

A Systematic Literature Review: Optimization Timetable in Education to Support Work-Life Balance (WLB)

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Received Date: 1 July 2022

Accepted Date: 10 September 2022

Published Date: 30 September 2022

HIGHLIGHTS

- Ignorance WLB in Timetabling optimization leads the unhealthy.
 - Optimization academic Timetable use many procedures.
 - Constructed a SLR to find current optimization and existing technique in Education Timetabling to support WLB.
 - Identified the significant and gap of optimization in Education Timetabling to support WLB.
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ABSTRACT

Scheduling academic staff timetables is crucial and necessary to avoid redundancy and clash of class between teacher and student timetables. A good timetable allows students and teachers to manage their time and support a good and healthy lifestyle. However, with the scheduling, academic staff timetable may use many procedures to get efficient results. Therefore, this paper provides a gap of study for existing work on Optimization Timetable to support Work-Life Balance (WLB) regarding their market commercial and research purposes. The methodology of this study was conducted using a Systematic Literature Review (SLR). Result: two findings investigate 1) relevant optimization timetable scheduling used and 2) the method for timetable optimization to support WLB. The strengths and weaknesses of the features and utilities behind each study are also presented to provide a further understanding of the gaps and weaknesses of each body of research. We conclude that these studies are still insufficient and require further evaluation and improvement.

Keywords: *timetable optimization, work-life balance, genetic algorithm, swarm intelligence*

INTRODUCTION

Due to their wide range of applications, timetabling problems have received a lot of attention, such as the flight timetable problem, employee timetabling problem, university, or high school timetabling problem. It is, however, more sophisticated than generic scheduling because it involves teachers, students, classrooms, and courses. Besides, due to the numerous constraints, resource constraints, and intricate human aspects involved, course scheduling has always been done manually and take a long time. Using a computer not only consolidates the preferences of the individuals involved, but it also allows for a high level of



satisfaction despite the numerous constraints. Thus, this saves a significant amount of time and manpower. As a result, an automation scheduling timetable is required for algorithm selection.

Furthermore, academic staff timetable scheduling is critical to optimise and balance academic staff working hours. As a result, maintaining a work-life balance is essential. However, failure to reach a work-life balance when scheduling teacher timetables may result in poor teaching and learning quality. In this research, extension work by (Yusop, 2022) a review of existing works and tools supporting the optimization timetabling with WLB are presented.

The paper is organized as follows: Section 2 describes the background of study; followed by Section 3 presents the Methodology to conduct this research; then Section 4 provides the overall findings and provides discussion of this study; and, lastly, Section 5 of this paper ends with a conclusion and recommendations of future work.

RESEARCH BACKGROUND

Definition of Timetabling

Wren (1995) has defined timetabling as “Timetabling is 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”.

Definition of Swarm Intelligence

Swarm intelligence is a relatively recent problem-solving strategy that was identified through simplified social behaviour model simulations of insects and other animals (Bonabeau et al., 1999) . It is inspired by the collective intelligence of swarms of biological populations. The algorithms of ants, bees, wasps, termites, fish in schools, and birds in flocks have all been studied computationally (Caro, 2022). The Ant Colony Optimization (ACO) algorithm is a meta-heuristic optimization technique inspired by biological systems that computes the shortest path between a source and a destination to find optimal solutions.

Definition of Genetic Algorithm

Genetic algorithms (GA), which are a type of gradual developmental algorithm, are influenced by the process of natural selection. Natural selection begins with the selection of suitable individuals from a population (Aminu et al., 2019). GAs is a type of approach that may be used to address these problems quickly. They are founded on genetics and natural selection principles, with the primary notion being that the fittest individuals in a population are selected, and subsequently recombine or mutate into new forms to establish new groupings (Jalal & K Mukhopadhyay, Anal Grasley, 2019).

Definition of Work-Life-Balance

Duxbury (2004) had defined work life balance as a mix of role overload, work-family interference, and family-work interference. Hill, et al.(2001) describes WBL as a person's ability to manage the emotional, behavioural, and temporal demands of paid work, personal, and family duties at the same time.



To overcome the problems and issues defined above, this study presents a Systematic Literature Review (SLR), which will be discussed further in the following section.

