ASSESSMENT OF KEY SUCCESS FACTORS IN THE UTILIZATION OF GEOGRAPHIC INFORMATION SYSTEM FOR DISTRIBUTION ELECTRICAL NETWORK AT TENAGA NASIONAL BERHAD

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DEDICATION

This thesis is dedicated to my beloved husband, kids and mother for their everlasting love, devotion and cooperation during my studies year. Thank you for their unfailing support and understanding and easing my study path until graduation. May Allah bless them all.

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ABSTRACT

Tenaga Nasional Berhad Distribution Network (TNB DN) has embarked on the development of a Geographic Information System (GIS) since 2009 to map and digitize TNB DN electrical assets, networks and customers' premise. GIS is one of the enablers for TNB becoming a smart electric utility towards grid of the future. Previous GIS implementation needs to be re-implemented due to problems with the GIS components. The components comprised system, data, business process and user have led to low utilization of GIS that impacted data asset mapping delivery date and data quality. As a result, the management of TNB decided GIS to be re-implemented and to ensure that it is successful. Therefore, Key Success Factors (KSFs) were chosen due to their high influence on the outcome of a project status. The re-implementation took placed in Cheras area as the case study. The study developed a revised strategy for evaluation of successful GIS re-implementation through KSFs methodology. Data from previous implementations such as surveys, workshops and feedback from users of TNB Cheras were used as secondary data. A revised strategy was planned to implement the propose improvements, enhancement and new methods from the review exercise based on GIS components. KSFs were identified from the implementation of a TNB GIS success model. The KSFs were later developed and implemented on GIS components using Technical Evaluation Data Sheet (TEDS), which was established to measure the success of the re-implementation of the GIS components. The TEDS of the KSFs were executed for pre-evaluation and post evaluation phases. In addition, measurement methods namely, Mean Score method (MSm) and System Usability Scale survey ranking method (SUSsrm) were used to determine the KSFs outcome. The outcomes of these two measurement methods established KSFs index and both evaluation phases showed results above 85%. In conclusion, the study in Cheras was a success with the KSFs index post evaluation of 88%. Based on the findings, the top management of TNB approved the outcome of the KSFs index of post evaluation and have agreed to rollout the project nationwide using Cheras GIS re-implementation methods as the benchmark.

ABSTRAK

Tenaga Nasional Berhad Rangkaian Pembahagian (TNB DN) telah membangunkan Sistem Maklumat Geografi (GIS) sejak 2009 untuk memetakan dan mendigitalkan aset elektrik, rangkaian dan premis pelanggan TNB DN. GIS merupakan salah satu pemboleh bagi TNB menjadi utiliti elektrik pintar ke grid masa depan. Pelaksanaan GIS sebelum ini perlu dilaksanakan semula kerana masalah dengan komponen GIS. Komponen yang terdiri daripada sistem, data, proses perniagaan dan pengguna telah menyebabkan penggunaan GIS yang rendah yang memberi kesan kepada tarikh penghantaran data aset pemetaan dan kualiti data. Ekoran dari itu, pihak pengurusan TNB memutuskan GIS untuk dilaksanakan semula dan memastikan ianya berjaya. Oleh itu, factor kejayaan utama (KSFs) dipilih kerana pengaruh mereka yang tinggi terhadap hasil status sesebuah projek. Pelaksanaan semula dilaksanakan di kawasan Cheras sebagai kajian kes. Kajian ini telah membangunkan strategi yang telah disemak untuk penilaian pelaksanaan semula GIS melalui metodologi KSFs. Data daripada pelaksanaan sebelumnya seperti tinjauan, bengkel dan maklum balas daripada pengguna TNB Cheras digunakan sebagai data sekunder. Strategi yang disemak semula dirancang untuk melaksanakan cadangan penambahbaikan, peningkatan dan kaedah baru dari semakan kajian berdasarkan komponen GIS. KSFs telah dikenal pasti melalui pelaksanaan model kejayaan TNB GIS. KSFs kemudiannya dibangunkan dan dilaksanakan pada komponen GIS menggunakan helaian data penilaian teknikal (TEDS), yang dibangunkan untuk mengukur kejayaan pelaksanaan semula komponen GIS. TEDS KSFs telah dilaksanakan untuk fasa pra-penilaian dan pasca-penilaian. Di samping itu, kaedah pengukuran iaitu kaedah skor min (MSm) dan sistem skala kebolehgunaan (SUSsrm) digunakan untuk menentukan hasil KSFs. Hasil dari kedua-dua kaedah pengukuran ini menghasilkan indeks KSFs dan kedua-dua fasa penilaian menunjukkan hasil di atas 85%. Kesimpulannya, kajian di Cheras berjaya dengan penilaian pasca indeks KSFs sebanyak 88%. Berdasarkan penemuan itu, pengurusan tertinggi TNB meluluskan hasil indeks penilaian pasca KSFs dan telah bersetuju untuk melaksanakan projek di seluruh negara menggunakan kaedah pelaksanaan semula GIS di Cheras sebagai tanda aras.

