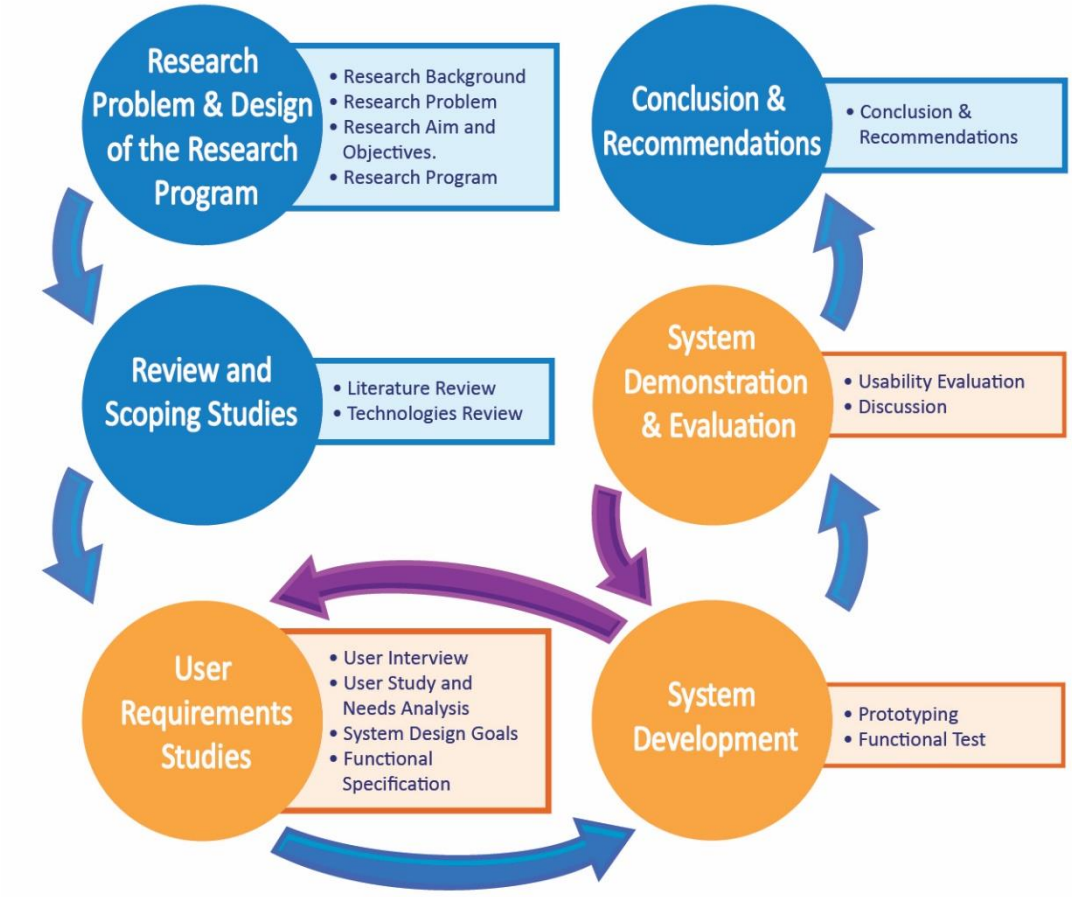

Figure 1.1 Outline of the Research Programme and Methodological Approach.

The outline of the research programme and methods presented in Figure 1.1 summerised the main activities undertaken, represented in a graphical model. The study was categorised into six stages, which were generated repetitively with a number of feedback loops (represented by arrows in Figure 1.1). Those phases were (a) research problem and design; (b) review and scoping studies; (c) user requirements study; (d) system development; (e) system demonstration and evaluation; and (f) conclusions and recommendations.

In the first phase, numerous works of literature had been reviewed to recognise the field of work to be considered. This revision involved the field of building maintenance management, building maintenance technology, information technology

and context-aware computing. It was a basic phase in narrowing down the scopes and aims of the study. An analytical outline was then initiated, consisting of the objectives, unit of analysis and designs of applicable data-gathering methodologies, accompanied by a research programme. The research programme was formulated upon identifying the principal focus of the study, objectives, methods used to attain the objectives and estimating the length of each task and activity.

The second phase involved reviewing and scoping the research studies. The literature review, technologies, research methods, and introductory semi- structured interviews were carried out to enhance the researcher's understanding of the field of study and explain some notable challenges in building maintenance management, information systems, research techniques, and facilitating technologies of context-aware computing. It had increased the awareness of the research challenges and approaches, which in sequence, developed the urgency of being more particular in the literature review with an in-depth observation on the fieldof building maintenance management, building maintenance's software, mobile information systems and analytical research method approaches (nested research approach).

In the third phase, the user requirements were studied by conducting interviews among 18 maintenance managers in the public universities to gather specific information about the requirements and users' demands. The information obtained using the semi-structured interviews was analysed and applied accordingly in the formation of the system design and a theoretical prototype, leading to the establishment of the functional specifications. Later in the next phase, the architectural system and prototype were established, and their functions were then evaluated.

The prototype was interactively presented and assessed by the maintenance manager of all the universities in the fifth phase. The functions and practicality of the prototypes were evaluated and the data gathered through the evaluations will be analysed and explained. Built upon the observation, the model was then improved. Consequently,the last phase epitomised and wrapped up the conclusions of the study. Depended upon those conclusions, recommendations for future research were made. The next section will give a brief outline of this thesis.

1.8 Thesis Outline

This thesis documented the works undertook in the research project and divided them into eight chapters. The content of each chapter can be summarised as follows:

Chapter 1: Introduction

Firstly, Chapter 1 will introduce the research project by providing a general background to the research. It was followed by pointing out the problem statement and significance of the research. Next, the aim, research question, and research objectives were stated. This chapter also provides a diagram of the research programme and the methodological approach used in this study. Finally, it ended with highlighting the thesis outline.

Chapter 2: Literature Review

This chapter provides reviews and discussions on building maintenance. Firstly, as an introduction, it presented the definition of building maintenance, subsequently described the issues in building maintenance operation. Later, it provided some reviews of the building maintenance practice in Malaysia. Chapter 2 also discussed the current technology in supporting the building maintenance works. The chapter then provides discussions on the computerised maintenance management system, followed by the context-aware application system.

Chapter 3: Research Methodology

This chapter analysed, explained, and demonstrated the research principles, methods and techniques accessible to tackle the research problems. It was divided into two phases: the first phase concentrated on data collection to data analysis and content analysis, whilst in second phase, it discussed the system development and prototyping to usability evaluation.

Chapter 4: Data Analysis

The data analysis of this study will be presented in this chapter. It will start with developing the building maintenance workflow, followed by analysis of the maintenance activities practised in Malaysian universities. The user requirement study as a major part of this thesis was also being discussed in chapter 4.

Chapter 5: System Development

The system developed in chapter 5 began with explaining the supporting tools such as the server, language, programming, and kit. It was followed by analysing the user requirements according to the maintenance workflow and developing the user requirement to suit into the system. The final stage of chapter 5 was developing the interface between the screen layout based on the maintenance workflow, user, and user requirements.

Chapter 6: Proof of Concept Demonstration and Evaluation

Chapter 6 involves the demonstration and evaluation of the prototype. Towards the end, it will list down the comments and suggestions obtained from the practitioners. This chapter also discussed the building maintenance practice, technologies involved (especially on the computerised maintenance management system and context-aware), and the prototype development.

Chapter 7: Conclusion and Recommendation

This final chapter starts with discussing the synthesis of the research. It will briefly explain the finding of each objective. There will also be some write-ups provided onthe limitation and conclusion of the research. Chapter 7 ends with the contribution of the research, recommendation and concluding remarks.

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Appendix A Interview Form

UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Soal selidik berkaitan : *Context-Specific Information Delivery for Building Maintenance of Public Institution of Higher Education in Malaysia*

Objektif-objektif soal selidik:
1- Untuk melihat pekembangan dan praktis kerja-kerja penyenggaraan bangunan di Malaysia ;
2- Untuk mengenalpasti perkakasan dan teknologi yang di gunakan dalam praktis penyelenggaraan bangunan;
3- Untuk menilai keperluan-keperluan dalam kerja-kerja penyelenggaraan bangunan yang berhubung kait dengan perlaksanaan perkhidmatan dan system maklumat berdasarkan *context-aware*.

Tatacara soalselidik:
Soalselidik ini terbahagi kepada 2 bahagian:

Bahagian 1: memerlukan responden memberikan maklumat peribadi.
Bahagian 2: memerlukan responden memberikan maklumat tentang Unit / Jabatan Penyelenggaraan.
Bahagian 3: memerlukan responden memberikan maklumat lanjut berhubung penggunaan teknologi maklumat dan komunikasi *(information technology and communication (ICT))* di Unit / Jabatan Penyelenggaraan.
Bahagian 4:memerlukan responden mamberikan pendapat tentang penyampaian maklumat secara *context specific* untuk kerja-kerja penyelenggaraan bangunan.

Semua maklum balas adalah SULIT dan di dalam laporan nanti tidak akan menyatakan identiti pemberi maklumat. Kami sangat menghargai sumbangan yang telah tuan / puan berikan bagi menjawab soalselidik ini. Sumbangan dan kemahiran tuan / puan adalah sangat penting dalam menjayakan kajian ini. Sekian terima kasih.

Pelajar PhD:
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Penyelia:
1. Dr Mohamad Syazli bin Fathi
2. Dr Siti Uzairiah Tobi

Bahagian 1

1.0 Latarbelakang Responden.

1.1 Jawatan Sekarang
[ ] JUSA [ ] J54 [ ] J52 [ ] J48 [ ] J44 [ ] J41
Lain-lain (Sila nyatakan) _____

1.2 Disiplin
[ ] Arkitek [ ] Jurutera Elektrik [ ] Jurutera Mekanikal
[ ] Juru Ukur Bahan [ ] Jurutera Awam [ ] Juru Ukur Bangunan
[ ] Lain-lain (Sila nyatakan) _____

1.3 Nama Syarikat _____

1.4 Bahagian / Jabatan /Unit
[ ] Pembangunan [ ] Penyelenggaraan [ ] Pengurusan
[ ] Harta [ ] Cawangan [ ] Lain-lain (Sila nyatakan) _____

1.5 Kelayakan Professional
[ ]Jurutera Professional (Ir).
[ ] Juruukur Professional (Sr).
[ ] Arkitek Professional (Ar).
[ ] Lain-lain (Sila nyatakan) _____

1.6 Keahlian Pertubuhan / Persatuan
[ ] Royal Institute of Surveyor
[ ] Malaysia Association of Facility Managemet (MAFM)
[ ] Malaysian Asset and Project Management Association (MAPMA)
[ ] Lain-lain (Sila Nyatakan) _____

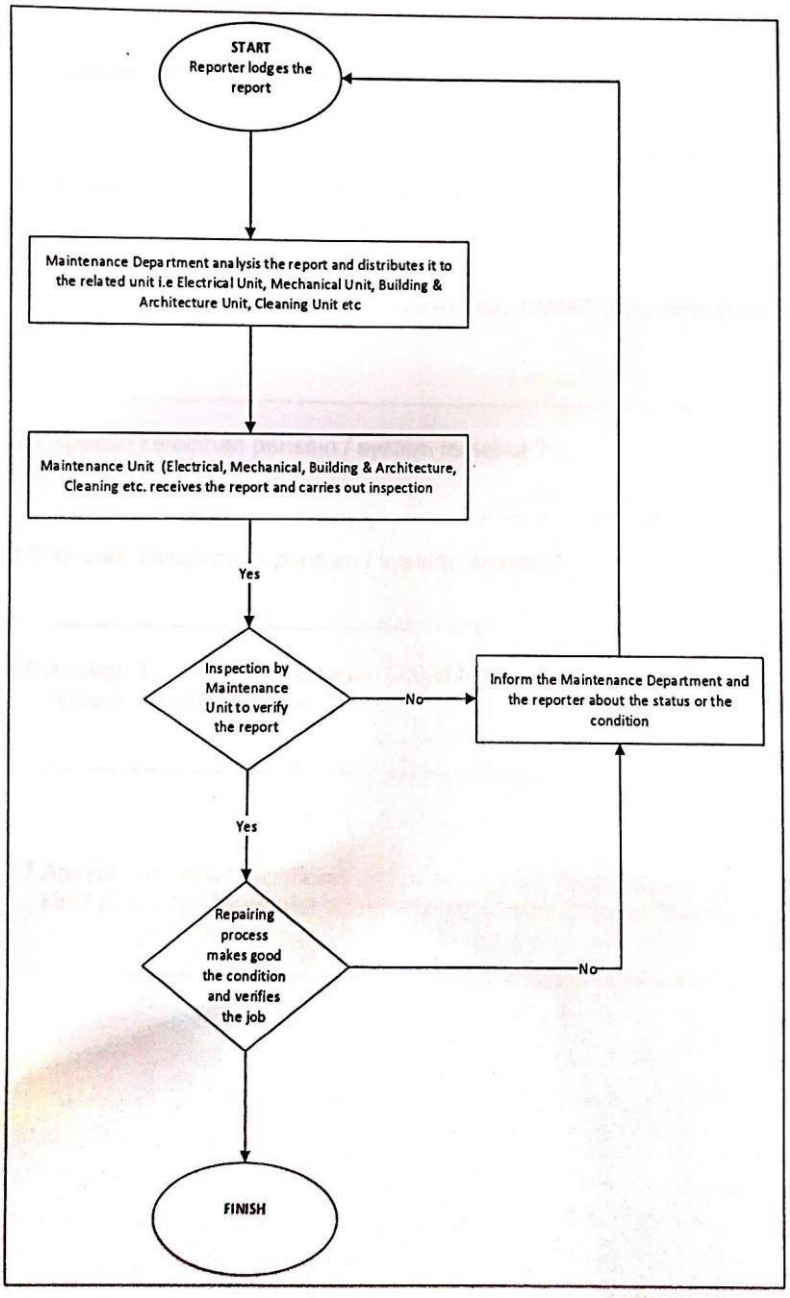
1.7 Isu-isu berkaitan praktis kerja-kerja pengurusan fasiliti (Tanda mana yang berkaitan)
[ ] Kerenah pelanggan
[ ] Kerenah pihak tertinggi pengurusan
[ ] Masalah system
[ ] Masalah kontraktor
[ ] Lain-lain sila nyatakan

_____
_____
_____
_____
_____

Bahagian 2

2.1 Berikut adalah carta alir bagi aktiviti penyelenggaraan yang merangkumi peringkat-peringkat yang penting dalam proses-proses penyelenggaraan. Sila berikan komen atau cadangan merujuk pada aktiviti-akitivi di organisasi anda.

Adakah proses-proses penyelenggaraan ini mudah difahami ? Ya / Tidak



Ruangan Komen

Bahagian 3

3.0 Penggunaan ICT (Information Technology and Communication) di dalam Jabatan / Bahagian / Unit Penyelenggaraan.

3.1 Apakah system / perisian (software) atau CMMS (Computerized Maintenance Management System) yang di gunakan bagi kerja-kerja penyelenggaraan masa kini? Contoh: Archibus, SAP, TAMMS, CWORKS dan lain-lain.

