

**MASENO UNIVERSITY**

**SCHOOL OF COMPUTING AND INFORMATICS**

**DEPARTMENT OF INFORMATION TECHNOLOGY**

# **AUTOMATED TIMETABLING SYSTEM**

**CIT 409: IT PROJECT I**

**PROJECT PROPOSAL SUBMITTED TO THE SCHOOL OF COMPUTING AND INFORMATICS IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY**

**MASENO UNIVERSITY**

**P.O. BOX PRIVATE BAG**

**MASENO, KENYA**

**JANUARY, 2023**

# **DECLARATION**

I the undersigned do hereby declare that this project proposal is my original work and where there's work or contributions of other individuals, it has been duly acknowledged and relevant citations are given. To the best of my knowledge, no material herein has been previously presented to any other academic institution for examination, award of a degree, or any other award(s).

---------------------------------------------------- ---------------------------------------

**KATUMO BENSON MAKAU Date**

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**Supervisor**

I hereby certify that this project proposal was presented for examination with my approval as the university-appointed supervisor.

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Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# DEDICATION

I dedicate this proposal first and foremost to Almighty God who has been there since the beginning to this far. Special dedication also to my supportive parents/guardians and friends who have shown total support and compassion towards my achievements. Again, I want to dedicate this proposal to my supervisor Dr. Muhambe Mukisa for his progressive impact on knowledge.

# ACKNOWLEDGMENT

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# CHAPTER ONE: INTRODUCTION

## 1.1 Background Information

Over the recent past, there has been an increase in course offerings and enrollment surges in institutions of higher learning. This has raised the demand for more facilities for academic institutions. This has proven that the ability to work within the set constraints of time, facilities, and resources is the greatest asset of any learning institution. Therefore, problems relating to timetabling vary between different institutions depending on the constraints at hand. In most schools, timetables are manually designed by lecturers, an activity that requires them to set aside a week for that task. This manual way of timetabling is prone to human errors and is difficult to meet all the requirements.

Due to the inherent challenges, timetabling is still done manually. For example, for each semester, schools are forced to redo the timetables, thus making the task repetitive, tedious, and painful. For the case of Maseno University, departments are forced to communicate before making timetables for purposes ensuring lecture halls don’t conflict with more than one class assigned to the same hall at the same time. However this process is tedious and repetitive since the university offers many courses which are subdivided into several departments. With the number of limited resources, the chances of having a conflict free timetable are very high. Class representatives are forced to seek for lecture halls if a class conflicts with another. This way time is wasted for both the students and lecturers. For a timetable to be complete, all the departments have to share information so classes could be arranged. This takes up to about a week or two since so many courses are offered by Maseno University.

This has however presented the need to have an automated timetabling system. Failure to have the timetabling problems addressed would lead to schedules with a maximum number of disputes that fail to meet several side restrictions, allocated time, and rooms within the restricted period (Henry, 2021, p.g 1). Therefore, it is within this context that the proposed timetabling system needs to assess and fill the gap by designing and implementing the proposed system to help manage the learning activities at Maseno University.

## 1.2 Problem Statement

Management of learning activities is a complex venture in institutions of higher learning. Lecture venues and laboratories are essential but scarce resources. Scheduling a class requires one to consider the nature of the class, the number of students, the time of the day, and whether or not the unit is common across different programs. Manual designing of timetables thus is a complex and time-consuming affair, which contributes to the loss of valuable time not to forget the complaints from both students and lecturers over errors in the timetables.

## 1.3 Study Objectives

### 1.3.1 Overall Project Objective

To develop a web-based automated timetabling management system for Maseno University.

### 1.3.2 Specific Objectives

i). To identify the required modules of the automated timetabling system.

ii). To design an automated timetabling system prototype.

iii). To code the designed automated timetabling system prototype.

iv). To test the developed prototype.

## 1.4 Research Questions

1. What modules are needed for the implementation of this timetabling system?
2. What is the appropriate and suitable design for this system?
3. What implementation approach will be appropriate for this system?
4. What system testing and validation techniques will be suitable for this system?

