



SCIENTIFIC OASIS

Journal of Operations Intelligence

Journal homepage: [www.jopi-journal.org](http://www.jopi-journal.org)  
eISSN: 3009-4267



## Literature Review on Multi-Criteria Analysis and Application in Education Environment

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### ARTICLE INFO

#### Article history:

Received 9 August 2024  
Received in revised form 11 September 2024  
Accepted 3 October 2024  
Available online 13 October 2024

#### Keywords:

MCDM, Education; Decision Analysis; E-learning; Evaluation.

### ABSTRACT

Due to the increasing complexity of educational data, the use of decision analysis techniques such as Multi-Criteria Decision Making (MCDM) models has become more popular in the education system in recent years. Multi-criteria decision-making methods provide faster and more efficient data analysis techniques for revealing hidden patterns and other meaningful information from vast educational data that conventional analytics are unable to discover in a reasonable amount of time. Particularly, MCDM techniques have been demonstrated to be effective methods for pattern recognition in educational systems. Motivated by this consideration, the purpose of this paper is to investigate the MCDM approaches applied to education systems through a review of new architectures, applications, and educational trends. The primary objective of this paper is to provide extensive insight into the application of MCDM models to education solutions in order to bridge the gap between MCDM techniques and human-based education interpretability. Then, the application of MCDM to various aspects of education is categorized. Finally, we present the current open challenges and future directions.

### 1. Introduction

Multi criteria decision making (MCDM) is considered a set of criteria and factors in decision making area. MCDM is concerned with structure to solve decision making problem involve multi criteria. MCDM is applied to different applications and find the best solution to select the best alternative [1] Recently, MCDM applied in education section and show its performance for evaluation of education environment such as E-learning system [2]. A survey of MCDM proposed by [3] to analyse the related works and attributes to make an appropriate MCDM models for decision making in education.

Geng et al, [4] conducted an evaluation curriculum to clarify the position of evaluation of network curriculum using decision-making analysis approaches. This curriculum evaluation is affected by

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<https://doi.org/10.31181/jopi21202428>

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complicated criteria aggregating with analytic Hierarchy process AHP and Fuzzy logic methods. This study contains many complex criteria and curriculum assessment, AHP FSE is attempt to collect and combine criteria and obtain the final solutions. C.-H. Chen [5] presents the position of curriculum evaluation in the curriculum development model in primary schools. The evaluation process is derived by three decisions making techniques such as Analytic Network Process (ANP), Decision-Making Trial and Evaluation Laboratory (DEMATEL) and ViseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR). The data obtained through questionnaire process and gathering information from student. The ANP, DEMATEL and VIKOR are applied to solve the problems and find the best solutions. Their framework designed to evaluate the process based on decision making techniques. The ANP weights for each criterion are based on the DEMATEL method with the MCDM method for resolving the problems of dependence and feedback among criteria, and a VIKOR method with ANP weights is proposed for addressing and reducing the performance gaps for each criterion.

Another curriculum evaluation is presented by [6] to construct a competence model for evaluation of English language curriculum for the MICE industry in Taiwan. Data were collected from students using a questionnaire and analyzed by decision-making techniques which is AHP. The data were analyzed using the AHP technique through which are solving problems and finding appropriate solutions [7]. However, there are few MCDM applied in education with specific fields and the direction of research is not clear for scholars. Mustafa et al, [8] This paper presents a comprehensive examination of the documented implementations of MCDM techniques in the administration of higher education. Analyzing articles published from 1972 onwards, the study categorizes them based on their primary objectives. The findings reveal that resource allocation has emerged as the predominant motive for utilizing MCDM methods in higher education administration, closely followed by planning, evaluation, and other objectives. Thus, the lack of survey paper in MCDM in education motivate us to focus on review paper which analyses MCDM and combination of MCDM with machine learning in different specific education sectors to show the appropriate research direction for future works.

The aim of this survey paper is to review the most recent works which focused of Multi criteria decision making (MCDM) and its application in education environment. Then, we will categories the MCDM applied in different sector of education such as Curriculum, University, Student, Teacher, Course, E-learning. To do this, we extracted the Web of Science (WoS) and Scopus's manuscripts and then tried to classify them in different applications in education.

The primary accomplishments of this paper can be outlined as follows:

- i. Categorization of the available MCDM methods utilized in the education domain.
- ii. Offering comprehensive perspectives on the precision and suitability of MCDM models in educational solutions.
- iii. Exploring the fundamental technologies that have the potential to reshape MCDM approaches in educational technologies.
- iv. Highlighting the existing problems and challenges in present MCDM models in education.

We will summarize our claims from the literature survey and show a basic taxonomy for multi criteria decision making and application in education area. This taxonomy indicated below reviews the main streams of consideration in multi criteria decision making and their applications in education institutions in general. This taxonomy provides the comprehensive developments of various methods of MCDM and its application in education. In this research, systematic literature survey protocol is utilized. Systematic review is an approach of literature review that collected a set of academic papers and looks at multiple studies. The systematic review provided a summary of

previous and relevant study Table 4 . The first steps of systematic review are a deep search in multi criteria decision making and application in education area and thorough search of literature for relevant papers. The methodology of the review will list the different databases.