_____

3.2 Apakah kelebihan perisian / system ini?

_____

3.3 Apakah kekurangan perisian / system ini?

_____

3.4 Apakah system / perisian (software) atau CMMS yang terdahulu yang di gunakan bagi kerja-kerja penyelenggaraan

_____

3.4 Apakah kelebihan perisian / system tersebut ?

_____

3.5 Apakah kekurangan perisian / system tersebut?

_____

3.6 Apakah kreteria-kreteria atau fungsi-fungsi tambahan yang perlu ada pada perisian / system penyelenggaraan?

_____

3.7 Apakah peralatan-peralatan sokongan (gajet) bagi kerja-kerja penyelenggaraan masa kini? (Contoh – Komputer tablet / Kamera/ Smartphone/ Thermal detector)

_____

Bahagian 4

4.1 Komen berkaitan paparan Reporter / Pelapor

4.2 Komen berkaitan paparan Maintenance Management

4.3 Komen berkaitan paparan Maintenance Unit

4.4 Komen berkaitan paparan Technician

4.5 Komen berkaitan paparan Maintenance Manager

Appendix B Verification Form

Name:

Company:

Company activities:

Position:

Department

Responsibilities:

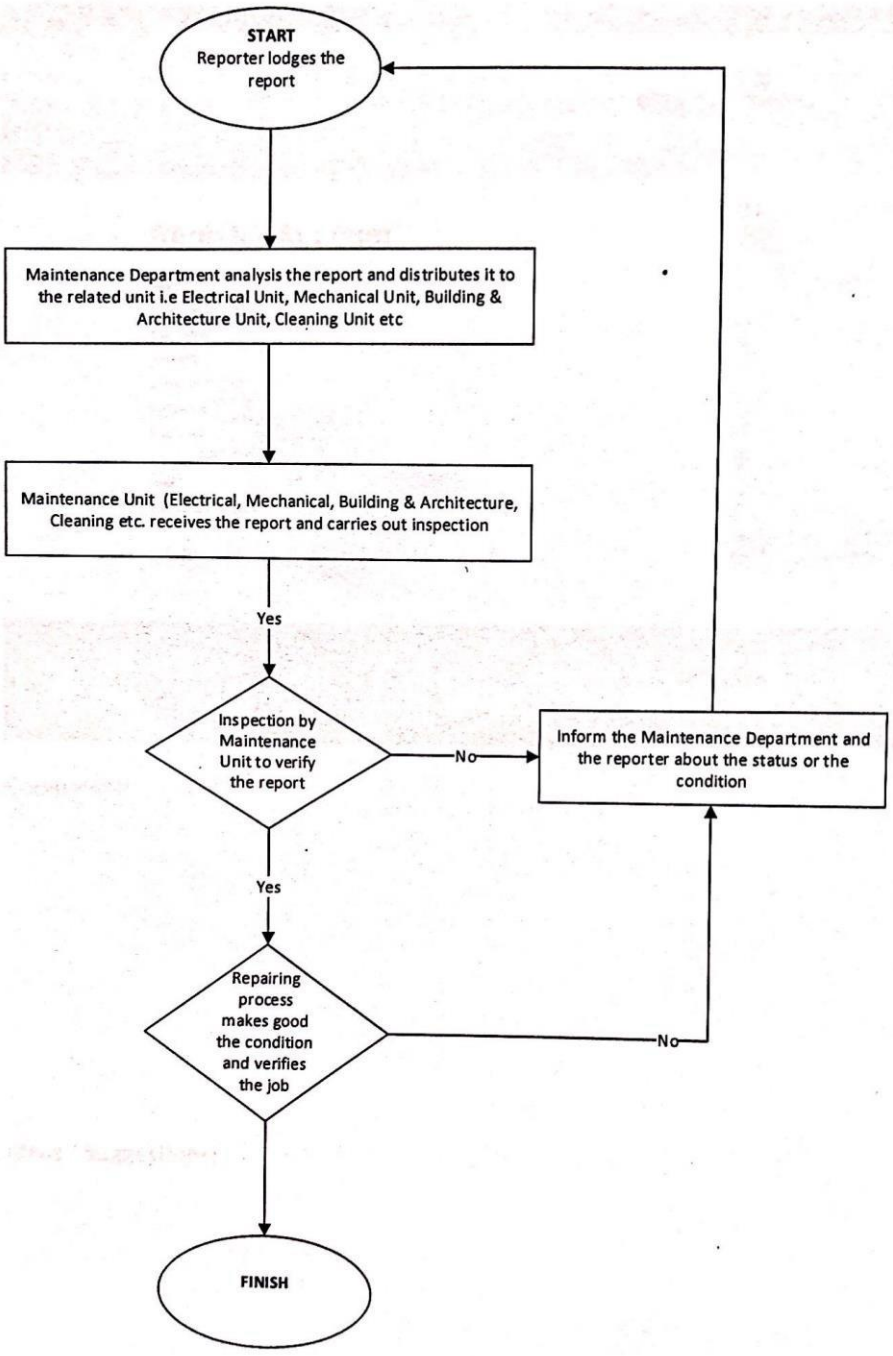
Years of experience:

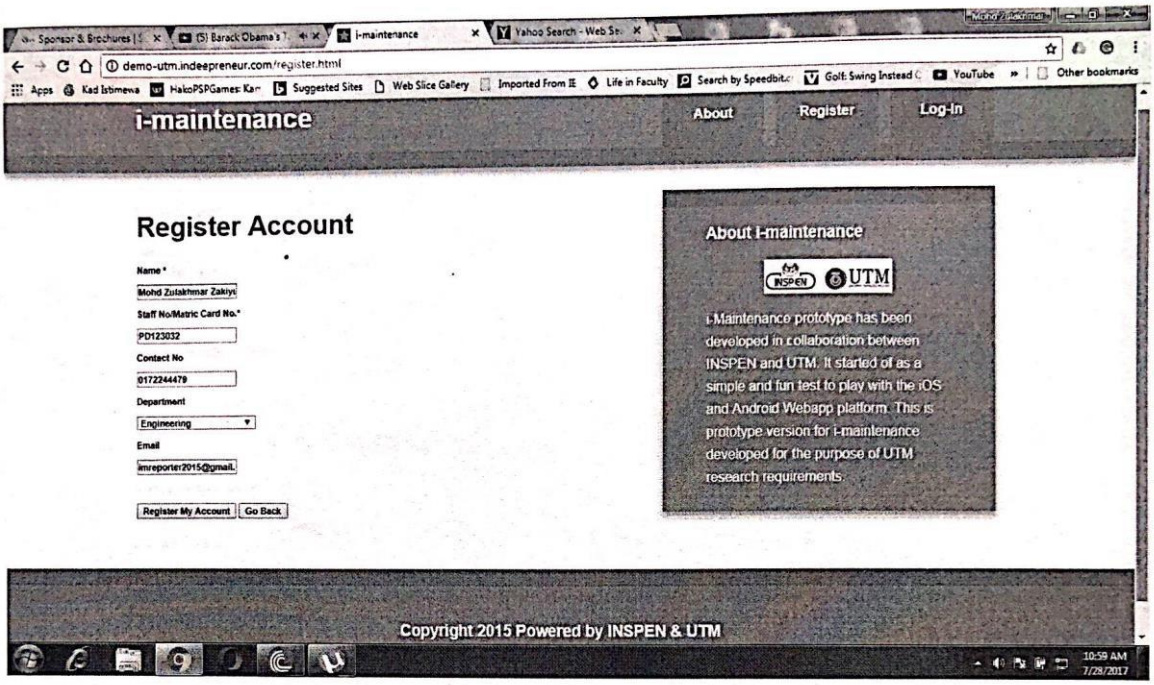
Previous company (practices):

Current CMMS in use:

Previous CMMS experiences:

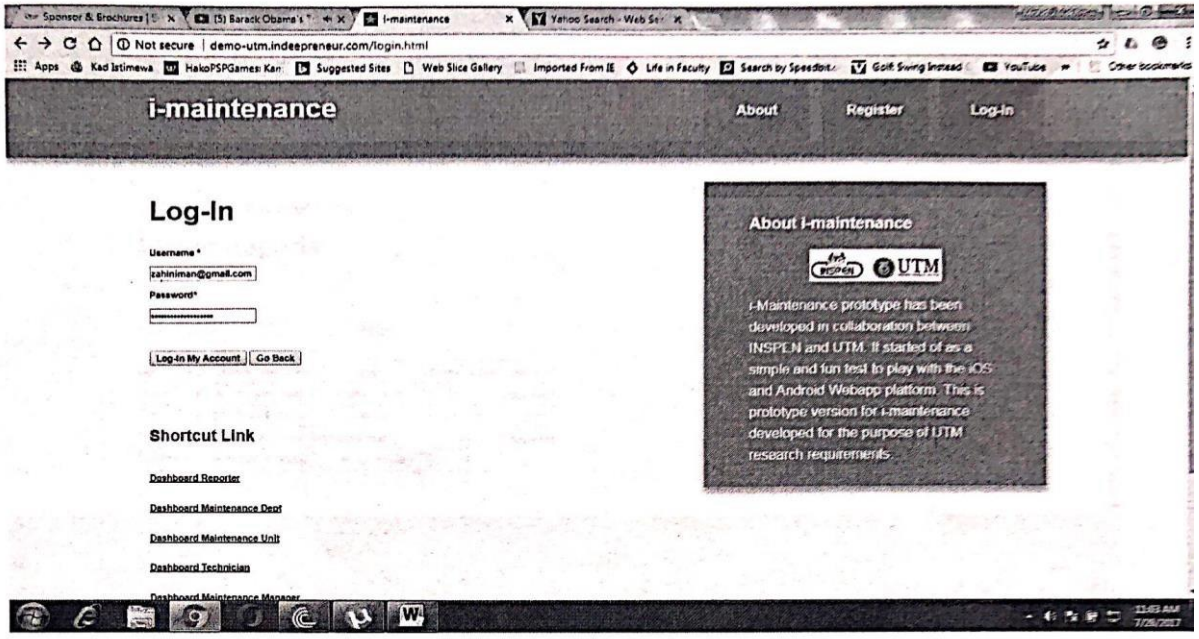
What are the main issues in CMMS?


START
Reporter lodges the report
Maintenance Department analysis the report and distributes it to the related unit i.e Electrical Unit, Mechanical Unit, Building & Architecture Unit, Cleaning Unit etc
Maintenance Unit (Electrical, Mechanical, Building & Architecture, Cleaning etc. receives the report and carries out inspection
Yes
Inspection by Maintenance Unit to verify the report
No
Inform the Maintenance Department and the reporter about the status or the condition
Yes
Repairing process makes good the condition and verifies the job
No
FINISH



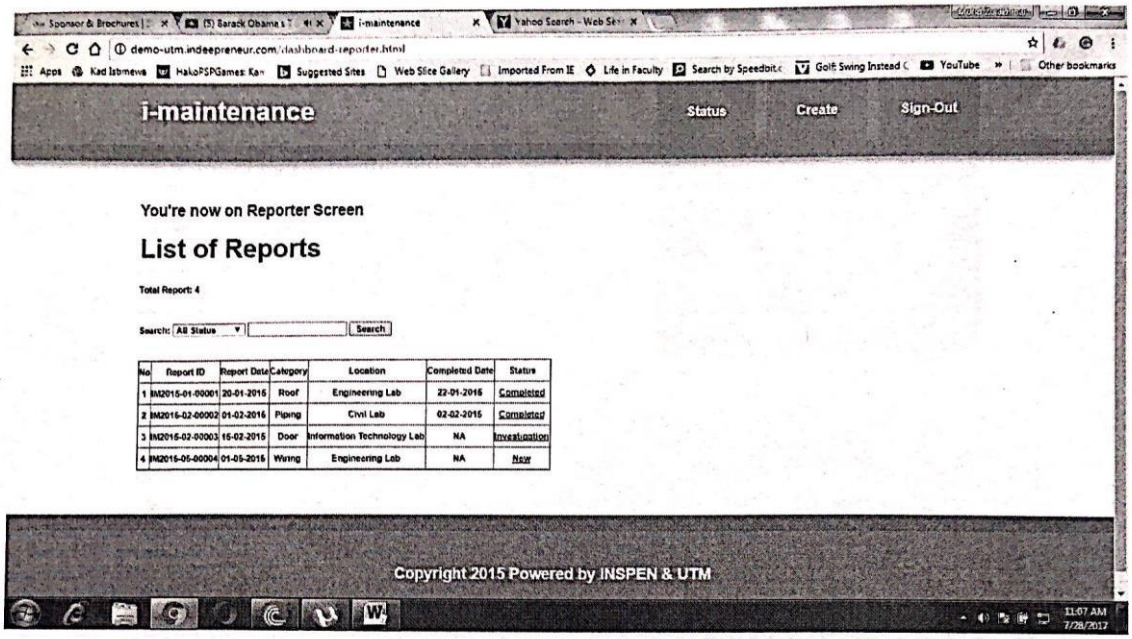
Comments:

Ideas / Suggestions:



Comments:

Ideas / Suggestions:



Comments:

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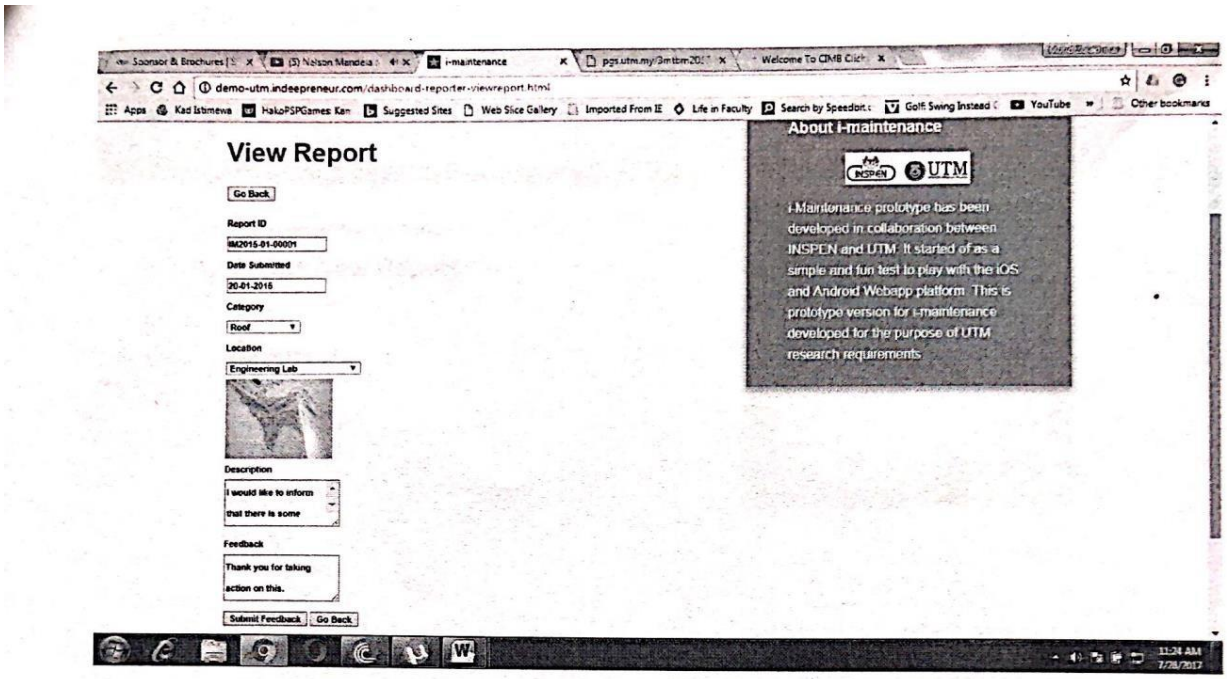
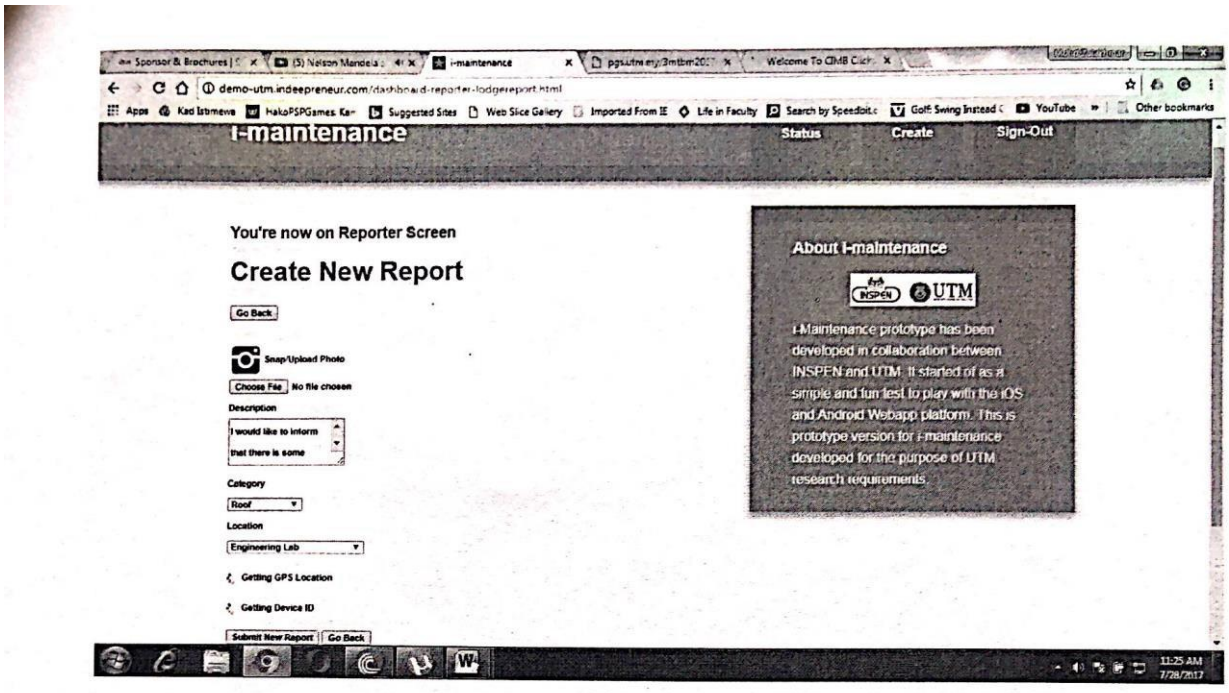


