Malaysian Journal of Mathematical Sciences 10(S) March : 105-116 (2016)
Special Issue: The 10th IMT-GT International Conference on Mathematics, Statistics and its Applications 2014 (ICMSA 2014)

**MALAYSIAN JOURNAL OF MATHEMATICAL SCIENCES**

Journal homepage: http://einspem.upm.edu.my/journal

# A Survey on the Timetabling Communities' Demands for an Effective Examination Timetabling in Universiti Malaysia Terengganu

**Nur Aidya Hanum Aizam [*], Nurul Farahin Jamaluddin and Sabri Ahmad**

*School of Informatics and Applied Mathematics (SIAM)*
*Universiti Malaysia Terengganu, 21030 Kuala Terengganu, Malaysia*

*E-mail: aidya@umt.edu.my*

*Corresponding author

## ABSTRACT

In education sector, there are many branches of problems involving timetabling. The examination timetabling problem is one of the many problems that exist for a very long time. This problem is faced by all educational institutions every end of the semester. As far as we are concern, there is no single model that can solve this problem up to the satisfaction of the users due to the many challenging factors that need to be considered. In solving this problem, not only we should consider the 'must' constraints, but also be aware of the requirements of the timetabling communities since they involves directly with the resulted timetable. Therefore, to produce the best examination timetable, it is important that we consider the human factor such as demands from the timetabling communities' (students and lecturers). This paper discusses the preferences of the timetabling communities at Universiti Malaysia Terengganu regarding the timetable especially their perspective on the time, date, place and period of the examination, also the effectiveness of existing timetables. A survey was conducted to study the demands of students and lecturers regarding their preferred schedule. Cronbach's alpha and factor analysis tests was conducted with the purpose to check the reliability and identifying the factors of the question. From the results obtained, problem related to the current timetable was detected. The students and lecturers preferences gained from this study can be included as constraints in the modelling of an effective timetable. These constraints are crucial to be considered in developing a quality timetable which does not only fulfil the requirements of a university, but also the demands from the timetabling communities. Additionally, the criteria of a good timetable are also listed in the paper.

Keywords: Examination Timetabling, Timetabling Problem, Factor Analysis, Survey.

## 1. Introduction

Timetabling problem arises in various fields such as sport, job, education and etc. There are many type of problem regarding timetabling, particularly in educational sector such as university course timetabling problem, classroom assignment and teacher assignment problem (de Werra, 1985). The timetabling problem is known as one of the biggest problem faced by every educational institution especially to the institution that has large capacity of students and staff. One of the common timetabling problems that arise in education sector that will be discussed in this paper is university examination timetabling problem which involves the scheduling of examination to a certain timeslots.

Examination timetabling problem arises due to several factors and become more complicated because it changes every semester due to the increased number of subject or students. This problem involved many factors such as number of students and lecturers, classroom, subject and etc. However, in order to solve the problem, it is also important to consider how the schedule can affect the performance of students, lecturers or the exam itself. Students and lecturers of the institution have their own opinion on having a timetable that can help them to manage their time during the examination period. Desai (2011) mentioned that in order to produce a human friendly system, it is important to take the human perspective into consideration.

Many research papers have been made regarding examination timetabling problem but not many of them are focusing on the needs of the timetabling communities that will be using their product. Commonly, other researchers will use data sets provided by the institutions which are mostly gathered from their own observation and some used constraints from other research papers instead of referring to the needs of the timetabling communities (Kahar & Kendall, 2010). This is maybe because running a case study will consume more time whereas the given time to produce a model for the institutions is rather limited. Thus, the data provided by the registrar are the better option although only the basic data are provided.

There are several numbers of surveys regarding examination timetabling have been made to determine the candidates' perspectives about their exams nature at their institution such as the survey made by Cowling et al. (2002), Burke et al. (1996) and etc. Therefore by referring to these surveys, this paper is made to investigate the students' and lecturers' perspective. In this paper, the mathematics students and lecturers from School of Informatics and Applied Mathematics (SIAM) at Universiti

Malaysia Terengganu were given an opportunity to discuss their own perspective regarding the examination timetable that was prepared by their institution. The criteria of a good timetable that is agreed by all candidates is listed and the problems that arise in the current examination timetabling in Universiti Malaysia Terengganu is identified.