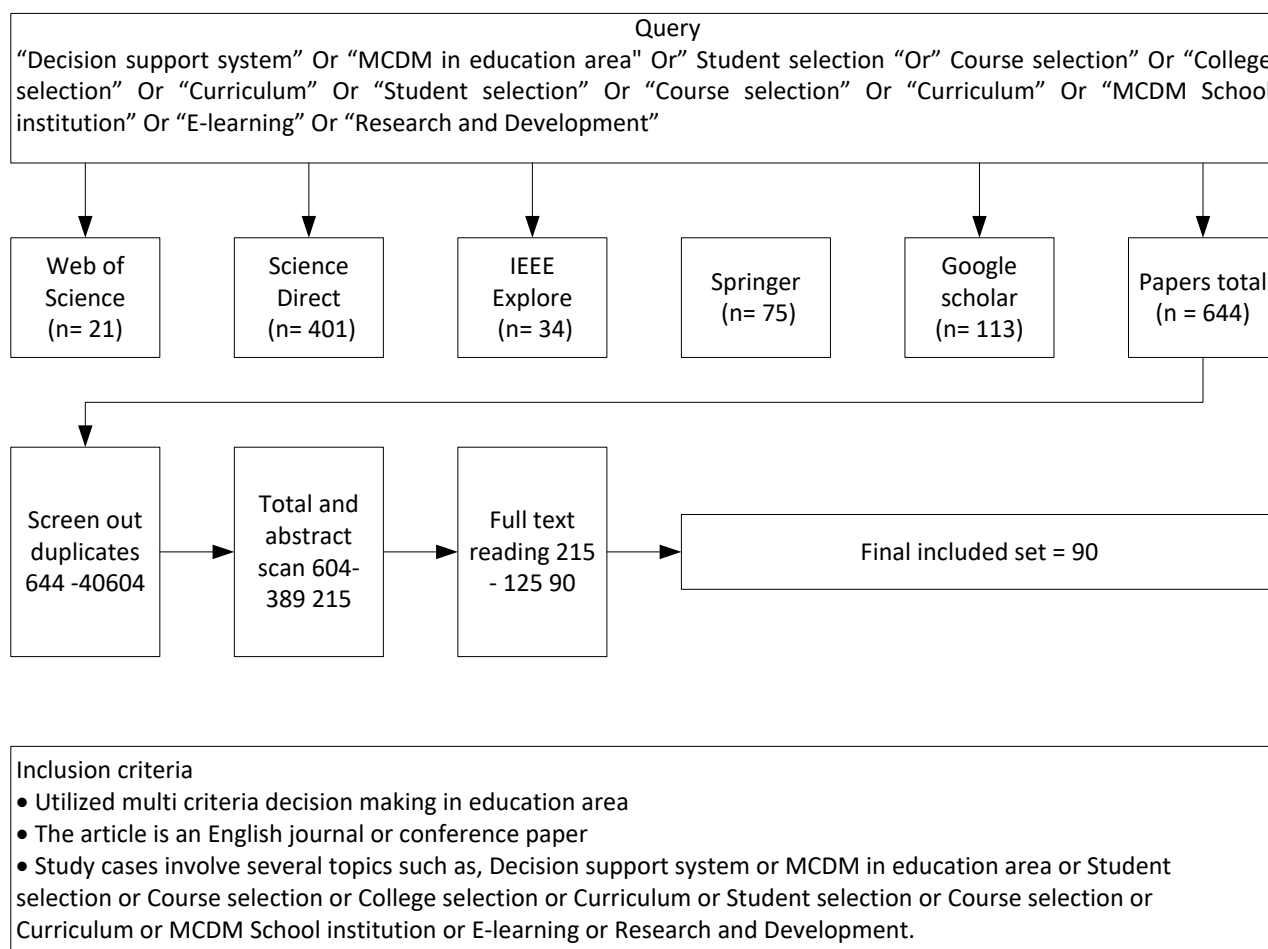
The current study is organized as follows. In Section 2, a research methodology is explained. In Section 3, taxonomy and classification of research literature, Section 4 presents the decision-making method and application in education, Multi criteria decision making methods using in educational environment and Discussion and result Sections 5 and 6, respectively.

## **2. Methodology**

The initial query search resulted in 644 articles. 21 from Web of Science, 75 from Springer, 401 from Science Direct, 34 from IEEE Explore and 113 from Google scholar. In the first monitoring stage, we excluded any article that does not have a topic related to education, any article does not use multi-criteria decision making or any article does not have study case over the span from 1996 to 2015. Forty (40) articles were duplicates among the five library databases. After scanning the titles and abstracts, three hundred eight nine (389) more articles were excluded. Resulting in 215 articles. Full text reading excluded one hundred twenty-five (125) articles, leaving ninety (90) articles in the final included set and papers is selected for the final analysis and classification based on multi criteria application in education area.