Comments:

Ideas / Suggestions:



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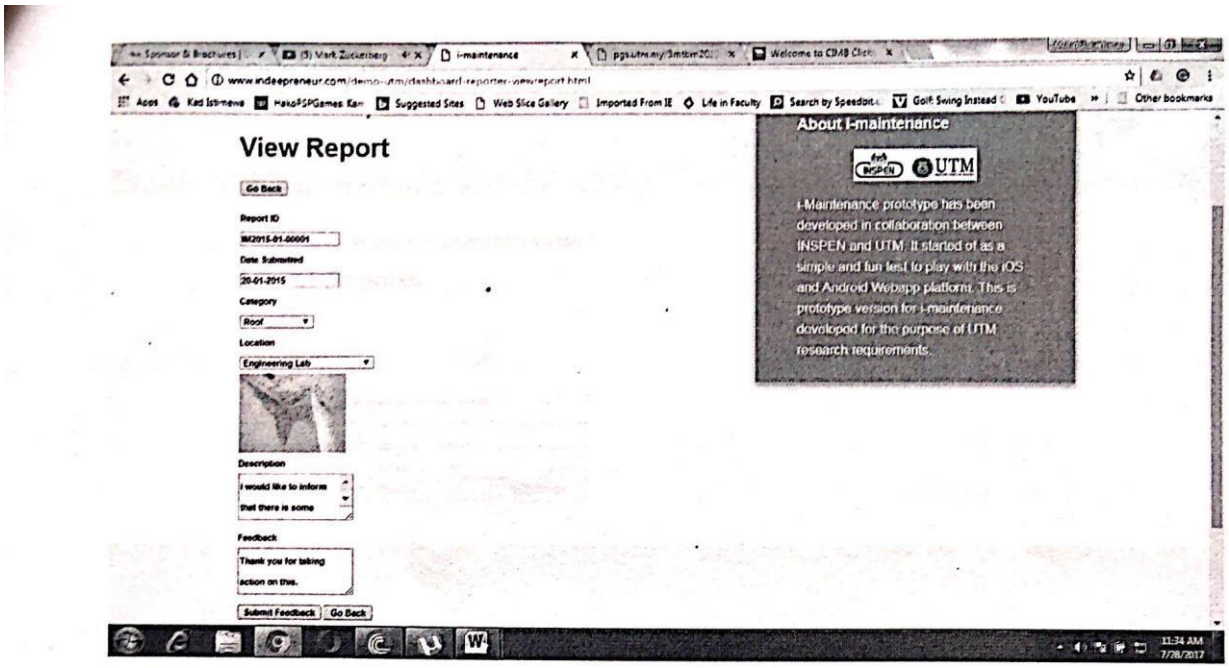
Ideas / Suggestions:



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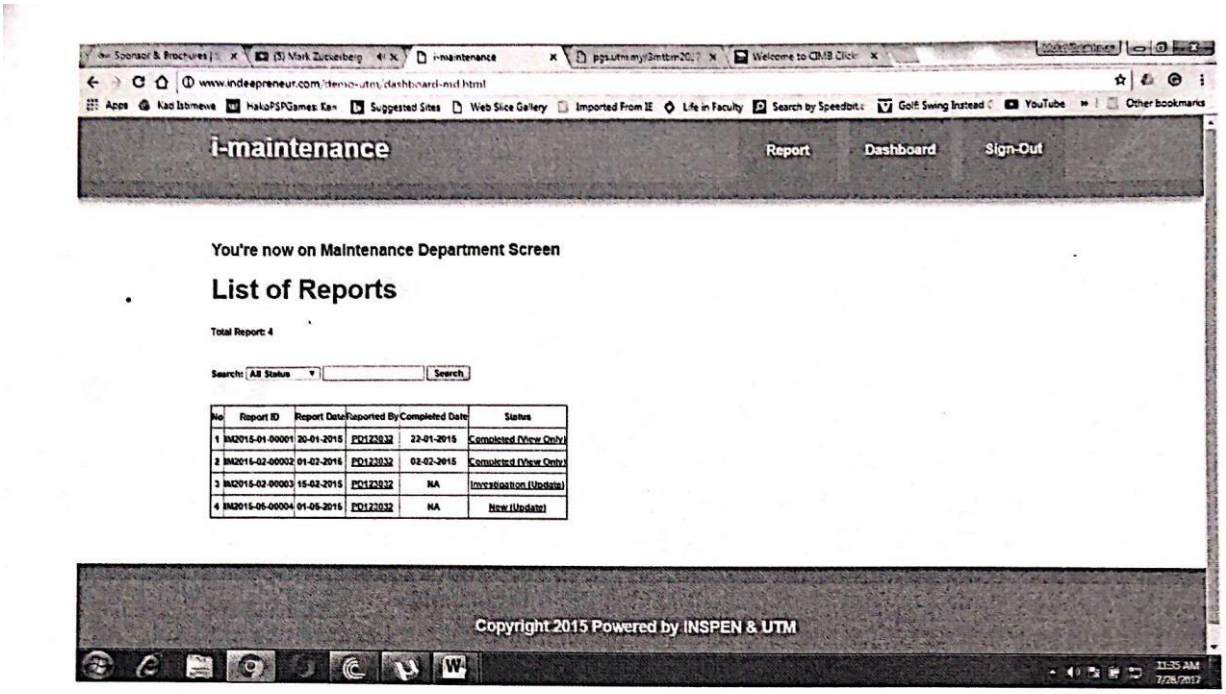
Ideas / Suggestions:



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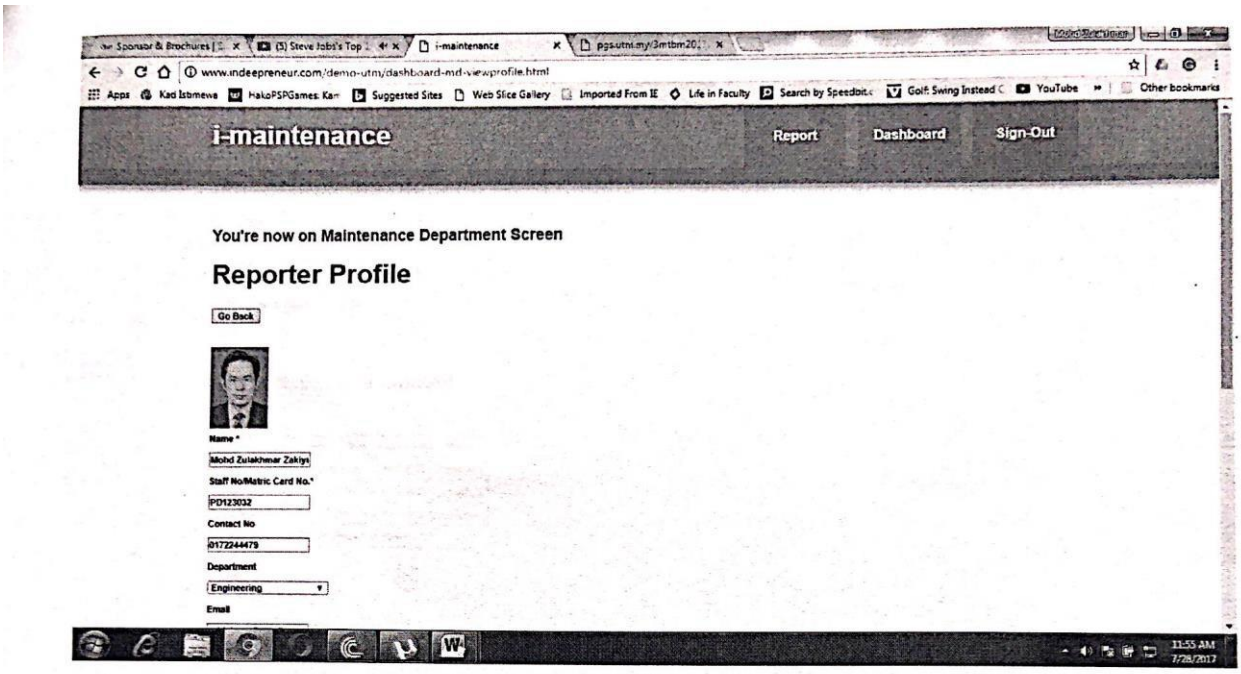

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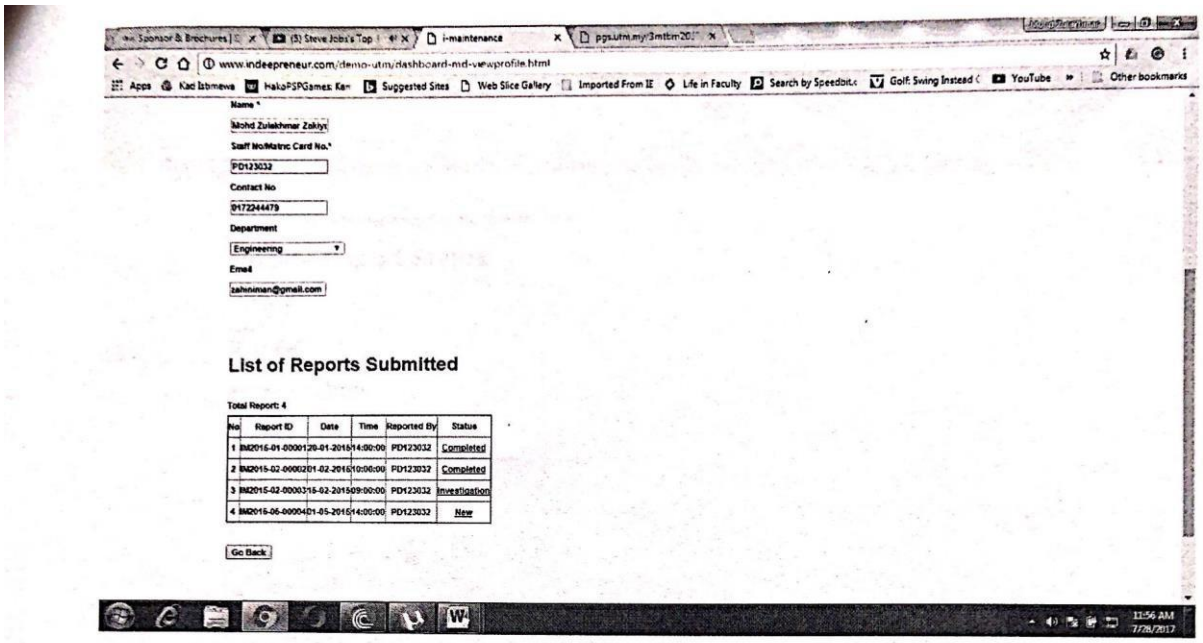

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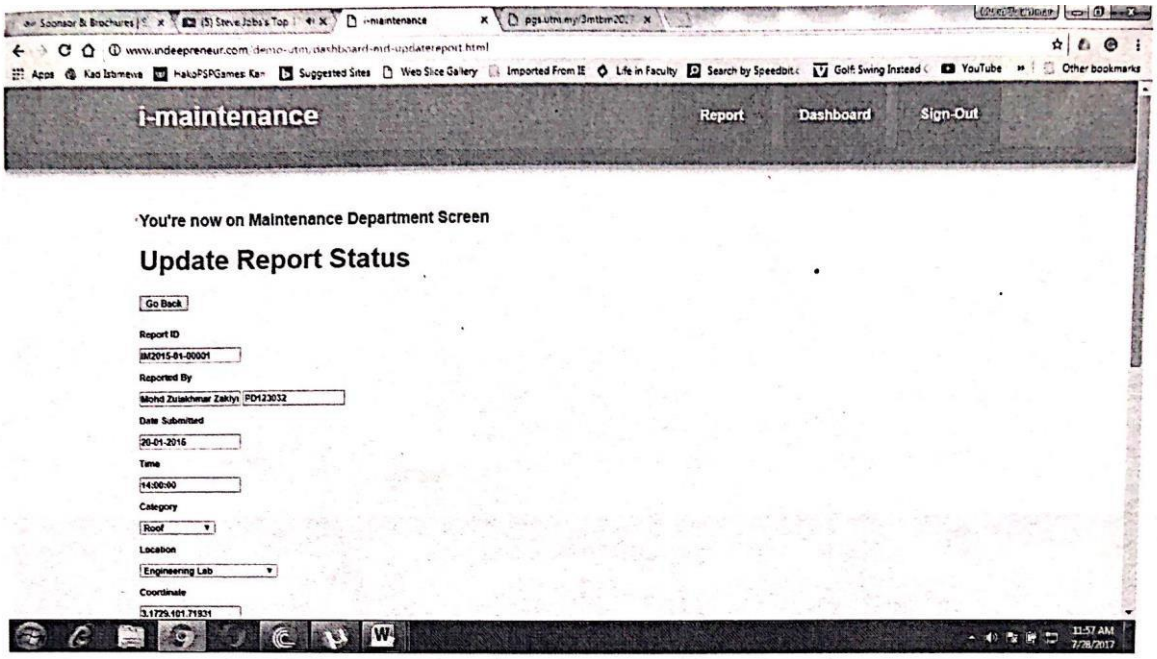

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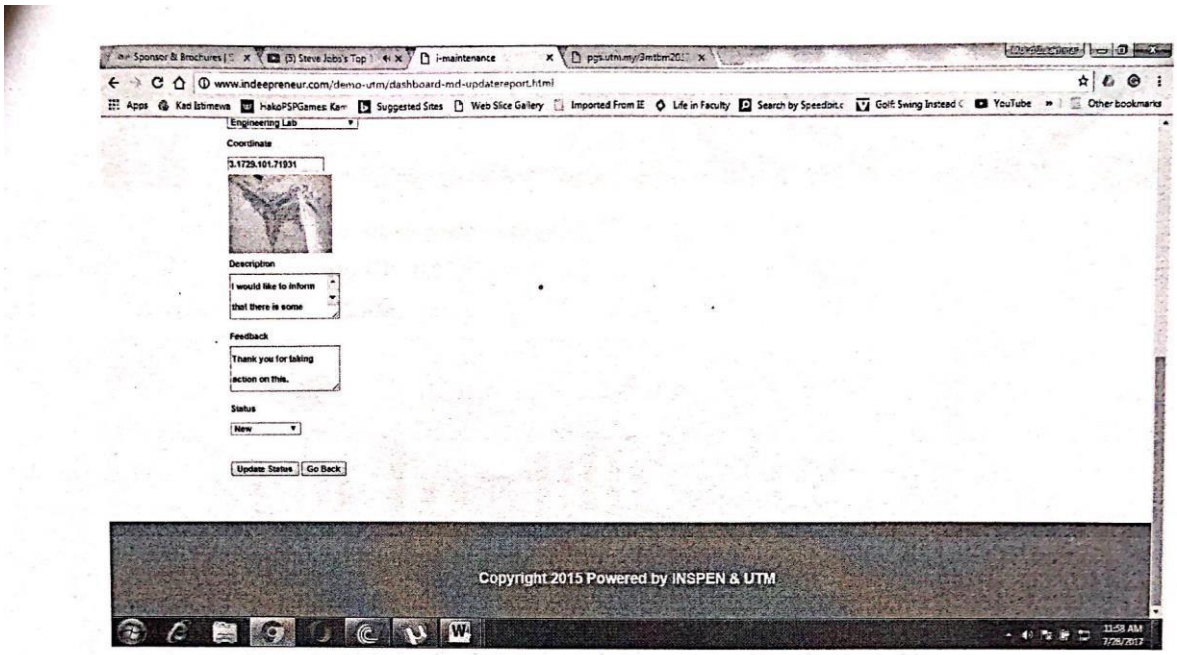

