Towards the Development of Malaysia’s Subsurface Asset Management Framework

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Abstract. Underground utility detection survey has been practiced in Malaysia for a long time but it was never regulated. While there are guidelines to govern the practice of utility detection survey, an enabling clause is required to regulate the practice. The aim of this paper is to study the available subsurface asset management framework and to propose a framework for subsurface asset management in Malaysia. The methodology to carry out this research shall involve data collections from stakeholders in the form of interviews, questionnaires and discussions. A case study of an underground utility detection survey shall provide data on the process flow a project which involves stakeholders and the authorities. The final input shall be in the form of intellectual discourses with expert committees related to subsurface utility survey and policy makers. From the findings, it was observed that there were significant discrepancies between the engineering and cadastral survey records. While the engineering survey information related to subsurface utility was up to date, the cadastral survey record was never updated. Furthermore, it was observed that there is no enabling clause in existence to govern the management of subsurface assets. The result of this research is a proposed framework for subsurface asset management based on the data collected. In conclusion, it was recommended for the subsurface asset management framework to be tested in the real working environment and to continue with the efforts to realise the framework.

1. Introduction
Underground Utility Detection Survey (UUDS) is one of the disciplines of Geomatics Sciences which involves non-destructive techniques to survey and map underground and subsurface objects. When underground utility survey and mapping is mentioned, the interests and role played by Licensed Land Surveyors (LLS) are to detect and map underground utilities such as water pipes, power cables, fibre optic cables, sewerage lines and others for the purpose of records, maintenance, planning and development. The selective depths detected by LLS are within the range of 0m to 5m. Any depth deeper than 5m is considered outside the scope of Licensed Land Surveyors.

With the rapid development in the construction and land development industries in Malaysia, the accidents rate which involves underground utility is alarming and on the rise. While there are no specific records on utility accidents in Malaysia and the cost impact of the accidents, Makana et al (2016) estimated that in the United Kingdom, the indirect and social cost of utility strike is 29 times the direct cost of the project.

The Department of Survey and Mapping Malaysia (DSMM) was given the mandate by the Malaysian Cabinet on 24th of August 1994 to manage Malaysia’s underground utility survey and mapping.
(DSMM, Circular 1/2006). After 27 years after the issuance of this mandate, the underground utilities survey and mapping infrastructure is still at its development stage and the task of managing the underground utility survey data is being hijacked by “State Utility Corridors” instead of DSMM.

The National Underground Utility Database (PADU) was developed by DSMM (DSMM, Circular 2/2016) to manage underground utility information with the integration of graphical and attributes data sets of:

| Cadastral lots information | Underground Utility Detection Survey (UUDS) | Images captured from various means |
|----------------------------|-------------------------------------------|----------------------------------|
| Topographic maps           |                                           |                                  |

The current challenge faced by DSMM is to populate and update PADU in conjunction with the rapid pace of utility installation nationwide while maintaining data accuracy and reliability. With the issuance of DSMM Circular No. 2/2016, Licensed Land Surveyors are required to submit to DSMM the underground utility survey drawings in the format that has been prescribed by DSMM. This posed further questions such as the enforcement of the circular, the issue of ownership and copyright of data and finally the liability of the Licensed Land Surveyors.

Singapore with its densely populated land has recognised this problem and has embarked on a program to establish a policy to govern subsurface utility ownership with land administration policy (Yan, J et al, 2021).

Consequently, this paper proposed a legal framework to manage subsurface assets in Malaysia similar to that of the Malaysian Land Registration system.

2. Literature Review

There are two aspects of literature produced within the study and practice of Underground Utility Survey and Mapping which are technical and legal. The interest of this research lies within the legal framework of the Underground Utility Survey and Mapping practice.

Technical literature involves the science of UUDS which covers aspects such as the technology and development of hardware and software. The technical aspects cover procedures from data capture, data processing, data interpretation, data lodgment and presentation of maps and plans.

Legal literature involves the laws and regulations governing the practice of Underground Utility Survey and Mapping. Much of the regulations and guidelines were produced by government bodies such as DSMM, Department of Town and Country Planning Malaysia, Public Works Department and other government agencies.

2.1. The Malaysian Guidelines

The guidelines listed below are the ones issued by various departments in Malaysia to regulate and govern the practice of UUDS in Malaysia.