This section provided a step-by-step explanation applications decision making in education area. The most important keyword in this scope of Section is to identify a survey of multi criteria decision making and its applications in education, and to survey approaches which are most strongly and effectively used to identify previous study in educational domain. This survey work also addresses the problem in MCDM approach in education field and provides the comprehensive developments of different methods. We chose five digital databases to conducted the search for target articles. This research, multiple criteria decision-making application in education environment is investigated. The rationale behind this selection is to cover both decision making and application in education area, and provide a broader view of researcher's' efforts in a wide, but relevant, range of disciplines.

Figure 1 shows every academic article that met the criteria. We have set of targets of mapping the space of research on multi criteria decision making and application in education area in to a general and coarse-grained taxonomy of four categories. These categories were derived from a pre-survey of the literature with no constraint. There are several keywords were utilized in this survey such as, but not limited to (Decision support system, multi criteria decision making, university selection, student selection, Curriculum, course selection, college selection, education, school, institutional and other related keywords). Example of inclusion criteria involve (1) the articles most involve decision making application in education area (2) the articles is an English journal or conference paper (3) the study case must be in education area based on several keywords as in Figure 1.



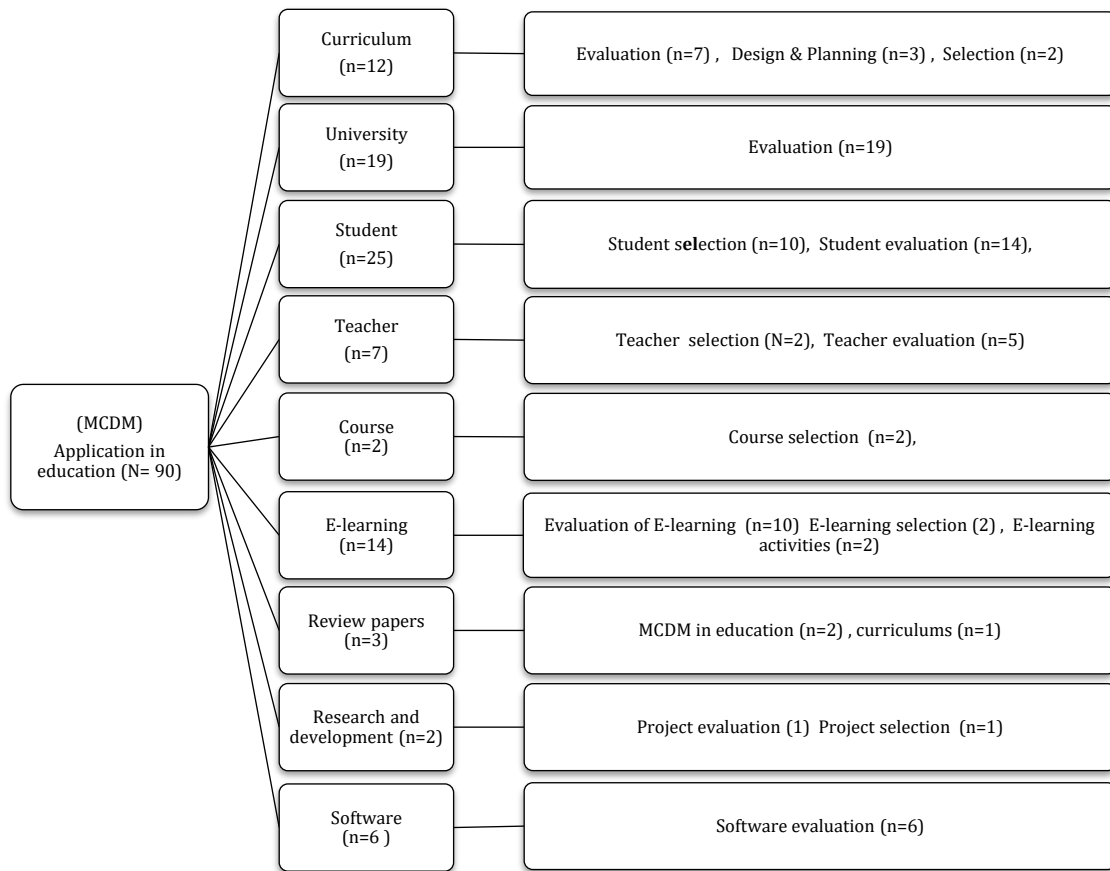
**Fig. 1.** Flowchart of study selection, including the search query and inclusion criteria

To make the steps easier, a full list of all included papers, with their corresponding initial categories It was collected from many different sources into a single word file. Several full-text readings were performed by me, and resulted in a large collection of highlights and comments on the to streamline subsequent tasks, we consolidated a comprehensive compilation of all included papers, along with their initial categories, by gathering information from various sources into unified Word and Excel files. We conducted extensive readings of the full texts, resulting in a substantial collection of highlights and comments on the surveyed works. Simultaneously, we classified the articles into a refined taxonomy. All comments were recorded within the texts themselves, either in hard or soft copy versions, depending on the authors' preferred style. Following this, we proceeded to summarize, tabulate, and describe the primary findings. We saved sets of relevant information in Word and Excel files, encompassing the complete list of articles, their respective source databases, summary and description tables, categorization tables based on MCDM techniques in education fields, purposes, review sources, target platforms and audiences, as well as various related figures. These datasets are provided as supplementary materials, serving as a comprehensive reference for the subsequent discussions on the results.