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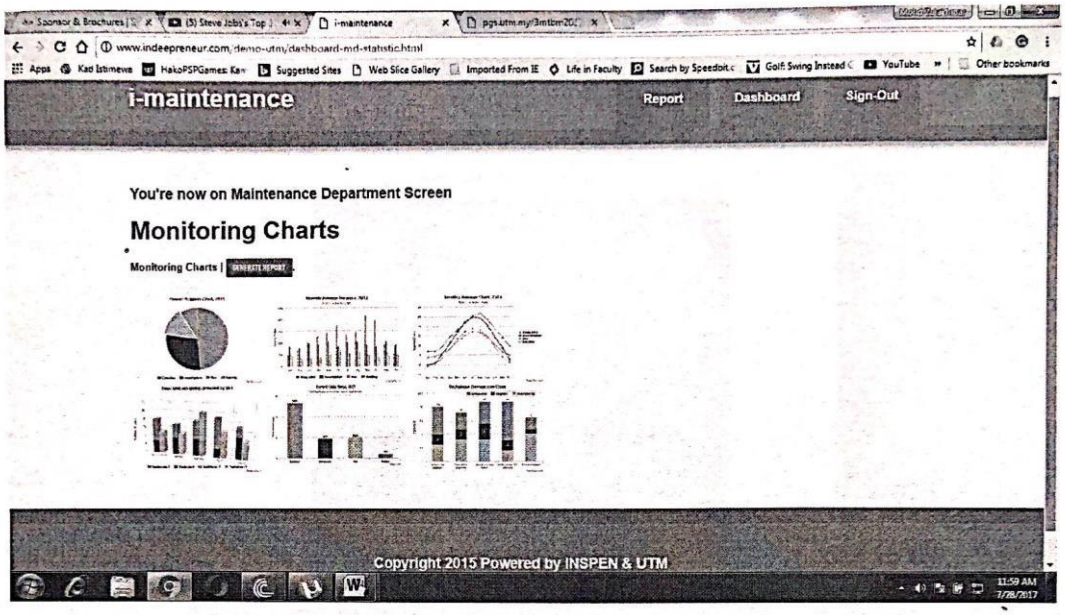

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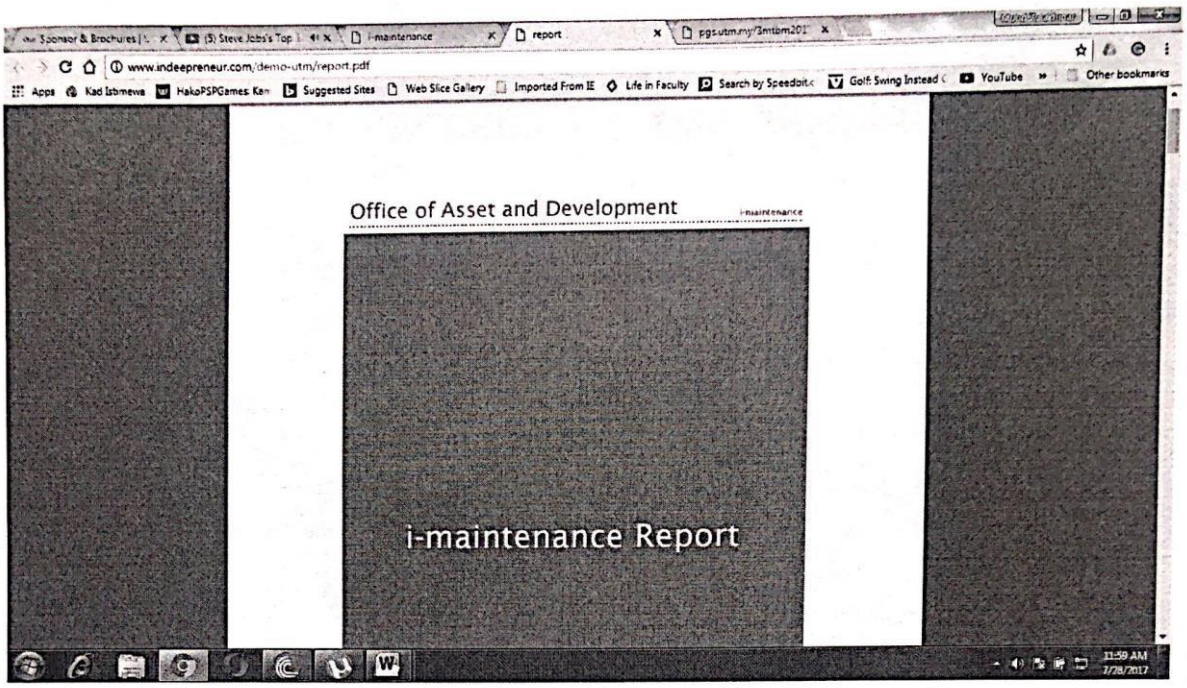
Ideas / Suggestions:



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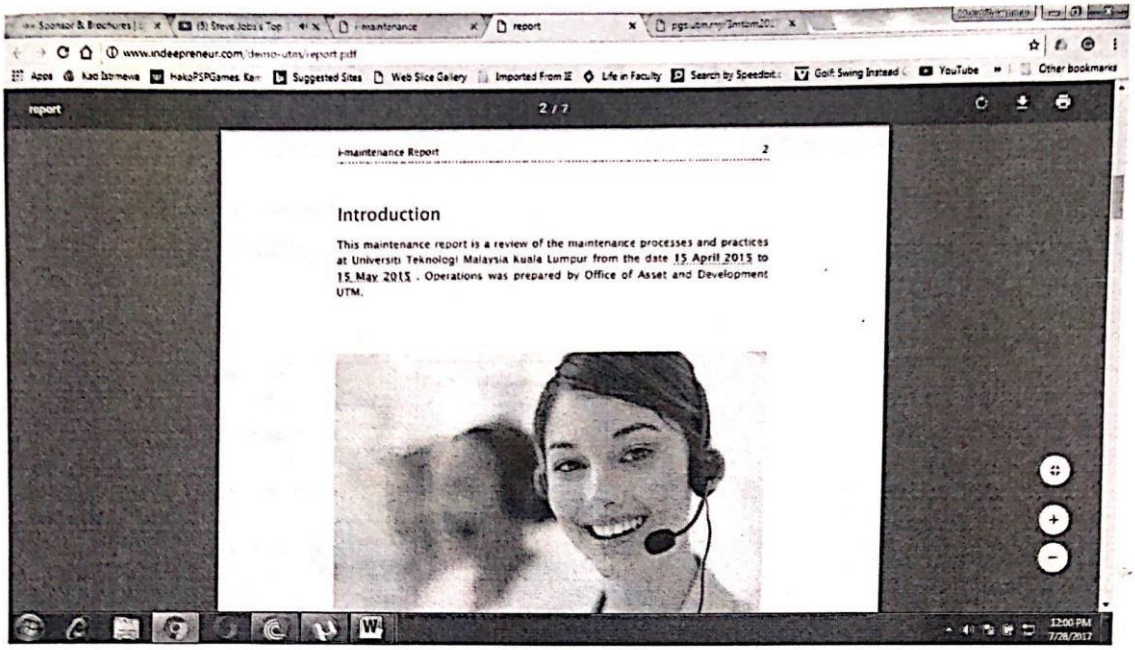

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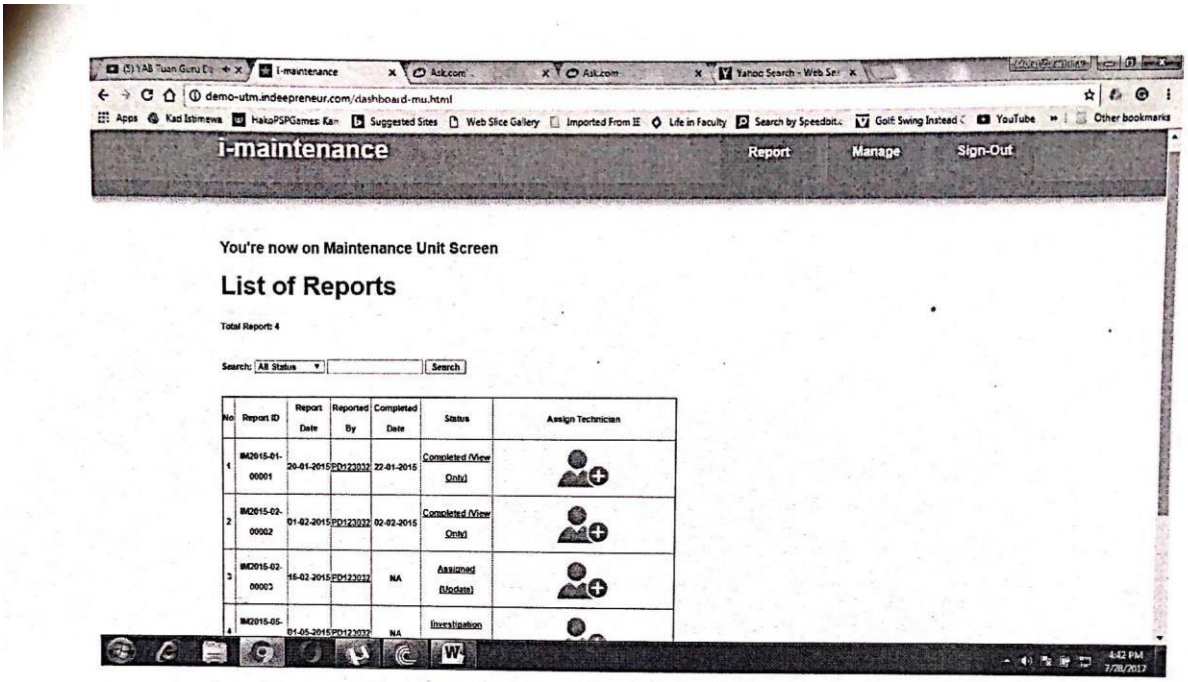

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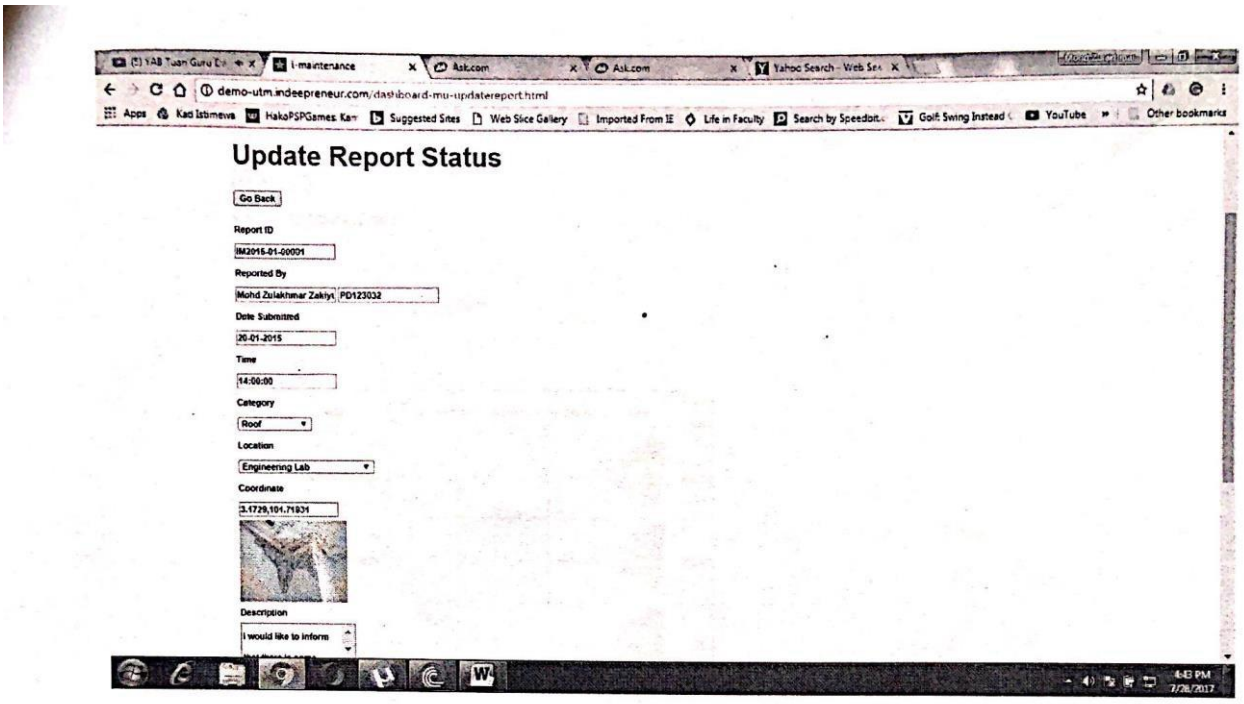

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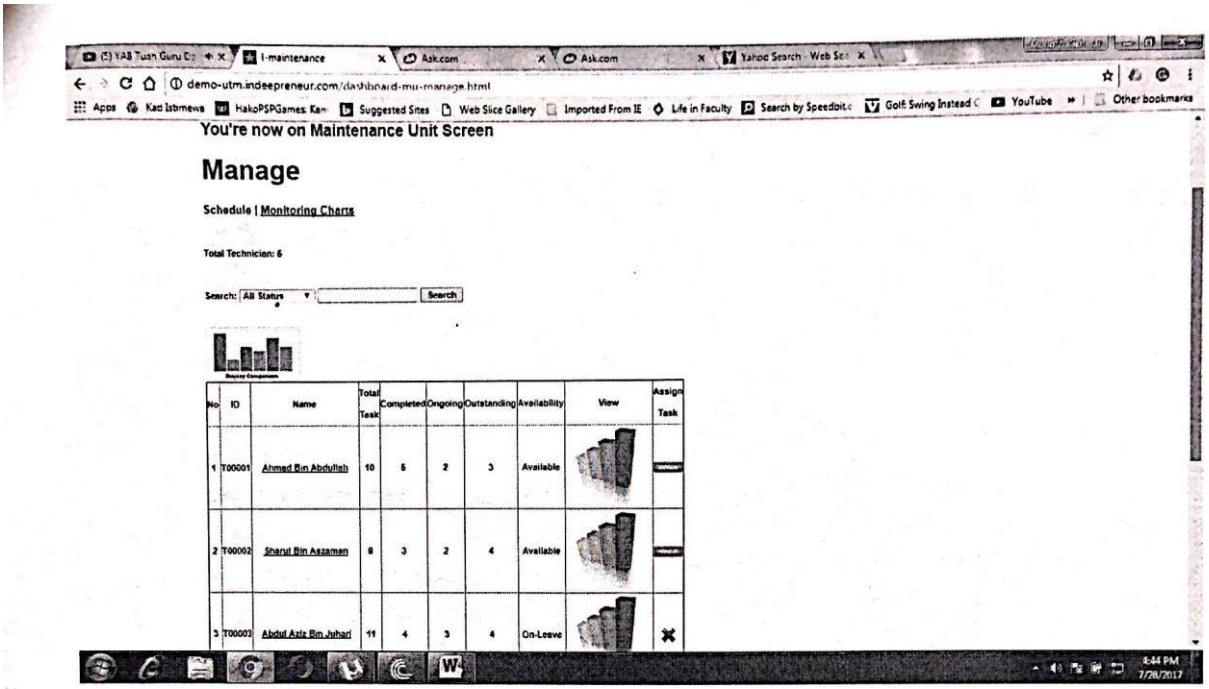

