

ENHANCEMENT OF RADIO SPECTRUM DATA MANAGEMENT FOR
MOBILE BROADBAND SERVICES VIA DASHBOARD SOLUTION

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DEDICATION

It is with genuine gratitude and warm regard that I dedicate this work to Allah s.w.t, my Creator and my Master, my great teacher and the messenger, Muhammad s.a.w (May Allah bless him and grant him), who thought us the purpose of life, my great parents, who never stop giving of themselves in countless ways, my lovely family, my dearest wife and kids.

Along with my lecturers and especially my supervisor, for the guidance, direction, and pearls of wisdom, but more importantly, for putting up patiently with questions while providing amazingly timely feedback, and offering encouragement precisely when needed and without which it would have been nearly impossible to produce this piece of work.

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ABSTRACT

The purpose of this action research paper is to develop and enhance the data management platform on the radio spectrum data specifically for mobile broadband services. The proposed enhancement by developing the dashboard solution is with aim to improve the work and business process of Mobile Planning Department of Malaysian Communication and Multimedia Commission. The abundant of collective information related to radio spectrum is required to be properly managed that could benefit the users by improving the work quality and delivery. This study is consisting of two cycles of interventions. The study implemented the mix methods approach which are qualitative and quantitative methodologies. Qualitative methodology was being used for identifying the problem statements and to propose the possible intervention in first cycle of the study, whilst quantitative methodology was being used for both cycles of the study. Quantitative method is used to measures the impact of the interventions to the relevance officers as the respondents. For qualitative methodology, the thematic approach was chosen to the key personnel and was analysed by using Nvivo software. For quantitative methodology, the data collection is involved with the distribution of questionnaires through online platform to twenty respondents. The analysis of quantitative was using a t-test analysis to determine the p-value variation result to determine the impact and efficiency of the dashboard solution. The quantitative analysis was done by using SPSS software. The triangulation approach was then being used to combine the findings from qualitative and quantitative to generate a reliable outcome. First intervention was focus on developing and introduce the dashboard solution to the users while the second intervention was focus on improving, and addition of other data and information to the dashboard solution. In general, the findings shown pure results of which both interventions were statistically efficient, based from the Technology Acceptance Model's variables.

Keywords: Spectrum Management, Information System, Resource Management, Knowledge Management

ABSTRAK

Tujuan kajian ini adalah untuk membangunkan dan meningkatkan platform pengurusan data pada data spektrum radio khusus untuk perkhidmatan jalur lebar mudah alih. Cadangan penambahbaikan dengan membangunkan aplikasi papan pemuka adalah bertujuan untuk menambah baik proses penyampaian kerja bagi Jabatan Perancangan Bergerak di Suruhanjaya Komunikasi dan Multimedia Malaysia. Terdapat pelbagai data dan maklumat kolektif yang berkaitan dengan spektrum radio yang memerlukan pengurusan yang betul dan efisien bagi memberi manfaat dan kemudahan kepada pengguna serta dapat meningkatkan kualiti kerja harian. Kajian ini terdiri daripada dua kitaran intervensi. Kajian ini dilaksanakan dengan menggunakan kaedah kajian secara campuran iaitu melalui metodologi kualitatif dan juga kuantitatif. Pendekatan secara kualitatif digunakan untuk mengenal pasti masalah-masalah yang sedia ada dan juga memberikan sebarang idea untuk mengatasinya di dalam kajian fasa pertama. Manakala pendekatan secara kuantitatif telah digunakan untuk kedua-dua fasa di dalam kajian ini. Kaedah kuantitatif pula digunakan untuk mengukur kesan intervensi kepada para pegawai yang terpilih sebagai responden. Untuk metodologi kualitatif, pendekatan secara tematik telah dipilih dan di analisa menggunakan perisian Nvivo. Bagi kaedah kuantitatif, pengumpulan data dilakukan dengan mengedarkan soalan kaji selidik melalui platform atas talian kepada dua puluh orang responden yang terpilih. Analisis terhadap kaedah kuantitatif ini telah dilakukan dengan menggunakan ujian-t untuk menentukan perbezaan keputusan nilai-p yang dapat menentukan impak dan keberkesanan platform pengurusan data tersebut. Analisis tersebut dilakukan dengan menggunakan perisian SPSS. Pendekatan triangulasi kemudiannya digunakan untuk menggabungkan keputusan analisis daripada kualitatif dan kuantitatif untuk menghasilkan keputusan yang dapat dipercayai. Intervensi pertama ialah fokus pada pembangunan dan memperkenalkan penyelesaian platform pengurusan data, manakala intervensi kedua ialah fokus pada penambahbaikan, penambahan data dan maklumat lain pada platform pengurusan data tersebut. Secara umum, hasil kajian menunjukkan bahawa kedua-dua intervensi yang dilakukan adalah efisien, berdasarkan dari pembolehubah *Technology Acceptance Model's*.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This research is focus on developing and enhancing the radio spectrum data management specifically for mobile broadband services via dashboard solution. The management of radio spectrum has been critically important for a nation in order to ensure that the use of radio spectrum for all type of services are in harmony within the country, border countries and globally.