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ACE	-	Application Configuration Environment
ADMS	-	Advanced Distribution Management System
AM	-	Adaptive Methods
AMI	-	Advanced Metering Infrastructure
AR	-	Asset Register
BCRM	-	Billing and Customer Relationship Management
BI	-	Business Intelligence
BPMN	-	Business Process Model and Notation
BQ	-	Bill of Quantity
CAPEX	-	Capital Expenditure
CEO	-	Chairman Executive Officer
CGIS	-	Corporate Geographic Information System
CMC	-	Call Management Center
CP	-	Construction Project
CPP	-	*Cadangan Pelan Pembangunan*
CR	-	Change Request
CRA	-	Change Readiness Assessment
CSA	-	Customer Service Assistant
CS	-	Customer Service
CSS	-	Customer Service Support
DC	-	Data Collection
DFD	-	Data Flow Diagram
DHC	-	Data Health Check
DMU	-	Data Management Unit
DN	-	Distribution Network
DNIM	-	Distribution Network Information Management
DNIS	-	Distribution Network Information System
DNPT	-	Distribution Network Project Team
DOIT	-	Distribution Organizational Improvement & Transformation
DPMS	-	Distribution Project Management System

EC	-	Energy Commission
e-CIBS	-	e- Customer Information Billing System
EO	-	Electric Office
ERD	-	Entity Relationship Diagram
ERMS	-	Enterprise Resource Management System
ESB	-	Enterprise Service Bus
EWIS	-	Enterprise Wide Information System
FAT	-	Final Acceptance Test
FDC	-	Field Data Collection
FL	-	Functional Location
FME	-	Feature Manipulation Engine
FOSS4G	-	Free and Open Source Software for Geospatial
FOU	-	Front Office User
FRR	-	Functional Requirement Reports
GE	-	General Electric
GIS	-	Geographical Information System
GISDN	-	GIS Distribution Network
GISDNPT	-	GIS Distribution Network Project Team
GISSM	-	GIS Success Model
GLCs	-	Government Linked Companies
GMSC	-	Geo Media Smart Client
GSA	-	Geospatial Analysis
GUI	-	Graphical User Interface
HDD	-	Horizontal Directional Drilling
HV	-	High Voltage
ICT	-	Information and Communication Technology
ICTGC	-	Information and Communication Technology Governance Council
ILMAS	-	Internet Load Management System
INA	-	Information Not Available
IoT	-	Internet of Things
IS	-	Information System
ISD	-	International System Development

ISO	-	International Standard Organization
ISPT	-	Identify Source Point Tool
IT	-	Information Technology
JUPEM	-	*Jabatan Ukur Dan Pemetaan* Malaysia
KL	-	Kuala Lumpur
KSFs	-	Key Success Factors
kV	-	kilovolt
LKKK	-	*Lembaran Kerja-Kerja Kecil*
LPC	-	Large Power Consumer
LV	-	Low Voltage
LVDB	-	Low Voltage Distribution Board
MFFA	-	Mobile Field Force Automation
MS	-	Malaysian Standard
MSm	-	Mean Score method
MV	-	Medium Voltage
NA	-	Not Available
NCR	-	New Connection and Reconnection
NDCDB	-	National Digital Cadastral Database
OO	-	Object Oriented
O & M	-	Operation & Maintenance
OMS	-	Outage Management System
OPC	-	Ordinary Power Consumer
OSGeo	-	Open Source Geospatial
OTC	-	Operational Technical Committee
PDUK	-	*Pangkalan Data Ukur Kadaster*
PE	-	*Pencawang Elektrik*
PM	-	Plant Maintenance
PMO	-	Project Management Office
PMU	-	*Pencawang Masuk Utama*
PNI	-	Physical Network Inventory
PPU	-	*Pencawang Pembahagian Utama*
PPWP	-	Project Planning and Wayleave Planning
PPWPCP	-	Project Planning and Wayleave Planning and Construction

PS	-	Project System
PSC	-	Project Steering Committee
PSI	-	Process Standardization and Improvement
PSS	-	Power System Simulator
PVE	-	Production Verification Environment
QAQC	-	Quality Assurance and Quality Control
QMS	-	Quality Management System
QR	-	Quality Record
R	-	Reconnection
RFI	-	Request for Information
RJO	-	Rechargeable Job Order
RU	-	Reading Unit
SAP	-	System Application and Products
SC	-	Success Criteria
SCADA	-	Supervisory Control and Data Acquisition
SD	-	Sales and Distribution
SDLC	-	System Development Life Cycle
SDM	-	System Development Method
SF	-	Success Factor
SGM	-	Senior General Manager
SI	-	System Implementer
SJHT	-	*Senarai Jadual Harga Tetap*
SME	-	Subject Matter Expert
SMS	-	Short Message Service
SNC	-	Supply New Connection
SNCR	-	Supply New Connection and Reconnection
SO	-	Structure Oriented
SOA	-	Service Oriented Architecture
SOP	-	Standard Operating Procedures
SSU	-	*Stesen Suis Utama*
SUS	-	System Usability Scale
SUSsrm	-	System Usability Scale survey ranking method
sWP	-	Sub Work Package

TCS	-	Trouble Call Management System
TEDS	-	Technical Evaluation Data Sheet
TFR	-	Technical Fault Repair Crew
TM	-	Telekom Malaysia
TNB	-	Tenaga Nasional Berhad
TOMS	-	TNB Outage Management System
UAT	-	User Acceptance Test
UG	-	Under Ground
UI	-	User Interface
UK	-	United Kingdom
UTM	-	Universiti Teknologi Malaysia
VMDS	-	Version Managed Data Store
WP	-	Work Package

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CHAPTER 1

INTRODUCTION

1.1 Background

Tenaga Nasional Berhad (TNB) is one of the Malaysian Government Linked Companies (GLCs). The company is the largest electric utility company in Malaysia and also the largest power company in Southeast Asia (TNB, 2018).