### 3. Taxonomy and classification of research literature

Figure 2 indicates the taxonomy of the reviews on the main streams of consideration in multi criteria decision making and their applications in education institutions in general. This taxonomy

provides the comprehensive developments of various methods of MCDM and its application in education.



**Fig 2.** Taxonomy of research literature on MCDM in the education area

The classification suggested different classes and subclasses which include as follows:

- i. Research articles concern about curriculum with an (n= 12), these articles are mainly focused on the development and evaluation of curriculums in all educational institutions.
- ii. The second class explored the research articles that used MCDM techniques on university with (n=19), these articles primarily investigate related topics to university selection, university development and university ranking.
- iii. The third class is the student related articles with (n = 25), these articles focus on many aspects related to improving or select the most proper students for that particular study case.
- iv. The fourth class is concerning research articles with interest of investigating research related to the Teachers to (n=7), these articles focus on teacher's tasks and function in education institutions, in addition to that the article that evaluate the teachers.
- v. The fifth class is related the research that investigated the Courses with (n=2), these four articles have invented a framework to select the most appropriate courses to be taken.
- vi. The six class is related to E-learning which from the literature with (n=14), these articles focus on e-learning activities and developments.

- vii. The seven class was regarding the review articles related to decision making and educational environment with (n=3).
- viii. The eighth class is related to research articles which discussed different topics such as Research and development (RND) with (n=2).
- ix. The last class is related to research investigated the usage of MCDM on educational software with (n=6), the nine class is presenting by these articles in general focus educational software development, implementation, selection and capabilities.

### *3.1 Introduction of curriculum development on MCDM applications*

The curriculum area is a sub-discipline of education environment. Different type of research conducted in curriculum area is particular, curriculum evaluation, curriculum Design and planning and curriculum selection. This area of curriculum covered academic publication based on applications of multi criteria decision making approaches.

#### *3.1.1 Curriculum evaluation*

Curriculum evaluation is a practical discipline which is control over the learning environment in all educational institutions. curriculum evaluation is the basis for curriculum development and increased cultural awareness in all educational institutions. There are many studies on this subject. We will review some of the previous studies on this subject. Evaluation process based on decision making techniques. This evaluation covered the academic publication with focus on evaluation of curriculum in education environment based on MCDM approaches. MCDM approaches in education environment have investigated to solve the studies problems. Evaluation curriculum is conducted by [4]. This study begins with clarifying the position of evaluation of network curriculum using decision-making analysis approaches. This curriculum evaluation is affected by complicated criteria aggregating with AHP and Fuzzy logic methods. This study contains many complex criteria and curriculum assessment, AHP FSE is attempt to collect and combine criteria and obtain the final solutions [4]. Another evaluation of curriculum is presented by C.-H. [5]. This study starts with explaining the position of curriculum evaluation in the curriculum development model in primary schools. The evaluation process is derived by three decisions making techniques ANP, DEMATEL and VIKOR. Evaluation process in this study based on complex ways and steps to assess the curriculums at the school. The data obtained through questionnaire process and gathering information from student. The ANP, DEMATEL and VIKOR are applied to solve the problems and find the best solutions. This study presented framework design to evaluation process based on decision making techniques. The ANP weights for each criterion are based on the DEMATEL method with the MCDM method for resolving the problems of dependence and feedback among criteria. And , a VIKOR method with ANP weights is proposed for addressing and reducing the performance gaps for each criterion, [5]. Another curriculum evaluation is presented by [6]The author of this study is to construct a competence model for evaluation of English language curriculum for the MICE industry in Taiwan. Data were collected from students using a questionnaire and analysed by decision-making techniques which is AHP. The data were analysed using the AHP technique through which are solving problems and finding appropriate solutions [7]. In the context of this study presented by in [9]. The focus was on the structure of curriculum evaluation in university. The evaluation process uses decision making technique to evaluate the curriculum structure. This study prepared questionnaire process in order to collect data from students. The data analysed using decision making technique ELECTRE, this technique is applied to solve different problems and find the best solutions. [10]. Another curriculum evaluation is conducted by [11] propose evaluation of English curriculums. The questionnaire was

used to collect data from students. After collecting the data was analyzed by using the decision-making techniques. This study contains different complex criteria for evaluation of English curriculums, AHP and Delphi is attempted to collect and combine criteria and obtain the final solutions [12]. This study presents evaluation suitable curriculums in Information Technologies department in university. The evaluation process using TOPSIS and FUZZY LINMAP decision making techniques in order to obtain the solutions [13]. In [14], the purpose of the study is to describe the implementation of formative evaluation. This study utilized multi criteria decision making approach and fuzzy logic to select suitable database software to evaluate two curriculums Information System (IS) and Information Technology (IT) [14]. Finally, as shown in the above studies, evaluation of curriculum materials is one of the most important decisions in educational institutions. The questionnaire was used in different studies, consisting of a series of questions and other claims for the purpose of gathering information from students about the curriculums. the studies describe the proposed evaluation system and its application in different methods and complex criteria. Curriculum evaluation is considered important to increase cultural awareness and education.