2.1.1. Department of Survey and Mapping Malaysia (DSMM) Circulars. DSMM has issued six circulars to date which are specifically related to the practice of Underground Utilities Detection Survey by DSMM and LLSs which are:

1) Circular No. 1/2006 : Guidelines for Underground Utility Survey
2) Circular No. 1/2007 : Guidelines for Survey of Underground Utility
3) Circular No. 1/2013 : Guidelines for Survey of New Underground Utility Corridor
4) Circular No. 1/2016 : Guidelines for Colour Code and Marking of Underground Utility Survey
5) Circular No. 2/2016 : Guidelines for Lodgement of Digital Data and Utility Survey Plans from LLS to DSMM
6) Circular No. 1/2020 : Standardisation of the Terms Surveyor, Land Surveyor and Licensed Land Surveyor in Circulars Related to Utility Mapping and Recognition of Competency Certification in Underground Utility Detection Survey
The first four DSMM Circula-
rds (Circular No. 1/2006, 1/2007, 1/2013 and 1/2016) defines the
technical aspects of underground utilities detection and mapping. These circulars relate to quality levels
(A, B, C and D), planimetric and vertical accuracies, colour codes presentation on maps and plans.

The fifth circular, Circular No. 2/2016 defines the submission standards for submission of
underground utilities detection and mapping data to DSMM by LLSs. This includes the plan format and
the GIS data format for submission.

However, the issues that arise from Circular No. 2/2016 are:

a) The legal issue pertaining to the ownership of the underground utilities survey data. The
underground utilities survey was commissioned by the client or owner of the utilities, will
submitting the data to DSMM cause any violation of their rights or confidentiality issues?
b) How about copyright issues? Is DSMM given the authority to sell the underground utilities survey
data to the public like the sale of Certified Plans?
c) The liability of the LLSs with respect to the correctness and accuracy of the underground utilities
detection survey. Underground utilities are subsurface elements that are buried and not visible. Over
time, surface activities such as trenching and resurface of roads may affect their positions in
planimetric and vertical positions. Will the LLSs be held liable for these unforeseen changes to the
underground utilities?
d) The role played by State Utility Corridors such as Koridor Utiliti Johor (KUJ), Koridor Utiliti
Pahang (KUP) and others in collecting utility survey information and becoming the de facto utility
survey data custodian duplicating the role of DSMM.

The sixth circular, Circular No. 1/2020 regulates that only LLS with UUDS Competency Certificate
are allowed to carry out UUDS. Circular No. 1/2020 was issued to further regulate the conduct of UUDS
in terms of technical and legal competency.

2.1.2. Department of Town and Country Planning Malaysia Circulars. Department of Town and
Country Planning Malaysia has produced one guideline which is GP006A Guidelines for Planning of
Utility Corridor. This guideline is meant as reference for Town Planners while preparing Layout Plans
for Planning Permission process. The LLSs will then prepare the Pre-computation Plan based on the
approved Layout Plans. While the Department of Town and Country Planning Malaysia guideline was
developed in 2011, it does not refer to the two DSMM Circulars (DSMM Circular 1/2006 and 1/2007)
which existed before the final development of the Department of Town and Country Planning Malaysia
guideline.

2.2. International Guidelines
The guidelines listed below are from various countries which have established themselves in the field
of underground utility survey and mapping.

2.2.1. The American Society of Civil Engineers (ASCE) Standard 38-02. Quality Level in UUDS which
defines the field survey data standard was developed by the American Society of Civil Engineers
(ASCE, Standard 38-02) and adopted by DSMM in Circular No. 1/2007.

In 2003, the American Society of Civil Engineers (ASCE) published Standard 38-02 titled Standard
Guideline for the Collection and Depiction of Existing Subsurface Utility Data. The standard defined
Subsurface Utility Engineering (SUE) and set guidance for the collection and depiction of subsurface
utility information. The ASCE standard presents a system to classify the quality of existing subsurface
utility data, in accordance with four quality levels:

a) Quality Level D. QL-D is the most basic level of information for utility locations. It comes from
existing utility records or verbal recollections. QL-D is useful primarily for project planning and
route selection activities.
b) Quality Level C. QL-C involves surveying visible above ground utility facilities (e.g., manholes, valve boxes, etc.) and correlating this information with existing utility records (QL-D information).

c) Quality Level B. QL-B involves the application of appropriate surface geophysical methods to determine the existence and horizontal position of virtually all subsurface utilities within a project’s limits.

d) Quality Level A. QL-A, also known as "daylighting", is the highest level of accuracy presently available. It provides information for the precise plan and profile mapping of underground utilities through the actual exposure of underground utilities (usually at a specific point), and also provides the type, size, condition, material and other characteristics of underground features. Exposure is typically achieved through hand digging or Hydro-Vacuuming.