In general, radio spectrum is chunk of a group of electromagnetic spectrum corresponding to radio frequencies, also known as radio waves and a scarce resource for each of the nations. As mentioned in the spectrum premier series (GSMA, 2017), radio spectrum is used to carry information wirelessly for a vast number of everyday services ranging from television and radio broadcasting, mobile phones and Wi-Fi to communications systems for the emergency services, global positioning service, aeronautical and maritime communications, radar and many others.

The use of radio spectrum is determined and decided at the international level. The international organisation body that responsible for the decision on which radio spectrum to be used to specific services is the International Telecommunications Union (“ITU”) and all the decisions mentioned are made through World Radiocommunications Conference (“WRC”) which was held once in four (4) years in Geneva, Switzerland. The agreement for use of radio spectrum considering the possible impact on the existing users and services, applicable international standards, technical requirements and the impact on economic growth by the world regions is

agreed by one hundred and ninety-three (193) country members of ITU, in which Malaysia is also part of the member of ITU. The outcomes decide on the harmonized, equitable and rational global use of the limited natural resources of the frequency spectrum (ITU News, 2020).

Use of the spectrum needs to be regulated in order to ensure the spectrum is use efficiently and minimising the possible interference in which most of the radio services are for use safety of life. According to the spectrum premier series (GSMA, 2017), there are wide ranges of radio spectrum that required coordination for its uses.

In Malaysia, the radio spectrum allocation is being managed from the range of 3 kHz to 420 THz. The whole range of radio spectrum covers all the available type of radiocommunications in Malaysia. This element on managing the radio spectrum to its specific channeling block is very important to take care of. There is a significant impact if the group of radio spectrum is not well managed such as the possibility of frequency interference between the radiocommunication services and it will impact to the process of spectrum harmonisation. The radio spectrum allocation for whole range in Malaysia is shown as in **Figure 1.1** below.