## 2. Literature Review

The problem regarding timetabling has been commonly known among researcher around the world. Wren (1996) defines timetabling as "the allocation, subject to constraints, of given resources to objects being placed in space time, in such a way as to satisfy as nearly as possible a set of desirable objectives". The timetabling problem is a branch set of problem in operational research and a part of optimization problem. Operational research is first introduced in drafting the military technique during the world war II. In order to solve the problem faced regarding the shortage of resources during the war, a group of scientist is command to deal with this problem so that the resource could be allocate fairly to each unit every time there is operation instructed (Hillier & Lieberman, 2001). The concept to solve this problem is similar with the concept used to solve the timetabling problem. A job scheduling, sport timetabling, and course scheduling are examples of timetabling problem.

### 2.1 Examination Timetabling Problem

This paper will be discussing on examination timetabling problem. It is a problem of assigning exams to a limited timeslot with condition that no hard constraint is violated. This problem has been haunting many universities every time examination seasons are around the corner. de Werra (1985) mentioned that examination timetabling problems is similar to course timetabling problem except that for course timetabling, the purpose is to avoid conflict between subject while examination timetabling is to avoid having two or more exams per day or having exams on consecutive days. The differences between course and exams timetabling problem is also stated in Aizam (2013).

The main problem faced by each university in order to arrange their examination timetable includes the constraint like number of students, number of lecturers, number of subject that each student take in one semester and subject offered by their faculty and also room assignment for the examinations to take place. Besides, there are soft constraints which are

often ignored when scheduling the examination timetable such as the preference of students and lecturers especially regarding the time they want to take exam, the time gap between an exams, the place where they think suitable to take exams, the number of period of exams and etc. Abdullah et al. (2011) mentioned that unlike soft constraints, every hard constraint must be satisfied when constructing a timetable. Although university could set aside the soft constraints, it is still important to take these constraints into consideration so that the examination timetable could be more of a higher quality.

## 2.2 Factor Analysis

Factor analysis is first introduced in early 1900s as a test to identify latent traits of a questionnaire by data reduction technique to get the most reliable data (Fricker et al., 2012). We use this method to analyze our original questionnaire to get the factor related to our study. The question or item in questionnaire is grouped into a number of factors and the unrelated item is reduced. To do this, a large sample of data needs to be collected first. This is because in factor analysis, the analysis is measured on correlation matrix of each variable used in which a large sample size is needed to performed test to get the stabilized result (UCLA, 2014a). Field (2000) mention that "the most important factors in determining reliable factor solutions were the absolute sample size and the absolute magnitude of factor loadings". Therefore, it is best if the data considered suits the number of variable used; otherwise result will not be as expected. For an overview of steps involved in factor analysis can be found in Kootstra (2004).

## 2.3 Previous Survey

To produce the best schedule that can satisfy all the hard constraints and solve maximum number of soft constraints especially related to human perspective, many surveys and research have been conducted. Carter (1986) in his survey for operational research, studied about the applications used to design timetable at several chosen institutes. His purpose is to identify the best algorithm to be used to select or design the timetable for the institutions. Cowling et al. (2002) conducted a survey on student and invigilator at University Technology MARA (UiTM) about their view on the current examination timetable at UiTM and what they expect as an improvement in their future examination timetable. Another survey is made by Desai (2011) about the timetable that is close to the teacher's and student's preferences. A method to include the soft constraints of human in the timetable system so that a human-friendly timetable can be produced

was suggested. Others are Burke et al. (1996) and Kahar & Kendall (2010), which were used as our references in this paper.

## 3. Methodology

The focus of this research is the students and lecturers from the School of Informatics and Applied Mathematics (SIAM) at Universiti Malaysia Terengganu. The purpose of this survey is to investigate their perspectives on the examination's time, date, place and period and also to determine whether the current timetable is effective. Other desirable outcome for this survey is gaining the information on the criteria of the students' and lecturers' preferred timetable. Therefore, the best method to collect the data is by using questionnaire that is distributed to the students and lecturers at the studied university.

The initial step in collecting the data for this research was by constructing the survey questionnaire. All question related to survey are listed and among the questions, only the best questions are chosen to be included in the questionnaire. To do that, pre-test known as pilot test are distributed to the first 60 candidates from a department in order to check the compatibility of the question. Pilot test is a trial version of questionnaire used as test for the main questionnaire (van Teijlingen & Hundley, 2001). When the pilot test has successfully satisfied the objective, full questionnaire are distributed to the candidates.