### *3.1.2 Curriculum selection*

Choosing curriculum is one of the main things in which we can increase the capabilities of students and increase cultural awareness in educational institutions and organizations. In this context of this study [15], In this study the focus was on the process of selecting the appropriate curriculum for teaching English. In this study using multiple criteria decision-making and to make a final decision on the selection of the appropriate curriculum for students. This study curriculum selection is essential to enhance the education quality, develop potential and scientific capabilities based on student interests. The purpose of the study is that the institutional education attempted to select suitable curriculum and replace the old. This study contains complex criteria, AHP technique is attempt to collect and combine criteria and obtain the final solutions [16]. Another study of curriculum selection process concluded by [17], authors presented a study case of select best textbook based on group of decision-making approaches a DS/AHP techniques. Group decision making (GDM) is and active within MCDM method integrated to get the best curriculum. The decision maker in this study makes judgments on the preference of a set of curriculums in order to select suitable textbooks depending on a number of criteria and selection technique. The decision maker reveals equal and non-equal curriculums [17]. Finally, the summary of curriculum selection a review of some of the previous studies about how to choose the suitable curriculums using multiple criteria decision making. Selection process based on different decision-making techniques and complex criteria. These techniques are attempted to solve the problems and find the solutions.

### *3.1.3 Curriculum planning and design*

Curriculum design and planning are the processes that are used to determine the needs of a group of learners, to develop aims or objectives for a program to address these needs, to determine an appropriate syllabus, course structure, teaching methods and materials. curriculum design usually starts with needs analysis on the learners and situation analysis on the teaching contexts. in this section multi criteria decision making approach is applied to solve the problem and find the solutions. In [18] author is proposed the curriculum planning and designing of MICE Course. This study presents the curriculum framework of MICE course for continuing in education area, rather than the baccalaureate program. This study presented a hybrid technique Fuzzy Delphi and AHP with MCDM method are given in this research in order to measure and judges the operation data provided by two techniques. AHP techniques discover the important curriculums and their corresponding training

objectives. Delphi techniques is applied in this study to collect expert opinion and gaining consensus among experts on different criteria [19]. Another study according to [20] presented other curriculum planning and design for bachelor's degree industrial engineering in Turkish University. This study work to focus attention on the choice of the modern curriculum, according to industry and scientific needs. The purpose of the study is to fill knowledge gap as regard a joint group decision in the faculty about curriculum design and planning. AHP technique with MCDM is determined in this study to reveal the final result. The curriculums in the faculty are divided in to three curriculums core, focus and elective. AHP technique is applied to judge and measure the final score for each curriculum based on MCDM approaches [21]. A study conducted by [22] proposed another study about planning and design approaches. This study is to fill knowledge gap regarding reaching a uniform group decision in planning and design English curriculum. AHP technique with MCDM methods is determined in this study to identify the important criteria. The paper presented description of previous studies based on AHP techniques with multi criteria optimization and curriculum planning and design approaches utilizing hierarchy module [22].

### *3.2 Introduction of university and applications on decision making approach*

University development on the MCDM application mentioned below reveal several of development process in particular evaluation and innovations in universities. The main objectives are providing a background about evaluations and innovations in universities based on MCDM process. During our investigation in the literature, there are widely criticized in the literature about MCDM application in university and several techniques and methods. In recent years, educational institutions focus on increasing the efficiency of universities and educational side, which is something essential to increase education.

#### *3.2.1 University evaluation*

University evaluation is one of the main things to increase efficiencies and scientific awareness in the university. Different types of research conducted in university evaluation. The literature survey covered the academic publication with focus on university evaluation, research articles that involve several evaluations on university based on MCDM applications and various techniques. A study conducted by [23]. The main purpose of the study presents evaluation of suitable performance for education center in Taiwan universities. evaluation process using a set of questions that are given to students in universities in order to collect opinions about universities performances. after that. The concept of evaluation process in this study utilized three decisions making techniques DEMATEL, VIKOR and ANP within MCDM approaches to analysis the student's answer. This evaluation process helping universities to plan futures strategies and increase the education. The evaluation process using complex criteria and decision making techniques are attempt to collect and combine criteria and obtain the final solutions [23].