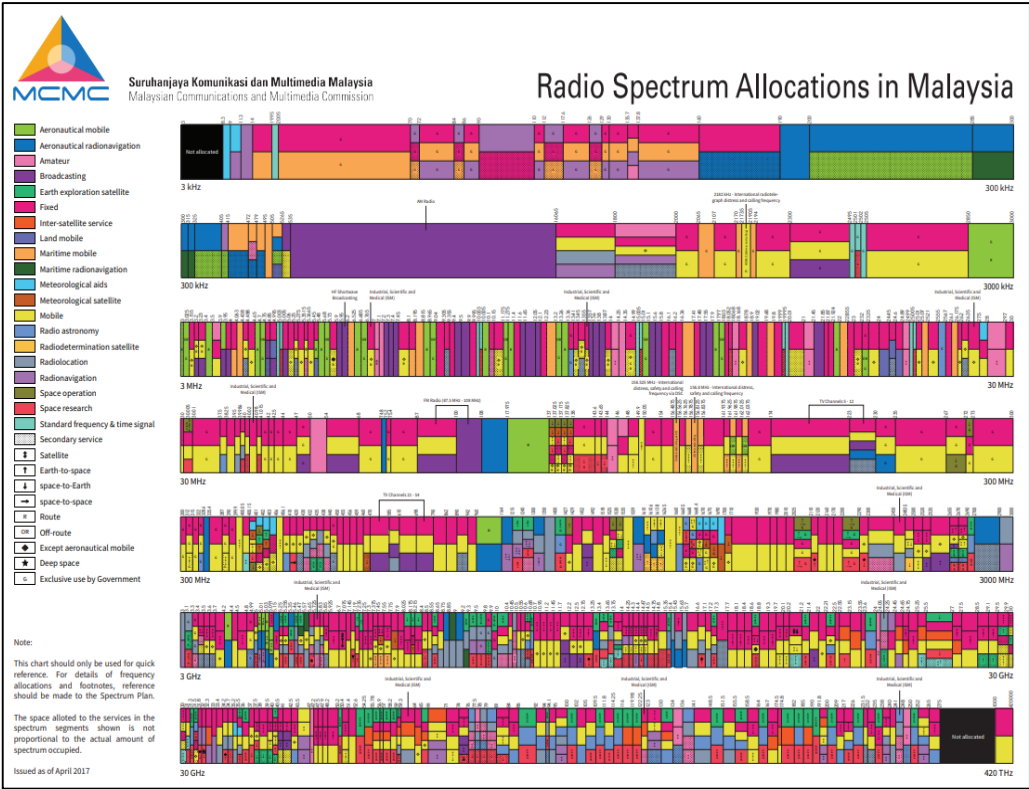


Figure 1.1: Radio spectrum allocation in Malaysia

However, to specifically limit this research to only mobile broadband services, the frequency range specified is from 500 MHz to 30 GHz, as of today and as shown in **Figure 1.2** below. The possible use of the radio spectrum below 500 MHz and above 30 GHz is subject to the later agreements that will be decided at WRC in the future. In addition, the use within this frequency range is not only applicable for mobile broadband service, it includes several type of services that can be used in parallel with mobile broadband services.

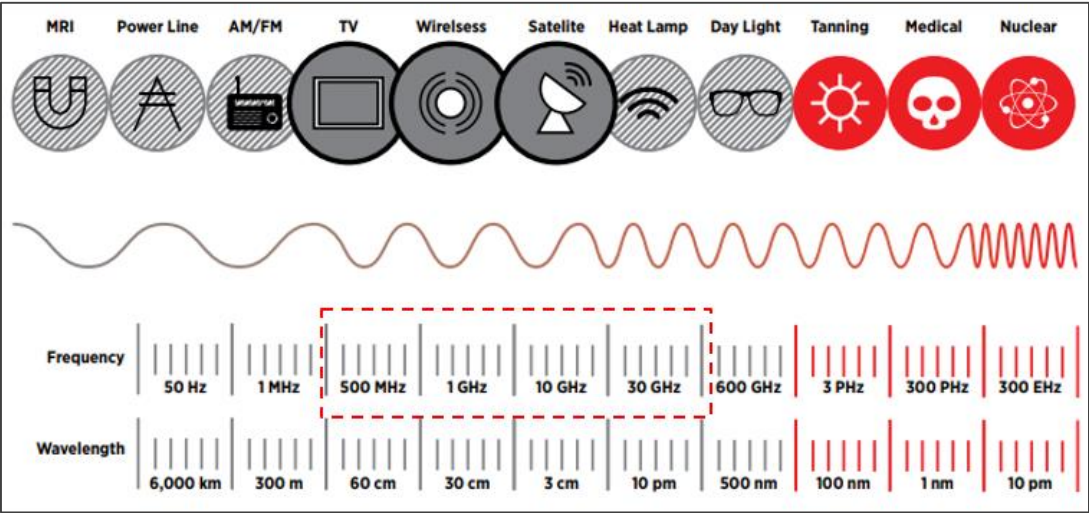


Figure 1.2: Radio spectrum range for mobile broadband services

In this action research, the focus would be only specific to only one type of service which is for the mobile broadband services in Malaysia. Even only one type or service, the pool and amount of radio spectrum allocated to this service is abundant with detailed regulatory provisions, technical parameters and technology details which incorporated within the allocation. This shows the important of having this sort of data management via a digital platform which is the dashboard solution in order to keep the objectives of this action research study are met and to ease the spectrum users.

1.2 Case Company Introduction

1.2.1 Malaysian Communications and Multimedia Commission

The Malaysian Communications and Multimedia Commission (“MCMC”) is a regulatory body established under the Malaysian Communications and Multimedia Commission Act 1998 [Act 589] with the responsibility to supervise and regulate the

communications and multimedia industry and to enforce the communications and multimedia laws of Malaysia and other relevant laws in Malaysia. The matters regulated under the purview of MCMC include, among others, broadcasting, mobile and fixed services, broadband, postal and courier services, universal service provisions and digital signature.