TNB's core activities are in the generation, transmission and distribution of electricity as shown in Figure 1.1. TNB Distribution has two value chain business activities which are Network Operations and Retail Operations. Network Operations are under Distribution Network Department. Distribution Network (DN) strategizes system and supply planning projects, constructs, operates, performs repairs and maintenance as well as manages the assets of the 33 kilovolt (kV), 22 kV, 11 kV, 6.6 kV and 415/240 volts in the Peninsular Malaysia distribution network.

TNB Distribution existing assets are huge and continue to grow daily as new assets are added every day in the system from new supply application and asset changes. The statistics of assets in year 2017 (AMSDS, 2017) that was published for the Energy Commission (EC), Malaysia, stated that there are about 76,700 substations, 1.3 million kilometres of cables, 2.4 million streetlights and 8.6 million meters of assets that need to be operated and maintained by Distribution Network Departments. Therefore, TNB Distribution has 110 stations located in all the states in Peninsular Malaysia in order to deliver good service performance to the customers.

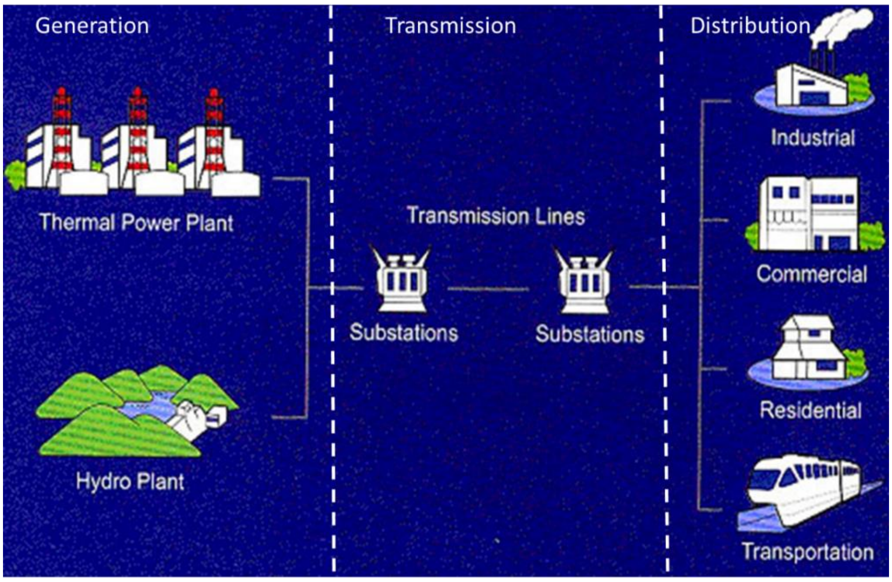

Figure 1.1 Illustration of Energy Generated, Transmitted and Distributed to Customers (TNB, 2018)

Current business needs have made TNB's top management lead TNB to transformation. Gemici and Alpkan (2015) explained, that the changes in the market relate to disruptive technologies due to new customers and existing customers wanting new products, services and others that drive industry into harsh competition but the successful industry is the one that identified the gaps and created a new mass market. Therefore, TNB has transformed its organisation by focusing in important tasks such as shaping the regulatory outcome by the EC in terms of fast supply application, reduce duration and frequency of breakdown, exceed customer expectation, drive operational cost efficiency and transform and improve the business process through technology emergence. This transformation is important and embracing technology can help prevent the demise of great companies. Geographic Information System is one of the technology introduced in creating digital database for better Asset Management Tool and Performance and Big Data in TNB. Therefore, Corporate Geographical Information System (CGIS) was introduced and executed to six divisions in TNB in year 2009.

CGIS project in TNB uses Enterprise Wide Information System (EWIS) and Information and Communications Technology (ICT) division was given the authority as the project champion and the six divisions were part of the ICT CGIS structure as Data Management Unit (DMU). The six divisions involved with the implementation of CGIS are:

i. Generation Division
ii. Transmission Division
iii. Distribution Division
iv. ICT Division
v. Corporate Services and Affairs Division
vi. System Planning Division

The implementation of CGIS was based on TNB's Ten Year GIS Master Plan (Accenture, 2008). The scope of work is to map and digitize TNB Distribution electrical assets and to systematically establish the customer database. The GIS road map was defined in year 2008 and the year 2009 to 2012 were identified as foundation project implementation period i.e. to register all identified and relevant TNB assets in Geographic Information System (GIS) software as shown in Figure 1.2.