METHODOLOGY

We conducted the SLR in accordance with Barbara Kitchenham's (2007) original guidelines with qualitative research methodology. This SLR consists of three phases, which are (1) Planning the SLR, (2) Conducting the review and (3) Reporting the review. For planning, we initialise the terms and functional of timetabling in education for its factor and issues. Here, Population, Intervention, Comparison, Outcomes and Context criteria (PICOC) to structure the research questions from Barbara Kitchenham (2007) as shown in Tables 1 and Table 2. The document search technique as shown in Table 3 was used to collect the data from Google Scholar, ScienceDirect, Springer, IEEE Xplore, ACM Digital Library and Scopus and then the selection procedure was carried out systematically based on the steps shown in Table 4 and the inclusion and exclusion criteria shown in Table 5. Following that, we are classifying relevant studies and primary studies to conduct the research. Then, as shown in Table 6, data extraction and quality assessments were performed to elicit data from primary studies. Finally, we present the extraction data from ten papers that were used to construct answers to the two RQs. The Kitchenham guidelines are widely used in the preparation of this Systematic literature review report. Each phase is depicted in detail in the section below.



Figure 1: Conducting SLR

Planning

Table 1: Summary of PICOC

Population	Timetable, worklife balance
Intervention	Challenging of timetable scheduling in worklife balance in teaching and learning
Comparison	Existing model, methods and techniques
Outcomes	Prediction of timetable scheduling in WLB, success factors
Context	Empirical in research studies and industry

Table 2: Research Questions

Research Objectives	Research Questions	Motivations
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To identify the relevant Timetable optimization in education to support WLB	What is Timetable optimization in education to support WLB?	Identify the relevant for Timetable optimization in education to support WLB
To identify the gaps and limitations of existing techniques and approaches used to apply Timetable optimization in education to support WLB	What are the available approaches or models, or methods used to apply Timetable optimization in education to support WLB?	Explaining the ways to Timetable optimization in education to support WLB. Identifying approach or tools available to apply Timetable optimization in education to support WLB.

Table 3: Searching string

Type searching of Objective 1	OR	Type searching of Objective 2	AND	Type searching of Objective 2
Issues		Method		Timetabling optimization in education to support WLB
Problems		Technique		
Characters		Approaches		
Factor				

Table 4: Selection Process

1	RQ is used to generate major searches.
2	Examined the paper title or removed studies that did not fit our search criteria
3	To connect result terms in the search string, use the Boolean operator (AND, OR, NOT).
4	To identify relevant studies, retrieve the citation and examine the abstract and keywords in the remaining studies.
5	The remaining studies were filtered using the inclusion/exclusion criteria listed in Table 5.

Table 5: Inclusion/Exclusion

Inclusion	Exclusion
Papers focusing on Timetable optimization in education to support WLB	The papers presented do not require peer review.
Papers describes Timetable optimization in education to support WLB	Papers that present results without providing supporting evidence.
Systematic literature review	Unrelated studies to the research questions.
Paper describes Timetable optimization in education to support WLB	Studies not clear
Paper describes Timetable optimization in education to support WLB	

Table 6: Data Extraction



Focus of Search	Item of Data	Description
General	Bibliography	Author, year, title, source
	Article types	<ul style="list-style-type: none"> Journal/conference paper/technical report
	Study aims Study design	<ul style="list-style-type: none"> The primary study's goal(s) Surveys and controlled experiments
RQ1	Comparison	<ul style="list-style-type: none"> Define Timetable optimization in education to support WLB
	Examples	<ul style="list-style-type: none"> Examples of Timetable optimization
RQ2	Approach Method	<ul style="list-style-type: none"> Describe the method used Timetable optimization in education to support WLB
	Existing/new/extension	<ul style="list-style-type: none"> Explain whether method is new, or already has existing method

Conducting Review

Identifying Relevant Studies and Primary Studies

We began by reviewing the titles of the papers to eliminate any studies that were not clearly related to the research focus. The abstract, keywords, and conclusion were then used to eliminate additional unrelated studies. After applying these two steps, 55 studies remained. We examined these 55 studies and used the inclusion/exclusion criteria listed in Table 5 to select 24 papers as primary studies for this SLR. Further, we used the same selection steps to the reference lists of the selected 24 primary studies to find additional primary studies that are related to the research focus.