Another study for evaluation process is conducted by [24] are present evaluation system on Taiwan universities on complex evaluations and different tasks. This study presents a network hierarchical feedback (NHFS) based on Total Quality Management (TQM) and National Quality Award (NQA). These modules are used multi criteria to evaluate the best educational quality performance and development in different university in Taiwan using decision making techniques DEMATEL, FANP, FAHP and GRA techniques. These techniques are applied to combine complex criteria and multi evaluation problems [25]. Another study of evaluation process conducted by [26], author proposed decision making techniques ANP and DEMATEL to evaluate a privet university in Taiwan. evaluation process using a set of questions that are given to students in universities in order to collect opinions about privet universities performances. The evaluation framework using twenty-two criteria to

measure and evaluate student's opinion about universities quality performance. Decision making techniques utilized to solve the criteria conflicting and the multi evaluation problems and obtained the final solutions [26].

Another university evaluation is conducted by [27]. The educational quality performance in Taiwan universities has been decreasing in recent years. the universities losing their competitive and activities while facing foreign counters. This study is attempted to evaluate the efficiency and activates of ninety-nine Taiwan universities. Decision making techniques is adopted by using DEA technique to evaluation process and to measure final evaluation [28]. In [29], this study utilized decision making techniques DEMATEL, TOPSIS and FANP to evaluate and numbers of Taiwanese universities. These universities depend on academic research to evaluate innovation performance. This study was conducted using a questionnaire to collect data from students. A questionnaire was given to experts to measure the innovation performance for each university based on multi criteria evaluations. The evaluation process dealing with complex criteria, decision making techniques combine the criteria and obtain the final evaluation [30]. The aim of this study evaluation of performance and ranking for twelve private universities. This study was conducted using a questionnaire to collect data from students. The evaluation framework using multi criteria to measure student's response. Decision making techniques AHP and VIKOR deal with criteria conflicting and evaluation result to obtain the final evaluation [31]. Another study of evaluation presented by [32]. This study present evaluation ranking for MBA universities in South American. The evaluation process based on decision making techniques. The mathematical module and DEA are applied to compute efficiency scores of top-ranked MBA Programs in South American using multi criteria evaluation. The results of the evaluation are reviewed annually, and this study is rated the best 100 University, although about 140 University invited to participate [32]. Another university evaluation is presented by [33]. The aim of the study is evaluation of quality criteria and educational performance at the University of technology in Taiwan. This study was selected lecturers who have experience in teaching at the University of technology with more than five years of experience. the questionnaires process was sent mainly to the North and central regions to collect data from lecturers. There were 50 lecturers who accepted test. The decision making techniques DEMATEL is applied in this study to evaluate and measure the quality of criteria [33]. In [34], the aim of the research presents a new evaluation modal of Canadian universities based on fuzzy logic and MCDM approach. The main display of this evaluation is to find out the levels of education in the University in order to increase the efficiency of the education in the future. The survey methods are used to collect information from higher education institutions staff. There are complex criteria that have been applied in this study. Thus, the decision-making techniques make the final decision of evaluation This study contains many complex criteria for evaluation process, the decision making techniques is attempt to collect and combine criteria and obtain the final solutions [35]. Another evaluation process is accompanied by [36]. Intellectual capital has become today a key concept to assess universities and organizations, such as patents and copyrights. In the present study is to assess the intellectual capital of the universities on the basis of indicators of innovation capital. The main purpose of universities in Taiwan that are certainly more knowledge to gain competitive advantage. This research presented evaluation process utilizing a hybrid techniques FAHP and VIKER within MCDM approaches [37]. Another evaluation of intellectual capital is conducted by [38]. Author is proposed another evaluation process on intellectual capital to develop new strategies in Taiwan universities out of its performance and innovations. This study is proposing FAHP within MCDM method to evaluate intellectual capital evaluation model and their performance and contributions in Taiwan universities [38]. In [39], The main purpose of the study is to evaluate Iranian universities

using importance performance analysis. The study is attempted to presents model in order to determine the concept. Decision making technique is applied TOPSIS technique to evaluate universities performance. This study was conducted using a questionnaire to collect data amongst university professors and higher education students. The evaluation framework using multi criteria to measure the response [40]. In [41], This study applied to evaluate the services quality performance for university library in Iran. The questionnaire process utilized using a set of questions that are given to students in universities in order to collect opinions about library service quality performances. Decision making techniques TOPSIS and fuzzy logic can evaluate and measure a future services quality performance and improvement [41]. Author (s) in [42], The purpose of the study is to evaluate of education quality in Italian education environment. This study identify aspect for all education related services in Italian universities. The study was conducted for three months, between February until April 2013, around 200 students and the number of participants 20 only. Decision-making techniques AHP and Fuzzy responsible for evaluations and measurements of quality education and performance in higher Education-Italian [42]. Another study of evaluation is accompanied by [43], this study is investigation of multiple criteria for decision making approaches to evaluate of education quality in Thailand universities. The questionnaire process used a number of questions that are given to students in order to collect data about education quality performances. Decision making techniques FAHP and AHP to measure the quality of education performance in Thailand university [43]. In [44], this study used resource allocation to evaluate education performance and increase education performance in the university , including teaching and research. resource allocation resource allocation is considered as one of the major decision problems arising in educational environment. resource allocation is involves many activities such as , project management, resource management is the scheduling of activities and the resources required by those activities A hybrid techniques are utilized AHP and Goal programming within MCDM approach to solve the resource allocation problems and, select the best projects without override the restricted available resources [44]. According to [45]. this study presents transfer of university technologies to industries and organization. the transfer of technologies includes many mechanisms can be divided into a larger number of activities. The technologies providing the following, contract research, consulting services, technology licensing, advanced training for staff, exchange of research staff, and works in higher education. In this study is questionnaire expert group and gather their opinion about how to evaluate best technology for industries and institutions using decision-making techniques FANP [45]. Another study is interested by [24], this research present evaluation of creativity strategy and improve innovations for the university system to implement creativity improvement and enhancement developed by universities in Taiwan. This study uses questionnaire process to gather information form students. Decision making techniques VIKOR is applied to evaluate and analysis student's opinion. The evaluation process using complex criteria and decision making techniques are attempt to collect and combine criteria and obtain the final solutions [46]. Another evaluation is conducted by [47]Author proposes evaluation redistribution of university budgets to the fifteen university in United states. The distribution process is conducted by five target criteria in this study. General techniques within MCDM approaches that contribute to evaluate the problems and distribute the budget for universities [47].