The four Quality Levels defined by ASCE is widely used worldwide as the benchmark to categorize underground utility survey and mapping standard.

2.2.2. The British Standard PAS 128. The PAS 128 has adopted the Quality Level standard as defined by ASCE 38-02 but further refined the Quality Level into a more detailed definition and specifications. Quality Level B was further refined into sub-sections such as QL-B4, B3, B2 and B1. The planimetric and vertical accuracy of the survey would increase from QL-B4 to B1.

2.2.3. The Singapore Utility Survey Standard. The Standard and Specifications for Utility Survey in Singapore was published in August 2017 by the Singapore Land Authority (SLA) to regulate the practice of underground utility survey and mapping in Singapore (SLA, 2017).

The SLA standard is meant for new installation of subsurface utilities and only Quality Level A is accepted as the survey and data submission standard. The data structure for submission was clearly defined by the SLA standard and the utility surveyor is required to prepare data for submission to SLA based on the defined standard. The SLA is currently developing its database with the assistance from a Swiss based Company.

2.3. Current Research on Subsurface Asset Management Issues

Pouliot (2016) has produced a study of the possibility of issuing land titles for underground utilities in the Quebec province of Canada and from the basis of Pouliot’s study, this research will expand the possibility to implement the approach in Malaysia.

Di Wu and Xueqing Zhang (2015) has proposed a framework for effective management of subsurface assets in Hong Kong whereby the process flow is almost similar to the process of land development in Malaysia. The Hong Kong framework requires an Excavation Permit (XP) that is the pre-requisite before any subsurface utility installation works can be carried out. This process is almost similar to the process of registration of Qualified Title in Malaysia whereby the Land Surveyors Board shall issue a certificate prior to the registration of Qualified Titles.

In October 2017, the Singapore government started a Digital Underground project in order to develop a roadmap to provide a reliable underground utility database for planning and development purposes. The Digital Underground project involves collaboration from Singapore Land Authority (SLA), Singapore-ETH Centre, and the Geomatics Department of the City of Zürich (Schrotter, 2020).

The Land Surveyors Board of Malaysia is currently in the process of amending the Licensed Land Surveyors Act 1958 (Act 458) and UUDS has been included as part of the Act.

3. Methodology

This research shall involve the following components as part of the data and information collection process. Table 1 summarizes these phases with respect to data collection, analysis, and output and detail explanation of each phase is described in Section 3.1 to 3.3.
### Table 1. Phases of Study

| Data Collection       | Phase 1: Interview, Questionnaires and Discussion | Phase 2: Case Study | Phase 3: Intellectual Discourse |
|-----------------------|-----------------------------------------------|---------------------|--------------------------------|
| Target Group:         | Stakeholders                                  | KEJORA Water Reticulation Project | Target Group:                  |
|                       | Utility owners                                 |                     | DSMM UUDS Department            |
|                       | Practitioners (LLS)                            |                     | PEJUTA                         |
|                       |                                               |                     | SLA                            |
|                       |                                               |                     | Other expert committees        |
| Data Analysis         | Output: Statistics from interview, discussion and questionnaires | Output: Engineering Survey Plan, Land Acquisition Plan | Output: Circulars, Policy papers, Technical papers |
| Output                | Subsurface Asset Management Framework          |                     |                                |

3.1. Phase 1: Interview, Questionnaires and Discussion with Stakeholders

For the purpose of this study, interviews and discussions were conducted with four of the underground utility stakeholders which are DSMM Utiliti Mapping Section, Tenaga Nasional Berhad (TNB), Johor Utility Corridor (KUJ) and Johor Water Company (SAJ). The interview method shall be semi-structured as it is deemed most suitable for the qualitative research.