## 1.5 Significance of the Project

The automation of timetabling activities at Maseno University will ensure the smooth management of learning activities and save time for both lecturers and students. It will ensure that lectures don't collide and lecturers aren't assigned two classes at the same time. It will also ensure that lecture halls are utilized well.

## 1.6 Limitations

1. The design and methodology selected to implement this system would be time-consuming.
2. The evaluation/testing of this system would not be ideal depending on the environment.

## 1.7 Assumptions

1. We assume that the system to be developed would run effectively on the laptops of the users of this system.
2. We assume that the entire process of developing this system would be cost-effective.
3. We also assume that this system would be integrated with the existing systems.

# CHAPTER TWO: LITERATURE REVIEW

## Introduction

This chapter covers a review of relevant and related literature. It gives a background of the application areas, reviews and critiques similar systems, highlighting their functions, strengths, and weaknesses. It includes a review of local and foreign-related literature that can help gathering ideas that guide the development of the proposed prototype. It gives an overview of the different study that has been done before and the proponents to collect some ideas from another survey to formulate a new concept to apply when developing the proposed prototype.

## 2.1 Timetabling

There are various definitions of the term timetabling. According to oxford dictionary, Timetabling is the act of arranging something to take place at a particular time (Cross, 2005). On the other hand, Burke (Burke, 2002, p.g 2) defines timetabling as the allocation, subject to constraints, of given resources to objects being placed in space time in a way that nearly or fully satisfies the set of desirable objectives. The Business Dictionary (Gibson, 2009) defines timetabling as the formal organization of teachers' and learners' time, and the allocation and coordination of timings, and other resources within an educational institution. From the above definitions, timetabling can be described as the process of planning, and allocating resources to objects relative to the available time to satisfy the desirable objectives. This process should be carried out in a systemic manner with equity in resource allocation in mind. For this process to be efficient, there is need to have a system that puts into consideration the available resources and the objects in need of the resources before allocating the resources. Having an automated system will guarantee better resource allocation than having a human manually do the same.

## **2.2 Lessons Timetabling in Higher Learning Institutions**

Timetabling in Institutions of Higher Learning is an optimization problem that takes a large number of variables and constraints into account. Optimizing medium and large instances is a very challenging task. When the resources are limited, it is often difficult to even find a solution that satisfies the defined constraints and requirements. For example, in Brazilian schools, a schedule for teachers must meet two requirements: minimization of working days and avoidance of idle time slots (Dorneles, 2014 p.g 32). The timetabling problem is common in academic institutions such as colleges and universities. It is a problem that has seen to attract the interests of many researchers. This problem is difficult to address due to the existing hard and soft constraints and the size of the problem (Chen, 2021, p.g 106522).

## 2.3 Challenges In Timetabling

A number of approaches were proposed in tackling the timetabling problem, such as operational research, human-machine interaction, constraint programming, expert systems, and neural networks. However, there are still several challenges to be addressed: easily reformulated to support changes, a generalized framework to handle various timetabling problems, and ability to incorporate knowledge in the timetabling system (Lee, 2005, p.g 1150). The University Timetabling problem is a particular type of scheduling known as a difficult problem arising in academic institutions. The problem consists of coordination of lecturers, students, and classrooms to avoid clashes between lectures.

## **2.4 Existing Timetabling Systems**

### 2.4.1 Manual Timetabling System

Using the manual system, lecturers have to manually evaluate lessons to ensure they don’t clash and resources such as lecture halls are allocated fairly. Different departments have to communicate to smoothen the process of resource sharing and also minimize the chances of having lessons clash. Despite being complex, the timetable however helps manage almost sixty percent of the lectures fairly. It is also very flexible since lecturers can just shift their lessons to different time slots if they seek the availability of a lecture hall. This method may seem simpler however it has so much weaknesses: it wastes a lot of time and it is very complex. The possibilities of having errors is endless as it may not be easy to avoid lessons clashing. With the limited number of resources, lessons end up clashing and resources are never fairly allocated (Nguyen-HQ, 1980). All these challenges are because the timetable is made out of uninformed guesses which makes it unreliable. Every day several lessons clash on the use of lecture halls and lecturers have two lessons assigned to them at the same time slots.