### *3.3 Introduction of student and applications on decision making approach*

In this part of literature review introduces the academic literature published and the main topic presented, in particularly, student evaluation and student selection. Investigating the literature

suggested several topics that discuss student performance in MCDM approaches and founded during deep research.

### *3.3.1 Student evaluation*

Exploring the literature reviews an observable number of research articles in student evaluation process. the literature suggested several topics that discuss student evaluation performance in MCDM approaches, and founded during deep research. This study is conducted by [48]. The aim proposes of the study evaluation process of creativity of engineering student as an examination process. The question involved requests to develop five advantages to an unusual design given. This study illustrated creativity of the students this creativity helps them to think well. The study presented some of the techniques evaluate the creativity of the students to measure the summit of creativity and innovation performance. AHP technique within MCDM approaches is attempt to measure student creativity and evaluate a number of evaluation criteria. [48]. Another part of evaluation student is conducted by [49], this research goal to evaluate a number of criteria evaluation affecting the creative and innovation development of college students. This study evaluation process-based hybrid techniques within MCDM approaches. The FDM technique can resolve the issue of ambiguity in the consensus of the expert opinion, and a questionnaire process is used to collect the substantive views of experts in this area. FAHP technique is utilized to calculate the relative weights of the selected multi criteria that impact in innovation for college students [49].

Student evaluation process is conducted by [50]. The objective in this research presents a concept of methodology is to evaluate design for chemical engineering students are called Sustainability Assessment and Selection (SAS). Computer Aided Plant Design (CAPD) course at the Technology University of Berlin/ Germany is given. The main aim of this study to evaluate designs engineering students based on AHP technique within MCDM approach. AHP technique is utilize to explore the adaptability of these techniques to solve the problems of evaluation of students design [50].

Another study for evaluation students is conducted by in [51]. This study is presented the evaluation process of student performance and innovations in organization is called student-central learning. Fuzzy and WABL in these techniques the ability to demonstrate the best results to assess this way and give better results and more accurate based on MCDM approach [51]. In [52], this study presents a structure methodology to evaluate the students results of an academic training course in the University of Palermo (Italy). In this study, data collection and student's opinions collected by the questionnaire process. FAHP technique within MCDM approach widely used to identify evaluation criteria and analysis the student opinion that collected by questionnaire process in order to obtain the ideal solutions [52]. Another study of evaluation process is accommodated by [53]). The authors are proposed student group project assessment based on FAHP technique and MCDM. The approach can help the students to increase their performance and the deep approach to learning which leads to better project. it contributes to evaluation process and solve the problem of evaluation of students' projects. FAHP technique is applied to rank the alternative in the proposed MCDM approach for evaluate students' projects [53].

Another evaluation student is conducted by [54]. The purpose of the study is presented overall evaluation of capacity and teaching performance of college students. the mathematics evaluation model of the capacity of college students are applied based on FAHP and MCDM methods. the main purpose of evaluation student can encourage students to participate in the business practices, join workshops and increase more knowledge and their confidence [54]. Another evaluation study presented by [55], this study presented Fuzzy group decision support system for evaluation of student project in education environment. A fuzzy approach is allied in this study for the evaluation

of student projects in several courses in the faculty of information system in China based on four steps in particular, namely generation of basic assessment criteria, selection of assessment criteria, determination of the assessment criteria weight and fuzzy grading of students' projects. The stapes helps the student to develop the educational performance and innovations in education institution [55]. In [56], Author (s) is presented another kind of student evaluation. This study explores evaluation process of teaching performance and innovation in higher education institutions and improve the quality of education based on FAHP techniques and MCDM approach [56]. In [57], Authors are proposed evaluation of students' project achievement. based Fuzzy and criterion-referenced assessment (CRA) model to evaluate the laboratory for the project by the students in the university. This technique is utilized to judge the student's project quality through a set of multi criteria evaluation and examination process [57].