DSMM established a Utility Mapping Section under the Mapping Division in 2006. DSMM later acquired a Utility Mapping System and developed a national underground utility database called PADU. The database consists of four major components of information namely large scale photogrammetric base maps that are tied to the geodetic networks, cadastral overlays delineating all land parcels, topographic data and a series of utility layers, each containing utility features and attributes (Jamil et al, 2012).

KUJ has been entrusted as the Utility Supervisor by the State of Johor and is mandated to establish and manage the One Stop Agency for Johor’s Utility Infrastructure Corridor. KUJ, as a One Stop Agency is given the responsibility to coordinate, plan, implement policies, and procedures to integrate utility development information in order to help the government in preparing a comprehensive and inclusive Master Plan that is able to balance utility infrastructure development. The purpose of the interview and discussion with KUJ was to understand the roles and responsibilities of KUJ with respect to the management of underground utilities in Johor.

SAJ is an integrated water supply company, involved in the process of water treatment and distribution of treated water to consumers right up to billing and collection. The purpose of the interview and discussion with SAJ was to understand the roles and responsibilities of SAJ with respect to water reticulation system and its relationship with subsurface asset management.

3.2. Phase 2: A Case Study of Johor Tenggara Development Board (KEJORA) Proposed Installation of Water Reticulation System in Kota Tinggi, Johor

The project above was awarded to a consultant land surveying firm, Ezam & Associates by Johor Tenggara Development Board (KEJORA) in January 2018 and was completed in July 2020. Ezam & Associates was assigned to carry out land surveying services and supply the final survey data for the purpose of installation of new water reticulation system from Teluk Sengat to a new “kampung tersusun” in Tanjung Buai.
The project above was chosen as a case study for this research due to the following reasons:

a) The project involves topographic survey, UUDS and land acquisition process which are the main topics of discussion for this research. This project shall supply the relevant data for this research in order to establish the process flow related to utility survey and subsurface asset management.
b) The project involves survey alignment which was based on an old land acquisition performed in 1987 by Jurukur Perunding. However, based on the records kept by Kota Tinggi Land Office and Department of Survey and Mapping Malaysia (DSMM) the land acquisition process was never fully completed. The findings shall be the basis to support the need for the development of a subsurface asset management framework.
c) A framework of subsurface asset management shall be proposed based on the two reasons above and study of the current research literature available on the subject matter of subsurface asset management.

3.3. Phase 3: Intellectual Discourse with PEJUTA UUDS Committee, DSMM Technical Committee for Utility Mapping, Singapore Land Authority (SLA) and other technical committees

Intellectual discourse from Professionals and Expert Opinions Committee shall be documented as part of the data collection exercise. This committee shall be comprised of DSMM underground detection survey division, Land Surveyors Board, PEJUTA underground detection survey committee, Department of Town and Country Planning and other committees that are directly involved in the policy making of subsurface assets.

In August 2020, DSMM awarded University Technology Malaysia (UTM) for the research and development of National Underground Utility Mapping Policy (NUUMP). The author was selected as part of the data analysis and validation committee member.

4. Preliminary Results

A new Act specific to Underground Utility Mapping is proposed based on the results of the data collection and analysis. This proposal is expected to be presented by the NUUMP research committee to DSMM in March 2021. This Act is expected to be implemented with other Acts related to land matters such as the National Land Code as part of the subsurface asset management framework.

Among the features of the proposed Act are:

a. To establish the enabling clause for DSMM as the custodian of the underground utility data in Malaysia. This is in junction with DSMM Circular No. 1/2006.
b. To make it compulsory for the UUDS data to be submitted to DSMM. This is in junction with DSMM Circular No. 2/2016. The purpose of this requirement is to ensure that the PADU database is being populated.
c. To define and establish the authority of LLS as the competent authority in carrying out UUDS survey. This is a significant contribution to the integrity of the UUDS data since it ensures that the survey is being carried out by authorised and competent professionals.

5. Conclusion

In conclusion, an enabling clause is required to be established in order to develop the subsurface asset management framework. The proposal to draft a specific Act with regards to Underground Utility Mapping shall pave the way to the establishment of a subsurface asset management framework. The process of passing the Act via the Parliamentary process is outside the scope of this research and is expected to take a significant time.
The authors anticipate that by having the Underground Utility Mapping Act in place, subsurface assets in Malaysia will be better managed. DSMM PADU shall be updated and act as a centralised database for the national subsurface asset management system.

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