The questions are divided into two formats which is close and open-ended format. Closed format is in the format of Likert scale from "strongly disagree" to "strongly agree" and the open-ended format which candidates give their own answer based on their perspective. The question for students and lecturers is in simple closed format for section A and B and for section C there will be 3 open format questions. The question is designed by referring to the constraints used by Burke et al. (1996), Cowling et al. (2002), Desai (2011) and Abdullah et al. (2011) in their article.

All the result from the questionnaire was analyzed using software which is known as Statistical Product and Service Solutions (SPSS). SPSS is commonly used in statistical analysis to calculate as well as to interpret the data collected. We will determine the internal consistency of the items using Cronbach's alpha for our pilot test data before the real questionnaire is distributed. The purpose of this test is to check how closely related 1 item is to another in a questionnaire. The Cronbach's alpha must surpass

minimum value of 0.6 to be recorded as good consistency (UCLA, 2014b). However minimum value of 0.5 can at least be considered as acceptable. The higher the alpha, we will obtain a better internal consistency of items in the scales. The formula of Cronbach's alpha is shown below:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

where $N =$ numbers of item, $\bar{c} =$ average inter-item covariance among the items and $\bar{v} =$ average variance.

If the number of items increases, then the Cronbach's alpha value will also increase (UCLA, 2014b). It is important to know that if the result of the Cronbach's alpha is unlike to our expectation. Thus, we may need to consider reducing or adding our variable or questions. After the result in our Cronbach's alpha analysis is obtained, which is more than 0.5, factor analysis method is conducted. The question passes through a process of reduction where the questions that are similar were factored to the same factor or component. By using this method our data is divided to a number of factors which are named accordingly. The question which does not belong to any factor or does not satisfy the condition is reduced. The result from the factor analysis is interpreted depending on the objectives. Through this factor, we can then further analyse the data with other tests to satisfy the objective.

## 4. Results and Discussions

The result of Cronbach's alpha for this data is $\alpha = 0.768$. It surpasses the minimum value of 0.5 and can be considered as a good data. Hence, we were able to start with the analysis for our real data. From the factor analysis, we were able to identify 8 factors which represent the students' preferences. The factors are named as in Table 1.

TABLE 1 : The Results Obtained from Factor Analysis

| Component | Name | Items |
|---|---|---|
| 1 | Exams period | Q3: Students are scheduled to have exams in two consecutive timeslots.<br>Q4: Students are scheduled to have exams in two consecutive days.<br>Q2: Students can be scheduled to more than one exam in any particular days. |
| 2 | Exams gap | Q7: The gap between exams in the same day should be longer than two hours.<br>Q8: There must be at least two days gap between exams.<br>Q6: There are at least a day gaps between exams. |
| 3 | Exams time and date | Q22: Exams should be scheduled on public holidays.<br>Q23: Exam should be scheduled during lunch hour.<br>Q20: Exams should be scheduled on weekends. |
| 4 | Exams preparation | Q40: Lecturers in charge of the subject should be in charged in invigilating the exams.<br>Q39: Scheduling of the exam should be done at certain time so that student could be prepared.<br>Q34: Extra time or special room should be provided for disabled students. |
| 5 | Exams conducting time | Q13: Students prefer to take exam only in the morning.<br>Q10: Exams starts at 8 in the morning.<br>Q11: Exams starts at 9 in the morning.<br>Q15: Students prefer to take exam only in the evening. |
| 6 | Exams place | Q33: Student should not be scheduled to a room with not enough seats.<br>Q31: Additional time for students and lecturers to travel between one exam places to another must be provided.<br>Q32: Exams must be scheduled to a venue near to the relevant department. |
| 7 | Exams length and students | Q25: Distance between exams on the same day is depending on how long the time gap between each exam.<br>Q30: Only same length period exams may be scheduled at the same timeslots in the same rooms.<br>Q26: For each exam, the number of invigilator suits the number of student. |
| 8 | Exams room and availability | Q28: Students taking the same exam can be assigned to different room regardless his/her course.<br>Q27: Students from the same course should be separated to different room for the same exams.<br>Q35: Availability of part time students should be respected. |

Table 1 explains the component or factor which was obtained from the factor analysis. The data we analyzed is factored into 8 component or factor in which these factors was then named with the suitable name based on the items on it.

From Table 1, we were able to list few constraints that are preferred by both students and lecturers that could be added into consideration before constructing the examination timetable. Some of the constraints are:

1. Travelling time are provided between each exams
2. Exam is most preferred to be conducted in the morning.
3. No students from same course are separated to different rooms.
4. No exams scheduled during lunch hour, 1-2 pm.
5. Religious conviction must be respected.

