
# JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY (JKUAT)

## DEPARTMENT OF COMPUTING

## ICS2406: COMPUTER SYSTEMS PROJECT

## PROJECT DOCUMENTATION

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# TITLE: STUDENT DECISION SUPPORT SYSTEM FOR HIGHER LEARNING ENROLLMENT

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# ABSTRACT

Our system, BetterUni works like KUCCPS which is used to select university courses, except that it will analyse the individual grades of the candidates, their aggregate cluster points and then run that data through an algorithm that can advise the candidate what causes to take. It is then going to provide the users with an aggregate list of the units in each course that the candidate qualifies for. We will take it further by building another algorithm to analyse the hardness level of each unit in each course that the candidate qualifies for. For example, if they said candidate wasn't strong in chemistry back in high school but they qualify for a course that has chemistry somewhere in second or third year, our system analyses their chemistry grade against the hardness level of the chemistry they'll encounter in second or third year and advise if they should or should not consider taking the course. Therefore, there will be a list of units in that course, hardness level, the workload in terms of projects, assignments, exams, CATs and the success rate. If the candidate needs further help, the system will be able to link them with an academic counsellor for better one on one human assistance.

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# BACKGROUND/INTRODUCTION

We observed that most students who clear form four and are anticipating to join campus, colleges and other higher learning institutions have no clear way of navigating around suitable courses for their grade. This is because they have no idea what awaits them two or three years into the course. Our younger siblings just cleared high school and all they had with them are stereotypes concerning different renowned courses and looked down on others because they seemed doable. Safe to say we also had the same views, which has led to most of our colleagues dropping out mid-course because they had no prior information concerning the meat of the courses at hand. Very few people are able to adapt as they go, so this system should give a feel of what to expect years into the course of choice, as per your grades and preference.

# PROBLEM STATEMENT

Over the years, as the education curriculum evolved and devolved with many more courses being add and scrubbed from the academic curriculum, the average high school candidate ready to join university has tons of options, in terms of the course they would like to take at university, put Infront of them. Having many options can be a great thing when you know what you want but if you don't, it almost always becomes confusing. It becomes an anxious task to carry out and sometimes makes things worse. Even then, when a candidate knows what they want to pursue in university, this might be guided by a career path, it is a major plus for the said candidate to know what awaits them in the course they select, have an inkling of what is required of them, how many years it'll take to complete the course, material and skills needed to excel in the course and possible career paths that might follow after the course. This is one of the shortcomings experienced by the current higher education placement system/service, KUCCPS. Not having such vital information about the courses candidates select has had an impact on less students willing joining university, it has seen an increase in number of

universities drop out where students drop out after a year or two of school, it's affected student's mental health and has even had an impact in the less and less individuals pursuing post graduate courses eg: masters and PhD. This is what BetterUni seeks to set right.

# JUSTIFICATION

The Higher Education Placement system in Kenya, KUCCPS should give the forthcoming candidates very good interactive decision support system that aids the candidate in their course decision. Whether the candidate is after a Degree, diploma or Certificate, with our system, the candidate will able to choose their desired course after the evaluation of their high school grades. BetterUni will run the candidates aggregate/cluster points against an algorithm which will then filter out and present the candidate with a list of possible courses, and institutions, they qualify for. Based on the above provided details, the algorithm will also evaluate the aggregate subject grades (e.g., Math – B+. English A-, Chemistry C…) against the available course units (e.g., Advanced Mathematics, Calculus 1, Molecular Chemistry…) to predict the course's hardness level and candidate's success rate in the course. This will save the candidate time on the course exploration rather going on all courses he/she will have the courses at hand. The system will also offer samples of notes, past papers, cats and assignments of each course unit, hence prepares the candidate for the course their want to pursue. The goal of the above defined decision support system is to help the students understand the success factor of their course based on their high school grades before making the decision for their higher education.

# LITERATURE RELEVANT TO OUR PROPOSAL

[1] World Bank's Report on Higher Education Performance in Kenya. Improving-Higher-Education-Performance-in-Kenya-A-Policy-Report.pdf. Report dated 21 Aug 2019

[2] Ndung'u, Karanja & Obae, Rose. (2020). Effects of Career Placement by KUCCPS among the Undergraduate Students in Public Universities in Kiambu County, Kenya. International Journal of Research and Innovation in Social Science. 04. 323-329. 10.47772/IJRISS.2020.41216.