1.2.2 Spectrum Planning Division

Spectrum Planning Division (“SPD”) is a division within the MCMC that responsible for planning, managing and overseeing the use of spectrum with efficiency for all of the radiocommunication services in Malaysia. The strategic decision in managing the spectrum as a nation’s scarce resource is based on the Communications and Multimedia Act 1998 (“CMA”), ITU and also the decision made at WRC.

1.2.3 Mobile Planning Department

Mobile Planning Department (“MPD”) is a department under the SPD that responsible for planning, strategy and managing the use of spectrum to ensure the efficiency use of scarce resources specifically for mobile broadband services in Malaysia. The responsibilities include the allocation of identified spectrum bands for mobile broadband services to selected Mobile Network Operators (“MNO”) to ensure the utilisation of spectrum for provision of services to the public as nationwide basis. The allocation shall have considered the deployment strategies of MNO for benefit of the people be provided with sufficient communications required such as cellular and data for the internet.

Apart of allocation, the standards for technologies such as 2G, 3G, 4G and 5G were also identified and set by MPD to the MNO to ensure that people will not be left out in term of technology advancement compared to other nations. The packages fees offered by MNO were also being determined by MPD in order to control the mobile broadband market for people to afford such services. In short, all angles of regulatory provisions from perspectives of mobile broadband services needs to be covered by MPD as a whole to ensure the benefit to the people.

1.3 Problem Statement

Radio spectrum is a scarce resources and it comes with wide ranges of frequency in which every radiocommunication services could be in operations for each of the tiny chunks of the spectrum channels. Each of the channels are incorporated with various and abundant of information that need to be kept and referred to. According to Struzak (2003), the number of terrestrial and space radio stations is increasing at an unprecedented rate, and frequency demand is following suit. In the last several years, the ITU has documented more frequency assignments than in the entire history of radio. This shows that the ubiquitous of information on the radio spectrum that need to be monitored at all time by SPD for its day-to-day operations and reporting to the management purposes. **Figure 1.3** shows whole spectrum ranges for radiocommunication services as set by the ITU.

Band No.	Symbol	Frequency	Wavelength
4	VLF	Very Low Frequency 3 to 30 kHz	Myriametric waves 100 to 10 km
5	LF	Low Frequency 30 to 300 kHz	Kilometric waves 10 to 1 km
6	MF	Medium Frequency 300 to 3000 kHz	Hectometric waves 1000 to 100 m
7	HF	High Frequency 3 to 30 MHz	Decametric waves 100 to 10 m
8	VHF	Very High Frequency 30 to 300 MHz	Metric waves 10 to 1 m
9	UHF	Ultra High Frequency 300 to 3000 MHz	Decimetric waves 100 to 10 cm
10	SHF	Super High Frequency 3 to 30 GHz	Centimetric waves 10 to 1 cm
11	EHF	Extremely High Frequency 30 to 300 GHz	Millimetric waves 10 to 1 mm
12	THF	Tremendously High Frequency 300 to 3000 GHz	Decimillimetric waves 1 to 0,1 mm

Figure 1.3: The ITU spectrum bands

Looking at the national spectrum use specifically to the mobile broadband services, the amount of data and information is abundant with various ranges of spectrum bands from the lower band to the higher band. Among the parameters of data

and information required to be managed for mobile broadband services are as shown in **Figure 1.4** below.

