

# **Timetabling System for Medical Officer**

By

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Dissertation submitted in partial fulfilment of  
the requirements for the  
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(Information & Communication Technology)

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## CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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SITI NOOR ZAHIRAH BINTI MOHD ZAHARI

CERTIFICATION OF APPROVAL

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Approved by,

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(Mr. Helmi bin Rais)

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## **Abstract**

The idea was proposed due to the issues that Medical Officer face which is unorganized and unstructured duty roster management. Thus, inspired by Prototyping – based methodology, Timetabling System for Medical officer was developed. This research studied about the scheduling algorithm, tools and knowledge required for system development and the development process involved. Feasibility study was carried out to ensure the timetabling system can be develop within scope, time and constrains. Beside the main constrains, other minor constrains such as cultural, technical and operational was included. Methodology analysis is carried out in order to choose the suitable methodology to develop the system. The prototype architecture is shown in the result and discussion. At the end of the report, few recommendations were listed for the betterment of the system. Besides that, it also can be used as the reference for the custodian to understand the current status of the project.

# بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

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## **1.0 PROJECT BACKGROUND**

### **1.1 Introduction**

Medical officers are involved directly and indirectly in health delivery service such as examining, diagnosing and treating patients, administering, prescribing medication, performing procedures, surgery and alleviating pain in patients. Besides that, they also perform health checks on pregnant women, deliver babies, performing post – mortem and other related job required. As they are the ambassador that promoting good health and lifestyle, they are responsible in implementing family health and planning programmes as well as preventing and controlling communicable diseases. They also part of the team who disseminating public medical education.

A dedicated medical officer will ensure the services provided are high quality, equally balance and satisfy the patients. As times goes by, people are getting more aware about their health. That is why, Ministry of Health Malaysia needs more medical officers who are competent, dynamic, loves challenges and ready to serve the nation.

Medical officer are divided into 3 main fields: Medical Officer Administration, Medical Officer Clinical and Medical Officer Clinical in multi – disciplines. However, the research focuses on Medical Officer Clinical and Medical Officer Clinical in multi – discipline. This is because the research targeted hospital as the implementation field. Hence, this research only takes into consideration to study about the working nature of medical officer in hospital.

As we know, medical officer not only providing and serving the patient during a day time but also at night. Hence, they need a scheduling system whereby can help them managing their workforce efficiently and effectively. The propose idea is expected to help the medical officer with the flexible shift, fulfill personal preference, and ideal balance job distribution.

## **1.2 Problem Statement**

Throughout the years, medical officer (MO) shift scheduling and timetabling is made manually. In fact, it was arranged by the MOs' themselves. As we know, MO needs to perform multiple tasks at the same time. It involves people's life and will cause danger if late action is taken. Hence, they need a system which can help them in arranging, scheduling, preparing the timetable for their shift. It should be available 24 hours in 7 days.

Unorganized shift scheduling is another factor that contributes to proposing the Timetabling system for the MO. Due to some constraints such as time and personal preference, a well-developed and stand-alone system should be implemented to help the MO in organizing their time. The system should embed with artificial intelligence attributes in order to make it more user-friendly and flexible.

## **1.3 Objectives**

- To study on how artificial intelligence can help in the healthcare sector
- To help MO with unorganized shift distribution and fulfill MO's personal as well as organization needs
- To identify suitable algorithms that suit with the system

## **1.4 Scope of study**

The problem well stated Medical officer (MO) needs a scheduling system which arranging, and preparing the roster for their shift. The system should be a stand – alone and available 24 hours in 7 days. Thus, the research focuses on the developing a scheduling system embeds with artificial intelligence features.

In this case, MO needs a scheduling system which can help them with their time arrangement. It includes shift and job distribution arrangement. By considering human preference as one of the constraint has made the system more complex. Besides handling their additional tasks, they need to deliver their own job specification. Hence they need scheduling system that can help them with the shift management. As a result, they can deliver their task efficiently.

The research also will be focuses on the system requirement such as tools, skills and knowledge needed. Those elements should be precisely identified because they are the key elements in the planning stage. Planning stage played an important role in providing the developer with the solid and clear picture of the system. Hence the objective of having an intelligent scheduling system can be met.

Besides that, it also a study about the system's development processes, scheduling algorithms and method used. A few development methods and platform need to be reviewed. This is because only the most suitable methods and platform is going to be used in developing the system. The methods and platform are chose based on duration, knowledge and skills required.

## **1.5 Relevancy of the Project**

The scheduling system is the first version that is going to be implemented in hospital. Previously, the shift and job arrangement are made manually by the person in charge. However, it is not an efficient way to schedule a duty roster. This is because it can lead to certain issues such as outdated information and time constraints.

Besides performing daily routine activities, MO is responsible in handling the activities during night shift (on – call). This is because, they have to monitor patients' health progress in 24 hours and be prepared for any emergency matter. In fact, MO's shifts are divided into 3 which are day shift, night shift and evening shift. Hence, they need a system which on their behalf managing their work distribution faster and more effective.

In addition, to overcome the conflict within a workplace, this system is expected to help. The conflicts occur when duty roster did not fulfill MO's personal preferences and job distribution cannot be distributed equally. Due to some excuses, some MO might apply for leave or excluded from night shift. By having this system, it can help MO's in arranging their time based on their own personal preferences within certain constraints set.

## **1.6 Feasibility of the Project**

After analyzing the alternative and considering the Medical Officers' (MO) requirement finally they agreed that Timetabling System for Medical Officer (TSMO) as a good solution. Given below why it is feasible and the cost / benefits analysis.

### **1.6.1 Operational Feasibility**

Operational feasibility is the measure of how well TSMO solves the problem and takes advantage of the opportunities identified during the scope definition and problem analysis phases. Besides that, it determines how well it will fulfill the system requirement identified in the requirement analysis phase.

In TSMO, MOs' requirements are going to be implemented so they can work as they did manually. The system is provided with familiar and friendly user interfaces to users. With the implementation of TSMO, their working environment is not going to change lot more. Furthermore, MOs are satisfied and they accept TSMO will full fill their requirements.

### **1.6.2 Cultural Feasibility**

Cultural feasibility deals with the way MOs feel about TSMO. TSMO is expected to work in a given organizational climate. MOs feel good about TSMO because it is going to make their work easier and faster. Although they are not familiar with new system, but as time goes by, they will learn fast. With the help from user manual, they will master the system.

### **1.6.3 Technical Feasibility**

Familiarity with the needed technologies is the elements of technical feasibility. It is proposed to develop the system by using Netbeans IDE 7.1. Netbeans IDE 7.1 is an open source medium which available online. It has identified that the proposed system can be developed by Netbeans IDE 7.1. The tutorials are available to learn. In fact the basic knowledge on the capability and limitation of Netbeans IDE 7.1 are already known.

#### **1.6.4 Schedule Feasibility**

Schedule feasibility is a measure of reasonable time allocated for the project. According to the scope of the project, the timetable is reasonable. Included in the report a chart showing the times and scheduled tasks.

#### **1.6.5 Economics Feasibility**

Proprietary software is not going to be used during the implementation of the system. In addition, there is no cost for extra hardware needed. MO also has relevant computers to implement TSMO. In short, hospital does not have to bear any costs. From developer perspective, the software required to develop the system is available online and free to download. In fact, the developer personal computer is capable in developing the system. Hence, no cost should be bear by the developer.

#### **1.6.6 Legal Feasibility**

Legal feasibility is a measure of how well TSMO can be implemented within existing legal and contractual obligations. From the system, it can only be used and viewed by MO within the same hospital. This is because the records are private and confidential.

### 1.6.7 Cost / Benefits Analysis

#### Costs related to Timetabling System for Medical Officer

- **Development Costs**

Description	Cost (RM)
Network – ready PCs with supporting software	0.00
Server maintain and installation cost	0.00

Table 1: Development Costs

- **Operational Cost**

Description	Cost (RM)
Staff Training	0.00
Software	0.00

Table 2: Operational Costs

- **Personal Costs**

Description	Cost (RM)
Problem Identify	0.00
Requirement Gathering	0.00
Requirement Analysis	0.00
Database Development	0.00
Documentation	0.00

Table 3: Personal Costs

**No cost imposed for the system development**

### 1.6.8 Benefits gain thorough Timetabling System for Medical Officer

- Error reduction
  - Reduce errors on storing data
  - Reduce errors and also the time taken to retrieve data
  - Reduce waiting time
  - Job satisfaction - Fulfill individual preference within certain constraints set



## **2.0 LITERATURE REVIEW**

From Malaysia Employment Act 1955, medical officer can be defined as a registered medical practitioner who is employed in as medical capacity by the Federal Government or by the Government of a State. There are 3 type of medical officer which are clinical, clinical in multi- discipline and administration. Difference medical officer will have difference job requirement that have to be fulfilled. Ministry of Health Malaysia has prepared career development guidelines for Medical Officer under Ministry Of Health Malaysia supervision. In the guidelines, it is well stated the jobs and responsibilities of a medical officer. In fact, it is not only about performing specialized tasks but also multiple and simultaneous task. Hence, in order to help them with their duty roster scheduling, a suitable timetabling system is needed. The literature review will be divided into 3 chapters which are Chapter 1: Challenges and Successful Project, Chapter 2: Advantages and Benefits of Scheduling system and Chapter 3: Proposed Algorithm and Methods.

## **Chapter 1: Challenges and Successful Project**

Developing a suitable scheduling system that can fit into medical officer requirement is not an easy task. There are few obstacles and challenges that need to be faced. In addition, programmer should take into consideration to learn the pitfalls of the current existing system. In *Scheduling in the Real World: Lesson Learnt*, there are few views that are proposed to improve the current system. The author Krogt R., Little J. and Simonis H. (2009) said that the real – world scheduling problems seldom match the problem studied in the research community. In other words, the system build does not fit into the user requirement. In the same paper, the author stated that the biggest challenge of implementing a system in an organization is to successfully transfer the technology to the user.

Besides that, the authors also said different people in an organization have very different objective they want to optimize. This is indirectly related to this research paper which aim to fulfill both personal and organization needs. In fact, some of the medical officer might only consider about their personal preferences rather than meeting organization vision. Besides, scheduling system may not satisfy all constraints, the results are rarely much better than human scheduler. This is in contrast with the aim of having a scheduling system. Scheduling system should help and improve the manual scheduling processes in health care.

However in other research paper entitled *Implementation of a Self – Scheduling System for Hospital Nurse: Guidelines and Pitfalls* written by Bailyn L, Collins R. and Song Y. (2005) pointing a difference view. They said in some cases, unfavorable condition might develop such as complaint of peer pressure, favoritism and unavailability of staff. Under this situation, company might face a problem in promoting the scheduling system. Minority of the medical officer group might think that by having scheduling system, it may demolish the favoritism which is good from one perspective. It will inculcate professionalism among medical officer.

In order research paper entitle *Optimal algorithm for single – shift work force scheduling to avoid one day work stretches in cyclic schedule* written by Collin G. (1999) stated that typical classifications of workforce scheduling problems tend to focus on the following characteristic:

- [1] Workforce demand pattern
- [2] Number of shift
- [3] Length of shift
- [4] Number of worker categories
- [5] Worker category structure
- [6] Frequency of work

In order words, those are some of the constraints that should be taken into account when building the scheduling system.

Even though lot of obstacles needs to overcome but the system is feasible and possible to build. It is proven by two journals which discuss on the system that had been implemented. Chu C. K. (2005) said in his journal entitled *Generating, scheduling and rostering of shift crew – duties: Applications at the Hong Kong International Airport*, the problem is solved via decomposition into its duty generating phase – a goal programming (GP), followed by its GP scheduling and rostering system. The results can be adopted as a good crew schedule in the sense that it is both feasible, satisfying various work conditions, and “optimal” in maintaining idle shifts. Whereas in other journal entitle *Long term staff scheduling with regular temporal distribution* written by Carrase Rafel C. (2010) stated simple procedure, combining random and greedy strategies with heuristic has been successfully applied in a Spanish hospital to assign guard shift to the physicians in a department. Based on the gathered information, programmer should emphasize on the challenges listed. More effort should be put in order to build a system which meets the industry standard.

## Chapter 2: Advantages and Benefits of the Scheduling System

The selection and utilization of the work force are the keys to successful operation for service sector. Health care segment is considered to be significance in the major subset of the service sector. Nowadays, organization started to implement flexible working time. Human resource management department faced big problem regarding this implementation. This is because they have to organize the work force wisely and optimize their capabilities within certain period of time. As compared with the previous implemented working hours, employees are having the same working times and work forces are equally distributed. However, due to the flexible working hours some resources are not wisely used. Hence, scheduling system is needed in order to overcome this problem.

In a research paper entitle *A Particle Swarm Optimization Approach for Physician Scheduling in a Hospital Emergency Department* written by Lo C. C and Lin T. H. (2011), it is well stated that the proposed system effectiveness verification is measure by implementing the system in a hospital in Northeast Taiwan. The system was implemented in an experimental environment. At the end of the experiment, feedbacks are gathered. Some of the feedbacks are:

- [1] There is no violation of any hard constraint and the violations of soft constraints are limited in the work schedules provided by the proposed system
- [2] The execution time to find proper schedule is rather short

Meanwhile, in order research paper written by Gregory C. (1999) has difference opinions. In this research paper entitled *Optimal algorithm for single – shift workforce scheduling to avoid one – day work stretches in a cyclic schedule* stated that the selected algorithm provide solution approaches which address both the concern of management (minimum feasible work force size) and the interest of employees (predictable repeating schedule is provided that includes reasonable work stretches). In the same paper stated that the algorithm provide a concept of how solutions to other types of scheduling problems may be pursued with the goal of satisfying the one day work stretch and cyclic schedule constraints which have been imposed herein.