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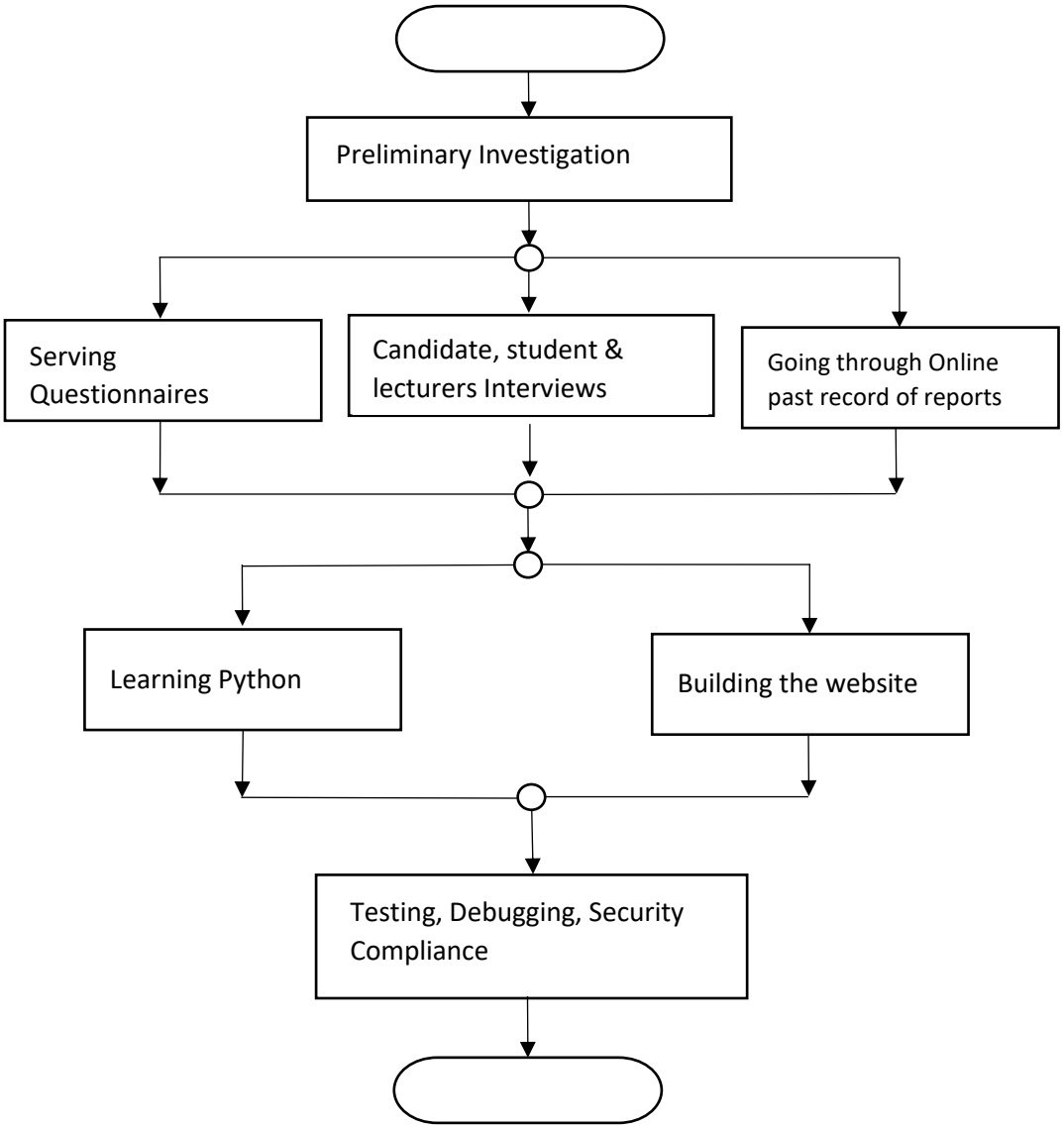
# RESEARCH METHODS AND DESIGN

Our main research goal is understanding the working and flaws of the current higher education placement system/service before and after a candidate applies for a course. We will want to gain this data from the placement service website, high school candidates that are ready to join university, university students and lecturers. We will use various qualitative and quantitative research methods.