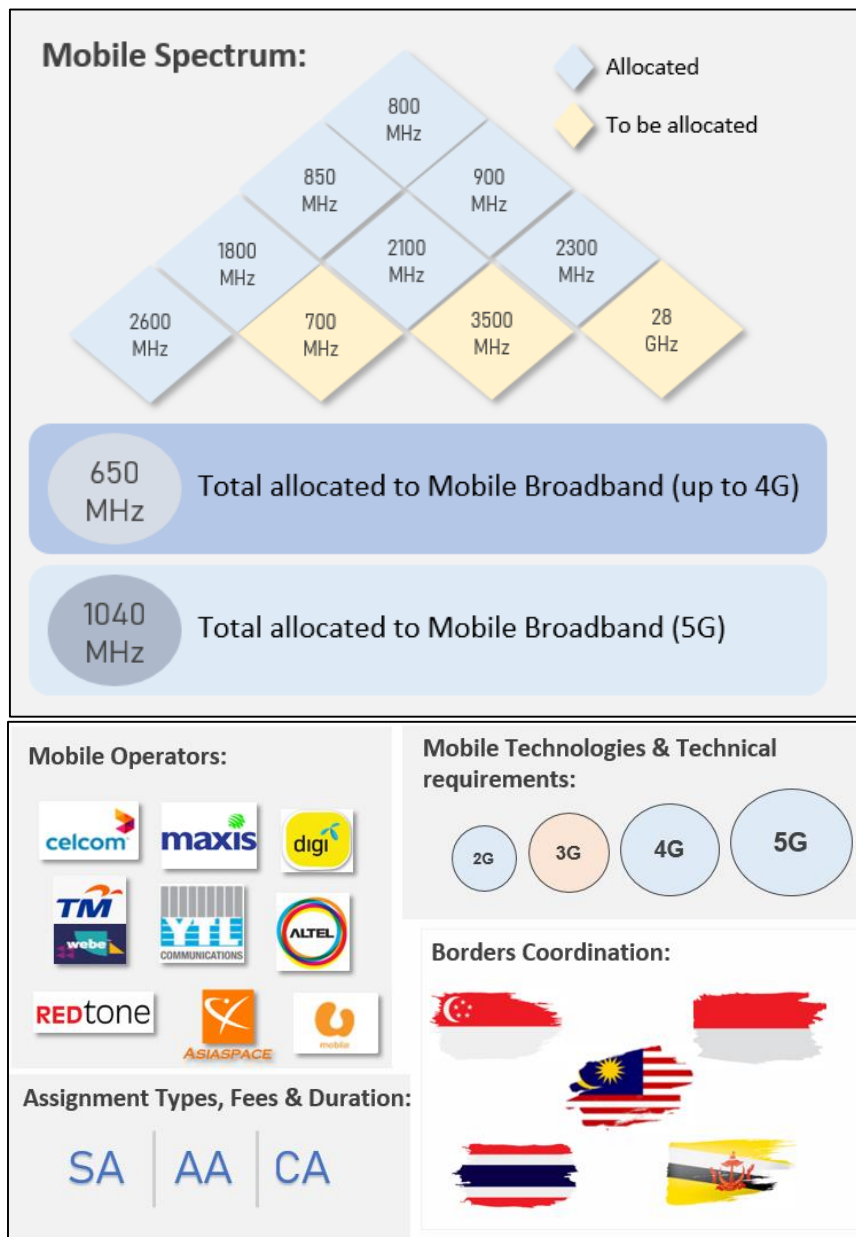


Figure 1.4: Examples of information for mobile broadband services

1.3.1 Massive Data Repository

Based on the amount of spectrum ranges that have been allocated and will be allocated to the MNO together with others information, a massive data repository was required for each of the officers in SPD to keep the data and information for their daily works routine. The information are consist from the following parameters.

- Spectrum band allocations;
- Type of assignments - apparatus assignment (“AA”), spectrum assignment (“SA”) and class assignment (“CA”);
- Duration of each assignment;
- Mobile broadband technologies;
- Technical requirements;
- Regulatory provisions;
- Assignment fees;
- Detailed on each MNO;
- Border countries coordination;
- International spectrum allocations; and
- Base station list.

1.3.2 No Proper Platform

There is no proper platform of these data and information for related for SPD officers to find the specific spectrum allocation and usage for certain frequency bands and services. Apart of none proper platform available, the SPD officers with different understanding and perspectives to the data and information could also contributed to the misconception and misunderstanding of the desired information needed.

1.3.3 Tedious Accessibility

The accessibility of all the data and information process is tedious for the current approach such as scattered references of information and the SPD officers need multiple other related documents to be cross-checked at the same time. It is also lengthy and complicated reference document with most of the information are incorporated with detailed technical requirement, specifications and framework.

1.3.4 No Real Time Updates

This is quite a major problem and issue due to the SPD officers are continuously besieged with on-going work, new requests, and voluminous paperwork, the necessary

requirement has also hampered the reporting mechanism's ability to provide a real-time update to the management for making a strategic decision. The most significant challenge for tracking and monitoring reasons is real-time updates, particularly for contentious or time-sensitive problems that necessitate urgent updates by the officers for management and stakeholders' necessary action or information.

1.3.5 Delay in Relaying the Information

A delay in retrieving information from the Department's and Division's available records is unavoidable under the existing reporting approach. For example, if the management and stakeholders required specific data and information related to the mobile broadband services, the officers are often need an additional time to extract and gather the required information. Some data and information is needed to get from inter Departments or Divisions. This is a rather common occurrence in SPD.