### 2.4.2 UniTime Scheduling System

UniTime system is a timetabling system build to address the issue of allocating lessons to lecturers and lecture halls. This system also addresses the issue of exam timetabling where exams are planned and scheduled when to happen. The system has proven to address almost every problem with timetabling. However it has its own weaknesses. The system does not address the issue of fair allocation of resources. The system also does not address the issue of conflicts fully as it allows for conflict to happen only that it produces a report of the conflicts. The system is also complex to use as its user interface is difficult to understand and access the services it is destined to provide. There is a need to have an easy to use system where all services are easily accessible. The system does not provide additional features such as class re-scheduling with notifications. These weaknesses make the system not efficient to rely on as time will still be wasted and and resources will not be fairly shared or allocated.

### 2.4.3 Utwente Timetabling System

Utwente is a system aimed at generating timetables for institutions. The system provides a calender which the user relies on to plan and build a timetable. The System however similar to the current manual system at Maseno University, it does not factor in the other variables such as equal measure on resource sharing such as halls, labs. The timetable is also build manually where the user has to manually enter a class and assign it to a specific time slot. The system does not in any way provide a mechanism to avoid or manage conflicts. The system does not provide an easy to use interface for class re-scheduling or requesting lab sessions. Therefore the system is not better placed to fill the gap at Maseno University. The system is not time conscious as the user manually feeds in the data instead of automating the process. The system doesn’t provide a fair resource sharing algorithm where students get a fair allocation of lecture halls and time slots. Therefore this system proves to be unreliable to solve the problem at hand as it’s not automated and does not factor in fair resource allocation and time saving.

### 2.4.4 Sagenda Timetabling System

Just like the current manual system, Sagenda system simply provides a calender to which you assign a class or a lesson to a particular date and time. The system provides the user with an interface of a calender where a lesson is set for a particular date. The system is also designed to encompass particular lessons e.g violin class. This could be seen to work similar to a task manager or an even reminder thus it does not fit the problem at hand. The system does not in anyway consider conflict management, or even automation of the whole process. The system does not even factor in other resources such as lecture halls, lecturers , lecture hall capacity and number of students. Additionally, the system is likely to waste time as the users have to manually enter the lessons to a particular day and time instead of having the process automated. The system also does not provide a user interface that is appealing to the eyes of the user. It could waste a lot of resources training the users as its not user-friendly and simple to use. For this reason the system doesn’t quantify to be the best suited system to solve the problem at hand as it also fails the test of fair resource allocation and time saving.

## 2.5 Conclusion

All the reviewed systems above have all a challenge that is common across the four of them. They are like to waste the users time and they don’t quantify to fairy allocate resources with zero conflicts of lectures. An automated timetabling system is essential in ensuring that universities don’t waste a lot of time planning and scheduling lectures thus ensuring fast, efficient and reliable class scheduling and fair resource allocation among the different students pursuing different courses. Such systems are also very crucial in managing lab sessions. The system also continuously reminds its users of a scheduled class or lab session, for example lecturers. This system brings onboard several benefits:

**Time-saving:-** Since every activity is automated, lecturers don’t have to spent a whole week planning for lessons.

**Efficient:-** It is efficient in the sense that it avoids conflicts during scheduling and produces a favorable timetable to be used.

**Reliable:-** Considering the current challenge of the manual system, the system is very reliable as it puts into consideration every variable and produces the best suited result at the end.

**Fair Resource Allocation:-** The system will ensure all the resources are fairly allocated and thus minimizing time wastage for both the staff and students at the university.