We will employ one on one participant interviews to gain a review of the current system, the problems the participants have faced, their experiences in the placement process and the courses they are currently involved in. This would provide a first person view of current systems and is also a way to interact with the potential system users and enquire about challenges with the current system and understand their thoughts about the system fully. This would be a great starting point on what features the system users would expect from a new system.

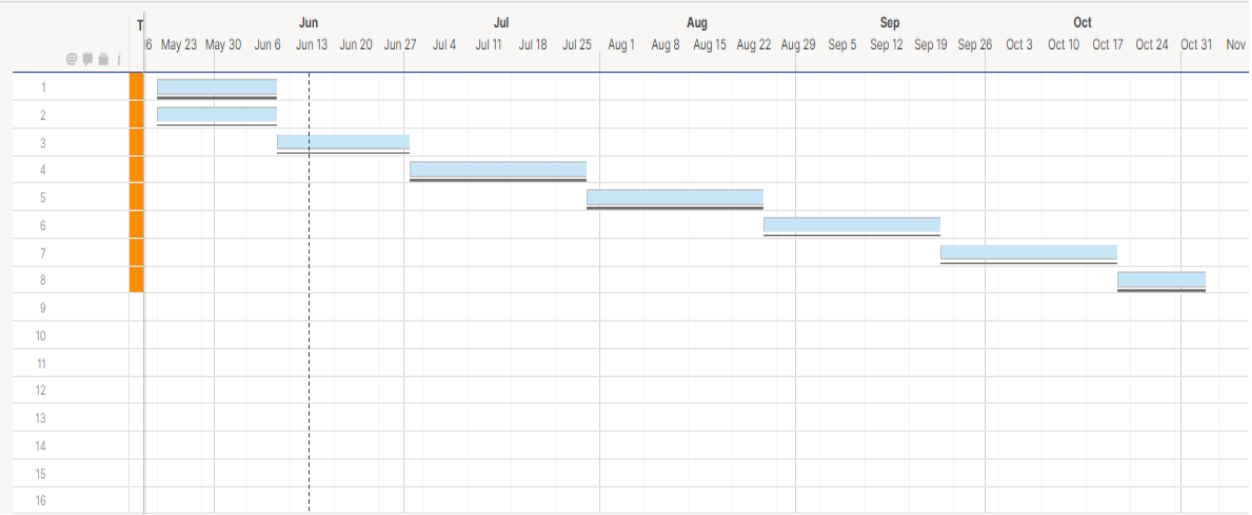
Participants will also be assessed through a questionnaire which would yield data to back the problem statement. The questionnaire will be based on questions such as how confident the participants are or were when selecting a higher education course, how well informed they are or were before making a decision and if they would appreciate a middle man system that will fill in the gap that the current placement service does not carter for. This would form a basis for a research paper on the topic and the subsequent system to be developed and to deduce some of the challenges we are likely to face along the way.

# METHODOLOGY



# SCHEDULE

| TASK | TASK DESCRIPTION | DURATION | PREDECESSOR |
|---|---|---|---|
| A | Preliminary Investigation | 3 weeks | - |
| B | Prerequisite Research | 3 weeks | - |
| C | Study of existing systems | 3 weeks | B |
| D | Objectives specification | 4 weeks | C |
| E | System Design | 4 weeks | D |
| F | Construction | 4 weeks | E |
| G | Implementation, Testing and Debugging | 4 weeks | E |
| H | Final Documentation | 2 weeks | G |




# BUDGET

| BUDGET | QUANTITY | UNIT PRICE | COST PRICE |
|---|---|---|---|
| Printing questionnaires | 100 | 5 | 500 |
| Website hosting | | 5000 | 5000 |
| Miscellaneous (Transport, Lunch etc.) | | | 3000 |
| **TOTAL (Ksh.)** | | | **8500** |

# OTHER INFORMATION

We need to know and understand the current higher education placement system in place (KUCCPS), and the regulations governing the running of the same. Our system will be implemented as per the set guidelines and regulations.