Officers have wasted significant resources conducting the searches to obtain essential data or information, which could have been done more efficiently. One possible answer is to investigate the possible use of technology, such as a dashboard solution, to automate processes within the Division daily operations, as this can surely assist officers in streamlining their work effectively. Technology could also be used to close any gaps in the Division's current practices and reporting mechanisms.

1.3.6 Ishikawa (fish bone) Diagram

Based on the findings on the problem statements, the study will be using the Ishikawa (fish bone) diagram to further finalised the causes of the identified problem statements as shown in the **Figure 1.5** below.

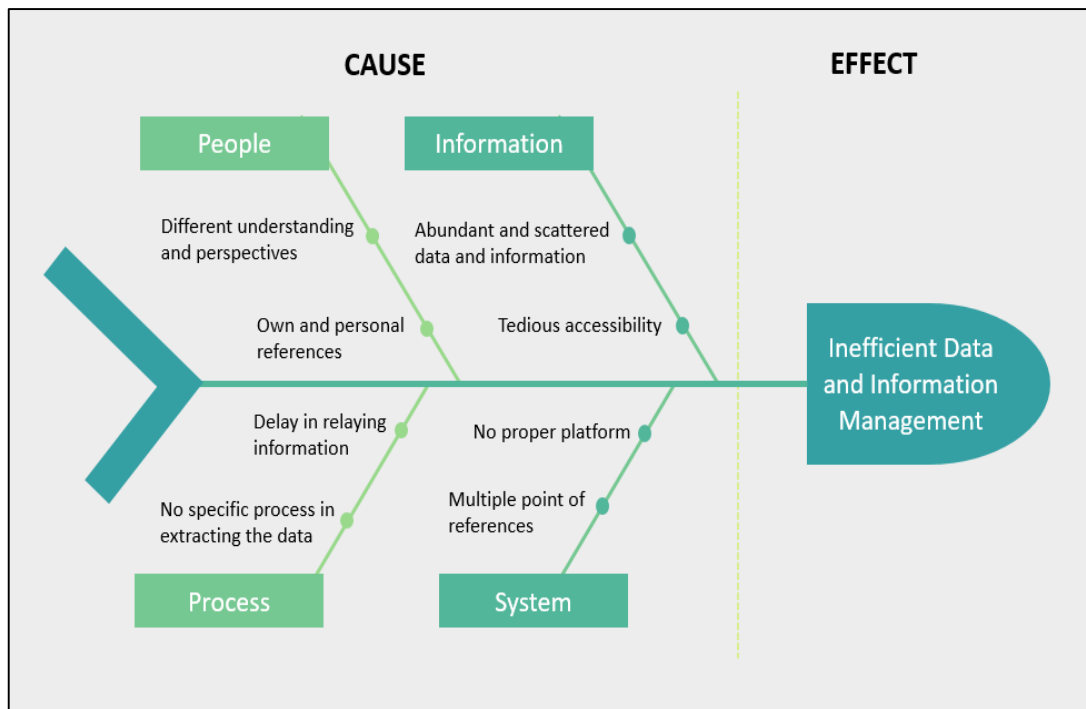


Figure 1.5: Ishikawa diagram for problem diagnosis

1.4 Research Questions

The identified action research questions are based on the problem statements and gap that have been discussed above. The relevant research questions are as stated below:

1. What are the factors that contributed to the inefficient of data and information management of radio spectrum for mobile broadband services?
2. How to the SPD officers implement its data extraction and information references for the current approaches?
3. How effective is the recommended dashboard solution for SPD to improve the data and information management?

1.5 Research Objectives

The goal of this research is to find viable technology-based solutions that meet the SPD officers' needs and to enhance the present data extracting, reference and reporting approaches. A dashboard solution for the Division reporting mechanism

is proposed in this regard. Based on the foregoing, the research objectives are as follows:

1. To identify the issues and difficulties of accessing the data and information by the SPD officers that contributed to the inefficiency of the data and information management;
2. To determine the current approaches of data extraction and information references for reporting mechanism and daily operations of SPD officers; and
3. To ensure on the efficiency and effectiveness on the use of dashboard solution within the SPD officers.

1.6 Research's Role

In this action research, the researchers' role is an important element to ensure the completion of this study and fulfilling the identified gaps that generated the problems and issues. The researcher needs to ensure that the SPD officers as participants in this action research also play their roles for an improvement from the current practices, such as the researcher need to build a good relationship with participants during the course of this action research for better outcomes.