# CHAPTER THREE: METHODOLOGY

## Introduction

This is an overview of system analysis, design, and implementation of the prototype. For requirement gathering and analysis, Unified Modeling Language (UML) diagrams will be drawn, which will include entity-relationship diagrams (ERD), Use Case Diagrams, and Sequence Diagrams. The methodology describes domain understanding, requirements gathering, requirements organization, constructed in a relevant manner, based on prioritization and justification. Suitable procedures will be involved to make this phase effectively handled on. Moreover, the functional requirements, non-functional requirements and hardware requirements of the system will also be described here on the methodology.

## 3.1 Research Design

Research design refers to the overall approach you select to combine the many study components in a cohesive and logical way, assuring you will successfully solve the research topic. The research design serves as a blueprint for collecting, measuring, and analyzing of data for this automated timetabling system in order to make sure that the research problem for this project is effectively addressed. For the implementation of this timetabling system, the research design chosen is Qualitative Research Design. This type of a research design is a process related to inquiry. This research design will be used to collect information information from the university students depending on the specific objectives of this timetabling system which includes; what modules are required for this system, what design should be used and the evaluation technique to be used for this system. This type of research design helps the researcher to create a thorough understanding of problem in their natural language, since it is a non-statistical method. Furthermore, it depends a lot on the researchers’ experience and the questions used to examine the sample. The tool of data collection that will be used in this research design is questionnaires.

## **3.2 Target Population**

This research for collecting information to implement this timetabling system for Maseno University targets its population which includes Lecturers, Students, and Management staff. Out of this population, is where sampling will be carried out in order to come up with a sample size of the participants to represent the entire university population. Therefore, from the sample size, we will able to inquire and get all the information required for the implementation of this timetabling system.

## 3.3 Sampling

A certain size of the Maseno University population will be chosen depending on the interest in the research study. Sampling from the entire Maseno University population is often more practical and would also allow data to be collected faster and at a lower cost than attempting to reach every number of the population. However, because the sample is used to make inferences about the population, understanding the means by which the data arrives in the database is an important aspect of analyzing and drawing conclusions from that data.

## 3.4 Sample Size

The sample size to represent the whole population of Maseno University will be based on the total number of Departments, which includes lecturers, students, and Management staff. The sample size will be selected as follows:20 lectures, 500 students, and 15 management staff from all the university departments. The final computed sample size was 535 representing the entire Maseno University population.

## 3.5 **Data Collection**

This is the process of gathering and measuring information collected from Maseno University, by evaluating the outcomes which would in turn enable answering of the research questions for this project. Furthermore, the tools that will be used in collecting the information for the development of this system is a great concern, specifically the budget of data collection and how accurate the data collected will be.

## 3.6 Data Collection Tools

These are the devices/ instruments that will be used in the collection of data for implementation of this timetabling system. The decision on which tool to be used in data collection is an essential thing because research will be carried out in different ways and for different purposes. The main objective of doing data collection in Maseno University is to capture quality evidence that will allow analysis to the formulation of convincing and credible answers to the posed questions. Below is the type of data collection method going that will be used to collect information for the development of the timetabling system;

1. Questionnaires

Questionnaires will be administered to the sampled size of the participants of the Maseno University. The kind of questions used to gather information from the university participants shall be open-ended questions. The reason for using this type of data collection method is that, it will be administered in large numbers and is cost-effective.

## 3.7 Choice of Proposed System Development Methodology

The methodology that will be used in the development of this timetabling system is Agile Software Development methodology. The main reason for choosing Agile development methodology is to minimize risk (such as bugs, cost overruns, and changing requirements) when adding new functionalities. In all the agile methods, we could develop the software in iterations that contain mini-increments of the new functionalities. The form of the agile development method going to be adopted would be scrum. The Agile methodology contains six phases namely: concept, inception, iteration, release, maintenance and retirement. This type of methodology will ensure the following in our system development;

* There would be rapid, continuous development and delivery of useful software.
* It will ensure that there is a continuous attention to technical excellence and good design.
* Regular adaptation to changing circumstances.
* Late changes in requirements would be welcomed.