We will also implement a news/blog update section where candidates can keep up with education news, semester updates, among others. We will have institutions create portfolios for their news, example, JKUAT, KU, UoN come and post their ads, news and updates in that section, which can include vital updates like which courses get scrubbed from the curriculum and why, what units were added or removed from various courses (for example, CISCO had CCNA 1,2,3,4 but as at now it has been revised to CCNA 1,2,3), among other details.

# CONCLUSION

BetterUni would generally make course selection and the hassle that comes with it easier. Students would pick courses that they prefer whilst having an in-depth knowledge of what exactly they are getting themselves into in terms of units, expectations, workload, time and future career paths. We believe this system will bring about benefits like having more students interested in enrolling into various higher learning institutions, less drop-out rates mid studies, more successful graduates and an overall boost in choosing the right course.

## CHAPTER 2:

## LITERATURE REVIEW

**Context**: Decision support systems already exist and the predominant one in Kenya is Kenya Universities and Colleges Central Placement Service (KUCCPS). The main objective of KUCCPS is," …to create awareness on the functions of the placement service, educate the students on career choices and sensitise their teachers on the current career trends and empower them to provide effective career guidance to the learners." In contrast, in this work, we seek to address the lack of adequate, rich information to the candidate that enables them make an informed decision(s) on their course before or during the placement season. The intent is to facilitate academic advising by means of optimal long-term course planning (LTCP), which is instrumental in students' retention and success. We will do this by presenting well-tailored algorithms and visual analytics for decision support.

**Objectives:** In this study, we investigate the impact of incorporating a decision support system in the higher learning placement service to enable candidates to make a well-informed decision on the best courser to choose depending on various factors for example: interest for each elective course, complexity of each course, amount of course load and mean complexity for each semester, and subjective relative weights of objective functions. We compare and contrast our implementation of a decision support system against the existing one with references on several published articles and research papers discussing in academic advising is long-term course planning. We strive to meet the following deliverables of the system; ease of use, cognitive effort required from the user and trustworthiness of the system by a user.

**Methods:** A literary study was performed in order to collect information on similar systems and subjects in order to build a comparable selection optimization model. The collected information and proposed model were then used to analyse possible drawbacks and to answer research questions.

**Keywords**: Selection Student Excellence, Excellence Student Class, Decision Support System, MOORA, LTCP, Educational data mining, predicting student performance, data mining classification.

# INTRODUCTION

Before joining the university, the first prospective student through the name of the process of admission of prospective students. The process of admission of prospective students to a private college is an early stage of learning conducted by a college. It is common to happen; a college receives many students who enter even though they have been through the selection process of acceptance. The results of the selection test are submitted to the students through the announcement, indicating the student is accepted or declared failed in the entrance examination selection process. In generating the information of superior class students, of course, through the terms and criteria set by the leadership of private universities. For the results to be decided better, of course through a series of the accurate assessment process, which is not only in the process by humans but also processed by the computer as a tool (Marlina et al. 2016) (Siahaan 2016). For this, it would be better to use a decision support system. Decision support system is a system intended for decision-makers in support of the resulting decisions. This system applies decision support methods applied in decision support systems.

Procurement selection process is just a procedural process that is commonly done by universities without grouping prospective students from superior students into a class that is superior compared to other classes. To process the selection results can be done using the help of computer systems, known as decision support systems. To produce a better, accurate and objective decision result is used a method that can be applied in decision support systems. Multi-Objective Optimization Method by Ratio Analysis (MOORA) is one of the MADM methods that can perform calculations on the value of criteria of attributes (prospective students) that helps decision makers to produce the right decision in the form of students who enter into the category of prospective students superior.

In this research, the researcher uses Multi-Objective Optimization method on the basis of Ratio Analysis (MOORA). This method is also included in the MCDM section that is capable of performing the process simultaneously optimizing two or more conflicting attributes (goals) subject to certain limits (Karande and Chakraborty 2012). In its application, MCDM is divided into Multi-Attribute Decision Making (MADM) and Multi-Objective Decision Making (MODM). MADM is intended to solve the problem in a discrete space so that it requires several alternatives, criteria, and weights (Kusumadewi et al. 2006).