### **Chapter 3: The proposed algorithm and methods.**

As scheduling system is not a new system hence, there are lots of proposed and available methods for references. For example in a research paper written by Ernst A. T., Jiang H., Krishnamoorthy M., and Sier D (2004) entitled *Staff scheduling and rostering : A review of applications, methods and models* has briefly explained on the applications and models used for scheduling algorithm. For applications, authors had listed few suggestions such as:

- [1] Demand modeling
- [2] Days off scheduling
- [3] Shift scheduling
- [4] Line of work construction
- [5] Task assignment
- [6] Staff assignment

Meanwhile, for models, authors had listed follows:

- [1] Artificial intelligence
- [2] Constraint programming
- [3] Metaheuristic
- [4] Mathematical programming

In other research paper entitle *A particle swarm optimization approach for physician scheduling in a Hospital emergency Department* written by Lo C. and Lin H. (2011) stated that, when time consuming what – if analysis is needed, Particle Swarm Optimization (PSO) is an efficient approach for intelligent physicians work scheduling. It is a nature – inspired optimization algorithm. In the same paper stated that experimental results of actual implementations indicate that PSO - based work scheduling support system efficiently and generated satisfactory work schedules.

Vincent M. (2008) has different approached. In his research paper entitled *Competitive Nurse rostering and rerostering* he proposed a series of agents based nurse rostering algorithm. It is named as Competitive Nurse Rosterin algorithm (CNRA). The set of CNRAs include Competitive Nurse Rostering (CNR), CNR with Iterated Local search (CNR –ILS) and CNR and rerostering (CNRR). He stated that the purpose of the CNRA is to develop better mathematical model of how nurse perceive preferences. Hence, we can conclude that, the algorithm created are aim to fulfill the nurse preferences which may applicable to this research paper.

As compared to other researcher, Priya G., Anandhakumar P., and Maheswari K. (2008) also have their own stand. In their research paper entitle *Dynamic scheduler – a pervasive healthcare system in smart hospital using RFID* presents a solution to this multi objective dynamic scheduling problem using evolutionary algorithm. They proposed Nondominated Sorting Genetic Algorithm II (NSGA II). Main objective of using this algorithm is to optimize resource allocation. Besides that, evolutionary algorithm is used to mazimize the solutions.

In fact, scheduling system not only been used by healthcare sector. It also has been implemented among the airlines crews. It shows that, scheduling system is widely used regardless the sector but with different models or algorithm. Dawid H., Konig J., and Strauss C. (2001) introduce in their research paper entitled *An enhanced rostering model for airlines crew* an efficient adaption of the branch and bound techniques that solves real world rostering problem for airline crews. The advantages of this approaches is shorten the solution process and outperform standard techniques. In order to be specified, they present the SWIFTROSTER algorithm. It is inspired partially by Peter Barth's pseudo-boolean Davis – Putnam algorithm but tailored to solve crew – rostering problems.

## **3.0 METHODOLOGY**

After the project has been approved and the preliminary requirements are defined, the suitable development methodology is selected.

### **3.1 Criteria of selecting the suitable methodology**

#### **3.1.1 Clarity of User Requirements**

In some cases, the user requirements are unclear. User does not briefly and precisely define their requirements. As a developer has to overview the system holistically. In fact, developer needs to understand what the requirements are as they are viewing the system from the user perspective.

#### **3.1.2 Familiarity with Technology**

There are risks to be bear if the system is design without some familiarity with the base technology. This is because the tools may not be capable of doing what is needed. Due to time constraints, developer cannot develop a system while learning the tools. Hence, the methodology chose should help in reducing the risk.

#### **3.1.3 System complexity**

Complex system requires careful and detailed analysis and design. However, for Timetabling System for Medical Officer, it requires complex and detailed analysis of the complete problem domain. The constraints and meeting the personal preferences are the main contributor for the system complexity.

#### **3.1.4 System Reliability**

System reliability is an important factor in system development. It is the ability of the system to perform and maintain its function in routine, as well as hostile or unexpected circumstances. In order to fit into these criteria, consideration should look into analysis and design phase of the system.

### 3.1.5 Short time schedules

Methodology chose should increase the speed of the development process. Developer needs to compete with time as well as the system should fulfill and meet the user requirements. Thus, the methodology choose should reduce the time taken to end the project and meet the user expectation.

### 3.1.6 Schedule Visibility

Due to time constraints, planning stage is crucial. Developer need a methodology which helps in recognizes and address risk factor earlier in the project. Thus, most of the critical design decisions are made at the beginning of the development process. This is to ensure development issues such as project behind schedule can be avoided.

The result is as below:

	<b>Structured Methodology</b>	<b>RAPID Methodology</b>	<b>Agile Methodology</b>
Methodology	Waterfall	Prototyping	XP
Clarity of user requirements	Poor	Excellent	Excellent
Familiarity with Technology	Poor	Poor	Poor
System Complexity	Good	Poor	Poor
System Reliability	Good	Poor	Good
Short Time Schedules	Poor	Excellent	Excellent
Schedule Visibility	Poor	Excellent	Good

Table 4: Methodology Analysis

From the research, Prototyping – based methodology (under the category of Rapid Application Development-based methodology) is chose.



### **3.2 Prototyping - based methodology**

A prototyping-based methodology ensures smooth communication between user and developer with different backgrounds. In this methodology, once the preliminary requirements are clarified, the next step is to quickly build the layout and prototype of the system. From then on, it is the continuing evolution of this prototype until it becomes the final product, exact to specifications.

With one significant challenge in this project which is the time constraint, prototyping-based is the methodology that attempts to address it. Furthermore, in building the system; the visibility effectiveness of the functions is critically important. The prototyping-based methodology allows the developer to identify the functions and attributes needed according to business requirements before the developer spends a lot of time developing and coding the functions. This is the reasons why developer has adapted this methodology to the development process.

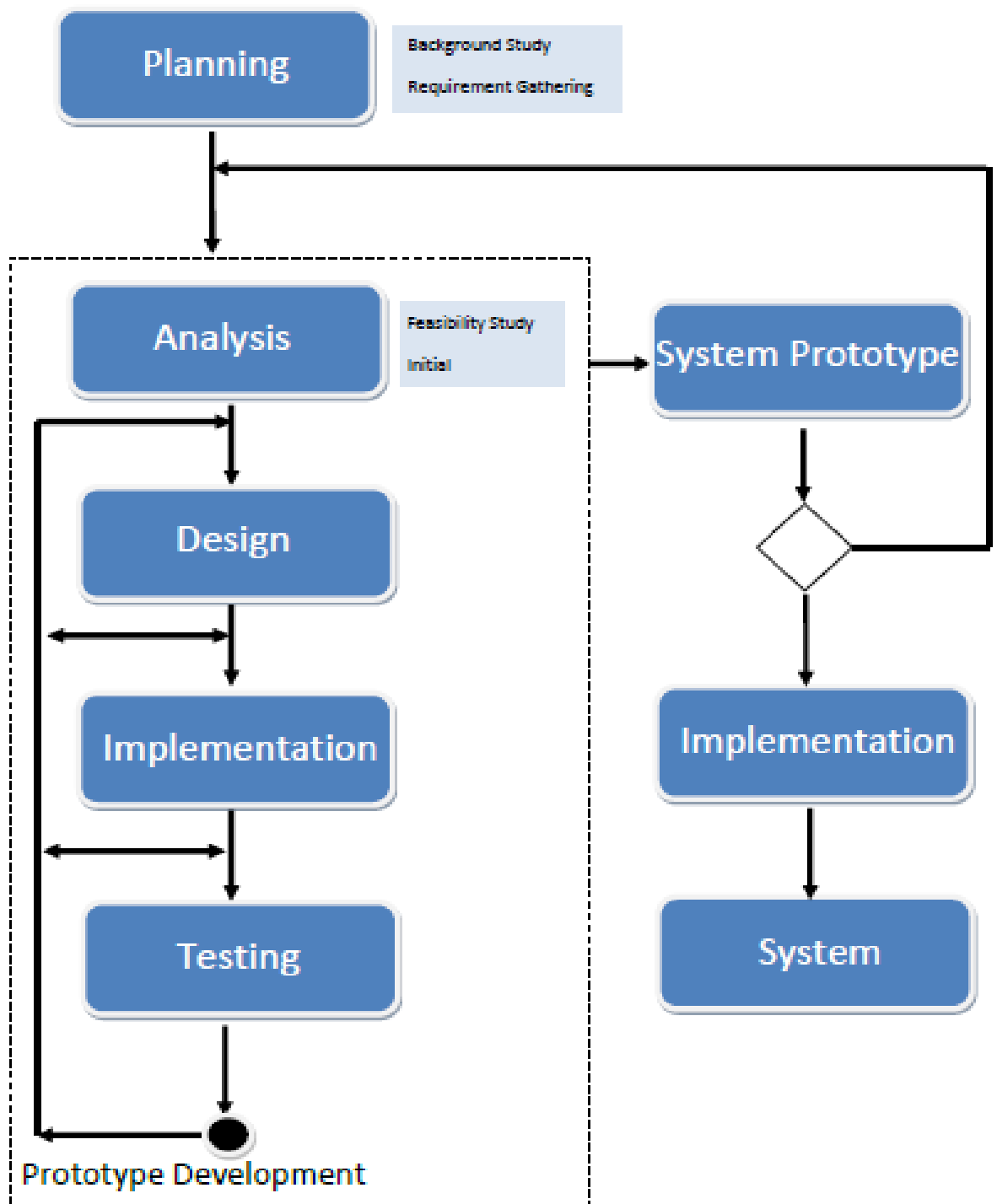


Figure 1: Phase involved in developing Timetabling System for Medical Officer

### **3.2.1 Planning**

Techniques used to obtain this understanding are using interviews, research, survey, discussion and determine of tools features. In this phase, problem statement, objectives and scope of studies is defined. Gantt chart and project timeline are prepared in order to monitor the development would be completed in the given time period.

Questionnaire is used as a medium to collect data in interview sessions. Several interview sessions were conducted. While doing a research, observation, discussion and survey are used in order to get more accurate conclusion. Other than that, internet research, journals, articles and books are also being used as references.

### **3.2.2 Analyzing**

Feasibility study is carried out in order to get prepare with the risks and problems that may arise during development. Several arising matters are considered such as time, skills, and resource. Based on the requirement gathered, the system was developed accordingly to the user requirement. Besides fulfilling the user satisfaction, the system was also expected to meet the technology requirement.

### **3.2.3 Design**

Design phase will be focus on the defining the hardware and software architecture, choosing the programming language, and indicating strategies to deal with issues. The designing phase is divided into two parts which are interface design and system design. Interface design consists of the Graphical User Interface (GUI) design and the mechanism behind. Meanwhile, the system design consists of designing UML Diagram for the system.

### **3.2.4 Implementation**

This phase may include several steps which are simulation, installation, maintenance, evaluation and modification. Simulation is carried out by launching the beta version of the database system to the users. The simulation is important in order to get feedback and collect the users' opinions about the system.

### 3.3 Project framework

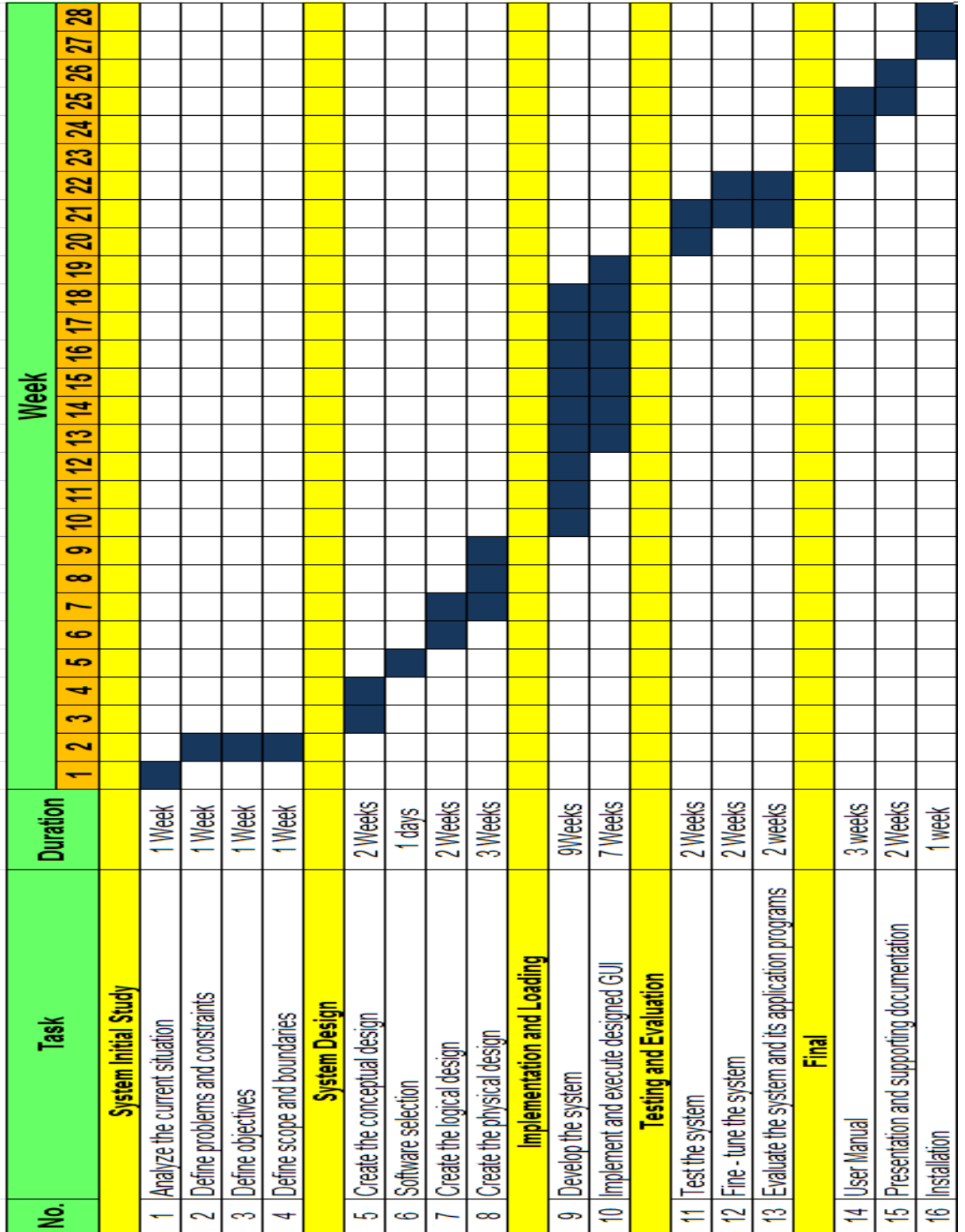
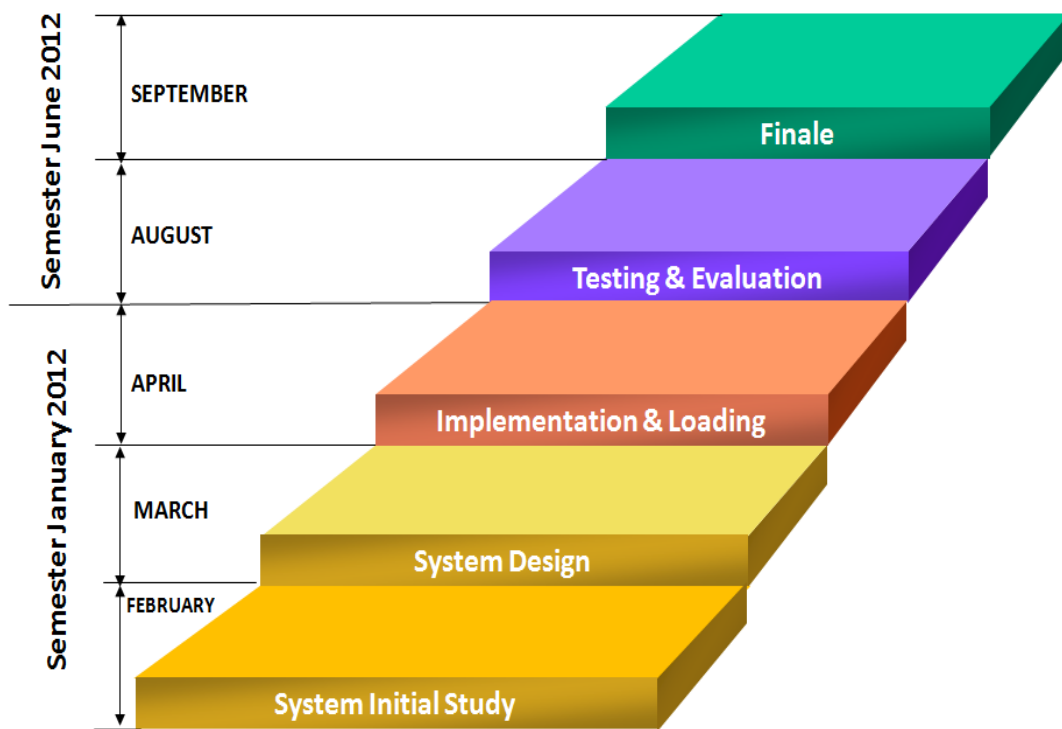