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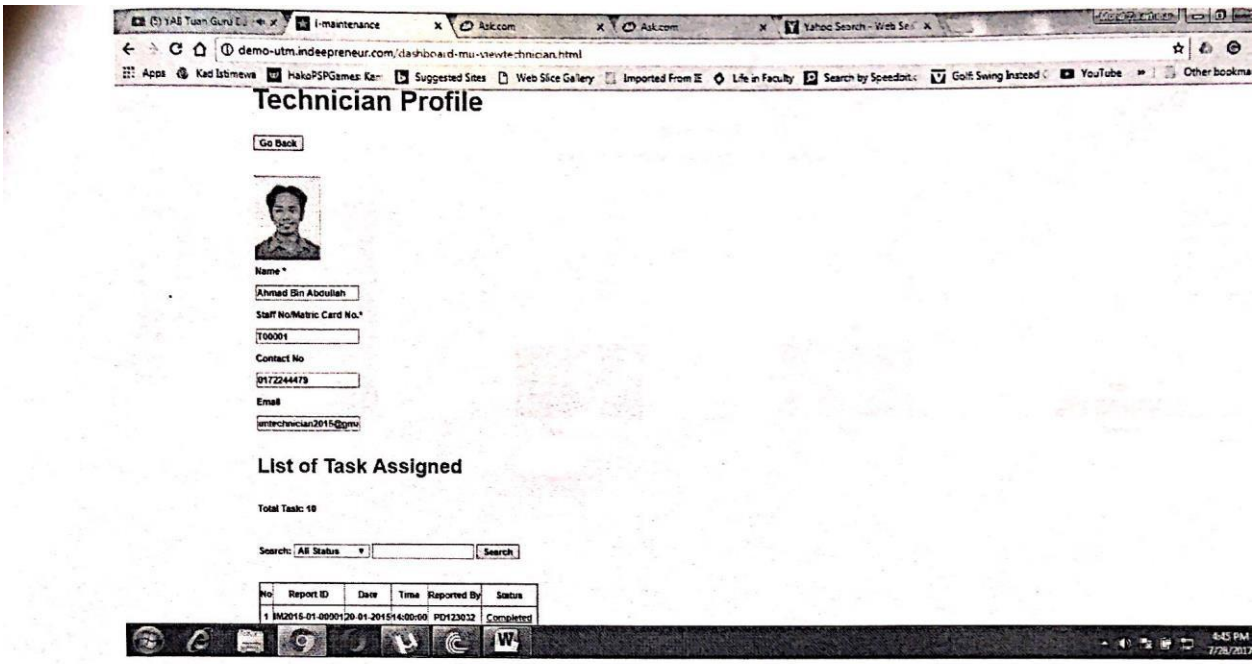

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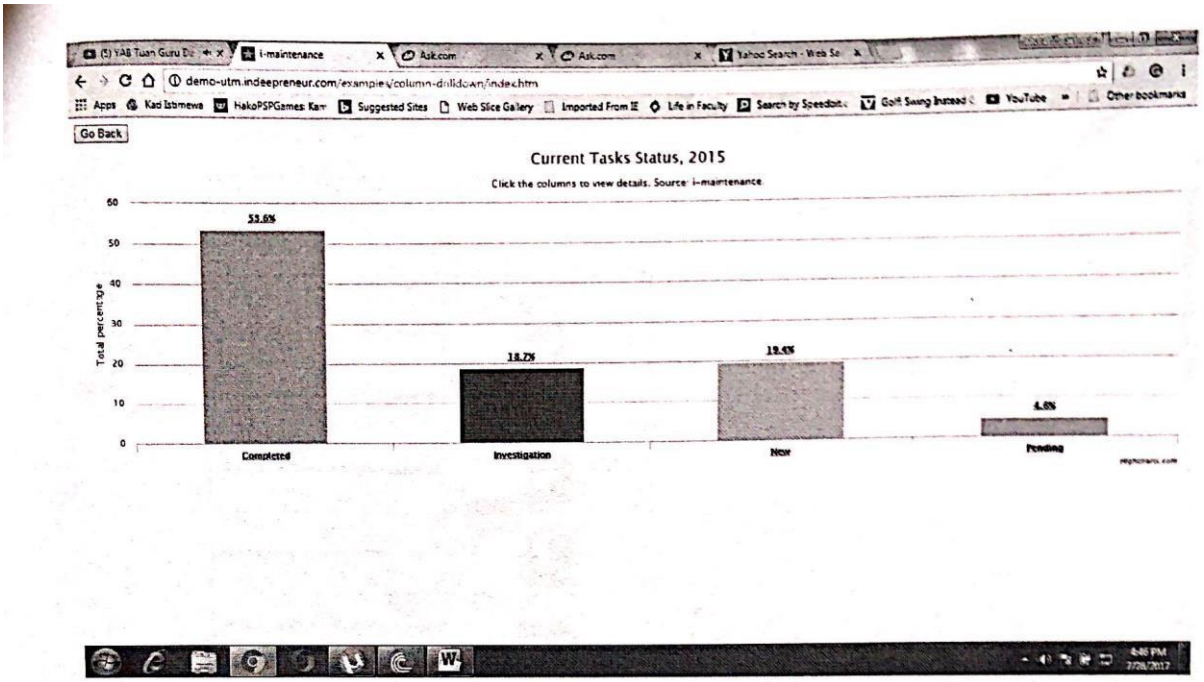

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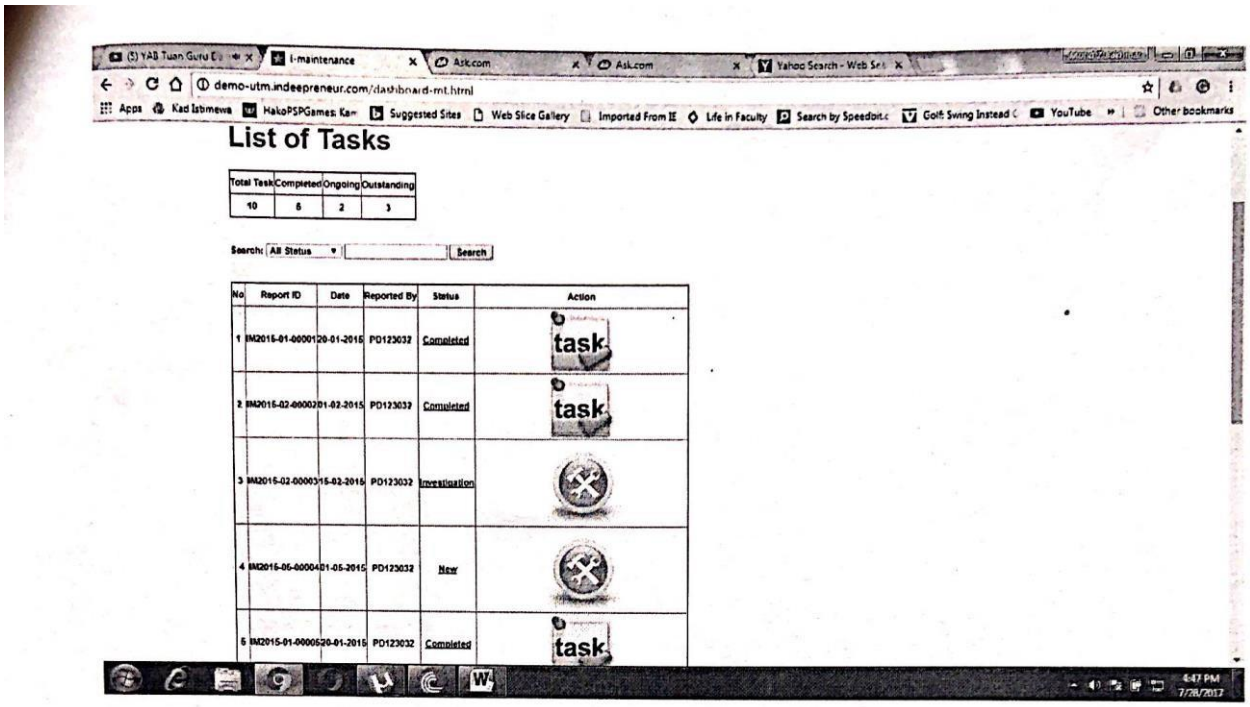

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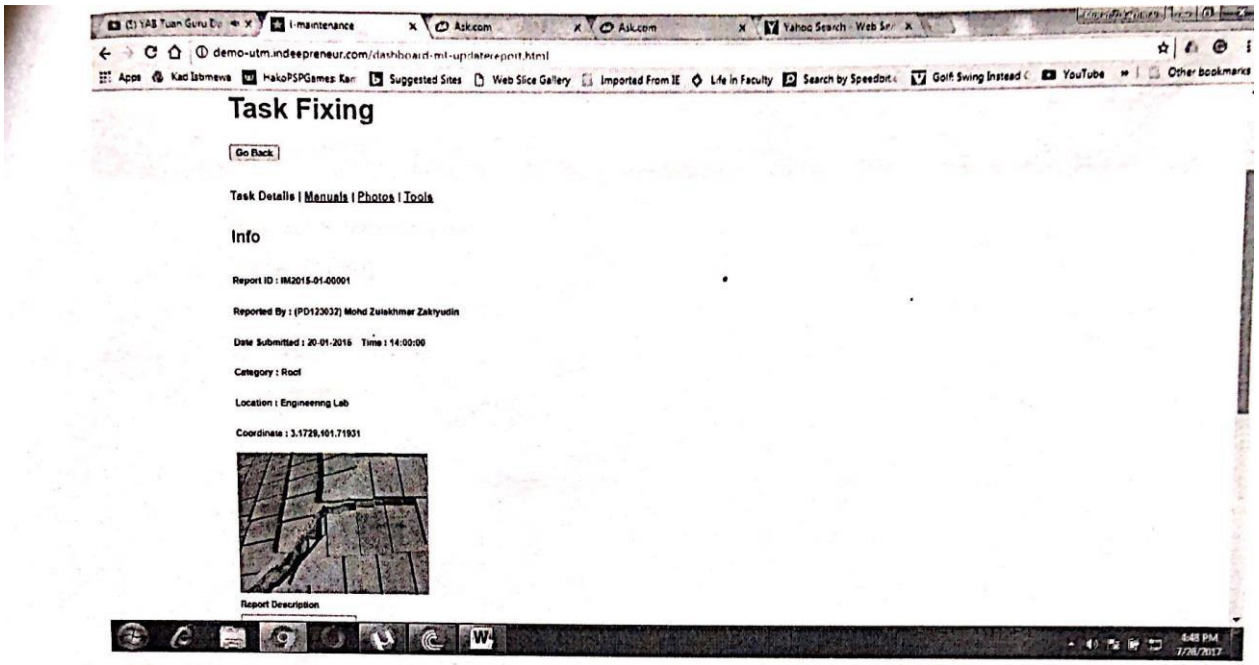

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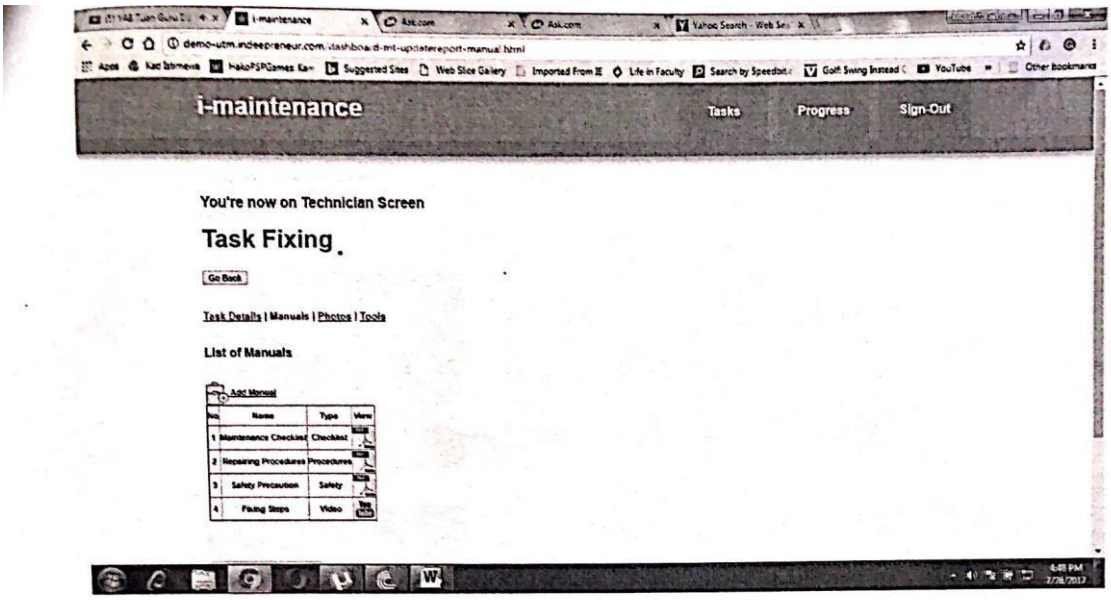
Ideas / Suggestions:



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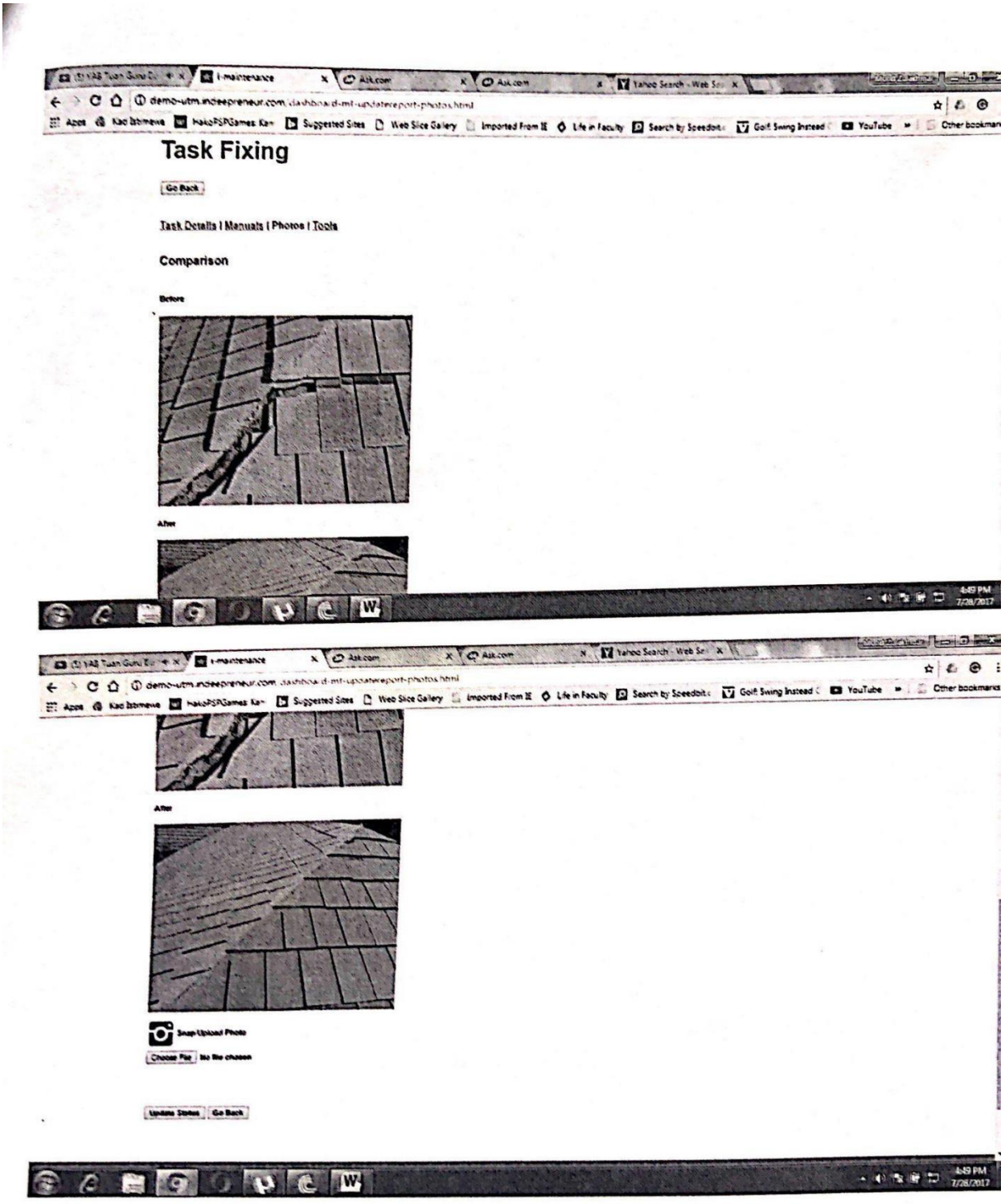
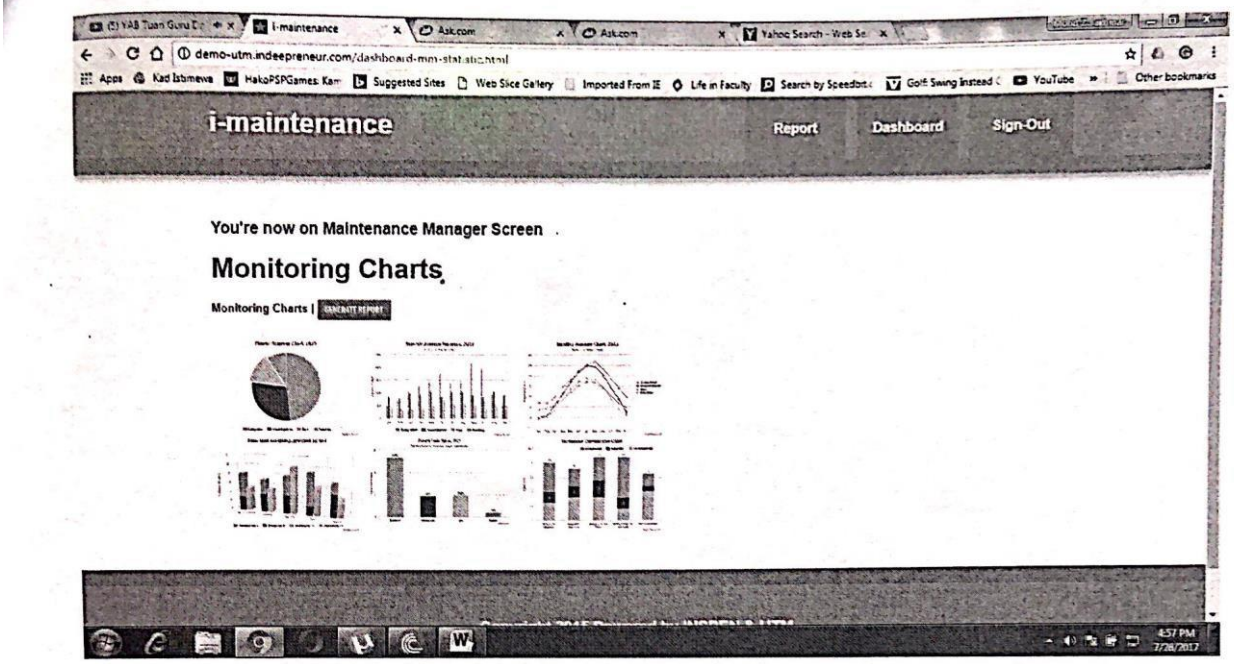