The research above is backed by Majid Shakhsi-Niaei who intends to discuss about academic advising by means of optimal long-term course planning (LTCP), which is instrumental in students' retention and success. LTCP ensures that students will satisfy the educational requirements without facing unnecessary delays. The proposed decision support system is based on an optimization model which deals with several student preferences, that is, maximum credits per semester, difficulty of courses, graduation semester, and elective courses priorities. The proposed system has been implemented in an industrial engineering department, and several improvements and modifications have been done based on student feedback. The developed system supports two kind of users, that is, educational staff and the students.

The courses, their relationships, and regulation parameters are defined/set by educational staff, whereas students determine their own information and preferences.

In the academic advising process, an institutional advisor gives direction to a student about a social, personal, or academic issues. Academic advising has become an integral part of higher education and plays a vital role in students' success.

An important role involved in academic advising is long-term course planning (LTCP), which is usually a time-consuming and challenging task. In LTCP, an advisor helps the students in preparing a course plan on the way to their graduation, including all unfinished courses and suggesting a course list for all future semesters for each student. The approach proposed in this paper executes this advisory role via an optimization- based decision support system (DSS).

The proposed system applies several regulations which are set by educational staff and also tackles students' preferences, for example, preferred graduation semester, interest for each elective course, complexity of each course, amount of course load and mean complexity for each semester, and subjective relative weights of objective functions. Therefore, course registration is a process which needs to notice many issues.

The above two researchers have their interest backed up by Dorina whom researches on the prediction of student performance under the basis of that many University management should focus more on the profile of admitted students, getting aware of the different types and specific students’ characteristics based on the received data. They should also consider if

they have all the data needed to analyze the students at the entry point of the university or they need other data to help the managers support their decisions as how to organize the marketing campaign and approach the promising potential students. The main goal of the research by Dorina, is to reveal the high potential of data mining applications for university management. This is a task for supervised learning because the classification models are constructed from data where the target (or response) variable is known.

# THEORITICAL / CONCEPTUAL FRAMEWORK

Mesra uses the following research resources:

## Decision Support System

Decision support system is a computer-based system capable of solving management problems in generating the best alternative to support decisions made by decision makers (Turban, E., Aronson, J., & Liang 2005).

## Multi-Objective Optimization on The Basis of Ratio Analysis (MOORA)

A multi-objective (or programming) optimization, also known as a multicriteria or multiple attribute optimization, is the process of simultaneously optimizing two or more conflicting attributes (goals) subject to certain restrictions.

The MOORA method, first introduced by Brauers (2004) is a multiobjective optimization technique that can be successfully applied to solve various types of complex decision-making problems in a manufacturing environment.

Steps to completion of MOORA method(Karande and Chakraborty 2012)(Onur Önay and Yıldırım 2016):

**Step 1: Create a Decision Matrix.**

The decision matrix is represented as the Xij matrix, where i is, m that is the number of alternatives whereas j represents n in the number of criteria, equation 1 is the matrix representation of the decision.

**Step 2: Normalize the Decision Matrix**

Brauers (2008) concludes that for this denominator, the best option is the square root of the sum of squares of each alternative per attribute.

**Step 3: Optimize attributes.**

For multi-objective optimization, these normalized performances are added in case of maximization (for favorable attributes) and reduced in case of minimization (for non-beneficial attributes). Where g is the number of attributes to be maximized, (n-g) is the number of attributes to be minimized, and yi is the normalized value of the alternative value against all attributes. In some cases, it is often observed that some attributes are more important than others.

Where wj is the weight of jth attribute, which can be determined applying an analytic hierarchy process (AHP) or an entropy method.

**Step 4:**

The value of yi can be positive or negative depending on its maximal number (favorable attribute) and minimal (unfavorable attribute) in the decision matrix. The ordinal rank of yi shows the final preference. Thus, the best alternative has the highest yi value, while the worst alternative has the lowest Yi value.

For the Majid's proposed system there are 3 common applications have been integrated to form the proposed system, that is, Microsoft Access, Microsoft Excel, and GAMS. Microsoft Access provides the user interfaces, and then, the data provided by users are exported to Microsoft Excel spreadsheets and imported into GAMS. Subsequently, the CPLEX solver is implemented in the GAMS environment to solve the optimization model. Finally, the results are exported to Microsoft Excel and then imported in Microsoft Access to produce user-friendly reports

The above-mentioned modules are explained in the following subsections.