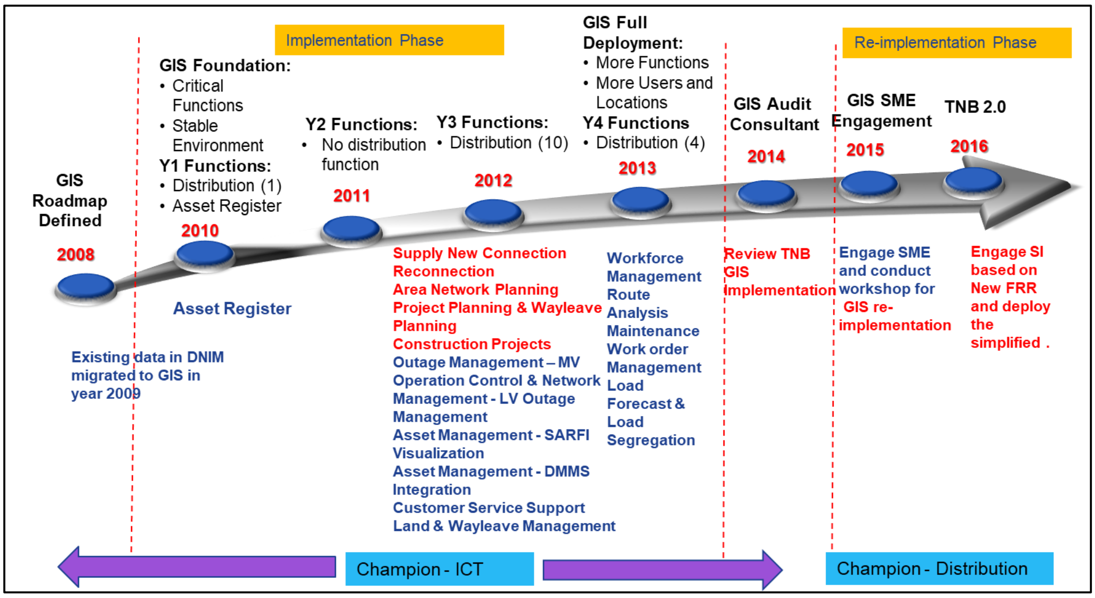

Figure 1.2 TNB GIS Distribution Road Map (KPMG, 014)

General Electric (GE) Smallworld has been awarded by procurement as GIS software for TNB. During the implementation period, many problems were experienced by users in TNBDN such as data conflict, data errors and the major one was data corrupted in September 2013 in GIS GE Smallworld software. These problems contributed to the lack of utilization by user and impacted the asset mapping delivery date and data quality. According to the GIS Master Plan, a review was supposed to take place after the fourth year of implementation. Considering also the users' feedback that has been gathered during the implementation period, ICT Governance Council (ICTGC) has decided to review TNB CGIS implementation in year 2014. The committee has decided to appoint a consultant to review CGIS Master Plan in January 2014. The review is to focus on four CGIS components which are System, Data, Business Process and User.

The outcome of the Master Plan reviewed in year 2014, ICTGC has decided to continue the project but with a revised strategy where the six divisions are the champion of their own project and the new champions must take into account gaps to be addressed and current technological landscape to be ventured.

For this thesis, the re-implementation of the reviewed GIS project is to take place at a pilot project area named TNB Cheras under a project team called GIS Distribution Network Project Team (GISDNPT) that reports to a GIS DN Project Steering Committee (PSC) where the project director is the Senior General Manager (SGM) of DN. The successful implementation of GIS at TNB Cheras is mandated by ICTGC as pre-requisite to further rollout GIS nationwide.

Successful implementation is identified as the most important criteria for the success of this GIS re-implementation project. Therefore, Key Success Factors (KSFs) must be identified, developed, implemented and measured in order to convince ICTGC decision to roll out the project nationwide. The developed KSFs is classified as Technical Evaluation Data Sheet (TEDS) and it is implemented using survey method, tracking log, interview and actual realization by user on the four GIS components which are System that comprises software and hardware, Data, Business Process and User. The User refers to internal customer i.e. staff of TNB Cheras and GISDNPT.

The most efficient ways of gathering statistically valid data and giving the survey data a clear and reasonably precise score for the ICTGC members to decide is with the usage of the Mean Score method (MSm) and System Usability Scale survey ranking method (SUSsrm). The KSFs index outcome is established from the outcome of these two methods to determine the success of the GIS re-implementation in Cheras.

1.2 Problem Statement

The CGIS project started in Distribution Division in year 2010 by implementing Asset Register (AR) function. AR function is used by GISDNPT to capture, digitize and map existing asset of TNB DN in GIS software. This function has been implemented not only in Cheras but also in Kuala Selangor, Sg. Besar, Putrajaya and Kuala Lumpur within the four-year period. Besides Asset Register, four other functions are deployed in Cheras. Those functions are:

i. Supply New Connection (SNC)
ii. Reconnection (R)
iii. Project Planning and Wayleave Planning (PPWP)
iv. Construction Projects (CP)

These four functions are used for capturing, digitizing and mapping of new data and data changes in GIS Software.

Feedback and utilization of GIS by Users are used as one of the benchmarks for the success of the project by top management beside time, cost and scope of work. The feedback from the User is gathered by the consultant during the review period through workshops, meetings, interviews and sampling of data and classified as 100 Gaps or Issues as in Appendix A. The evaluation is based on existing functions and CGIS system architecture. The identified problems are divided into two, first from the review reports by the appointed consultant and the second is from the 100 Gaps or

Issues that are documented through workshops, interviews and surveys. Below are the listed problems:

i. Problems Based on Review Reports

The problems discussed below are from the consultants and discussion focused on the four GIS components:

a. System

The existing system was highly customized with hard coded script by the previous System Implementer (SI). User seldom experienced system hang up or were kicked out from the working session.

b. Data

GIS project in TNB uses EWIS, the standard data model for the six divisions. There was no data governance in-place at that time to monitor changes in data model by any of the divisions.