Figure 2: Timetabling System for Medical Officer Project Gantt chart

Frequently used in project management, a Gantt chart provide a graphical illustration of the schedule that helps to plan, coordinate, and track specific task in a project. It is constructed with the project's total time span, broken down into weeks and the task that make up the project. In the real time working environment, it will show the triple constrains which are cost, time and scope. In addition, it will display the tasks' status and progression. Besides that, man power resource also can be managed wisely with the help from Gantt chart.

Based on Figure 2, it shows the Project Gantt's Chart of Timetabling System for Medical Officer Development. 28 weeks are given to complete the system prototype. The project started since January 2012 until September 2012. Weeks are divided accordingly based on the activities involved. Resources and time are channeled to the most crucial activities which are system development and system implementation. 16 weeks are given for the sated activities.

Gantt's Chart consists of project duration, milestone and key activities. Refer to Figure 2, orange columns indicating the duration or timeline for system development. It is shown in weekly basis. Blue columns show the allocated time and number of weeks to complete the key activities. On the other hand, yellow rows are labeling the milestones of the project development. It shows the level of completeness of the system. Meanwhile, the activities listed under milestones are known as key activities.



1

Figure 3: Project Key Milestone

The key activities' completion can be indicated by the milestone. In this research, there are 5 milestones that had been identified. There are system initial studies, system design, implementation and loading, testing and evaluation and finale. Each milestone carried different key activities to be completed. Give below are the explanation of each milestone and the key activities.

### **3.3.1 Initial studies**

This is the system's planning phase. Firstly, study about Medical Officer jobs nature, works deliverable, business processes and cultures. Then, learn about the working environment, work processes and framework. Define the problem, constraints, objectives, scopes and boundaries to develop the timetabling system.

### **3.3.2 System design**

This is the system's design phase. After the user requirement had been collected, create a conceptual design. This is important because it will show the system in holistic view. Based on knowledge and skills, the suitable developing software is selected. Then create the system's logical and physical design.

### **3.3.3 Implementation and loading**

This is the system's implementation phase. The system is ready to be developed. Once the system's backbone is ready, load the data. As for Timetabling System for Medical Officer, the data are created for sample purposes.

### **3.3.4 Testing and evaluation**

The system undergoes few testing procedure before it is ready to be used. This included alpha, beta and acceptance testing. Next, the system evaluation is conducted. This is to ensure the system meet the user requirements.

### **3.3.5 Finale**

After undergoes testing and evaluation processes, the system is ready to be used. User manual should be prepared as it is a new system in hospital. One of the Medical officers is assigned to be the custodian for the timetabling system and user manual.



### 3.4 Tools

<b>Language Used</b>	a) Java
<b>Requirements</b>	<b>Software Requirements</b> a) Netbeans™ IDE 7.1 <b>Hardware Requirements</b> a) Personal Computer, Acer Aspire 4750G <ul style="list-style-type: none"><li>• Intel® Core™ i5 – 2410M 2.3 GHz</li><li>• 4GB DDR3 Memory</li><li>• 500 GB HDD</li></ul>
<b>Database</b>	<b>MySQL</b>

Table 5: Language Used and Requirements

#### 3.4.1 Java

Java is one of the types of a programming language. Java differ from other language because, program written in Java can be run not only on computers it is write but also other computer. Java runs in runtime environment. Devices such as computer or cell phone which has Java runtime environment can run Java code.

It is an object – oriented programming (OOP) language. It is inspired by the first version of C++ but far way better than C and C++. OOP allows the developer to reuse written code and create modular programs. Hence, it will reduce time taken to develop a system. As time is the main challenge, it should be managed wisely.

Java programs are easy to understand and read. Although more effort needed in writing the code but programmer can understand the code faster and easier. Java is easy to learn. It was designed in a sense that easy to use. Hence, the process of writing, compiling, debugging, and learning the system is shorter and less complex.

Compared to C++, Java promoting a concept “Compile – Once – Run – Anywhere”. It is platform independent. It proved that, Java program can be transferred across different machine, different operating system, and different graphic user interface. This ability is crucial in system developed. This is because, system which can run in any platform is more economical to implement as compared to single platform system.

### **3.4.2 Netbeans IDE 7. 1**

Netbeans is the combination of Network and Java Beans. Based on the proposed name, it is expected to describe the capability and limitation of Netbeans. It is a sophisticated Integrated Development Environment (IDE) which helps developers to build any type of application such as desktop, web, mobile and enterprise. It is free and open source for software developer for application with Java platform, C, C++, PHP, and Javascript.

There are variety and tremendous plug – in available to be downloaded by the developers. It allows the developers to select the IDE based on their individual development preferences. Some features are highlighted to promote Netbeans. It has drag and drop functionality to create an applications’ Graphic User Interface (GUI) which known as Swing GUI builder. Besides that, it has profiler which tracks the speed and applications’ memory usage. In addition, it is supported with Netbeans Platform which helps in desktop application development.

As for the purpose of this research, Netbeans is used to develop a stand – alone java application which integrated with database system (MySQL). Several Java class were created in order to work with the designed Graphical User Interface (GUI). In addition, GUIs were design by using Java swing. The functions are well developed in order to help developer to design and arranging the user interface. Hence, the system can be more user friendly and user – oriented.

### 3.4.3 MySQL

MySQL is an open source Relational Database Management System. It allows user to create a relational database structure on the web server which is used to store the data. It is very reliable and flexible Database Management System. It falls under General Public License (GPL) as it is open source and can be used by public.

In order to interact with the MySQL, user is having options either by using SQL statements or by using another open source tool called PHPMysqlAdmin. PHPMysqlAdmin will help the user to create table and execute queries based on user specification. The interfaces provided are user friendly and easy to use. However, although the users are comfortable with the provided interface, it is advisable for them to know about SQL statement. This is because, in some cases, the SQL statement will produce more accurate queries results.

The system will communicate with the database once the connection is created. From java application, the data from the database can be access easily and be manipulated. However, developer has to be aware of how the SQL works in Java. This is because, the compiler may show error if the codes are not properly arrange and write.

## **3.5 Developer Constraint**

### **3.5.1 Skills and knowledge area**

Lack of knowledge in using Netbeans IDE 7.1 is the biggest challenge in developing the timetabling system. In order to build user – friendly and intelligent system, more exposure and discussion is needed to meet these requirements. In addition, it can be overcome by putting extraordinary effort to do research, discussion with the experts and spirit to learn new things.

### **3.5.2 Time**

The timetabling system should be ready within 28 weeks of study. In fact, it is not enough for the developer as other commitments also need to be performed. In addition, the system is come with supporting documents such as progress report and dissertation. Hence, besides focusing on system development, developer also have to work on the documentation for record purposes.

### **3.5.3 Data Access**

Data are collected from Hospital Pakar Sultanah Fatimah Muar. The data are confidential as it will disclose the data about the medical officer of the hospital. The process of data request is complex as the research should be register through National Medical Research Register (NMRR) of Ministry of Health (MOH). The process of registration is followed by the approval from Medical Review &Ethics Committee (MREC). The approved proposal will then submitted to respective National Institute of Health (NIH) research institute which for this research purposes Institute of Medical Research (IMR). Once the proposal approved, the director of hospital is allowed to share the requested data.

## **4.0 RESULT AND DISCUSSION**

Data gathering is used to discover business information details to define the information structure. Besides, data gathering helps to differentiate the priorities and non priorities of the information needed. Thus, data gathering helps to improve time of completion as it will help in selecting the proper modeling methods. It also helps in keep track of what has been done to date and what remains to be done for work completion.

### ***The sources of information***

- System users
- Forms and documents
- Procedure manuals

For Medical Officer Timetabling system, the generic techniques applied is through

### **Observation**

Observation is done with help from field supervisor, the Medical Laboratory Technologist, Jawilah binti Abu Naim. With her assistance, exposure was given in order to understand the working culture among medical officer. In order to familiarize with the process, opportunity was given to experience the environment. On 3<sup>rd</sup> August, 2012, a research visit to Hospital Pakar Sultanah Fatimah was conducted. The visit was aimed to study on how the medical officers perform their task. Based on the visit, it is proven that, difference department will have different orientation on how to arrange their duty roster. The factor affecting the roster scheduling is number of medical officer.

Compared to other district hospital, Hospital Pakar Sultanah Fatimah is a supporting hospital which will be referred in case of chronic cases. For some department, one of the job scopes for medical officer is to go to other district hospital. The district hospitals include Hospital Batu Pahat, Hospital Segamat and Hospital Tangkak. Besides that, medical officers also were entitled to support health clinic around Muar and Tankak (Ledang).

## **Interview**

Interview session is used as a medium to gather information on how scheduling works. A few questions are prepared before the discussion was conducted. It is conducted after office hours. It is an important approach because it can avoid from getting a wrong understanding about scheduling system.

There are 2 respondents involved during the interview. One of the respondents is expert in school timetable scheduling, Mohd Zahari bin Kanut. He started his career as teacher and now he is Senior Assistant Co – Curriculum at Sekolah Kebangsaan Pantai Layang, Ledang. He shared his experience on how to arrange the timetable manually. It is troublesome for him as the number of teacher, classes, venues and subjects are some of the constraints. He did share on how the scheduling software helps him in organizing the timetable for school. Instead of using pen and paper, now he can save his time by just generate the timetable by using that software.

As a matter expert, he recommended some ways on how to improve the system. He added that, even though timetabling system for medical officer is not the same as timetabling system for school but he did highlighted some guidelines on how to arrange the timetable. He said that, before we tell the system on how to do the schedule, the developer himself / herself should learnt to arrange it manually. Hence, he / she will get an idea on how the system will work. Before the interview end, he suggested to study on what are the constraints which will affect the timetable scheduling.

The second respondent is field supervisor, Jawilah binti Abu Naim. She started her career as Medical Laboratory Technologist. In 2007, she was promoted as U32 and sent to Hospital Segamat. Besides performing her daily job routines, she also involve in scheduling the duty roster for her department. However, she arranges the duty roster manually by using pen and paper. Her reason is the number of staff under her supervision is still practical and reliable to use manual way.

In 2009, she moved to Hospital Pakar Sultanah Fatimah. She continues her task in scheduling the duty roster beside routine tasks. However, she starts to face some problem when there is staff that made request to only have morning and evening shift but night. In other cases, there are few staffs who requested to have certain shift for certain date. The issues are getting serious when she herself has to work on shift while she supposed not to. Even though the department is having enough staff but the shifts are not well distributed among the staff.

Hence, she proposed that, even though technology had invented great scheduling system, but it does not ensure every personal preference can be fulfill. There is need of human touch. She did some recommendation to study on human factor which will affect the system. However, her advice was to have scope in selecting the human factors due to time constraints.

### **Informal Discussion**

The informal discussion was conducted with the expert from industry. Mohd Syukri bin Mohamad, 24 is programmer from well known IT Company. Graduated from Universiti Tun Hussein Onn, he started his carrier in 2009. Throughout the session, guidance and examples are given. He also gave his opinion about the system design and suitable platform to be used. The sessions conducted more or less help in developing the database as well as for the future.