The most important thing is the researcher's ethical while doing the action research. The researcher needs to look and manage the ethical issues in the positivist and constructivist paradigms, which presented during this action research. Further in this action research, the Cultural Historical Activity Theory ("CHAT") was referred to improve the role of researcher from the traditional way. This means that the researcher and the participants need to agreed and set the goals together in order to improve the current and existing processes, practices or situations. In this paradigm, the researcher's aim is to understand the participants' actions, and additionally to improve the practices together with the participants while this action research is being undertaken. This means that there can be a close relation between the researcher and the research participants in this paradigm (Postholm & Madsen, 2006).

1.7 Researcher Ethic

There are a number of ethical principles that should be considered when performing a research. Not only should the research aim to do good, but it should also avoid the potential harm to the research participants. This is important not only for ethical reasons, but also for practical ones, because failing to follow these basic principles can lead to the research being ridiculed and rejected. Minimizing the risk of harm to research participants is the first principle of research ethics that the researcher tries to follow when performing this study. While conducting this action research, the researcher briefed the participants in detail before starting this action research so that they were aware of the action research's flow and its direction.

Furthermore, the researcher has obtained the informed consent prior to the research from the participants, which means that respondents are fully aware of why they are participating in this action research and what they should expect from it. The objective of the study, the procedures utilised in completing the action research, the potential findings of the research, as well as the related requirements, inconveniences, and risks that the respondents may face are among the details that have been acknowledged by the participants. Additionally, during the data gathering procedure, the researcher also protects the confidentiality and privacy of all of the respondents. All sensitive information that might offend the respondents have been kept private. Finally, the respondents have also been given with the option to withdraw their participation in this action research if they felt uncomfortable while the research is being conducted.

1.8 Importance of the Proposed Research

According to the report by Forest Interactive (2020), the connection of mobile devices is forecasted to increase to 8.6 billion in 2025 from 7.9 billion in 2020. There will be around 600 million new added connections in which will be coming from the Asia Pacific Region. This shows that the increasing demand of mobile communications will contributed the tons of information and data for reference and daily operations of SPD and MCMC as a whole. In order to ensure the current operations and reference approaches is relevant in the coming years and also to achieve

greater efficiency, the possible use of technology is being highlighted and recommended. The significance of this action research is to find and implement the optimum solution for SPD needs and improve their operational activities.

In view of the above, introduction of the technology application could help improve the current approaches and practices to make it more efficiently. In this action research, as the recommendation for improvement is by implementing the dashboard solution. As stated by Lilien (2011), dashboard is the tool that could help the employees to efficiently manage data to make the required paperwork and document with better options for management's decision. The current use of dashboard not only limited to the business and marketing purposes. Dashboards are increasingly prevalent in the non-profit organisations as well, it could also be used to impose to drive the organisation for effectiveness and calibrate impact of a decision that has been made. More corporations and non-profits organisations are determined to improve the implementation for its business and corporate strategies have sought to devise a dashboard solution (Allio, 2012).

The lack of experimentation and adoption of technology in SPD's operations has caused the working environment to be segregated by the creation of a massive data repository, providing no real-time updates on operational activities and causing delays in information retrieval, as stated in the problem statements above. Therefore, the work efficiency and data management are hopefully can be further improved with this intervention through this action research.

1.9 Scope of the Study

The focus of this action research is solely on the SPD's operational activities, processes, data extraction for reference and reporting mechanisms. The study does not try to enhance the status of other data and information reference method to the similar organisations, nor does it reflect their practises or trends. In addition, the participants involved for the data collection and analysis in this action research are also only limited within the SPD officers with purpose of narrow scope of this whole research.

1.10 Definition of Terms

Among the key terms that mostly used in this action research can simply be referred and elaborated in **Table 1.1** below:

Term	Definition
Spectrum Planning Division (SPD)	Spectrum Planning Division is the user department or directly impacted with the possible intervention proposed in this study. Most of the participants of this study are referred to SPD in overall.
Radio Spectrum	Multiple chunks of frequency bands that use for communication technologies. Most of the wireless devices, services and systems available are using spectrum to deliver its data, information and messages.
Framework	The groups of database that incorporated in the proposed intervention. The database are referred from multiple sources of information documents scattered physically and digitally.
Dashboard Solution	An information management tool that visually tracks, analyses, and displays metrics, and critical data points is used. They can be tailored to an organisation's or company's specific requirements.

Table 1.1: Definition of terms

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