Data production itself is very challenging especially in the execution of data collection and data digitization that consist of Medium Voltage (MV) and Low Voltage (LV) asset, network, and customers. Data changes every day and also completeness of data is very important in the electricity utility, inadequate enforcement of data maintenance process contributes to poor data update and lead to poor decision making.

Also there is poor monitoring of data quality because of inadequate tools, in-experienced QAQC staff as well as poor existing process that made the LV data acceptance process lenient.

c. Business Process

A total of 15 functions were proposed in the TNB's Ten Year GIS Master Plan that were later developed and deployed in TNB DN with minimal stabilization period and limited daily work scenarios that contribute to low utilization of GIS.

d. User

KPMG (2014) claimed that the problem faced by ICT was insufficient project champions at the divisional level. This relates closely to lack of emphasis in people and manpower resourcing. In addition, performance measurement to support CGIS implementation was not performed by TNB ICT. At the end of the day, the user in Cheras has proven the project performance by low utilization of GIS applications i.e. 30% detected from the tracking logs by ICT.

ii. Problems Based on User Perspective

From the user's perspective, the problems that are gathered are listed in the 100 Gaps or Issues as in Appendix A. Some of the remaining balance of unresolved 100 issues are identified and discussed below:

a. System

The system has login, average response time and uptime issues. The Login time is on average 90 seconds which is too long for the user to wait and the average response time is on average 10 seconds which is unsatisfactory. In addition, the Uptime is on average 92%, which is unsatisfactory. The Uptime measures the computer operating system reliability where the computer still works even when left unattended. Also, the existing system is not able to perform query data from electric dataset against data in land dataset, for example locating customer address based on account number, nearest road name to substation and identify substation within Work Package (WP) boundaries.

b. Data

The upload task of collected coordinates at site into Smallworld was not automated. The GISDNPT has to digitize the coordinates manually. During digitization, users have identified inconsistency between parent object with child. The LV cable should have been four core cable but instead users have to do the checking manually for all the related data for data accurateness. In addition, there were cases where the objects without child, for example transformer without fuse or demand point without account number.

c. Business Process

The challenges centred on SNC, PPWP and AR. The SNC and supply PPWP are for new or existing customer who upgrades or applies electricity supply. The developed GIS functions for SNC and PPWP have limited supply application works scenarios. In daily work activities there are other scenarios available e.g. upgrading of existing supply application from single phase supply to three phase supply, LV supply improvement where upgrading of cable size to customer house and street light application.

d. User

The training provided was not sufficient, user needs continuous training and hand holding. It is important to reduce the steep learning curve due to new technology landscape that are being used.

The problems discussed above that are based on review reports and user perspective identified contributed to low utilization of the functions that has been deployed that affected the data management in GIS. Wing, Andrew and Petkov (2017) agreed that for an Information Technology (IT) project, project that is being utilized fully by user should be the indicator for project success. The data healthiness in GIS contributes very much to utilization. There was no data health checked performed, only system health check performed by ICT with low monitoring by GISDNPT. Hence, existing data is not updated, new data not captured and the data completeness status was questionable. This led to data incompleteness, data gaps become widened and the decision making process can be affected due to inaccurate information of TNB DN asset. Eldrandaly, Naguib and Hassan (2015a) discussed the challenges faced by developing countries on operating and maintaining phases of GIS life cycle where GIS projects are completed at high cost with not having good strategy and factors in determining its success. Therefore, it is very important to strategically identify, develop and implement KSFs for measurement of successful GIS project. The identified KSFs in the TEDS is implemented during the re-implementation stages focusing on the four GIS components in order to influence the successful outcome such that the issues are identified and corrected earlier.

Currently, the world industry is in Industrial Revolution 4.0. Smart grid is one of the Industrial Revolution 4.0 digital technologies. Since TNB is going towards becoming smart utility for the grid of the future industry, GIS must continue and become successful in order to become the platform for Advanced Distribution Management System (ADMS) that is going to replace Supervisory Control and Data Acquisition (SCADA). Interconnectivity through Internet of Things (IoT) enables GIS to provide maps and related services to Mobile Workforce and Advanced Metering Infrastructure (AMI) easily through digital infrastructure to expedite and produce work efficiency. For a mature GIS implementation, the outcome has proven cost reduction and increase operational efficiency as discussed in KPMG (2014) and benchmarked in Appendix B. Therefore, it is important for GIS to be re-implemented and become a successful project in order to gain its benefit to the users, stakeholders and company.

1.3 Aim and Objectives of Research

The aim of the research is to develop a revised strategy for measurement/evaluation of successful GIS project re-implementation in TNB Distribution electrical networks through KSF methodology. Therefore, the objectives of this research are:

i. To review the existing GIS implementation in TNB Distribution.
ii. To develop and evaluate strategize plan for the re-implementation of four GIS components which are System, Data, Business Process and Users.

iii. To identify, develop and implement key success factors for the re-implementation of four GIS components.
iv. To analyse and conclude the outcome of the key success factors based on the four GIS components for way forward in GIS implementation in TNB Distribution.