Setting the regulations by the educational staff

The educational staff defines the following five groups of data. These data will be fed into the optimization model as its parameters:

- Details of all courses, including credits, type of course (elective/compulsory), average complexity based on several student opinions, and so on.
- prerequisite courses.
- concurrent courses.

Preferences and personalized data entry by the students The remaining required data for the optimization model should be entered by each student, including:

- Starting semester of course planning preferred semester for graduation.
- GPA in his/her last semester.
- total number of previous on leave semesters.
- finished courses.
- personalized opinion on complexity of unfinished courses.
- interest for each elective course.
- activating/deactivating summer semesters.
- determining future planned on-leave semester(s).
- preferred number of credits for each semester.
- preferred mean complexity for each semester.

Extracting the input data for use in the optimization model

When the data entry is completed, they are transformed into acceptable formats for the optimization module. Because GAMS software supports Excel files, the data are integrated and, then, exported into six Excel files.

The proposed model in this paper is a linear multi-objective goal-programming model which is aggregated into a single-objective model. Goal programming (GP) is a key group of multiple criteria decision-making approaches that is broadly implemented to analyze conflicting objectives. The reputation and implementation of GP has been increased greatly because of its mathematical simplicity and modeling attractiveness. It is easy to comprehend and to implement using typical optimization software.

The methodology used by the linear programming is optimization of data through various given equations. Using the above notations, the following equations form the model.

**Equation (1)** ensures that exactly one semester is assigned to each unfinished compulsory course.

**Equation (2)** ensures that at most one semester is assigned to each unfinished elective course.

**Equation (3)** ensures that prerequisite course i′ will be placed sooner than course i, except in the last semester ($t < T$).

**Equation (4)** ensures that course i will not be placed sooner than its concurrent course i′ except for the last semester.

**Equation (5)** internships are allowed only in semesters after the summer of the third year of education, ($t \geq 9$).

**Equation (6)** ensures another semester-based regulation in the system, in which the final project, course code <…>, is allowed only after the given number of semesters.

**Equation (7)** The management principles course, course code <..> is only allowed after the student has finished at least 50 credits.

**Equation (8)** ensures a similar regulation for an advertising course which needs at least 80 previous credits.

**Equation (9)** ensures total required credits for graduation.

Maximum **{equation 10}** and minimum **{equation 11}** allowed credits in active semesters are, respectively.

**Equation (12)** prevents assigning courses to inactive semesters except for internship courses which are usually registered in summer semesters which may be selected as an inactive semester by the student.

**Equation (13)** implies the availability of courses.

**Equation (14)** ensures that no other course is assigned to the semester registered for internship.

**Equation (15**) maximizes the objective function 1 which attempts to select most preferred elective courses.

**Equation (16)** minimizes the objective function 2 which tries to satisfy the preferred mean complexity of each semester.

**Equation (17)** minimizes the objective function 3 by minimizing the deviation from the preferred number of assigned credits.

**Equation (18)** calculates the overachievement and also the underachievement of the target set for objective function 1.

**Equation (19)** calculates the deviation from the mean complexity target. So, the target for this deviation is set to zero as the right-hand-side value.

**Equation (20)** calculates deviation from the preferred number of assigned credits.

To linearize the absolute functions, dummy variables p (t) and q (t) are substituted for absolute functions. To do this substitution, **Equation (19)** is replaced with **Equations (21)** and **(22).** Similarly, **Equation (20)** is replaced with Equations **(23)** and **(24).**

Finally, **Equation (25)** tries to simultaneously minimize the weighted sum of all deviations from the above-mentioned targets.

**Extracting the optimization results and generating the reports**

On a computer with Core i3 processor and 4GB RAM, the duration of running the optimization model is ~5 min. When the optimization is done, optimal values are exported to an Excel file which is automatically fed into MS Access. An event-based macro checks the Excel file every 10 s and generates reports the moment that the data are exported. The user will see the report as soon as it is generated. The "what-if analysis" button provides users with the possibility of changing some regulations and also preferences, including the relative weights of the objective functions. Then, new results are shown by the side of the previous report. The students can easily compare these reports and make an informed choice. Figure 7 shows an example of what-if analysis report.