Task Fixing
Go Back
Task Details | Manuals | Photos | Tools
Comparison
Before
After
Before
After
Snap/Upload Photo
Choose File
No file chosen
Update Status
Go Back

Comments:



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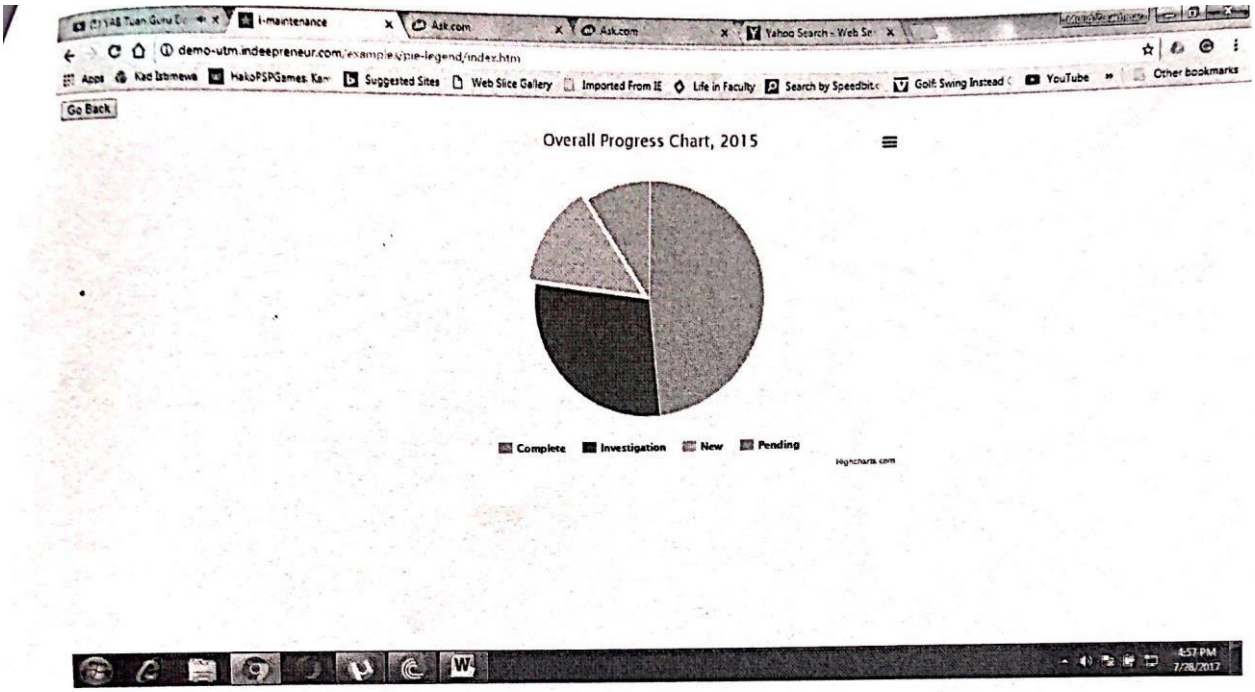

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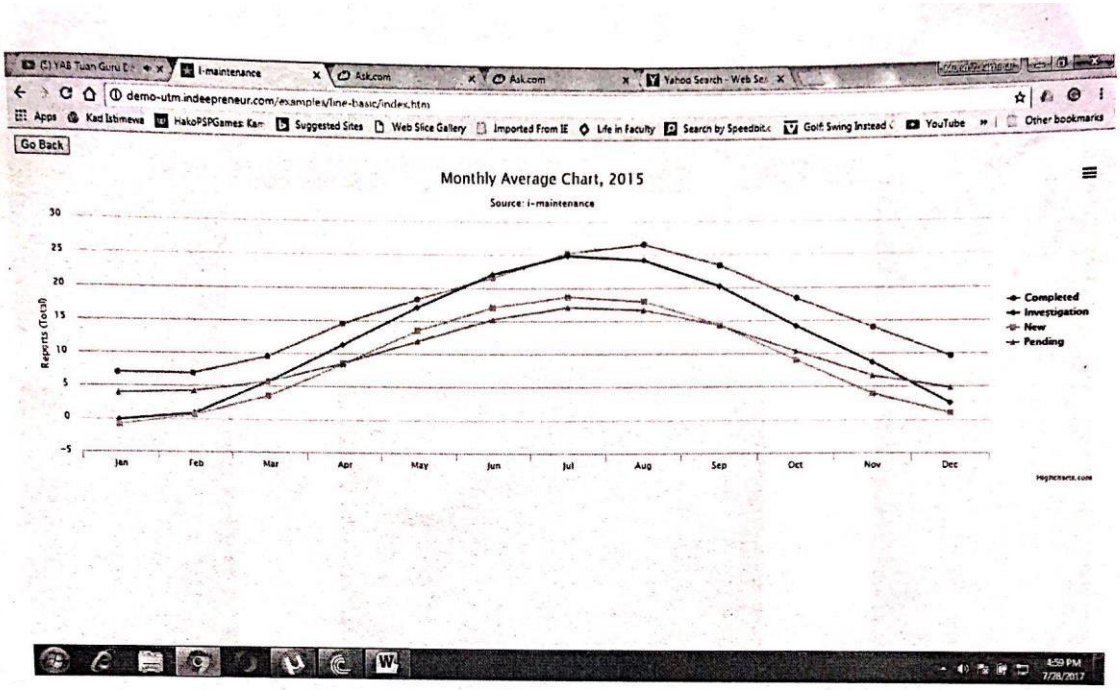
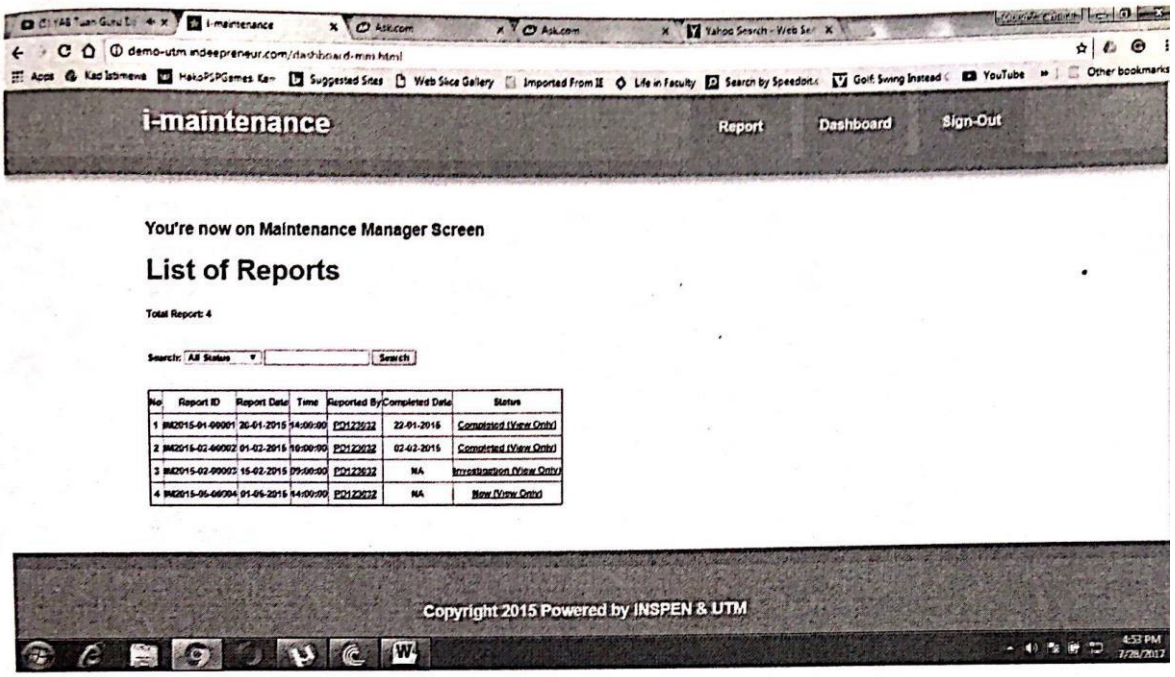


Comments:

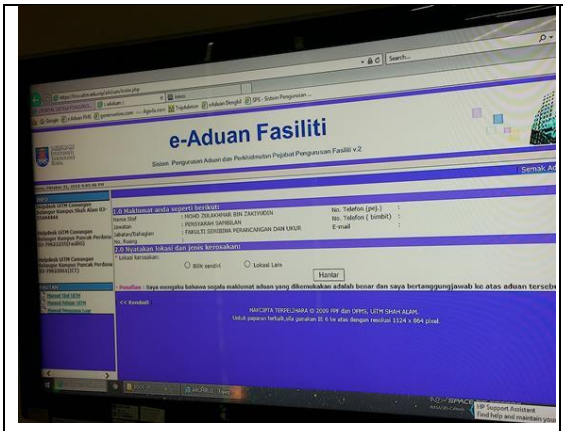
Ideas / Suggestions:

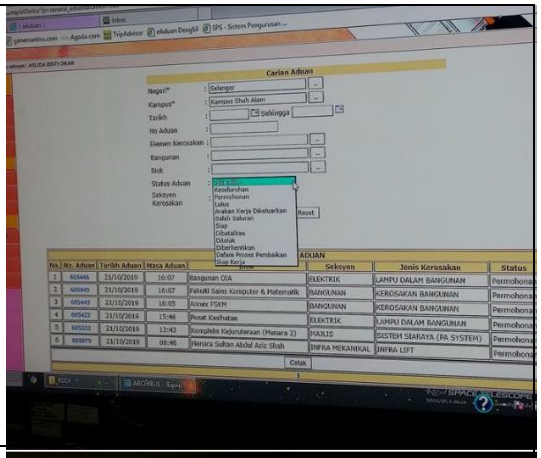


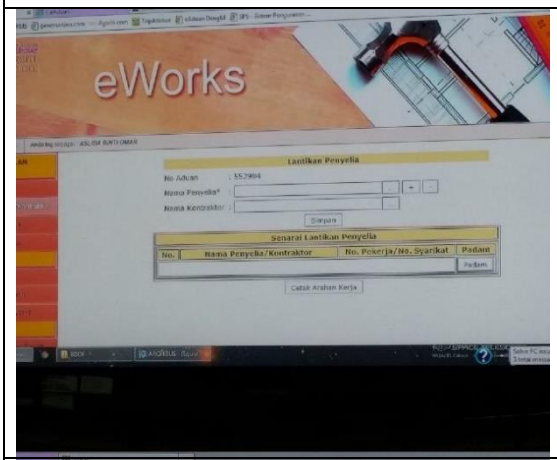
Comments:

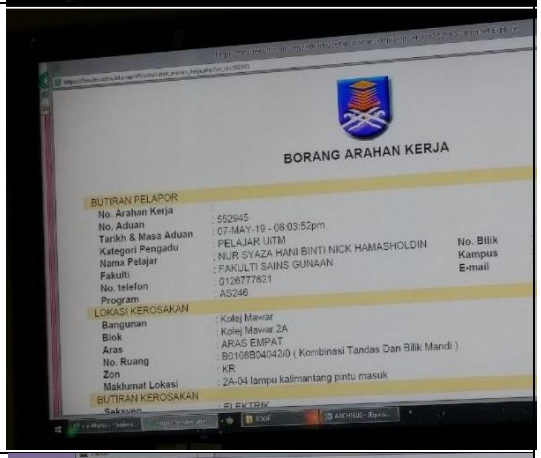
Ideas / Suggestions:

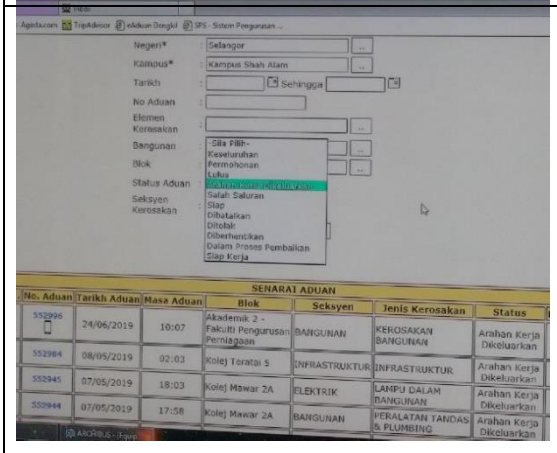
Appendix C Software Review of the Universities