Data Extraction and Quality Assessments

We extracted data from the primary studies using the data extraction form shown in Table 7. Many primary studies did not provide comprehensive answers in the data extraction form and we extracted the important information provided by the primary studies using the data extraction form. The quality assessment questions in Table 7 were then applied to each primary study that depending on the type of study. We answered our quality assessment questions with 'yes' or 'no.' We used a binary scale because we didn't want to provide a quality score for the studies.

Table 7: Quality Assessments (QA) and Question Scores(QS)

QA		QS		
QA1	Are the review's inclusion and exclusion criteria described and appropriate?	Y (yes), the inclusion criteria are explicitly defined in the study	P (Partly), the inclusion criteria are implicit.	N (No), the inclusion criteria are not defined and cannot be readily inferred
QA2	Is the literature search liable to have covered	Y(yes), the authors have either searched 4 or more digital	P (Partly), the authors have search ¾ digital libraries with no extra	N (No), The authors have search up to 2 digital libraries or an



	every single relevant studies?	libraries and included additional search strategies or identified and referenced all journals addressing the topic of interest	search strategies or search a defined but restricted set of journals and conference proceedings	extremely restricted set of journals
QA3	Did the reviewers assess the quality or validity of included studies?	Y(yes), the authors have explicitly defined quality criteria and extracted them from each primary study	P (Partly), the research question involves quality issues that are addressed by the study	N (No), no explicit quality assessment of individual primary studies has been attempted.
QA4	Were the essential information or studies sufficiently depicted?	Y, information is presented about each study	P (Partly), only summary information about primary studies is presented	N, the results of the individual primary studies are not specified

Reporting Review

The data extracted from the ten primary papers were used to formulate answers to the two research questions given in Table 2. When preparing the SLR report, we closely followed the guidelines provided by Kitchenham & Charters (2007).

We present the synthesis of evidence of our SLR, beginning with the analysis from the literature. We also used the selected primary papers to answer the research questions. Table 8 shows the number of studies for quality assessment using the SLR's level layer. On this paper, we excluded 28 studies with 3 studies being duplicates. After quality assessment of 24 studies, ten studies were chosen for evidence synthesis while fourteen studies is rejected.

Table 8: Result of Quality Assessment

Criteria	Study of Paper
Before Assessment of Quality	55
Redundance	3
Exclusion	28
After Assessment of Quality	24
Accepted	10
Rejected	14

FINDINGS AND DISCUSSIONS

Findings



We compared the ten existing works on Timetable optimization in education to support WLB. The comparison was made based on methodology, approach, technique, and Timetable optimization in education to support WLB, as shown in Tables 5 and Table 6. We discussed the paper in more detail below, within the parameters of the research questions defined above.

RQ1: What are the Factor of Timetable Optimization in Education?

The comparison analysis of timetable optimization in education is shown in Table 9 below. Genetic Algorithm contributes high number in timetable optimization. However, 3 out of 4 found have combination with other such as Rashmi and Arbhishkek (2021) developed an approach using prediction algorithm by combining genetic algorithm and particle swarm algorithm. Automated timetable generation enhances the quality of the education institutes and tends to greatly reduce time and manual efforts. Zandavi et al. (2021) proposed a hybrid optimization technique that combines the Nelder-Mead Simplex algorithm with the Non-dominated Sorting Genetic Algorithm to optimise the scheduling problem for distant laboratories to coordinate. Wang et al. (2019) developed a particle swarm optimization technique based on a genetic algorithm, in which the position vector and genetic evolution operators are reconstructed based on each train's departure and arrival timings at stations. The latest studied by Guerriero and Guido (2022) developed a novel optimization to improve employees' satisfaction and ensure the best work-life balance possible, an alternative partition of a workday into shifts to the usual two shifts, morning, and afternoon. Therefore, we believe that combination of algorithms is still limited to optimize the timetable scheduling specifically in teacher or lecturer timetable in university.