The discussion also was conducted with a group of friends who did throwing some ideas on how to develop the system. From the discussion, the ideas are analyze whether it is practical or not. Some algorithms and methods are proposed in order to arrange the medical officer name based on the set guidelines. Through this informal discussion also, the developer had gather some idea and be clear on the objectives of developing the system.

#### 4.1 Data Finding

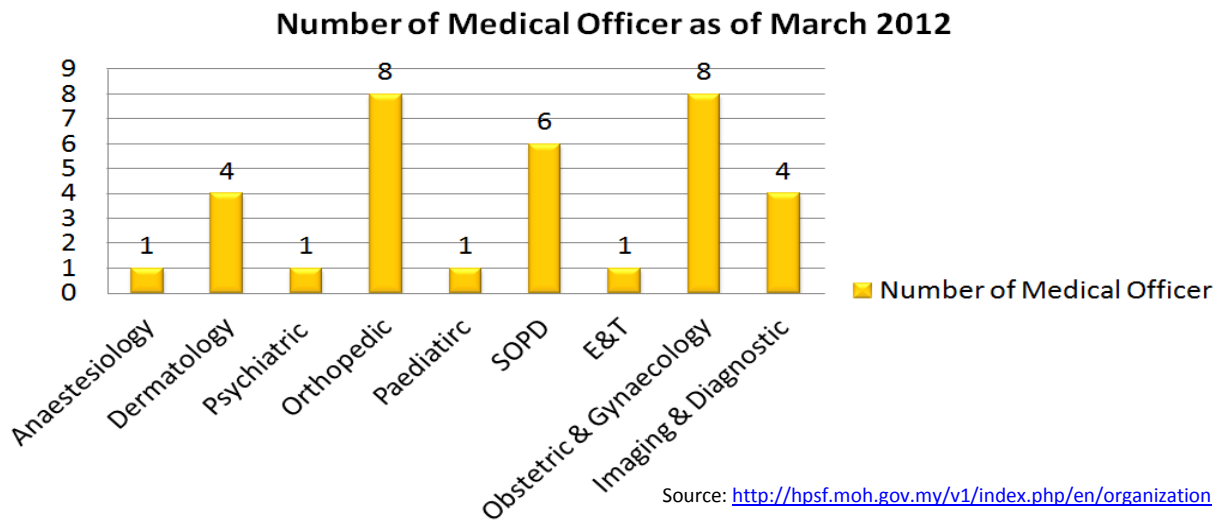


Figure 4: Number of Medical Officer in Hospital Pakar Sultanah Fatimah as of March 2012

Figure 4 shows the number of medical officer in Hospital Pakar Sultanah Fatimah arranging in department basis. It is clearly shows that different department having different number of medical officer. Based on the findings, there are 34 medical officers as a whole. The medical officers are allocated based on the number of cases in each department. The higher the number of patients cases, the higher number of medical officer in that department. As compared to houseman, medical officers will stay in each department. Normally, medical officer will request for further their studies and become specialist.



## 4.2 System modeling

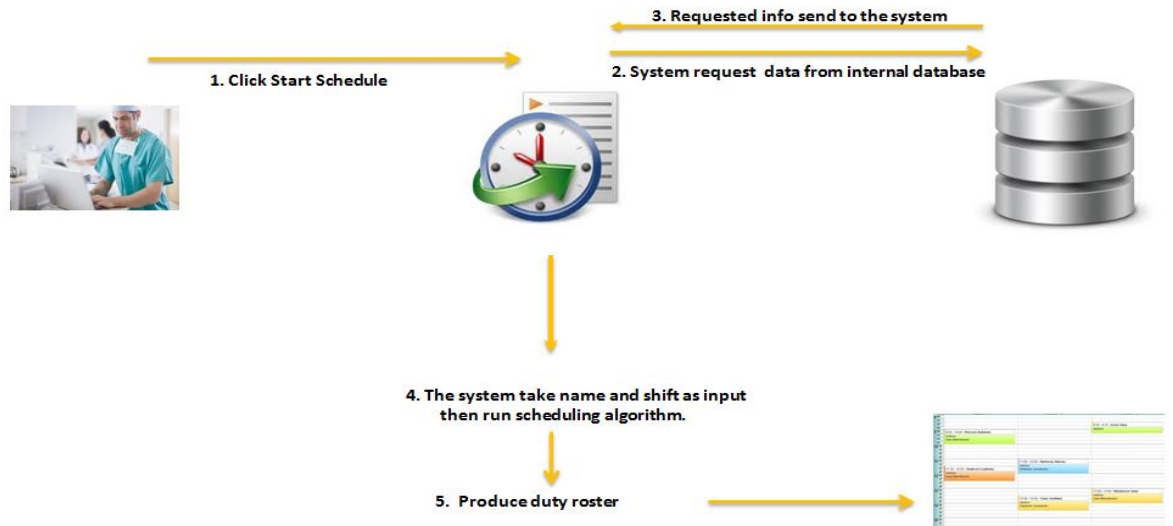


Figure 5: Timetabling System for Medical Officer Model

Based on figure 5, it shows on how Timetabling system for Medical Officer operates. There are 3 elements of the system operation which are medical officer as the input, database system as the data keeper and the system itself. The processes are revolving between those 3 elements and produce a duty roster.

Medical officer will select start schedule. Data are requested from main database which store the information. The database will return the data as per requested. However, in the case whereby, the information is not available in the database, medical officer can update the information through the system. The system will then collect the user input and use the information to produce a duty roster. The duty roster is produce automatically by using scheduling algorithm embeds in the timetabling system.

Medical officers' name will be randomly select from the database. This to ensure the duty roster is more dynamic rather than having the same person for every month.

### 4.3 Activity Diagram

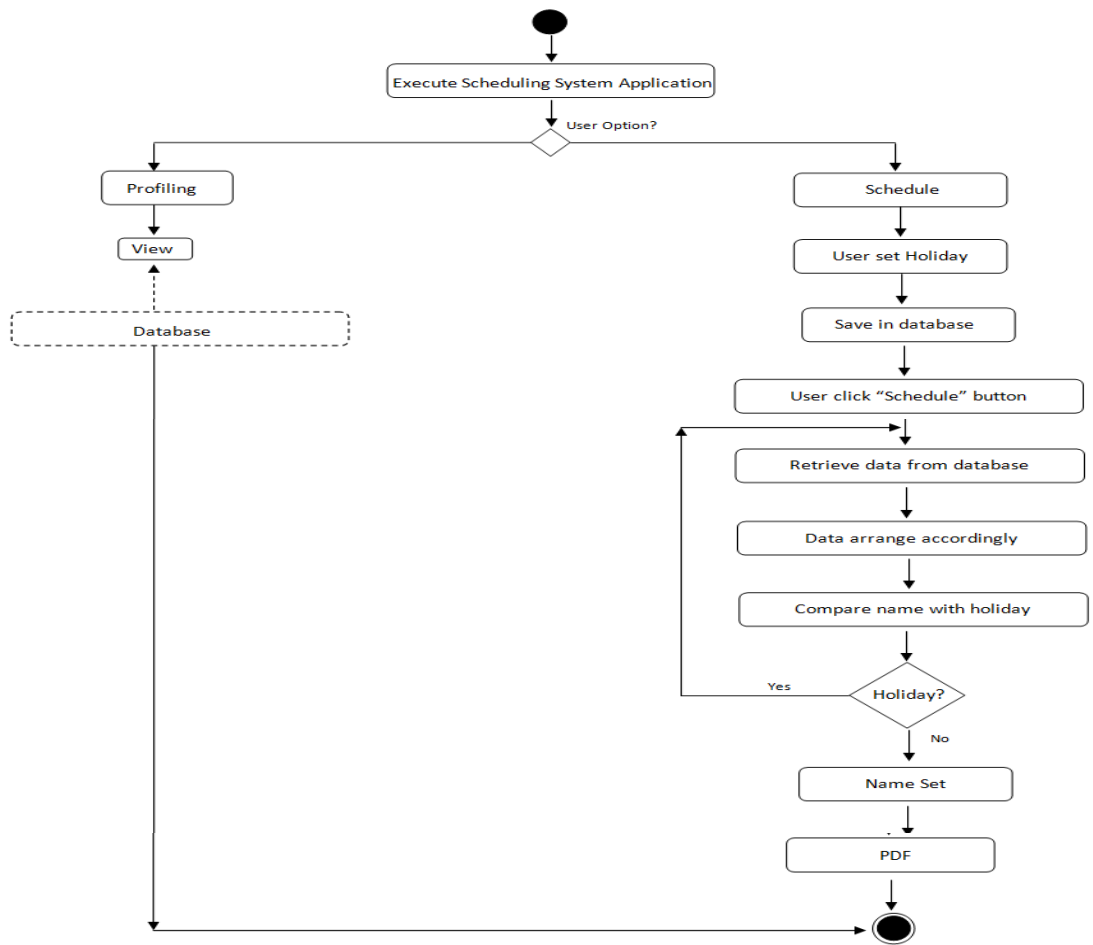


Figure 6: Timetabling System for Medical Officer Activity Diagram

Figure 6 shows the activity diagram for Timetabling System for Medical Officer. The system start once the users select to launch the application. Admin is having 2 options which are profiling and schedule. Profiling is part of the system which communicates with the database. Admin can view records from database. The record stores are medical officer profile – Staff Id and Name.

On the other hand, schedule will perform the core activity of the system. Before start with the scheduling, admin has to input dates where by the medical officer on leaves. The records will then be updated in database. After done with the on leave input, admin will click schedule button. It will then retrieve the data from database and arrange it according to the set arrangement. The system will than comparing the set value with the records of medical on leave. If the record in on leave is the same as the record in schedule, the name in schedule will be replaced with other medical officer's name. The process will continue until there is no same record.

## 4.4 Java Class Diagram

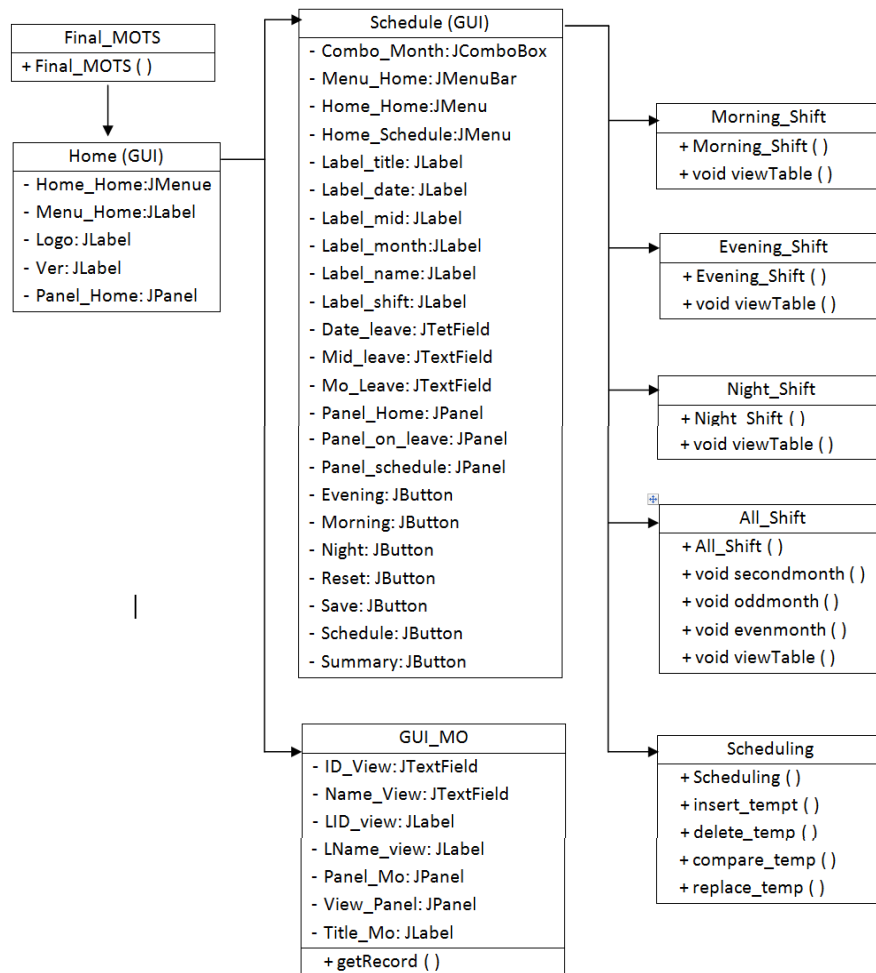


Figure 7: Java Class Diagram

Figure 7 show the UML Class Diagram for Timetabling System for Medical Officer. There are six (6) classes with two (3) GUI class. The classes are divided based on shift category, and scheduling function. As shown in the figure 7, Final\_MOTS is the main class. The main class will call Home (GUI) class. From Home, user may choose either would like to proceed with scheduling or medical officer profiling.

From schedule class, user can interact with the system to get the generated schedule. The schedule is divided into 4 which are Morning\_Shift, Evening\_Shift, Night\_Shift, All\_Shift. The functions are called according to user selection. Meanwhile, Scheduling function will execute several other methods in order to complete the scheduling process. As the figure shown, the methods involved are insert\_temp ( ), delete\_temp ( ), delete\_temp ( ), compare\_temp ( ) and replace\_temp ( ). All five (5) methods will be used to manipulate the records from table in database name temp\_table.

Class GUI\_Mo will display the records of mo\_table from database. From the table, it will show the Staff ID and name of medical officer accordingly. Method getRecord ( ) is used to retrieve the data from database to be displayed in respected Jtextfield.