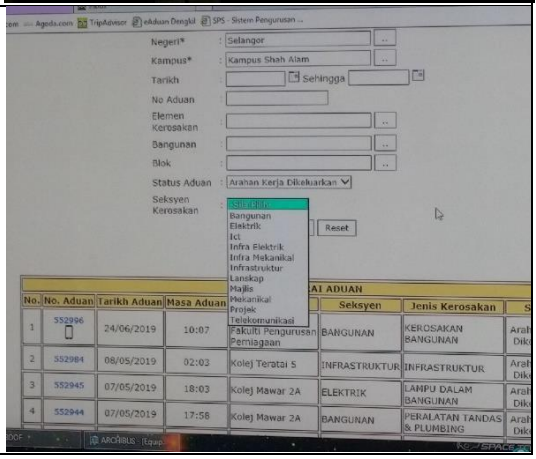


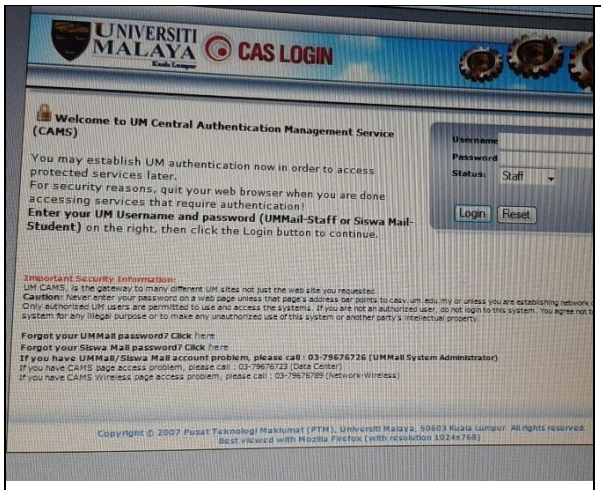


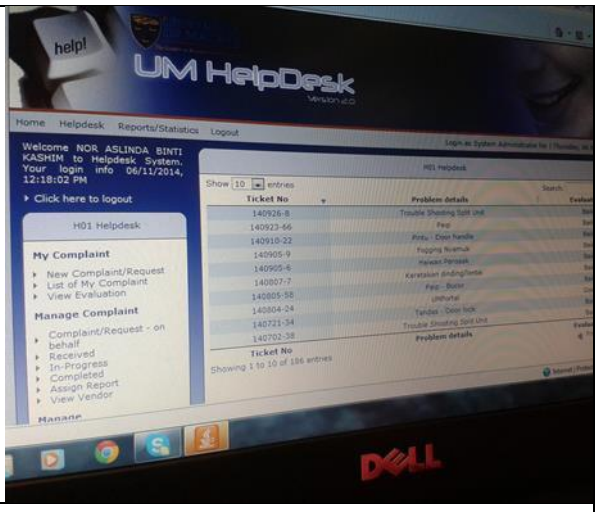


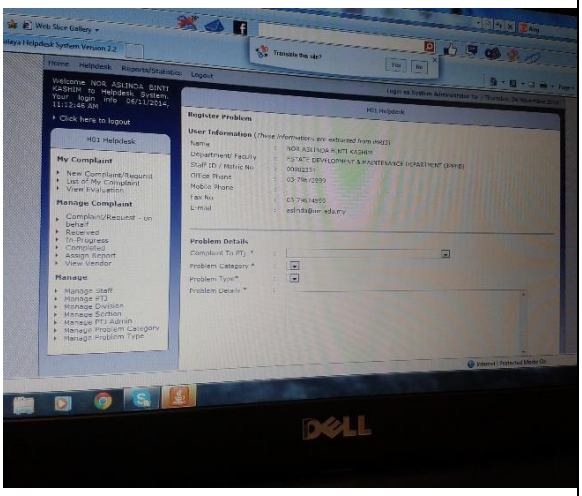


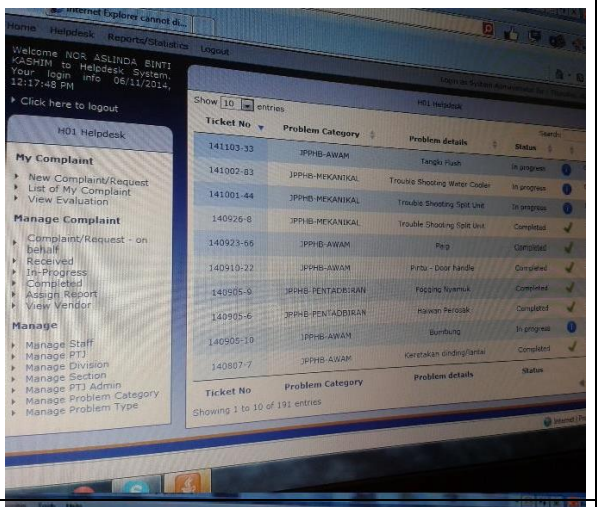


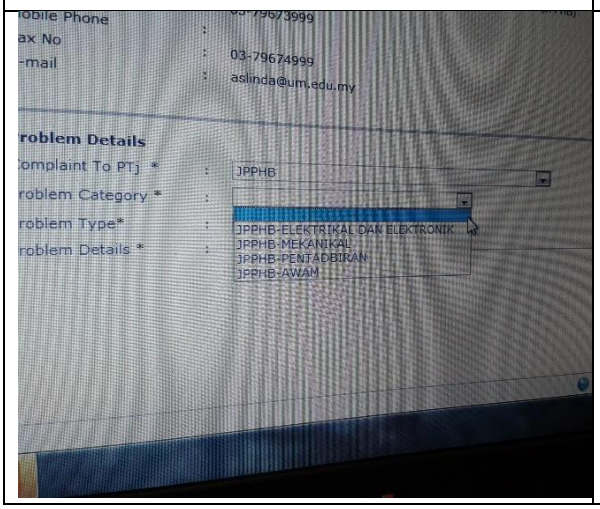


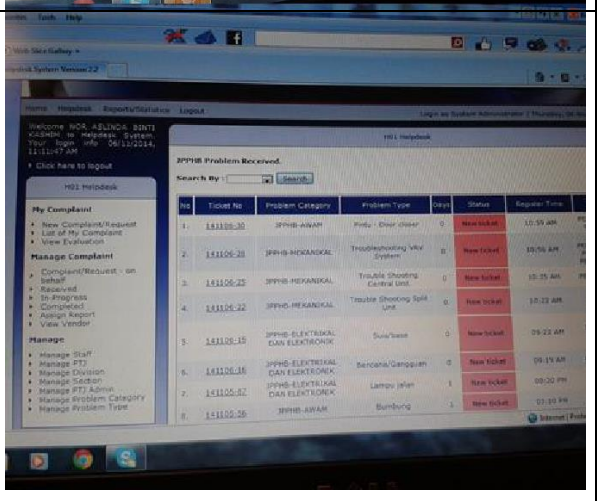

UNIVERSITI MALAYA
CAS LOGIN
Welcome to UM Central Authentication Management Service (CAMS)
Username
Password
Status: Staff
Login
Reset
Forgot your UMMail password? Click here
Forgot your Siswa Mail password? Click here

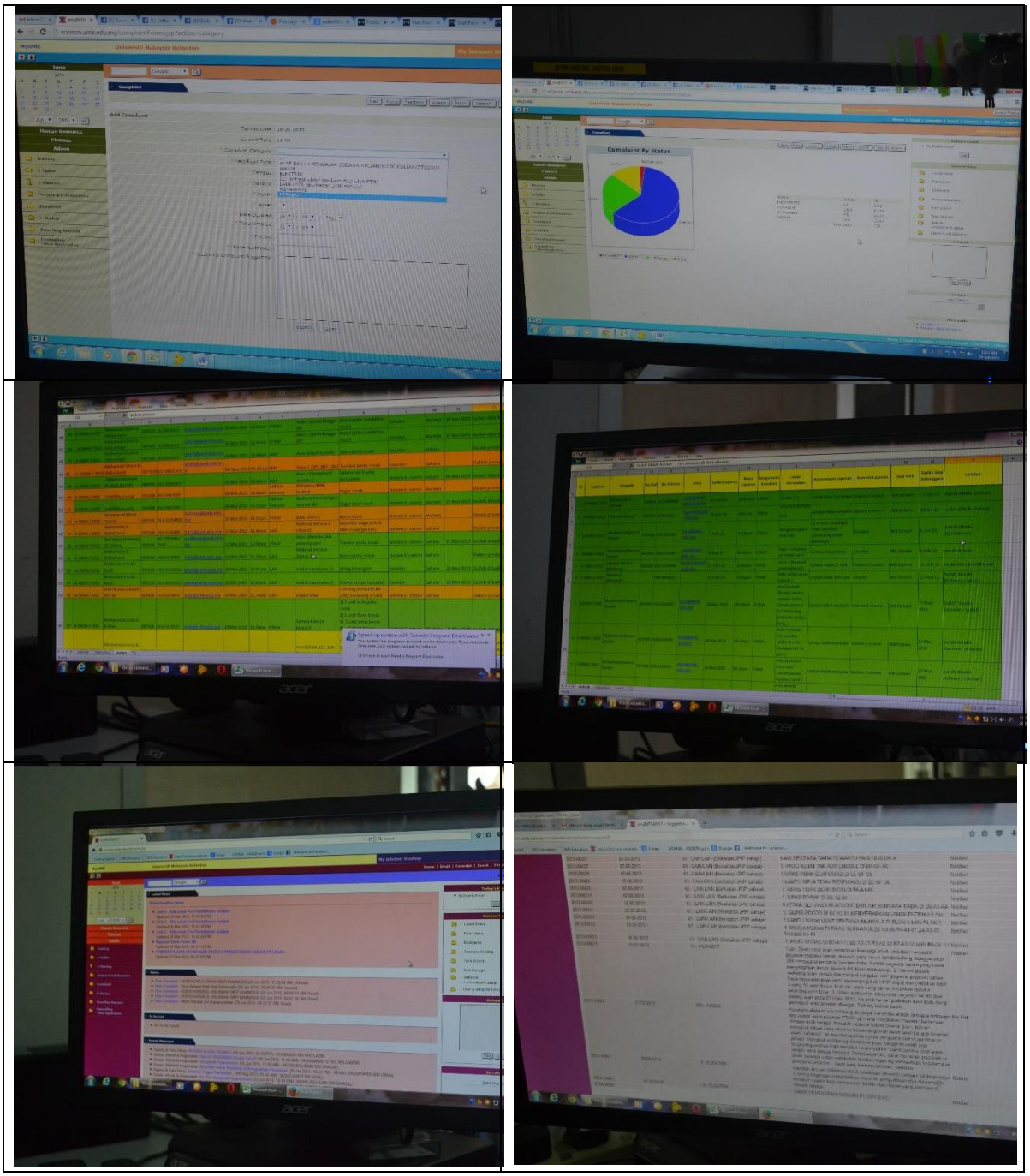

help!
UM HelpDesk
Home
Helpdesk
Reports/Statistics
Logout
Welcome NOR ASLINDA BINTI KASHIM to Helpdesk System. Your login info 06/11/2014, 12:18:02 PM
Click here to logout
H01 Helpdesk
My Complaint
New Complaint/Request
List of My Complaint
View Evaluation
Manage Complaint
Complaint/Request - on behalf
Received
In-Progress
Completed
Assign Report
View Vendor
Manage
Ticket No
Problem details
Showing 1 to 10 of 186 entries

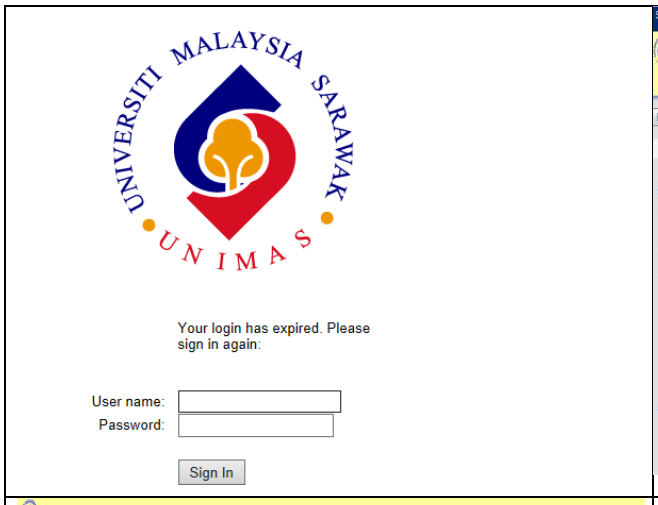

Register Problem
User Information
Problem Details
H01 Helpdesk

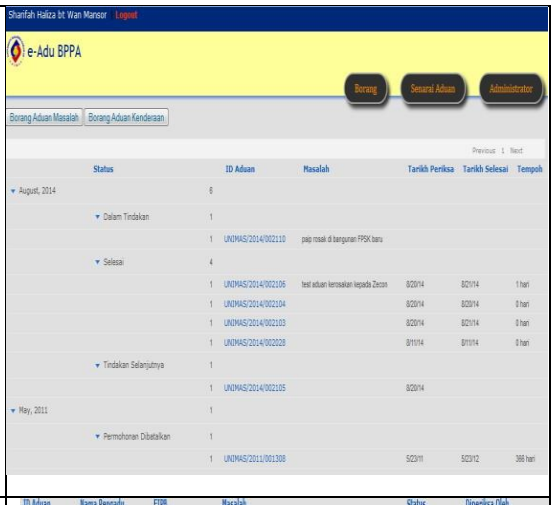

Welcome NOR ASLINDA BINTI KASHIM to Helpdesk System. Your login info 06/11/2014, 12:17:48 PM
Click here to logout
H01 Helpdesk
My Complaint
New Complaint/Request
List of My Complaint
View Evaluation
Manage Complaint
Complaint/Request - on behalf
Received
In-Progress
Completed
Assign Report
View Vendor
Manage
Manage Staff
Manage PTJ
Manage Division
Manage Section
Manage PTJ Admin
Manage Problem Category
Manage Problem Type
Ticket No
Problem Category
Problem details
Showing 1 to 10 of 191 entries

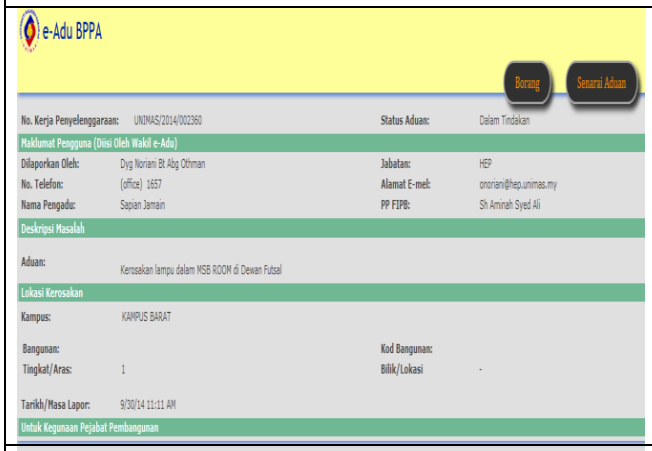

Mobile Phone : 03-79673999
Fax No : 03-79674999
E-mail : aslinda@um.edu.my
Problem Details
Complaint To PTj * : JPPHB
Problem Category * :
Problem Type* :
Problem Details * :
JPPHB-ELEKTRIKAL DAN ELEKTRONIK
JPPHB-MEKANIKAL
JPPHB-PENTADBIRAN
JPPHB-AWAM

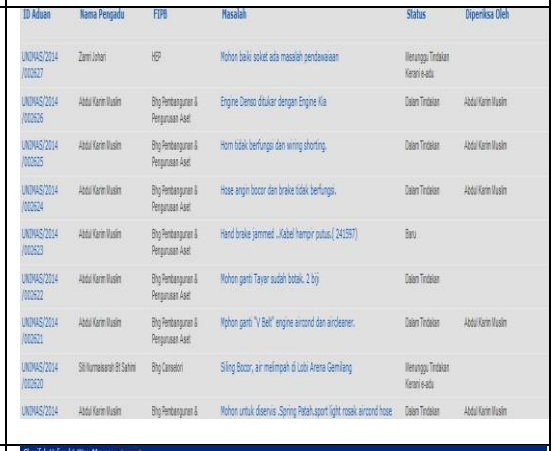

JPPHB Problem Received.
Search By
Search
My Complaint
Manage Complaint
Manage




UNIVERSITI MALAYSIA SARAWAK
UNIMAS
Your login has expired. Please sign in again:
User name:
Password:
Sign In

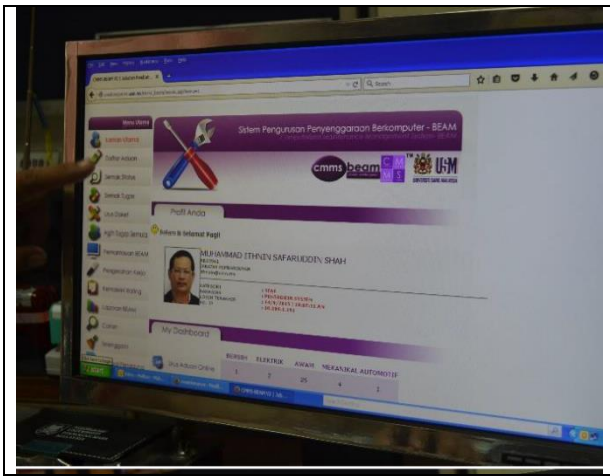

Sharifah Haliza bt Wan Mansor Logout
e-Adu BPPA
Borang
Senarai Aduan
Administrator
Borang Aduan Masalah
Borang Aduan Kenderaan
Status
ID Aduan
Masalah
Tarikh Periksa
Tarikh Selesai
Tempoh

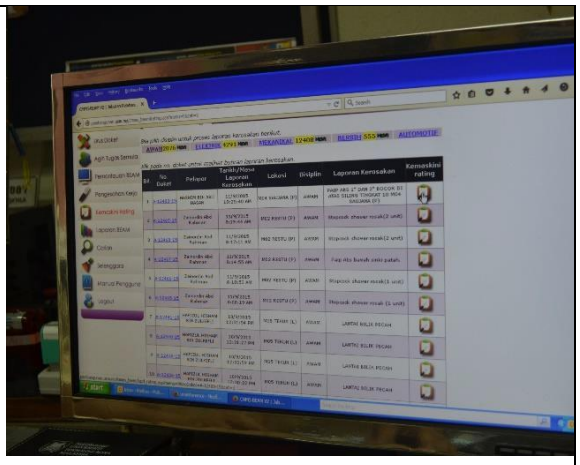

e-Adu BPPA
Borang
Senarai Aduan
No. Kerja Penyelenggaraan: UNIMAS/2014/002360
Status Aduan: Dalam Tindakan
Maklumat Pengguna (Diisi Oleh Wakil e-Adu)
Dilaporkan Oleh: Dyg Norani Bt Abg Othman
Jabatan: HEP
No. Telefon: (office) 1657
Alamat E-mel: onorian@hep.unimas.my
Nama Pengadu: Sapian Jamain
PP FIPB: Sh Aminah Syed Ali
Deskripsi Masalah
Aduan: Kerosakan lampu dalam MSB ROOM di Dewan Futsal
Lokasi Kerosakan
Kampus: KAMPUS BARAT
Bangunan:
Kod Bangunan:
Tingkat/Aras: 1
Bilik/Lokasi -
Tarikh/Masa Lapor: 9/30/14 11:11 AM
Untuk Kegunaan Pejabat Pembangunan