## 3.8 Systems Analysis, Design and Development

The main focus here is based on the Software Development Life Cycle (SDLC), where it has four-phase model which are planning, analysis, design, and implementation which is also common to all information systems development projects.

### 3.8.1 Requirements Gathering & Analysis

For the development of this project the following procedures will be employed here to collect requirements from different stakeholder viewpoints. The main approach that will be used for the requirement gathering process is questionnaires. Both open-ended and closed-ended questionnaires will be administered to identify new and existing problems. Requirements of the proposed system will be conducted as below:

**Functional Requirements**

A Functional Requirement is a description of the service that the software must offer. Functional requirements will be gathered to express the required behavior of the timetabling system to be built or what the system is supposed to do. Below are the main functional requirements of the proposed timetabling system;

* + Successfully logged in users could display the dashboard and there are several features available for the users.
  + Lecturers could be able to see personalized timetable.
  + Ability to add courses, faculties, departments, building, facilities and student’s feedback.
  + Ability to change an allocation.
  + Download the timetable.

**Non-Functional Requirements**

Non-functional requirements are not related to the software's functional aspect. They can be the necessities that specify the criteria that can be used to decide the operation instead of specific behaviors of the system.

* + Ability of the system to be secure and easily usable.
  + Testability, maintainability, extensibility, and scalability of the system.

### 3.8.1 Requirements Gathering & Analysis

This are the methods that will be used to model the timetabling system for the Maseno University. The prototyping design technique will be adopted in the development of this timetabling system. Object-oriented design will also be embodied as the suitable technique for the development of this timetabling system. This is because it has code re-usability and recycling facility, design benefits and maintainable facilities with objects and classes.

Use Case Diagrams – They will demonstrate what the system wants to do.

Sequence Diagrams – They will show how the objects relates actively.

Entity Relationship diagrams – shows how entities relate to each other.

# REFERENCES

Techie-Menson, H. and Nyagorme, P. 2021, Design and Implementation of a Web-Based Timetable System for Higher Education Institutions.

Burke, E.K. and Petrovic, S., 2002. Recent research directions in automated timetabling. European journal of operational research, 140(2), pp.266-280.

Cross, F.L. and Livingstone, E.A. eds., 2005. The Oxford dictionary of the Christian church. Oxford University Press, USA.

Gibson, K., 2009. BusinessDictionary. com. Reference Reviews.

Claessens, B.J.C., Eerde. WV Rutte CG & Roe, RA (2007). A Review of the Time Management Literature.

Dorneles, Á.P., de Araújo, O.C. and Buriol, L.S., 2014. A fix-and-optimize heuristic for the high school timetabling problem. Computers & Operations Research, 52, pp.29-38.

Chen, M.C., Goh, S.L., Sabar, N.R. and Kendall, G., 2021. A survey of university course timetabling problem: perspectives, trends and opportunities. IEEE Access, 9, pp.106515- 106529.

Lee, J., Ma, S.P., Lai, L.F., Hsueh, N.L. and Fanjiang, Y.Y., 2005. University timetabling through conceptual modeling. International Journal of Intelligent Systems, 20(11), pp.1137-1160.

Nguyen-HQ and McDonald-J. , 1980. Class scheduling to minimize student conflicts Proceedings of the American Institute for Decision Sciences Ninth Annual Meeting Western Regional Conference. American Inst. Decision Sci, Atlanta, GA, USA; 1980; xii+354 pp.

# APPENDICES

## GANTT CHART

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **WEEKS**  **Deliverables** | WEEK  1 | WEEK  2 | WEEK 3 | WEEK 4 | WEEK 5 | WEEK 6 | WEEK  7 | WEEK  8 | WEEK  9 | WEEK  10 |
| Build a Gantt Chart |  | |  |  |  |  |  |  |  |  |
| Chapter One |  |  |  | |  |  |  |  |  |  |
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| Final Copy and Presentation |  |  |  |  |  |  |  |  |  | |