1.4 Research Questions

Research questions are the questions that are prepared to guide the writer to focus on the core or objectives of the research. It provides clear and proper methods that are used in the preparation of the research and writing process. Table 1.1 presents the research questions prepared to be focused and aligned with the research objectives of this thesis as well as identifying the methodology used in acquiring data and the data source to be referred to.

Table 1.1 Research Questions

Research Questions				
No	**Research Objectives**	**Research Questions**	**Methodology of Acquiring Data**	**Data Source**
i	To review the existing GIS implementation in TNB Distribution.	a. What were the issues of the existing GIS implementation in TNB Distribution?	i. Existing TNB Documents ii. Feedbacks from Workshops and Meetings iii. Survey Before Re-implementation	i. TNB's Ten Year GIS Master Plan (Accenture, 2008) ii. 100 Gaps/issues report (Appendix A) iii. TNB's Review Report 2014 (KPMG, 2014) iv. Survey report with TNB Cheras and GISDNPT
		b. Why the issues of the existing GIS implementation were not resolved?	i. Insufficient Project Champions because project implementation driven by ICT ii. Performance measurement to support CGIS implementation was not performed	i. Function utilization Tracking log by TNB ICT ii. GIS Utilization report by TNB ICT iii. Reports of bugs fixing, enhancement and new requirement by TNB ICT iv. TNB's Review Report 2014 (KPMG, 2014)

			iii. Lack of emphasis in people and manpower resourcing iv. Poor communication between Users and implementers	
		c. How can the issues of the existing GIS implementation be resolved?	i. Conduct factual verification and validation with end users and senior management ii. Literature review from lesson learned by other companies iii. SMEs' advice and proposal after conducting production system control testing iv. Analyse TNB's Review Report	i. TNB's Review Report 2014 (KPMG, 2014) ii. Survey report with TNB Cheras and GISDNPT iii. Functional Requirement Reports (FRRs) from Infotech (2009)
ii	To develop and evaluate strategy for the re-	a. What was the strategy used in the existing GIS implementation in TNB Distribution?	i. Conduct factual verification on the developed functions ii. Analyse the document generated using GIS and	i. TNB's Ten Year GIS Master Plan (Accenture, 2008) ii. TNB's Review Report 2014 (KPMG, 2014) iii. Survey report with TNB Cheras and

	implementation of four GIS components which are System, data, Business Process and Users.		compare with the previous report generated before GIS	GIS DN Project Team iv. FRRs (Infotech, 2009)
		b. Why was the strategy used earlier need to be reviewed?	i. Low utilisation of functions ii. Low utilization of GIS	i. Utilization of tracking log by TNB ICT ii. Updated GIS Mater Data in Smallworld iii. Analyse the SNC and Cadangan Pelan Pembangunan (CPP) or Proposed Development Plan produced by users i.e. using GIS or not
		c. How to develop a revised strategy for the re-implementation of GIS ?	i. To review current strategy in the four component of GIS	i. TNB's Review Report 2014 (KPMG, 2014) ii. Survey report with TNB Cheras and GISDNPT iii. FRRs (Infotech, 2009) iv. Literature review

iii	To develop and implement key successful factor for the re-implementation of	a. Why is the need to develop key successful factors for the re-implementation of GIS?	i. Performance measurement to support successful re-implementation of GIS	i. Benchmarking against leading practices ii. Literature review iii. TNB's Review Report 2014 (KPMG, 2014)
		b. What type of key successful factors need to be developed for the GIS re-implementation?	i. To develop KSFs based on four GIS components	i. TNB's Review Report 2014 (KPMG, 2014) ii. Survey report with TNB Cheras and GISDNPT iii. Literature review
		c. Why were the factors chosen for the development?	i. The reviewed were based on the four GIS components ii. These factors contributed to the issues raised by TNB Cheras and GISDNPT	i. TNB's Review Report 2014 (KPMG, 2014) ii. Survey report with TNB Cheras and GISDNPT iii. Literature review
		d. How is the implementation of the key successful factor executed?	i. System: tracking log, interview the ICT related key personnel, audit related factors with TNB ICT,	i. TNB’s Review Report 2014 (KPMG, 2014) ii. Re-implementation Survey report with TNB Cheras and GISDNPT iii. Literature review

	four GIS components.		periodic system health check, walk through 100 issues ii. Business Process: Interview users, analyse actual data with master data source i.e. AR, SNC, CPP, do re-implementation survey with Cheras and GISDNPT, walk through 100 issues iii. Data Management: Data health check, Data governance, do re-implementation survey with Cheras and GIS DN PT, walk through 100 issues iv. Users: walk through 100 issues, do re-implementation survey with Cheras and GISDNPT	iv. System health check report data health check.