The research problem is a formed as an optimization problem with conflicting objectives and is optimally solved. The proposed system allows the students to fully control different aspects of the planning process.

The system benefits from a linear-goal-programming model which provides optimal solutions in a timely manner. In summary, the key contributions of the presented system are as follows:

- A comprehensive optimization model which tackles various real-world considerations and issues is developed.
- A user-friendly system is developed for two kinds of users, that is, educational staff and students.
- The proposed system is implemented in an industrial engineering department, and several improvements and modifications have been done based on student feedback.
- Several student preferences which are neglected in most existing long-term course-planning advisory systems are incorporated in formulating the optimization model.
- Both theoretical and practical issues have been considered in system development and improvement.
- The final solution is provided by what-if scenarios to make informed decisions.

Similarly, (Dorina Kabakchieva 2013)describes a prediction model which helps in predicting the performance of higher education students by use data mining methods which are often implemented at advanced universities today for analyzing available data and extracting information and knowledge to support decision-making.

The initiated data mining project at UNWE is implemented following the CRISP-DM (Cross-Industry Standard Process for Data Mining) model. It is a cyclic approach, including six main phases – Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation and Deployment.

The author states that, during the Data Understanding Phase the application process for student enrollment at the University is studied, including the formal procedures and application documents, in order to identify the types of data collected from the university applicants and stored in the university databases in electronic format. The rules and procedures for collecting and storing data about the academic performance of the university students are also reviewed. Discussions with representatives of the administrative staff responsible for the university data collection, storage and maintenance are also carried out. University data is basically stored in two databases. All the data related to the university admission campaigns is stored in the University Admission database, including personal data of university applicants (names, addresses, secondary education scores, selected admission

exams, etc.), data about the organization and performance of the admission exams, scores achieved by the applicants at the admission exams, data related to the final classification of applicants and student admission, etc. All the data concerning student performance at the university is stored in the University Students Performance database, including student personal and administrative data, the grades achieved at the exams on the different subjects, etc.

During the Data Preprocessing Phase, student data from the two databases is extracted and organized in a new flat file. The preliminary research sample isprovided by the university technical staff responsible for the data collection and maintenance, and includes data about X students, described by 20 parameters, including gender, birth year, birth place, living place and country, type of previous. The author discusses that some of the variables containing important data for the research are text fields where free text is being entered at the data collection stage. Therefore, these variables are processed and turned into nominal variables with a limited number of distinct values. Essentially, the challenge in the presented data mining project is to predict the student university performance based on the collection of attributes providing information about the student pre-university characteristics.

During the Modeling Phase, the methods for building a model that would classify the students into the five classes (categories), depending on their university performance and based on the student pre-university data, are considered and selected. Several different classification algorithms are applied during the performed research work, selected because they have potential to yield good results

The researcher furthers discusses about the data mining classifiers algorithms used in the prediction model and how their accuracy compares to one another of the class selected. . Popular WEKA classifiers (with their default settings unless specified otherwise) are used in the experimental study, including a common decision tree algorithm C4.5 (J48), two Bayesian classifiers (NaiveBayes and BayesNet), a Nearest Neighbour algorithm (IBk) and two rule learners (OneR and JRip).

# CONCLUSION

Mesra's research objective is aiming for the best optimization, it applies a very good optimizing technique, but lacks the integration of course units and the difficulties rate to optimize the future success rate of the student throughout the course. This is gap is however filled by Majid.s technique which employs the input of unit and course data that is fed from an evaluation database done by previous students. The evaluation database set is for every course unit. For the implementation and integration of the above techniques for a decision support system, on which students' evaluation program for university admission system would be of great to help determine the success rate of the student by optimization of the grades achieved with regard to unit difficult rate. The Dorina's research shows out the best classification algorithm for the dataset optimization. The results yielded from the literary study and analysis shows that our proposed model does add an advantage concerning course decision making. This is further backed up by the visual analytics that will be implemented in the system compared to the solutions offered by Kenya Universities and Colleges Central Placement Service (KUCCPS).

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