## 4.5 Database diagram

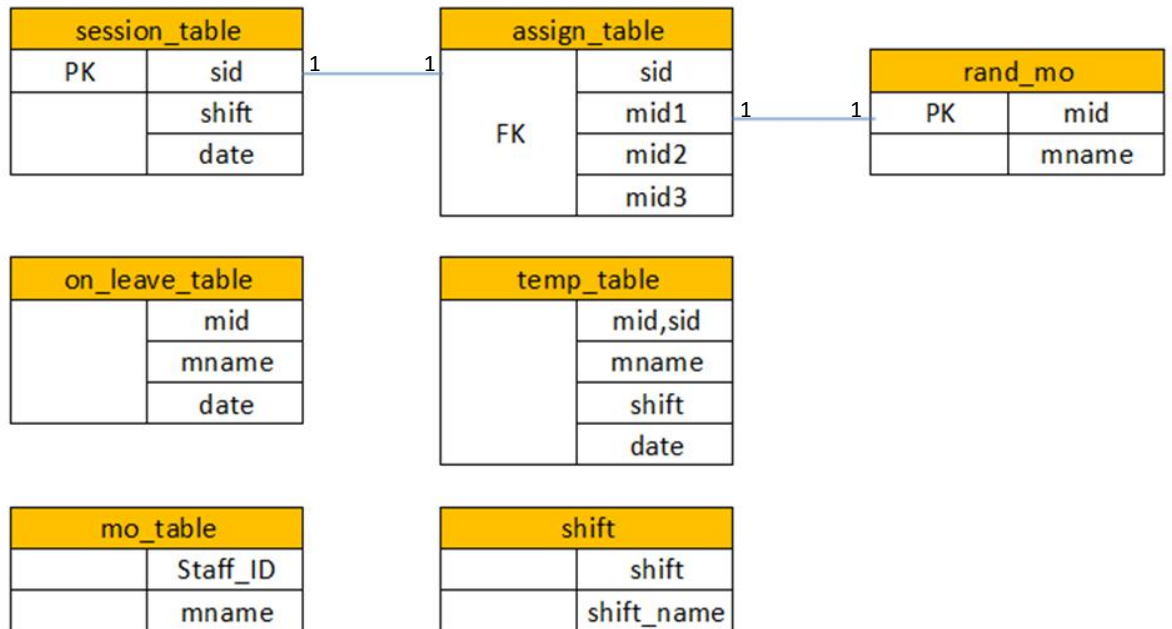


Figure 8: Database Diagram

Figure 8 shows database diagram for Timetabling System for Medical Officer. It consists of 7 tables which are interrelated with one another. Table session\_table consists of sid as primary key and another 2 attributes which are shift and date. This table will specify the session according to date and shift. Sid is the foreign key inside assign\_table. Besides sid, the table also consists of mid1, mid2 and mid3. This table will assign medical officer based on session id (sid). The main and core arrangement of scheduling is rely on this table. In order to change the order of arrangement, user may change the order of mid inside this table.

From rand\_mo table, medical officers' names were selected. By using rand ( ), names are arranged randomly. After being arranged, the name will be assign to the mid. For example, the first name from the list will be assign as mid 1. On\_leave\_table will store the records about the medical officer who will be on leave during particular date. The data can be repeated as it should cover system rules which one day, there will be 1 or 2 medical officer on leave.

The database also supported with another 3 tables which are temp\_table, mo\_table and shift table. Temp\_table is used to compare the generated scheduling name with the medical officer on leave. If the name of medical officer in temp\_table is equal to name inside on\_leave\_table, it will be replace with other medical officer's name. Here, comparing function will be executed in order to select the most suitable name to replace the clashes name. Shift table store records about number of shift and shift name. Currently, for the purpose of this research, the numbers of shift are fixed to 3 which are morning, evening and night.

In addition, the database also stores records about medical officer. Due to limited access, the data stored in this table are staff\_id and medical officers' name (mname). Basically, the main functions of scheduling algorithms are supported with data manipulation of database. Hence, even though the user is not well exposed with Java codes, he or she may have an option to change the data inside the database to manipulate the scheduling scheme.

## 4.6 Timetabling System for Medical Officer Prototype

### 4.6.1 Home

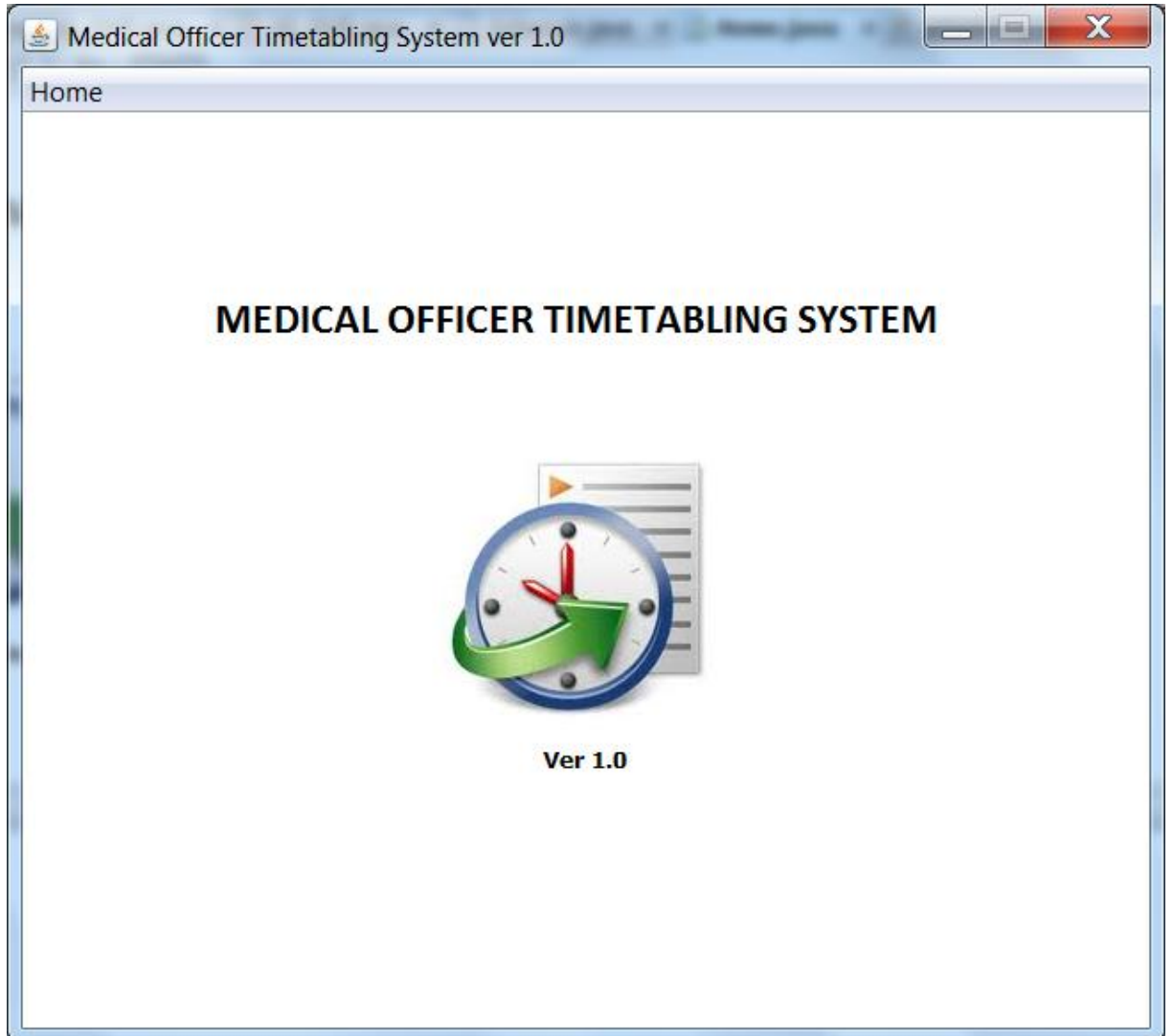
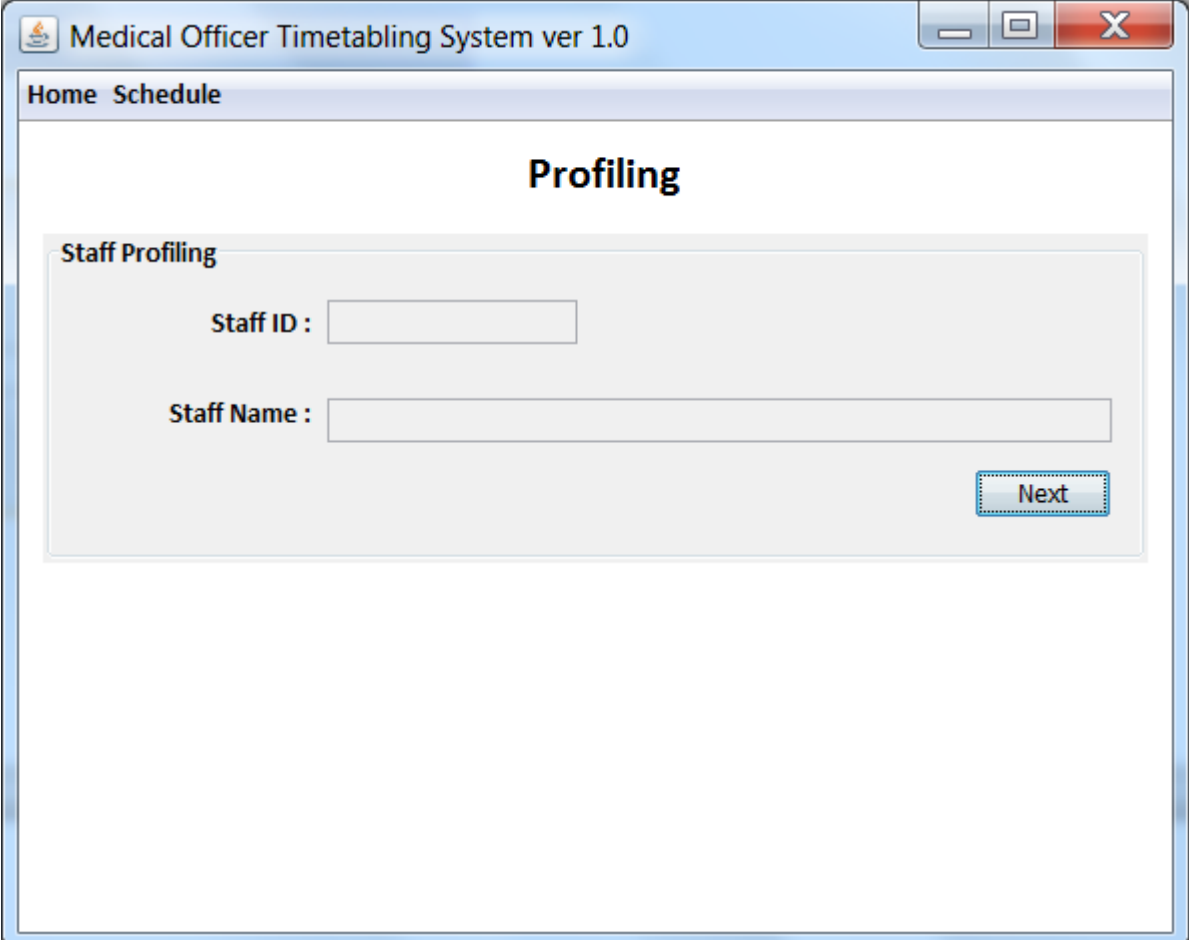


Figure 9: Home Page

Figure 9 shows the interface of Home Page of the system. Once the system is launched, user will be prompted with home page.



## 4.6.2 Profiling Interface



The screenshot shows a web browser window titled "Medical Officer Timetabling System ver 1.0". The browser's address bar shows "Home Schedule". The main content area is titled "Profiling" and contains a "Staff Profiling" section. This section has two input fields: "Staff ID :" and "Staff Name :". A "Next" button is located at the bottom right of the "Staff Profiling" section.

Figure 10: Profiling

Figure 10 shows the interface for profiling. It is used to retrieve records from mo\_table in database. It will show the Staff ID and Name of medical officer.

### 4.6.3 Set Holiday

The screenshot displays a web application window titled "Medical Officer Timetabling System ver 1.0". The interface is divided into two main sections: "On Leave" and "Schedule".

**On Leave Section:**

- Mid:
- Name:
- Date on Leave:
- Save button

**Schedule Section:**

- Month:  (dropdown menu) Start Schedule button
- Shift:
- 
- 
- 
- RESET button

Figure 11: Set Holiday

Figure 11 shows the interface for the admin to input the medical officer's name and date where the medical officer will be on leave. From on leave panel, the data will be collected and store inside on\_leave\_table in the database. The records will be used during scheduling process.