Apart from the Cronbach's Alpha and factor analysis, the following results were also obtained: students' and lecturers' opinion on the effectiveness of the current examination timetable, the effect of exams timetable to their performances and their preferred criteria of a good examination timetable. Figure 1 illustrates lecturers' opinion on the effectiveness of the current examination timetable and the effect towards their performances. More than 70% of lecturers found that the current examination timetabling for the year 2013 is well scheduled. However, there are a number of lecturers that disagreed. The reason behind this opinion is because they had their courses scheduled on public holidays and some might have two exams assigned close to each other. These two reasons were the factors that contributed to a least preferred examination timetable. When asked their opinion of whether the examination timetable produced will affect their performances, slightly higher number of lecturers disagreed. Examination timetable is informed in advance, allowing lecturers to manage their work schedule.

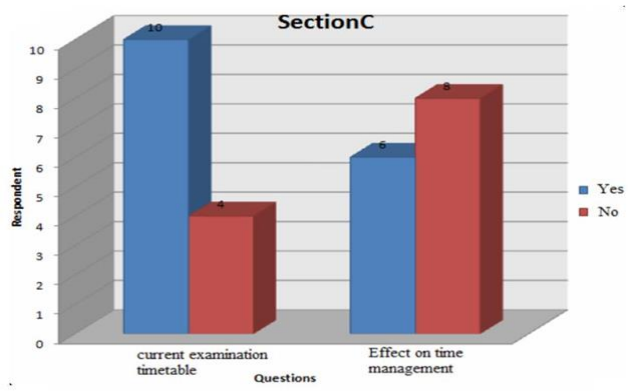


Figure 1: Lecturers' Opinion on the Effectiveness of the Current Examination Timetable and the Effect towards Their Performances

Figure 2 and Figure 3 show the students' perception on the effectiveness of the current examination timetable and to their performances respectively (in percentage).

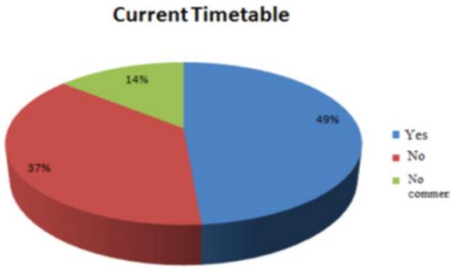


Figure 2: Students' Perception on the Effectiveness of the Current Examination Timetable

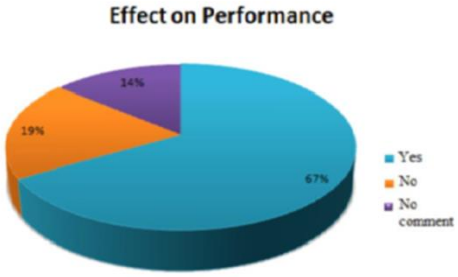


Figure 3: Students' Perception on the Effect of Examination Timetable towards Performance

Similar to the lecturers' perception, almost half of the students responded well to the current examination timetable, while 37% scored the opposite. We cater the ones disagreed, where they commented on a packed schedule, exams assigned during lunch hour and the occurrence of clashes between electives courses. In Figure 3, we observed a different outcome whereby 67% students agreed to the statement that the examination timetable has an impact on their performances, while only 19% disagreed. Among the reasons stated by the students are that a small time gap between two exams creates a shorter time for preparation, which will affect their results. Conversely, when the time gap given is too long, there's a tendency for loss of focus.

The discussed perception and opinion from the timetabling communities is crucial towards creating a healthy education environment. Minor dissatisfaction in scheduled examination timetabling can lead to a huge impact on the engagement from both lecturers and students. Summarizing up the survey, participants were asked of their view on the criteria that makes a good examination timetable. Some of the criteria are listed below:

1. Gap between exams is at least 2 days but not more than 4 days.
2. No exams conducted at night.
3. Evenly spread and fair for all courses.
4. Exams maybe conducted 3 times in a week.
5. Exams with most students are scheduled early.

In addition, this survey is conducted to identify the timetabling communities' preferences and opinions prior to develop a suitable model desired by all. This would lead to the increment of students' performance hence producing excellent graduates. Based on the final result, we could see that the constraints attained are slightly different from the usual constraints listed by other research. We managed to list the similar constraints and also found additional constraints to be used to design a new mathematical model for examination timetabling. We could also determine the most and least preferred constraints in a timetable. Therefore, our model will be designed by giving the priority to the aforementioned constraints. To know whether the results are constructive, a mathematical model should be designed based on the resulted constraints and implement the model to a real-world examination problem.