iv	To analyse the outcome of the key successful factor based on the four GIS components.	a. Why is it important to analyse the outcome of the key successful factors?	i. KSFs survey carried out during stabilization period i.e. after 6 months ii. Compare with previous result iii. Use MSm and SUSsrm to get the statistically valid data	i. TNB's Review Report 2014 (KPMG, 2014) ii. Re-implementation Survey report with TNB Cheras and GISDNPT iii. Literature review iii. System health check report data health check.
		b. What are the most important key successful factors that need to be focused on?	i. Four GIS components	i. TNB's Review Report 2014 (KPMG, 2014) ii. Re-implementation Survey report with TNB Cheras and GIS DN PT iii. Literature review iv. System health check report data health check.
		c. What is the interpretation used in determining the outcome of the analysis?	i. KSFs Index	i. KSFs Report ii. Literature review

		d. How can the outcome of the analysis influence the stakeholder decision making in the future implementation of GIS nationwide?	i. KSFs Index	i. KSFs Report ii. Literature review

1.5 Scope of Research

The scope of research is structured in accordance to the approved decision by the ICTGC on the 6th of June 2014. Those decisions are:

i. TNB Distribution Division to have dedicated structure to champion and support CGIS implementation for Data Management, Functional Requirement and Change Management. ICT to provide tools and IT solution.
ii. TNB to hire external GIS Subject Matter Expert (SME).
iii. Successful implementation of GIS at TNB Cheras as pre-requisite to further rollout.
iv. Distribution to focus on the following six reprioritized functions at Cheras station. Those functions are:

    a. Asset Register
    b. Supply New Connection
    c. Reconnection
    d. Project Planning and Wayleave Planning
    e. Construction Project
    f. Customer Service Support (via Smartview initiative)

The council has mandated that re-implementation is to move forward using the existing GIS software with a revised strategy taking into account gaps to be addressed and current technological landscape.

GISDNPT is specially created and given the mandate by top management to do the re-implementation of GIS successfully throughout the study. Therefore, main data sources used in this study are referred to Red Planet Consulting (RPC) and Antaragrafik (AG) are listed in Table 1.2. These data sources are revised FRRs that are used for re-implementation. Proposed development for improvement, enhancement and new proposals are introduced in this FRRs.

Table 1.2 Main Data Sources

No.	Reference Data Main Sources	Functions
1	RPC and AG (2015a).	Aset Register Functional Requirement Report. Identify pain points and propose improvement, enhancement as well as new proposals.
2	RPC and AG (2015b).	Supply New Connection and Reconnection Functional Requirement Report. Identify pain points and propose improvement, enhancement as well as new proposals.
3	RPC and AG (2015c).	Project Planning, Wayleave Planning and Construction Projects Functional Requirement Report. Identify pain points and propose improvement, enhancement as well as new proposals.
4	RPC and AG (2015d).	Customer Service Support Functional Requirement Report. Identify pain points and propose improvement, and enhancement.
5	RPC and AG (2016).	Data Governance Functional Requirement Report. New proposal is introduced to govern the data

Secondary data from the existing GIS i.e. KPMG (2014), Infotech (2008) and AMSDS (2017) are used for review and statistical references. All these data sources are important in the development and implementation in Chapter 3.

Since TNB Cheras station has been selected as a pilot area for the re-implementation of GIS, the GIS data used are TNB Cheras existing data in GE Smallworld from year 2010 to 2014. The research focused on the four components of GIS which are System, Data, Business Process, and User. The methods used are both qualitative and quantitative survey, actual realization of the work process, interview with personnel and system tracking logs.

Figure 1.3 shows the TNB DN electricity network for Cheras station for the GIS re-implementation.