#### 4.6.4 Morning Shift

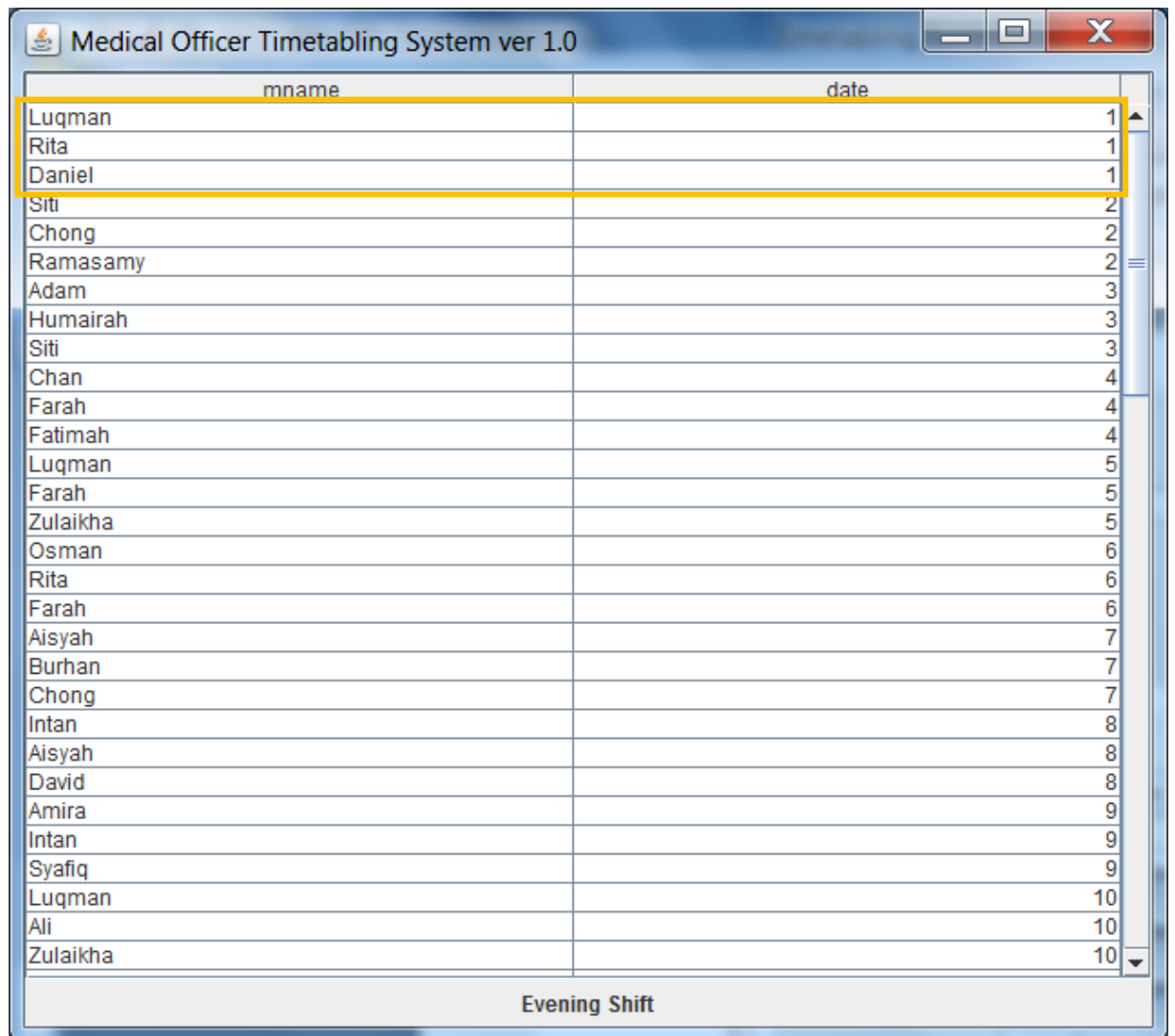
mname	date
Chan	1
Farah	1
Fatimah	1
Luqman	2
Farah	2
Zulaikha	2
Osman	3
Rita	3
Farah	3
Aisyah	4
Burhan	4
Chong	4
Intan	5
Aisyah	5
David	5
Amira	6
Intan	6
Syafiq	6
Luqman	7
Ali	7
Zulaikha	7
Luqman	8
Rita	8
Daniel	8
Siti	9
Chong	9
Ramasamy	9
Adam	10
Humairah	10
Siti	10

**Morning Shift**

Figure 12: Morning Shift

Figure 12 shows the generated schedule for morning shift. The names are arranged according to the default arrangement set. As shown, there are no repeating names and the dates are listed accordingly. Based on the figure above, on 1<sup>st</sup> the medical officers in charge for morning shift are Chan, Farah and Fatimah.

#### 4.6.5 Evening Shift



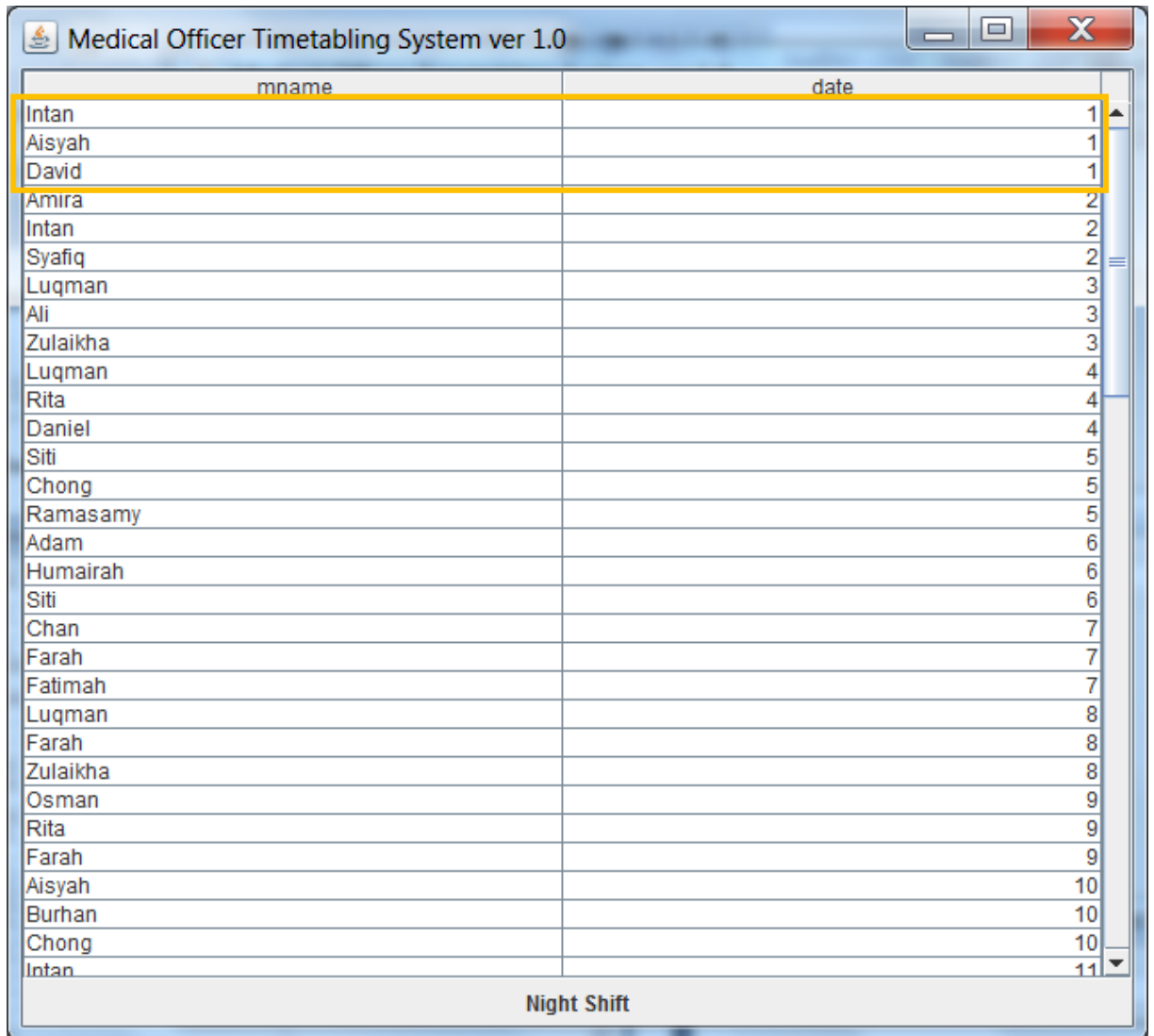
mname	date
Luqman	1
Rita	1
Daniel	1
Siti	2
Chong	2
Ramasamy	2
Adam	3
Humairah	3
Siti	3
Chan	4
Farah	4
Fatimah	4
Luqman	5
Farah	5
Zulaikha	5
Osman	6
Rita	6
Farah	6
Aisyah	7
Burhan	7
Chong	7
Intan	8
Aisyah	8
David	8
Amira	9
Intan	9
Syafiq	9
Luqman	10
Ali	10
Zulaikha	10

**Evening Shift**

Figure 13: Evening Shift

Figure 13 shows the generated schedule for evening shift. The names are arranged according to the default arrangement set. As shown, there are no repeating names and the dates are listed accordingly. Based on the figure above, on 1<sup>st</sup> the medical officer in charge for evening shift are Luqman, Rita and Daniel.

#### 4.6.6 Night Shift



mname	date
Intan	1
Aisyah	1
David	1
Amira	2
Intan	2
Syafiq	2
Luqman	3
Ali	3
Zulaikha	3
Luqman	4
Rita	4
Daniel	4
Siti	5
Chong	5
Ramasamy	5
Adam	6
Humairah	6
Siti	6
Chan	7
Farah	7
Fatimah	7
Luqman	8
Farah	8
Zulaikha	8
Osman	9
Rita	9
Farah	9
Aisyah	10
Burhan	10
Chong	10
Intan	11

**Night Shift**

Figure14: Night Shift

Figure 14 shows the generated schedule for night shift. The name are arrange according to the default arrangement set. As shown, there are no repeating names and the dates are listed accordingly. Based on the figure above, on 1<sup>st</sup> the medical officers in charge for night shift are Intan, Aisyah and David.

#### 4.6.7 Summary Shift

The screenshot shows a window titled "Medical Officer Timetabling System ver 1.0" containing a table with three columns: "mname", "Shift Name", and "date". The table lists medical officers and their assigned shifts across four dates. The names are arranged in a specific order for each date, and the dates are listed sequentially from 1 to 4. A "Summary" label is centered at the bottom of the table area.

mname	Shift Name	date
Chan	Morning	1
Farah	Morning	1
Fatimah	Morning	1
Luqman	Evening	1
Rita	Evening	1
Daniel	Evening	1
Intan	Night	1
Aisyah	Night	1
David	Night	1
Luqman	Morning	2
Farah	Morning	2
Zulaikha	Morning	2
Siti	Evening	2
Chong	Evening	2
Ramasamy	Evening	2
Amira	Night	2
Intan	Night	2
Syafiq	Night	2
Osman	Morning	3
Rita	Morning	3
Farah	Morning	3
Adam	Evening	3
Humairah	Evening	3
Siti	Evening	3
Luqman	Night	3
Ali	Night	3
Zulaikha	Night	3
Aisyah	Morning	4
Burhan	Morning	4
Chong	Morning	4
Chan	Evening	4

Summary

Figure 15: Summary Shift

Figure 15 shows the generated schedule as a whole. The names are arranged according to the default arrangement set. As shown, there are no repeating names and the dates are listed accordingly. It will show the medical officer in charge for that particular date for the entire 3 shift. As compared with Figure 12, 13, 14, the names of medical officer in charge are the same for the 3 shift.

## **4.7 System rules and constraints**

There are several rules are listed in order to cater the scheduling process. However, for the purpose of this research the rules are group into two (2) categories which are leave and shift.

### **4.7.1 Leave**

Leave is one of the constraints for the scheduling system. Leave will effecting the arrangement of medical officer name. In a case where by number of medical officer is less than optimum value, the name arrangement will be more pack. This is because; one medical officer may have more than normal number of shift.

Besides that, medical officer within the same department have to cover the on leave medical officer. He or she has to replace the medical officer on leave. Hence, number of medical officer for each month is very crucial in arranging the duty roster. As the number of medical officer on leave increases, the number of medical officer available to work on shift will be affected. It will cause the duty roster generated is not well balanced.

As medical officer is part of the workforce under health sector, hence public holiday is treated as normal working days. However, medical officer may request 2 weeks earlier before the scheduling process started if he or she would like to apply for on leave. However, in the case of emergency leave, the medical officer has to find replacement to replace his or her shift.

#### **4.7.2 Shift**

Shift is another category of constraints to generate duty roster. Based on the finding, there are 3 shifts per day which are morning, evening and night. However, the number of shift may be different according to what sector the scheduling system will be. For this research purposes, the number of medical officer per shift is fixed to 3 medical officers.

Besides number of shift and number of medical officer per shift, another constraint should be considered is arrangement of name according to shift. It is stated that, medical officer cannot work in three (3) consecutive shift on the same date. For example, medical officer who work on morning shift cannot work in evening and night shift of the same date. Medical officer also are not advice to work on same shift for two (2) consecutive days. For example, medical officer who work on evening shift of 1<sup>st</sup> is not advice to on evening shift of 2<sup>nd</sup>. In addition, medical officer also is not advice to work in two (2) consecutive shifts. For example, medical officer who work on night shift of 1<sup>st</sup> is not advice to work on morning shift of 2<sup>nd</sup>.

However, the arrangement of name is strictly based on the number of medical officer. In a case where by the number of medical officer is not enough, certain rules have to be violate.



## **4.8 System intelligent**

As compared with the manual basis of scheduling, the name of medical officer will be picked manually. By using pen and paper, it will be selected based on the available name. Meanwhile, by using Timetabling System for Medical Officer, the scheduling is generated automatically. User just only needs to input the on leave date for respective medical officer.

Besides that, the name of medical officer will be selected by the system. Hence, it will help user in scheduling the duty roster. Thus, for every month, different name arrangement will be produce. For certain stand it will be good for the duty roster to have a fixed name for every month. However, it will be not fair for everyone. This is because the medical officer will have the same shift for every month. On the other hand, the system developed will help user in selecting the name for the duty roster. Hence, there will be more variety in name selection.

As a conclusion, the system help user in deleting one of the process of arranging the scheduling system which is name selection. Even though it is something that can be questionable but by reducing one of the step in arranging the duty roster is another way of improvement given.

## **5.0 CONCLUSION**

As a conclusion, timetabling system is expected to manage Medical Officer (MO) duty roster in more efficient way. Proper and organized duty roster can improve the work effectiveness and meet job satisfaction. Thus, MO feels happier with their work and create harmony working environment.

Besides that, even though the user is not an IT expert but using Timetabling System, it can help them with the human resource management. With only click, drag and drop function, they can retrieve and store the data faster and easily.

After went through a few phases and processes, Timetabling System is ready to be used. With hope, it may help Medical Officer in their work deliverable and make them one of the most efficient services team in hospital.

Hopefully, in the near future, the timetabling system not only capable to schedule and arrange the MO shift but applicable to all services unit in hospital. It is expected to run automatically with less user input. Thus, it can help user in making a good decision.

## **6.0 RECOMMENDATION**

### **6.1 Medical Officer Notification**

It is recommended if the timetabling system can notified the Medical Officer (MO). The notification can be distributed through multiple channels such as Short Message System (SMS), and Electronic Mail (E-mail). The notifications include shift time, venue and main activities.