ID Aduan
Nama Pengadu
FIPB
Masalah
Status
Diperiksa Oleh

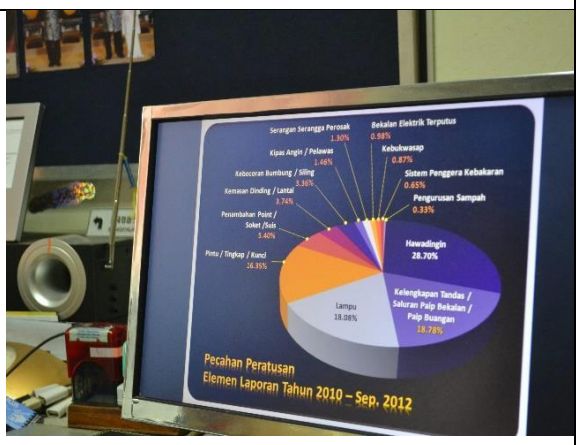

No. Laporan
Status Laporan
FIPB
Kategori Masalah
Lokasi Kampus
Bulan
Nama Pengadu
Kerosakan Kenderaan
Expand All
Collapse All
Previous 1 Next
Status
ID Aduan
Masalah
Jumlah
Pemeriksa
Tarikh Lapor
Tarikh Selesai
Tempoh
Menunggu Tindakan Kerani e-adu 4
Dalam Tindakan 715
Tindakan Selanjutnya 626
Selesai 16300
Permohonan Dibatalkan 150
Not Categorized 1
17796

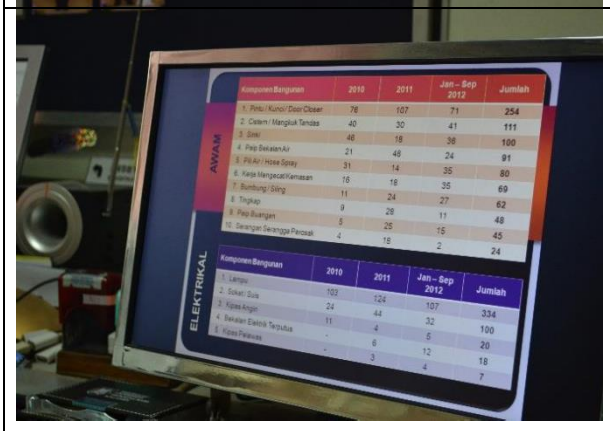

Sharifah Haliza bt Wan Mansor Logout
e-Adu BPPA
Borang
Senarai Aduan
Unit
Penyelenggaraan Kolej
Kategori:
Kolej Kediaman Pelajar CMS Zon 2
Juruteru/PP:
E-mel Juruteru:
Pembantu Teknik/PPT:
E-mel PPT:
Juruteknik/Kerani:
E-mel Juruteknik:
Flag:
Save
Cancel

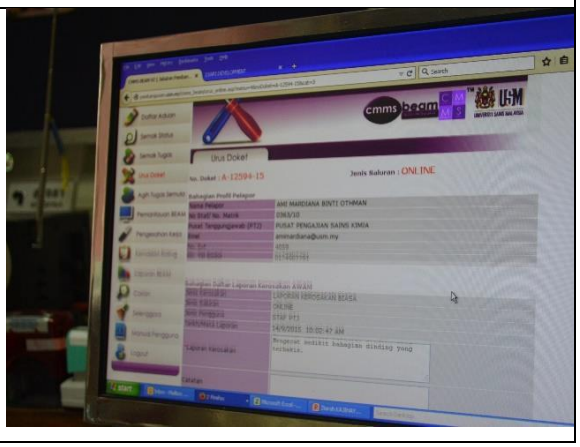

Sistem Pengurusan Penyenggaraan Berkomputer - BEAM
cmms beam
USM
Profil Anda
MUHAMMAD ETHNIN SAFARUDDIN SHAH
My Dashboard

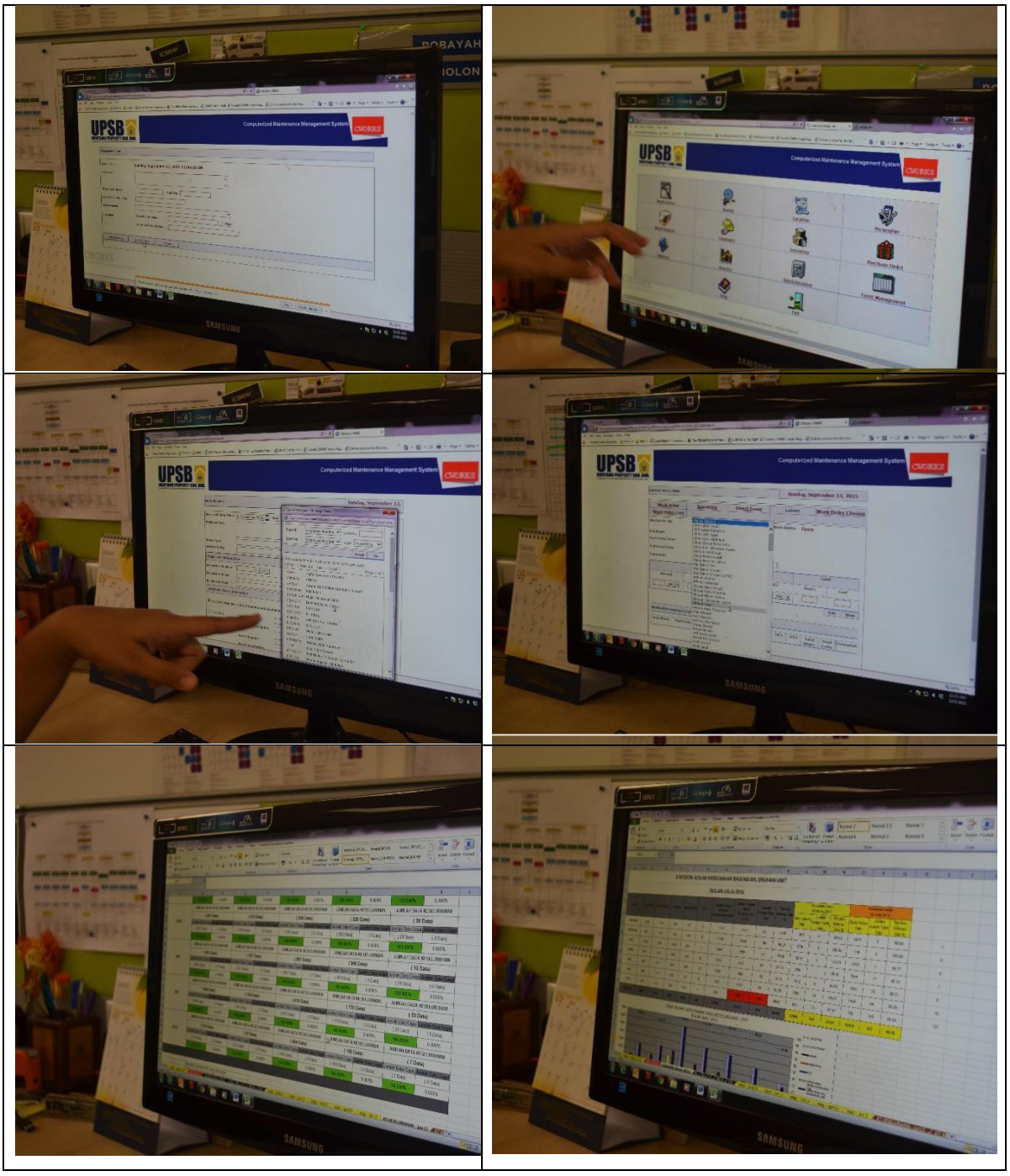



cmms beam
USM


Serangan Serangga Perosak 1.30%
Bekalan Elektrik Terputus 0.98%
Kipas Angin / Pelawas 1.48%
Kebukwasap 0.87%
Kebocoran Bumbung / Siling 3.36%
Sistem Penggera Kebakaran 0.65%
Kemasan Dinding / Lantai 3.74%
Pengurusan Sampah 0.33%
Penambahan Point / Soket /Suis 3.40%
Hawadingin 28.70%
Pintu / Tingkap / Kunci 16.35%
Kelengkapan Tandas / Saluran Paip Bekalan / Paip Buangan 18.78%
Lampu 18.08%
Pecahan Peratusan
Elemen Laporan Tahun 2010 – Sep. 2012

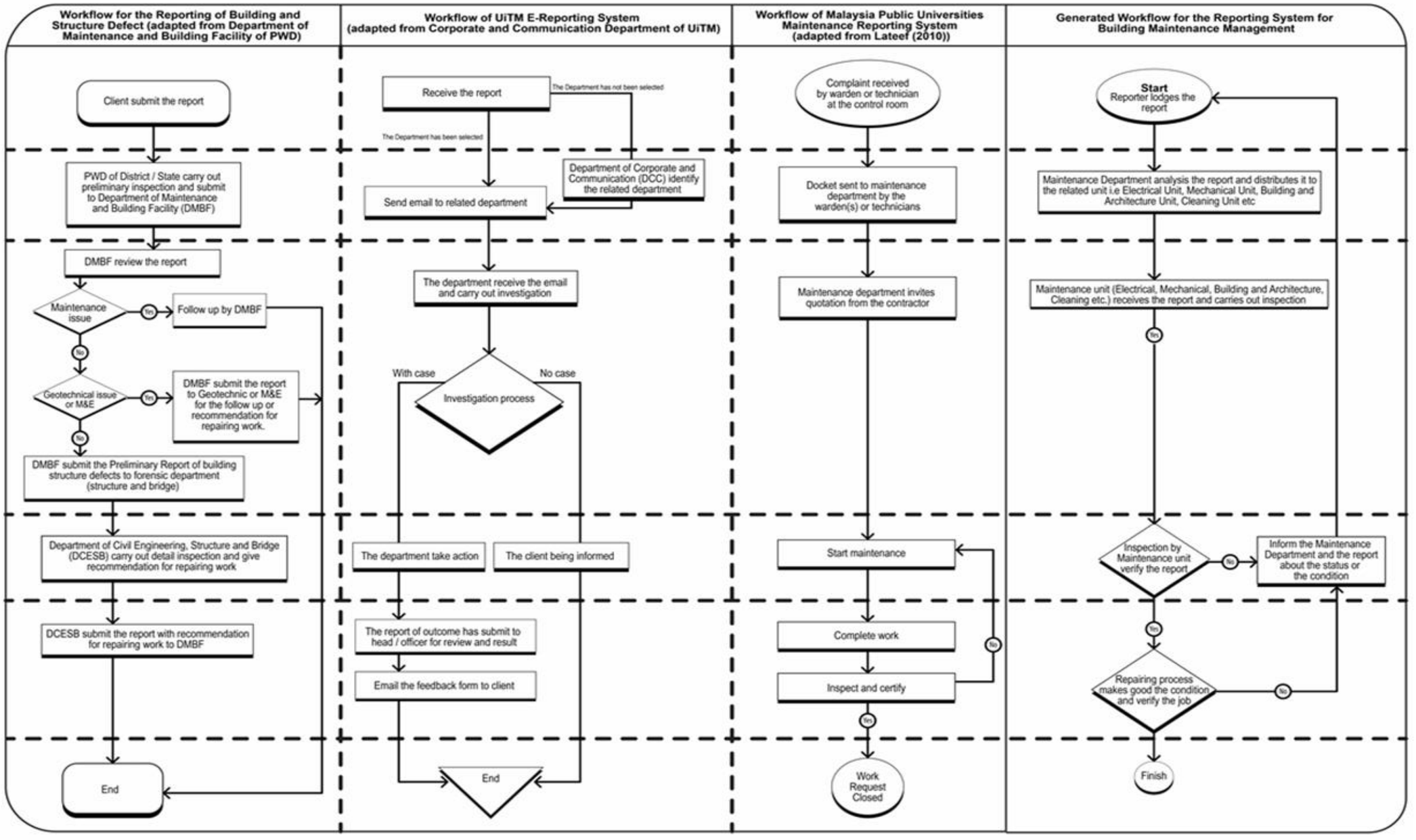

AWAM
ELEKTRIKAL
Komponen Bangunan
2010
2011
Jan – Sep 2012
Jumlah
1. Pintu / Kunci / Door Closer 76 107 71 254
2. Cetem / Mangkuk Tandas 40 30 41 111
3. Siling 46 18 36 100
4. Paip Bekalan Air 21 48 24 91
5. PB Air / Hose Spray 31 14 35 80
6. Kerja Mengecat/Kemasan 16 18 35 69
7. Bumbung / Siling 11 24 27 62
8. Tingkap 9 28 11 48
9. Paip Buangan 5 25 15 45
10. Serangan Serangga Perosak 4 18 2 24
Komponen Bangunan
2010
2011
Jan – Sep 2012
Jumlah
1. Lampu 103 124 107 334
2. Soket / Suis 24 44 32 100
3. Kipas Angin 11 4 5 20
4. Bekalan Elektrik Terputus - 6 12 18
5. Kipas Pelawas - 3 4 7


cmms beam
USM
Urus Dokef
Jenis Saluran : ONLINE


UPSB
Computerized Maintenance Management System
CMORKS
SAMSUNG

Appendix D

The Analysis of Maintenance Reporting System Workflow from BSPN or Bahagian Senggara Persekutuan Negeri (The State and Federal Maintenance Division), The Facilities Management Office of UiTM and Journal paper by Lateef (2010).



LIST OF PUBLICATIONS

Scopus Index Journals

1. Mohd Zulakhmar Zakiyudin, Mohamad Syazli Fathi, Shuib Rambat, Siti Uzairiah Tobi, and Nor A'ini Rajab. A Pilot Study of User-requirements for Building Maintenance Systems in Malaysian Higher Education Institutions. Applied Mechanics and Materials. Vols 773-774 (2015) pp 875-879 © (2015) Trans Tech Publications, Switzerland.

2. Mohd Zulakhmar Zakiyudin, Mohamad Syazli Fathi, Shuib Rambat, Siti Uzairiah Tobi and Nor A'ini Rajab. The User Requirements for Building Maintenance Management Systems in Malaysian Public Universities. IOP Conference Series: Materials Science and Engineering, Volume 620, Sriwijaya International Conference on Science, Engineering, and Technology 15–16 October 2018, Palembang, Indonesia.

3. Mohd Zulakhmar Zakiyudin, Mohamad Syazli Fathi, Shuib Rambat, Siti Uzairiah Mohd Tobi, Narimah Kasim, and Aryani Ahmad Latiffi. The Potential of Context-Aware Computing for Building Maintenance Management Systems. Published by Applied Mechanics and Materials Vols. 405-408 (2013) pp 3505-3508 © (2013) Trans Tech Publications, Switzerland.

Other Journal (Non-Index)

1. Mohd Zulakhmar Zakiyudin, Mohamad Syazli Fathi, Siti Uzairiah Tobi, and Shuib Rambat. Building Maintenance Information Systems: The Adaptation of Context Aware Technology. International Journal of Research in Chemical, Metallurgical and Civil Engg. (IJRCMCE) Vol. 3, Issue 1 (2016) ISSN 2349-1442 EISSN 2349-1450.

Conference Proceeding

1. Mohd Zulakhmar Zakiyudin, Mohamad Syazli Fathi, Siti Uzairiah Tobi, and Shuib Rambat. A Technology Review of Context Aware Information Systems

in Building Maintenance in the 13th Annual Research Conference on Advancement in Business, Science and Technology, ARC-2014, Istanbul, Turkey, August 26-27, 2014.

2. Mohd Zulakhmar Zakiyudin, Dr. Mohamad Syazli Fathi, Dr. Shuib Rambat, Dr. Siti Uzairiah Tobi and Noraini Rejab. Building Maintenance Management in Malaysia: An Overview.7th IRERS IBIMA International Conference, INSPEN, Selangor, 29 - 30 April 2014.