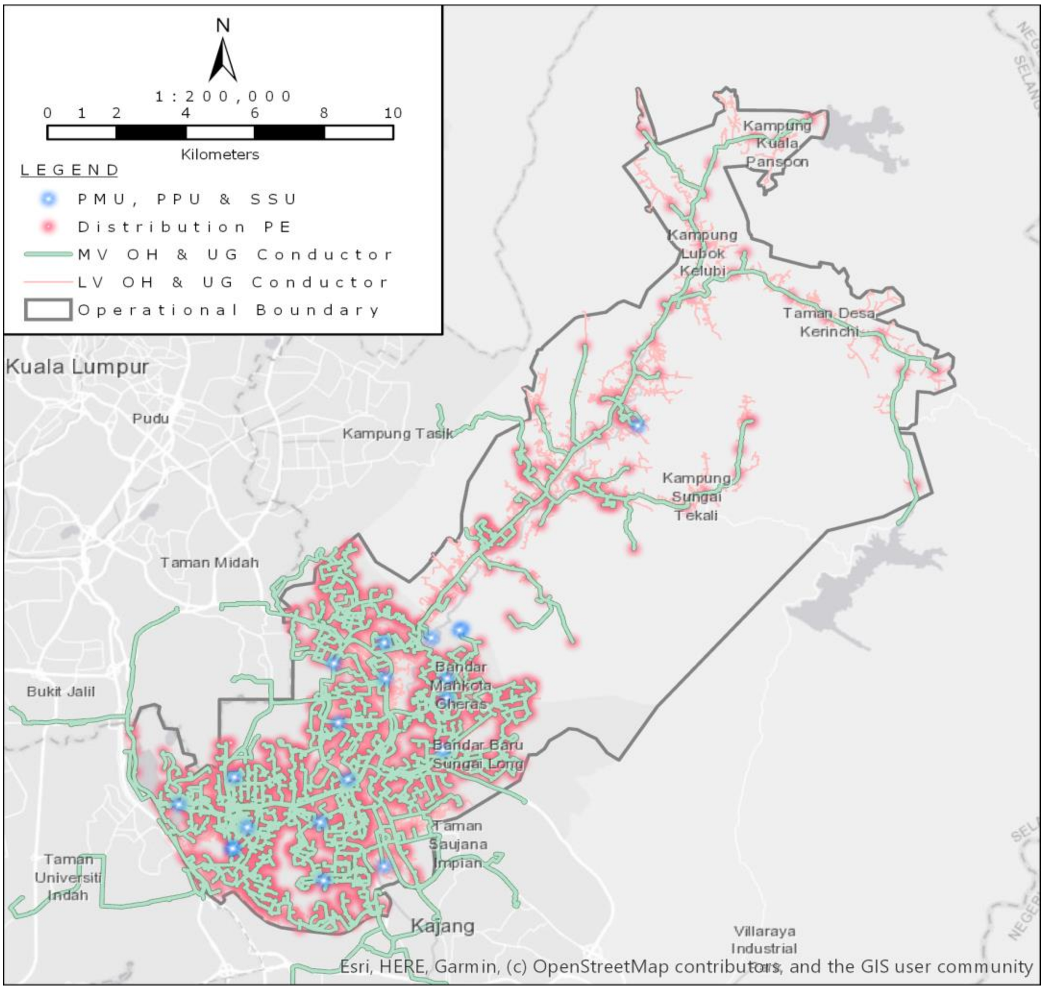

Figure 1.3 Map of TNB Cheras with TNB DN Network System

TNB Cheras boundary follows TNB electrical boundary. The boundary consists of electrical assets, networks and customers that are located in the designated and approved boundary by Planning Unit in TNB Distribution.

1.6 Significance of Research

TNB Distribution has identified GIS as one of the productivity revolution initiatives in driving excellent services in TNB. It provides platform that various business operations and technologies are able to integrate. The significances of this research are stated as below:

i. It reduces operation cost. TNB is able to save mileage reimbursement cost. Overtime and better decision making when scheduling operation and maintenance list.
ii. It increases productivity of daily works. Previously, there was a need to do site visit for processing e.g. new supply application. Using GIS, assets and connectivity can be viewed from Smallworld. Thus, the number of field visit has been reduced.
iii. It increases work efficiency and saves time. All assets are in spatial form. Reports and information can be generated for analytic from GIS.
iv. It provides effective communication. Many users understand or learn better with maps than words or numbers. In addition, users are able to communicate with different audiences using visually different views of the same data.
v. It provides a decision making framework whereby uniformity of data is available for usage. The use of common database eliminates the difference in decision making and evaluating, thus leading to better decision making.
vi. It provides better asset management by having spatial data for faster location identification, keeping records of assets for maintenance and daily activities.
vii. Able to analyse problems and recommend solution in a fraction of time.

1.7 Organization of the Thesis

This thesis has 5 chapters. The chapters are as below:

i. Chapter 1-Introduction

This chapter gave a brief background of TNB's core business. The problem statement of the project, aims and objectives of the research, scope of research, significance of research and further outline on how the thesis are approached.

ii. Chapter 2-Literature Review

The fundamental of GIS is introduced in this chapter. There is a discussion on the importance of criteria and factors that supported success of a project through establishment of measurement tools known as KSFs. The KSFs is used in measuring the performance of the project via four GIS components which are System, Data, Business Process and User. The planning, development, implement and evaluation of KSFs are identified according to model of success that is executed during implementation and post-implementation level. Agile scrum method is introduced to ensure the outcome of the project is as user expectation and data governance for sustaining the GIS life cycle.

iii. Chapter 3-Research Methodology

This chapter describes and explains the method used in the research. The research sources are from TNB reports, appointed consultant review reports, feedback gathered from the users of Cheras also called 100 gaps or issues, and lastly literature review. Details of research methodology flow chart is discussed and explained in this chapter. The strategy, improvement and new proposal for the re-implementation are gathered from the review reports and pain points of 100 gaps. The project implementation is executed using Project Management method and using a GIS success model and KSFs. KSFs index is established from the outcome of two KSFs evaluation methods used. There are four phases of re-implementation identified to achieve the four objectives:

a. Phase 1: Planning of KSFs
b. Phase 2: Development of KSFs
c. Phase 3: Implementation of KSFs
d. Phase 4: Evaluation KSFs

iv. Chapter 4 - Results and Discussions

In this chapter, there is discussion on the outcome of the proposed enhancement and improvement for the four merged functions using the proposed solution in daily work process. There are also new proposals and management method implemented such as data governance, agile scrum and KSFs. The results are analysed and measured to determine the overall results of the project performance and success. The analysis outcome of pre and post evaluation of KSF are discussed in this chapter. The result of the post evaluation is tabled to GISDN PSC for approval and later presented to the Project Sponsor for endorsement of GIS expansion nationwide.

v. Chapter 5 - Conclusion and Recommendations

This chapter, summaries all the chapters above and concludes the outcome of this thesis in line with the four objectives of the thesis. Few recommendations are proposed to the existing KSFs for improvement in order to better enhance GIS nationwide implementation. The KSFs that is produced is to be a copyright masterpiece between TNB and UTM.

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