### **6.2 Automated Scheduler**

It is recommended if the system is capable in automatically arrange the duty roster. The users only have to provide input about their preference time and personal constraints. The system then will arrange and schedule the duty for the Medical Officer.

### **6.3 Widely used within organization**

It is recommended if the system can support the duty roster of services unit as a whole. It means that, the system is capable in managing the staffs' shift working time in hospital. Hence, it can help in planning the human resource management. As, it is economically good to be implemented in hospital hence they should consider to have this system.

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[3] Mohd Zahari K. Senior Assistant Co – Curriculum DG32. Sekolah Kebangsaan Pantai Layang  
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# Timetabling System for Medical Officer

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## Abstract

*The idea was proposed due to the issues that Medical Officer face which is unorganized and unstructured duty roster management. Thus, inspired by Prototyping – based methodology, Timetabling System for Medical officer was developed. This research studied about the scheduling algorithm, tools and knowledge required for system development and the development process involved. Feasibility study was carried out to ensure the timetabling system can be develop within scope, time and constrains. Beside the main constrains, other minor constrains such as cultural, technical and operational was included. Methodology analysis is carried out in order to choose the suitable methodology to develop the system. The prototype architecture is shown in the result and discussion. At the end of the report, few recommendations were listed for the betterment of the system. Besides that, it also can be used as the reference for the custodian to understand the current status of the project.*

**Keywords:** *Medical Officer Timetabling System, Database Manipulation*

## I. INTRODUCTION

Medical officers are involved directly and indirectly in health delivery service such as examining, diagnosing and treating patients, administering, prescribing medication, performing procedures, surgery and alleviating pain in patients. Besides that, they also perform health checks on pregnant women, deliver babies, performing post – mortem and other related job required. As they are the ambassador that promoting good health and lifestyle, they are responsible in implementing family health and planning programmes as well as preventing and controlling communicable diseases. They also part of the team who disseminating public medical education.

Medical officer are divided into 3 main fields: Medical Officer Administration, Medical Officer Clinical and Medical Officer Clinical in multi – disciplines. However, the research focuses on Medical Officer Clinical and Medical Officer Clinical in multi – discipline. This is because the research targeted hospital as the implementation field. Hence, this research only takes into consideration to study about the working nature of medical officer in hospital.

As we know, medical officer not only providing and serving the patient during a day time but also at night. Hence, they need a scheduling system whereby can help them managing their workforce efficiently and effectively. The propose idea is expected to help the medical officer with the flexible shift, fulfill personal preference, and ideal balance job distribution.

## II. PROBLEM STATEMENT

Throughout the years, medical officer (MO) shift scheduling and timetabling is made manually. In fact, it was arrange by the MOs' themselves. As we know, MO needs to perform multiple tasks at the same time. It involves people life and will cause danger if late action taken. Hence, they need a system which can help them in arranging, scheduling, preparing the timetable for their shift. It should be available 24 hours in 7 days.

Unorganized shift scheduling is another factor contributes in proposing the Timetabling system for the MO. Due to some constraint such as time and personal preference, a well develop and stand alone system should be implemented to help the MO in organizing their time. The system should embed with artificial intelligence attribute in order to make it more users friendly and flexible.

- Objectives

The objectives of this study are to study on how artificial intelligence can help in healthcare sector, to help MO with unorganized shift distribution and fulfill MO's personal as well as organization needs and to identify suitable algorithm that suit with the system.

- Scope of study

The problem well stated Medical officer (MO) needs a scheduling system which arranging, and preparing the roster for their shift. The system should be a stand – alone and available 24 hours in 7 days. Thus, the research focuses on the developing a scheduling system embeds with artificial intelligence features.

In this case, MO needs a scheduling system which can help them with their time arrangement. It includes shift and job distribution arrangement. By considering human preference as one of the constraint has made the system more complex. Besides handling their additional tasks, they need to deliver their own job specification. Hence they need scheduling system that can help them with the shift management. As a result, they can deliver their task efficiently.

The research also will be focuses on the system requirement such as tools, skills and knowledge needed. Those elements should be precisely identified because they are the key elements in the planning stage. Planning stage played an important role in providing the developer with the solid and clear picture of the system. Hence the objective of having an intelligent scheduling system can be met.

Besides that, it also a study about the system's development processes, scheduling algorithms and method used. A few development methods and platform need to be reviewed. This is because only the most suitable methods and platform is going to be used in developing the system. The methods and platform are chose based on duration, knowledge and skills required.

### III. LITERATURE REVIEW

From Malaysia Employment Act 1955, medical officer can be defined as a registered medical practitioner who is employed in as medical capacity by the Federal Government or by the Government of a State. There are 3 type of medical officer which are clinical, clinical in multi- discipline and administration. Difference medical officer will have difference job requirement that have to be fulfilled. Ministry of Health Malaysia has prepared career development guidelines for Medical Officer under Ministry Of Health Malaysia supervision. In the guidelines, it is well stated the jobs and responsibilities of a medical officer. In fact, it is not only about performing specialized tasks but also multiple and simultaneous task. Hence, in order to help them with their duty roster scheduling, a suitable timetabling system is needed. The literature review will be divided into 3 chapters which are Chapter 1: Challenges and Successful Project, Chapter 2: Advantages and Benefits of Scheduling system and Chapter 3: Proposed Algorithm and Methods.

#### Chapter 1: Challenges and Successful Project

Developing a suitable scheduling system that can fit into medical officer requirement is not an easy task. There are few obstacles and challenges that need to be faced. In addition, programmer should take into consideration to learn the pitfalls of the current existing system. In *Scheduling in the Real World: Lesson Learnt*, there are few views that are proposed to improve the current system. The author Krogt R., Little J. and Simonis H. (2009) said that the real – world scheduling problems seldom match the problem studied in the research community. In order words, the system build does not fit into the user requirement. In the same paper, the author stated that the biggest challenge of implementing a system in an organization is to successfully transfer the technology to the user.

Besides that, the authors also said different people in an organization have very different objective they want to optimize. This is indirectly related to this research paper which aim to fulfill both personal and organization needs. In fact, some of the medical officer might only consider about their personal preferences rather than meeting organization vision. Besides, scheduling system may not satisfy all constraints, the results are rarely much better than human scheduler. This is in contrast with the aim of having a scheduling system. Scheduling system should help and improve the manual scheduling processes in health care.

However in other research paper entitled *Implementation of a Self – Scheduling System for Hospital Nurse: Guidelines and Pitfalls* written by Bailyn L, Collins R. and Song Y. (2005) pointing a difference view. They said in some cases, unfavorable condition might develop such as complaint of peer pressure, favoritism and unavailability of staff. Under this situation, company

might face a problem in promoting the scheduling system. Minority of the medical officer group might think that by having scheduling system, it may demolish the favoritism which is good from one perspective. It will inculcate professionalism among medical officer.

In order research paper entitle *Optimal algorithm for single – shift work force scheduling to avoid one day work stretches in cyclic schedule* written by Collin G. (1999) stated that typical classifications of workforce scheduling problems tend to focus on the following characteristic:

- [1] Workforce demand pattern
- [2] Number of shift
- [3] Length of shift
- [4] Number of worker categories
- [5] Worker category structure
- [6] Frequency of work

In order words, those are some of the constraints that should be taken into account when building the scheduling system.

Even though lot of obstacles needs to overcome but the system is feasible and possible to build. It is proven by two journals which discuss on the system that had been implemented. Chu C. K. (2005) said in his journal entitled *Generating, scheduling and rostering of shift crew – duties: Applications at the Hong Kong International Airport*, the problem is solved via decomposition into its duty generating phase – a goal programming (GP), followed by its GP scheduling and rostering system. The results can be adopted as a good crew schedule in the sense that it is both feasible, satisfying various work conditions, and “optimal” in maintaining idle shifts. Whereas in other journal entitle *Long term staff scheduling with regular temporal distribution* written by Carrase Rafel C. (2010) stated simple procedure, combining random and greedy strategies with heuristic has been successfully applied in a Spanish hospital to assign guard shift to the physicians in a department. Based on the gathered information, programmer should emphasize on the challenges listed. More effort should be put in order to build a system which meets the industry standard.

#### Chapter 2: Advantages and Benefits of the Scheduling System

The selection and utilization of the work force are the keys to successful operation for service sector. Health care segment is considered to be significance in the major subset of the service sector. Nowadays, organization started to implement flexible working time. Human resource management department faced big problem regarding this implementation. This is because they have to organize the work force wisely and optimize their capabilities within certain period of time. As compared with the previous implemented working hours, employees are having the same working times and work forces are equally distributed. However, due to the flexible working hours some resources are

not wisely used. Hence, scheduling system is needed in order to overcome this problem.

In a research paper entitled *A Particle Swarm Optimization Approach for Physician Scheduling in a Hospital Emergency Department* written by Lo C. C. and Lin T. H. (2011), it is well stated that the proposed system effectiveness verification is measure by implementing the system in a hospital in Northeast Taiwan. The system was implemented in an experimental environment. At the end of the experiment, feedbacks are gathered. Some of the feedbacks are:

- [1] There is no violation of any hard constraint and the violations of soft constraints are limited in the work schedules provided by the proposed system
- [2] The execution time to find proper schedule is rather short

Meanwhile, in order research paper written by Gregory C. (1999) has difference opinions. In this research paper entitled *Optimal algorithm for single – shift workforce scheduling to avoid one – day work stretches in a cyclic schedule* stated that the selected algorithm provide solution approaches which address both the concern of management (minimum feasible work force size) and the interest of employees (predictable repeating schedule is provided that includes reasonable work stretches). In the same paper stated that the algorithm provide a concept of how solutions to other types of scheduling problems may be pursued with the goal of satisfying the one day work stretch and cyclic schedule constraints which have been imposed herein.

### **Chapter 3: The proposed algorithm and methods.**

As scheduling system is not a new system hence, there are lots of proposed and available methods for references. For example in a research paper written by Ernst A. T., Jiang H., Krishnamoorthy M., and Sier D (2004) entitled *Staff scheduling and rostering : A review of applications, methods and models* has briefly explained on the applications and models used for scheduling algorithm. For applications, authors had listed few suggestions such as:

- [1] Demand modeling
- [2] Days off scheduling
- [3] Shift scheduling
- [4] Line of work construction
- [5] Task assignment
- [6] Staff assignment

Meanwhile, for models, authors had listed follows:

- [1] Artificial intelligence
- [2] Constraint programming
- [3] Metaheuristic
- [4] Mathematical programming

In other research paper entitled *A particle swarm optimization approach for physician scheduling in a Hospital emergency Department* written by Lo C. and Lin H. (2011) stated that, when time consuming

what – if analysis is needed, Particle Swarm Optimization (PSO) is an efficient approach for intelligent physicians work scheduling. It is a nature – inspired optimization algorithm. In the same paper stated that experimental results of actual implementations indicate that PSO - based work scheduling support system efficiently and generated satisfactory work schedules.

Vincent M. (2008) has different approached. In his research paper entitled *Competitive Nurse rostering and rerostering* he proposed a series of agents based nurse rostering algorithm. It is named as Competitive Nurse Rosterin algorithm (CNRA). The set of CNRAs include Competitive Nurse Rostering (CNR), CNR with Iterated Local search (CNR –ILS) and CNR and rerostering (CNRR). He stated that the purpose of the CNRA is to develop better mathematical model of how nurse perceive preferences. Hence, we can conclude that, the algorithm created are aim to fulfill the nurse preferences which may applicable to this research paper.

As compared to other researcher, Priya G., Anandhakumar P., and Maheswari K. (2008) also have their own stand. In their research paper entitled *Dynamic scheduler – a pervasive healthcare system in smart hospital using RFID* presents a solution to this multi objective dynamic scheduling problem using evolutionary algorithm. They proposed Nondominated Sorting Genetic Algorithm II (NSGA II). Main objective of using this algorithm is to optimize resource allocation. Besides that, evolutionary algorithm is used to mazimize the solutions.

In fact, scheduling system not only been used by healthcare sector. It also has been implemented among the airlines crews. It shows that, scheduling system is widely used regardless the sector but with different models or algorithm. Dawid H., Konig J., and Strauss C. (2001) introduce in their research paper entitled *An enhanced rostering model for airlines crew* an efficient adaption of the branch and bound techniques that solves real world rostering problem for airline crews. The advantages of this approaches is shorten the solution process and outperform standard techniques. In order to be specified, they present the SWIFTROSTER algorithm. It is inspired partially by Peter Barth's pseudo-boolean Davis – Putnam algorithm but tailored to solve crew – rostering problems.



## IV. METHODOLOGY

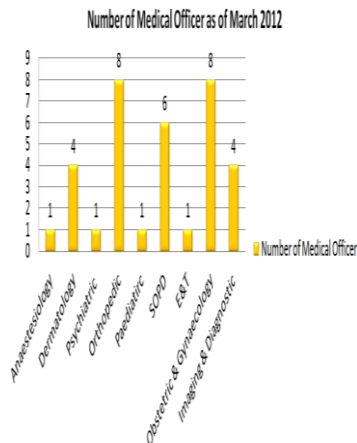


Figure 1: Phase involved in developing Timetabling System for Medical Officer

### Planning

Techniques used to obtain this understanding are using interviews, research, survey, discussion and determine of tools features. In this phase, problem statement, objectives and scope of studies is defined. Gantt chart and project timeline are prepared in order to monitor the development would be completed in the given time period.

Questionnaire is used as a medium to collect data in interview sessions. Several interview sessions were conducted. While doing a research, observation, discussion and survey are used in order to get more accurate conclusion. Other than that, internet research, journals, articles and books are also being used as references.

### Analyzing

Feasibility study is carried out in order to get prepare with the risks and problems that may arise during development. Several arising matters are considered such as time, skills, and resource. Based on the requirement gathered, the system was developed accordingly to the user requirement. Besides fulfilling the user satisfaction, the system was also expected to meet the technology requirement.