## 5. Conclusion And Future Work

In this paper, we have identified the students' and lecturers' preference and opinion regarding their examination timetable. We have also detected additional factors that will improve the satisfaction of students and lecturers regarding their preferred exams timetable. The best criteria of a good timetable and the problem related to the current examination timetable are listed. The result shows that students demand for time gaps between each exam to allow for extra preparation time to help them focus on the preceding exams. In other word, most of them wish that the current examination timetable can be changed to meet their needs. As a conclusion, in order to produce a better timetable, human constraints need to be considered as to satisfy all parties and to gain the best result. The output of this research can be used by other researchers especially in the modelling of

a timetable. It can be a guidance to find more relevant and most demand constraints to produce a better quality timetable. For future research in this area, we recommend on using larger communities which includes more staffs (administration and lecturers) as the respondents to produce a more accurate outcome. This is to avoid a one-sided timetable because timetabling is known to be the biggest problem to every institution and indirectly it involves many parties. Each of these parties has different role and involvement towards this problem. As to obtain the best result, a research similar to what we have done is a better option to identify the lacking in the system. By this a more efficient timetable can be produced thus will lead to the increasing of students' performance and all involved parties.

## References

Abdullah, S., Shaker, K., and Shaker, H. (2011). Investigating a round robin strategy over multi algorithms in optimising the quality of university course timetable. *International Journal of the Physical Science.* **6**: 1452-1462.

Aizam, N. A. H. (2013). Effective computational models for timetabling problem. Ph.D. Curtin University, Department of Mathematics and Statistics.

Burke, E., Elliman, D., Ford, P. and Weare, R. (1996). Examination timetabling in British universities: A survey. In *Practice and Theory of Automated Timetabling*. Springer Berlin Heidelberg, p. 76-90.

Carter, M. W. (1986). OR Practice-A survey of practical applications of examination timetabling algorithms. *Operations Research.* **34**: 193-202.

Cowling, P., Kendall, G. and Hussin, N. M. (2002, August). A survey and case study of practical examination timetabling problems. In *Proceedings of the 4th International Conference on the Practice and Theory of Automated Timetabling (PATAT 02),* p. 258-261.

de Werra, D. (1985). An introduction to timetabling. *Review of European Journal of Operational Research.* **19**: 151-162.

Desai, N. P. (2011). Preferences of teachers and students for auto generation of sensitive timetable: A case study. *Indian Journal of Computer Science and Engineering.* **2**: 461-465.

Field, A. (2000). *Discovering Statistics using SPSS for Windows*. London – Thousand Oaks –New Delhi: Sage publications.

Fricker, R. D., Jr., Kulzy, W. W. and Appleget, J. A. (2012). From data to information: using factor analysis with survey data. *Phalanx*, p. 30-34.

Hillier, F. S. and Lieberman, G. J. (2001). *Introduction to Operational Research.* 7th ed. New York, NY: McGraw-Hill.

Kahar, M. N. M. and Kendall, G. (2010). The examination timetabling problem at University Malaysia Pahang: Comparison of a constructive heuristic with an existing software solution. *European Journal of Operation Research Society*. **65**: 214-226.

Kootstra, G. J. (2004). Exploratory factor analysis: Theory and application. Retrieved March 15, 2014 from http://www.let.rug.nl/~nerbonne/teach/rema-stats-meth-seminar/Factor-Analysis-Kootstra-04.

UCLA (2014, March 15). Annotated SPSS output: factor analysis. Retrieved from Statistical Consulting Group: http://www.ats.ucla.edu/stat/spss/output/factor1.htm

UCLA (2014, March 15). What is Cronbach's alpha. Retrieved from Statistical Consulting Group: http://www.ats.ucla.edu/stat/spss/faq/alpha.html

van Teijlingen, E. R. and Hundley, V. (2001, December). The importance of pilot test. *Social Research Update*, p. 1-4.

Wren, A. (1996). Scheduling, timetabling and rostering- A special relationship? *The Practice and Theory of Automated Timetabling : Selected Papers from 1st International Conference on the Practice and Theory and Theory of Automated (PATAT I),* Edinburgh, UK, Lecture Notes in Computer Science 1153, Springer-Verlag, p. 46-75.