Table 9: Timetable optimization in education

Year	Name	Optimization	Particle Swarm Optimization	Simplex Algorithm	Genetic Algorithm	Swarm Algorithm	Constraint Satisfaction Problems (CSP)	Whole Optimization Algorithm (W/OA)	Ant Colony	Bee Colony
2003	(Sandhu, 2001)						✓			
2012	(Larsen, 2012)	✓								
2018	(Liu et al., 2018)									✓
2018	(Uslu et al., 2018)				✓				✓	
2019	(Wang et al., 2019)		✓		✓					
2019	(Knutsäter & Sandh, 2019)		✓							
2020	(Omar et al., 2020)							✓		
2020	(Zandavi et al., 2021)			✓	✓					



2020	(Guerriero & Guido, 2022)	✓								
2021	(Rashmi & Abhishek, 2021)		✓		✓					
	Total	2	3	1	4	0	1	1	1	1

RQ2: What are the Available Approaches or Models, or Methods used to Apply Timetable Optimization in Education to Support WLB?

To provide a better WLB, the optimization of timetable schedule need to through analyse and must be involve many elements inclusive of WLB attributes. The comparison features based on methodology/approach/technique as shown in Table 10. Based on Table 10, it founds that model is high contribution for applying the timetable optimization. However, to developed scheduling timetable, a proper requirement must be considered to encourage the positive effectiveness and success of optimization that able to support work-life balance. Further, there are work by Larsen (2012) and Guerriero & Guido (2022) support WLB but lack of tool developed to support the WLB. Thus, it is necessary to have a tool for supporting WLB specifically in academic level.

Table 10: Comparison of approaches or models, or methods used to apply Timetable optimization in education to support WLB

Year	Name	WL B		Optimization				
				Model	Method	Approach	Framework	Tool
2003	(Sandhu, 2001)			✓				
2012	(Larsen, 2012)	✓		✓				
2018	(Liu et al., 2018)			✓				
2018	(Uslu et al., 2018)			✓				
2019	(Wang et al., 2019)			✓				
2019	(Knutsäter & Sandh, 2019)			✓				
2020	(Omar et al., 2020)			✓				
2020	(Zandavi et al., 2021)			✓				
2020	(Ramos & Galleto, 2020)	✓						
2020	(Guerriero & Guido, 2022)	✓		✓				
2021	(Rashmi & Abhishek, 2021)						✓	



2021	(Tucker & Folkard, 1968)	✓		✓			
	Total	4		10			1

Discussions

We reviewed ten studies based on SLR results and compared them in terms of models, methods, approaches, and frameworks. We discovered that most of the studies investigated similar topics such as Genetic Algorithm and Particle Swarm Algorithms in optimization of timetable scheduling in education. Based on our findings, as shown in Tables 9 and Table 10, this study discovered that various models are used by optimize the timetable that supporting swarm intelligence. Based on the analysis, the analysis support genetic algorithm and analysis are required process to optimize the timetable. Further, most of tools is lack to support timetable. In this respect, this research believes that there is study related to the optimization for scheduling timetable but there is lack of method to work-life balance for academic timetable where automation scheduling of academic timetable. Thus, producing a tool to support WLB with integration of optimization techniques crucial and could help the educators' WLB. The development of algorithm of optimization in WLB specifically in educational setting should require a thorough study that include WLB attributes and optimization.

CONCLUSION AND RECOMMENDATIONS

Timetable scheduling is important and crucial to support WLB of teachers and educators in School or University. To keep them consistent to deliver work in good health, WLB attributes and Optimization timetable scheduling may considered. This allows the teacher and educators have sustain and less overload work. Therefore, these papers provided the Systematic Literature Review (SLR) methodology for optimization timetable to support WLB and research fields. We have reported the findings and analyses of different studies, which showed that optimization of timetable scheduling in education with WLB is limited. The strengths and weaknesses provide an understanding of the limitations of existing tools. We conclude that the current, existing research of optimization of timetable scheduling in education with WLB remains immature and needs further study to produce a better sustainable WLB for teacher and lecturer.

In future works, we plan to develop an approach and an automated tool to be used by both teachers and lecturer in university. This tool will assist the teacher and lecturer to their WLB in university as well as to improve educational settings purpose.

CONFLICT OF INTEREST DISCLOSURE

The author declare that he have no conflicts of interest to disclose

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