### Design

Design phase will be focus on the defining the hardware and software architecture, choosing the programming language, and indicating strategies to deal with issues. The designing phase is divided into two parts which are interface design and system design. Interface design consists of the Graphical User Interface (GUI) design and the mechanism behind. Meanwhile, the system design consists of designing UML Diagram for the system.

### Implementation

This phase may include several steps which are simulation, installation, maintenance, evaluation and modification. Simulation is carried out by launching the beta version of the database system to the users. The simulation is important in order to get feedback and collect the users' opinions about the system.

## V. RESULTS AND FINDINGS

### a) Data findings

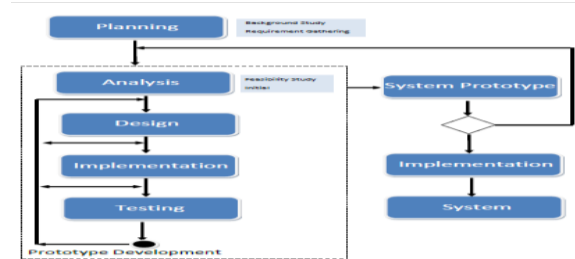


Figure 2: Number of Medical Officer in Hospital Pakar Sultanah Fatimah as of March 2012

Figure2 shows the number of medical officer in Hospital Pakar Sultanah Fatimah arranging in department basis. It is clearly shows that different department having different number of medical officer. Based on the findings, there are 34 medical officers as a whole. The medical officers are allocated based on the number of cases in each department. The higher the number of patients cases, the higher number of medical officer in that department. As compared to houseman, medical officers will stay in each department. Normally, medical officer will request for further their studies and become specialist.

### b) System modeling

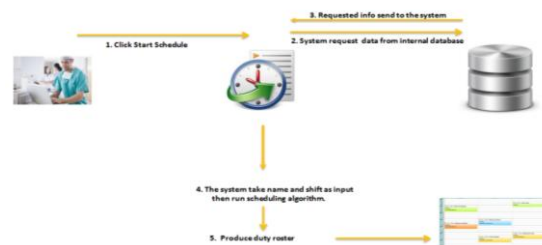


Figure 3: Timetabling System for Medical Officer Model

Based on figure 3, it shows on how Timetabling system for Medical Officer operates. There are 3 elements of the system operation which are medical officer as the input, database system as the data keeper and the system itself. The processes are revolving between those 3 elements and produce a duty roster.

Medical officer will select start schedule. Data are requested from main database which store the information. The database will return the data as per requested. However, in the case whereby, the information is not available in the database, medical officer can update the information through the system. The system will then collect the user input and use the information to produce a duty roster. The duty roster is produce automatically by using scheduling algorithm embeds in the timetabling system.

Medical officers' name will be randomly select from the database. This to ensure the duty roster is more dynamic rather than having the same person for every month

c) Prototype

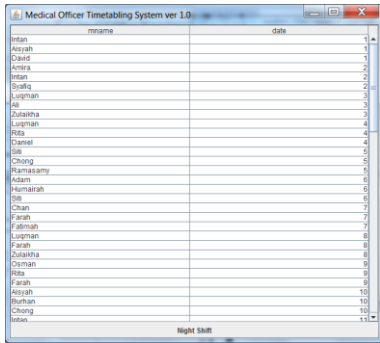


Figure 4: Home Page

Figure 4 shows the interface of Home Page of the system. Once the system is launched, user will be prompted with home page.

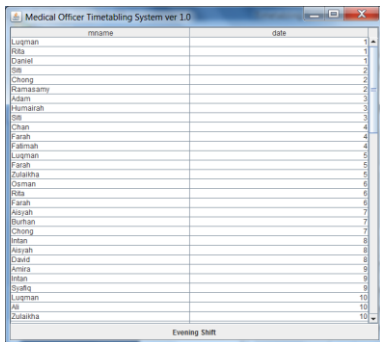


Figure 5: Profiling

Figure 5 shows the interface for profiling. It is used to retrieve records from mo\_table in database. It will show the Staff ID and Name of medical officer.

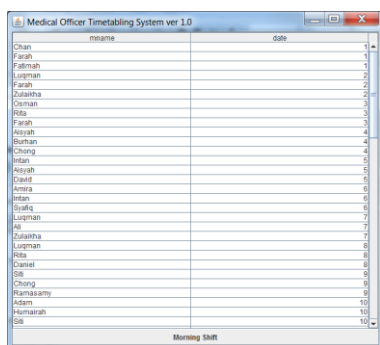


Figure 6: Set Holiday

Figure 6 shows the interface for the admin to input the medical officer's name and date where the medical officer will be on leave. From on leave panel, the data will be collected and store inside on\_leave\_table in the database. The records will be used during scheduling process.

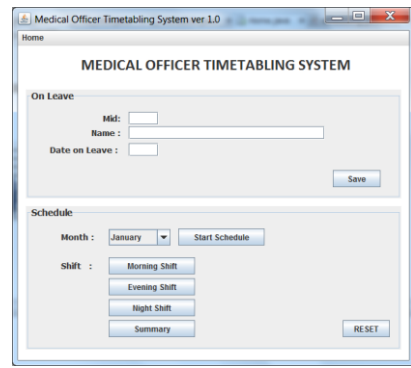


Figure 7: Morning Shift

Figure 7 shows the generated schedule for morning shift. The name are arrange according to the default arrangement set. As shown, there are no repeating names and the dates are listed accordingly. Based on the figure above, on 1<sup>st</sup> the medical officer in charge for morning shift are Chan, Farah and Fatimah.

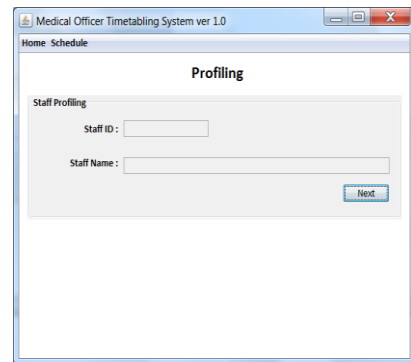


Figure 8: Evening Shift

Figure 8 shows the generated schedule for evening shift. The name are arrange according to the default arrangement set. As shown, there are no repeating names and the dates are listed accordingly. Based on the figure above, on 1<sup>st</sup> the medical officer in charge for evening shift are Luqman, Rita and Daniel.

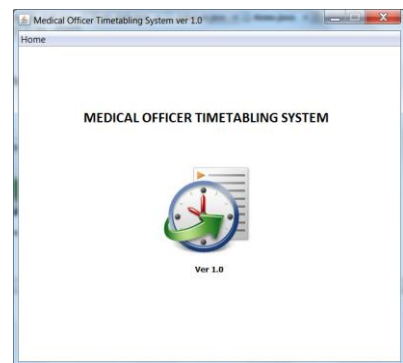


Figure 9: Night Shift

Figure 9 shows the generated schedule for night shift. The name are arrange according to the default arrangement set. As shown, there are no repeating names and the dates are listed accordingly. Based on the figure above, on 1<sup>st</sup> the medical officers in charge for night shift are Intan, Aisyah and David.

name	Shift Name	date
Chan	Morning	1
Farah	Morning	1
Faridhah	Morning	1
Lusman	Evening	1
Alfa	Evening	1
Daniel	Evening	1
Iman	Night	1
Alsyah	Night	1
David	Night	1
Lusman	Morning	2
Farah	Morning	2
Zulakha	Morning	2
Siti	Evening	2
Chong	Evening	2
Ranassamy	Evening	2
Amira	Night	2
Iman	Night	2
Staffy	Night	2
Desman	Morning	3
Siti	Morning	3
Farah	Morning	3
Adam	Evening	3
Husmah	Evening	3
Siti	Evening	3
Lusman	Night	3
Alfa	Night	3
Zulakha	Night	3
Hayah	Morning	3
Burhan	Morning	3
Chong	Morning	3
Chan	Evening	3

Figure 10: Summary Shift

Figure 10 shows the generated schedule as a whole. The name are arrange according to the default arrangement set. As shown, there are no repeating names and the dates are listed accordingly. It will show the medical officer in charge for that particular date for the entire 3 shift.

d) System rules and constraints

There are several rules are listed in order to cater the scheduling process. However, for the purpose of this research the rules are group into two (2) categories which are leave and shift.

• Leave

Leave is one of the constraints for the scheduling system. Leave will effecting the arrangement of medical officer name. In a case where by number of medical officer is less than optimum value, the name arrangement will be more pack. This is because; one medical officer may have more than normal number of shift.

Besides that, medical officer within the same department have to cover the on leave medical officer. He or she has to replace the medical officer on leave. Hence, number of medical officer for each month is very crucial in arranging the duty roster. As the number of medical officer on leave increases, the number of medical officer available to work on shift will be affected. It will cause the duty roster generated is not well balanced.

As medical officer is part of the workforce under health sector, hence public holiday is treated as normal working days. However, medical officer may request 2 weeks earlier before the scheduling process started if he or she would like to apply for on leave. However, in the case of emergency leave, the medical officer has to find replacement to replace his or her shift.

• Shift

Shift is another category of constraints to generate duty roster. Based on the finding, there are 3 shifts per day which are morning, evening and night. However, the number of shift may be different according to what sector the scheduling system will be. For this research purposes, the number of medical officer per shift is fixed to 3 medical officers.

Besides number of shift and number of medical officer per shift, another constraint should be considered is arrangement of name according to shift.

It is stated that, medical officer cannot work in three (3) consecutive shift on the same date. For example, medical officer who work on morning shift cannot work in evening and night shift of the same date. Medical officer also are not advice to work on same shift for two (2) consecutive days. For example, medical officer who work on evening shift of 1<sup>st</sup> is not advice to on evening shift of 2<sup>nd</sup>. In addition, medical officer also is not advice to work in two (2) consecutive shifts. For example, medical officer who work on night shift of 1<sup>st</sup> is not advice to work on morning shift of 2<sup>nd</sup>.

However, the arrangement of name is strictly based on the number of medical officer. In a case where by the number of medical officer is not enough, certain rules have to be violate.

e) System intelligent

As compared with the manual basis of scheduling, the name of medical officer will be picked manually. By using pen and paper, it will be selected based on the available name. Meanwhile, by using Timetabling System for Medical Officer, the scheduling is generated automatically. User just only needs to input the on leave date for respective medical officer.

Besides that, the name of medical officer will be selected by the system. Hence, it will help user in scheduling the duty roster. Thus, for every month, different name arrangement will be produce. For certain stand it will be good for the duty roster to have a fixed name for every month. However, it will be not fair for everyone. This is because the medical officer will have the same shift for every month. On the other hand, the system developed will help user in selecting the name for the duty roster. Hence, there will be more variety in name selection.

As a conclusion, the system help user in deleting one of the process of arranging the scheduling system which is name selection. Even though it is something that can be questionable but by reducing one of the step in arranging the duty roster is another way of improvement given.

VI. CONCLUSION

As a conclusion, timetabling system is expected to manage Medical Officer (MO) duty roster in more efficient way. Proper and organized duty roster can improve the work effectiveness and meet job satisfaction. Thus, MO feels happier with their work and create harmony working environment.

Besides that, even though the user is not an IT expert but using Timetabling System, it can help them with the human resource management. With only click, drag and drop function, they can retrieve and store the data faster and easily.

After went through a few phases and processes, Timetabling System is ready to be used. With hope, it may help Medical Officer in their work deliverable and make them one of the most efficient services team in hospital.

Hopefully, in the near future, the timetabling system not only capable to schedule and arrange the MO shift but applicable to all services unit in hospital. It is expected to run automatically with less user input. Thus, it can help user in making a good decision.

## VII. ACKNOWLEDGEMENT

First and foremost, I would like to thank Allah S.W.T for giving me a chance and strength to fulfill my final year project. Without His bless and guidance my effort are nothing. Alhamdulillah, He helps me and giving me chance to work with variety of people behaviors' and expose me with the real nature of system development

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In addition I wish to personally acknowledge Pn. Jawilah binti Abu Naim, who served as my field supervisor. It was always a pleasure to work with her. As a medical laboratory technologist, she did spend some of her time in helping me communicate with staff at Hospital Pakar Sultanah Fatimah, Muar. For your information, besides being my field supervisor, I would like to acknowledge her as my mother. Being supported with my own mother is a great bless I had experience. I wish her continued success in her career at Hospital Pakar Sultanah Fatimah, Muar.

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I also wish to thank my friends for their guidance and endless moral support in helping me to accomplish the project. Even though I am having a tough time with this final year project, but I was bless with the guidance, help and support from people surround me. Alhamdulillah.

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**UNIVERSITI  
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25<sup>th</sup> July 2012

**To Whom It May Concern**

Dear Sir / Madam

**DATA REQUEST FOR FINAL YEAR PROJECT DISSERTATION**

Referring to the above matter, I am Siti Noor Zahirah binti Mohd Zahari, Final Year Final Semester student of Universiti Teknologi PETRONAS (UTP). I am pursuing a Bachelor of Technology (Hons.) Information & Communication Technology minor in Corporate Management. I am requesting Medical Officer data to complete research funded by Universiti Teknologi PETRONAS. I will be using these data for a study entitled, "Timetabling System for Medical Officer.

The purposes of this study are:

- To study on how artificial intelligence can help in healthcare sector
- To help MO with unorganized shift distribution and fulfill MO's personal as well as organization needs
- To identify suitable algorithm that suit with the system

I am requesting the following data files:

- **Number of Medical Officer for the years 2010 - 2012**
- **Number of Medical Officer per shift**
- **Number of holiday per medical officer**
- **Rules and regulation to schedule the duty roster**

Included with this data request letter is the research project description. I'm looking forward to receive the data in PDF format. Thank you in advance for your attention to this data request. If you have any enquiries, I can be reached at:

**Tel: +6013 652 6727**

**Email: snzahirah.zahari@gmail.com**

Sincerely,

(Siti Noor Zahirah binti Mohd Zahari)

*Supported by:*

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