Another study of evaluation student is conducted by [58], Author (s) is proposed evaluation of teaching performance. it is considering as one of the main construction to improve the quality of student performance based on FAHP technique and MCDM approach [58]. In [59] this study present web based decision support system for evaluation student operations online based on evaluation system process. The main objective the students submit the projects online and the lecturer evaluate the project based on valuation system process. The technique is applied to measure the student's operations on stated preferences for some projects or topics. Mathematical Model within MCDM approach and to measure students' performance [59].The objective in this study are designed and developed based on multi criteria evaluation process according to [60]. The member of committees in the university provided description and analyse view opinion of student's request. The data collected from several students in the university using questionnaires process. FAHP technique within MCDM approaches are to analysis student's opinion for evaluating the results of the questionnaires process using multiple criteria analysis technique [60]. This study using appraisal universities system in Taiwan according to [29].Because of the economic pressures and disagree education development in Taiwan Universities. Universities looking for new ways to evaluate and improve the operational performance to gain a competitive advantage and attract more students. The evaluation process based on hybrid techniques FAHP and DEMATEL to measure and analyse multi criteria evaluation based on multiple criteria analysis techniques. This study presents a Pro-Performance Appraisal System (PPAS), this module is applied in this study and to aid in future performance evaluations and improvements of Taiwan universities [29].

In [61], authors present multiple criteria to evaluate student's essay. The proposed method is based on a group of methods TOPSIS and genetic algorithm and genetic algorithm with MCDM and DSS approach to provide evaluation process such as essay style and coherence [61].

### *3.3.2 Student selection*

This this part of literature proposes the direction of student selection process, a brief background about this process. the literature suggested several topics that discuss student selection performance in MCDM approaches, and founded during deep research. In [62], this study presents the scholarship student selection process as an MCDM problems. Australian University offered this program in order to develop the teaching performance. Four techniques are utilized in this study in particular AHP, SAW and TOPSIS with complex of MCDM methods to solve the scholarship student selection process problems and find best students [62]. Another selection student is conducted by [63]. The purpose of the research is to select a student from Faculty of Engineering in India who is suitable for ALL ROUND Excellence Award for the year 2004. MCDM techniques are suitable to be adopted in this area. MCDM with a hybrid technique techniques are to explore the adaptability of these techniques

to solve the problems of selection process and can find ideal solution [63]. This study is conducted approach [64], authors are proposed two objectives in this study, the objective one is to measure and revealing ranking for student's appropriateness for MBA program, and the second objective, select suitable criteria that can evaluating the students for MBA program. This study presented a genetic framework for student selection based on approaches MCDM and MTC techniques. MTC this technique presented in order to measure and circulate using a mathematical calculation depend on MCDM approach [64]. This study is mentioned by [65]. The main purpose of this study is how to select the students to study the MBA program online. According to the result of a case study that a number of students enrolled in a top ranked online MPA program. The data is collected from the participation student who were enrolled in the MBA program online, and they asked them to fill out a questionnaire. a hybrid techniques AHP and FAHP techniques within MCDM are attempt to measure the students survey and find ideal solutions [65].

In [66], authors are proposed selection problems for applicants for a PH.D. in the research, the OWA techniques with MCDM approach can solve the PH.D student selection problems [66]. Another selection process is conducted by [67], Authors presents comparisons different combination techniques within MCDM approach in order to guide to ideal solutions. this study present PH. D student selection problem as a study case. This study provided a set of techniques and methods in order to find appropriate solutions, in particular, OWA technique is compared with different techniques, based on only ordinal information. AHP techniques is utilized to analysis the student selection based on aggregation techniques. mathematical module to discuss details of the problem selection of PH. D student, Aggregation techniques are revealed in this study within MCDM approach to identify the criteria relevant to student problem , and can solve the problem and fine the ideal solutions [67]. In [48] The dream of the student to find job in the suitable place when the end of the study of the faculty of engineering. The purpose of the study presents selection of career opportunities are planning a happy and successful future. There is group pf engineering industry needed staff. FANP within MCDM approach which have in effective roles in this process. FANP is utilized to measure and analysis there criteria in order to select suitable engineering students to work in industrial engineering [48]. Another part is selection process is determined by [68]. This study proposes other idea of selection process. The main purpose of this study is to propose a multi-criteria decision-making approach to evaluate and select the nursing students in Ministry of health. AHP is applied to analyse selection criteria and to reveal the nursing students as a carrier [68]. In this study, doctoral students are selected using a variety of techniques according to [67]. Author proposes aggregation techniques based on MCDM approach. The case study offers a program at the university in order to obtain the Ph. D students in the faculty of Computer Science and Information Systems. OWA operators with aggregation techniques can help to find the suitable students for PH. D studies according to MCDM approach [67]. Another study of selection process is conducted by [69]. The authors are presented some implementation and approach to select best notebooks for students based on two decision maker, four criteria and four alternatives. TOPSIS is applied to resolve multi-criteria decision making (MCDM) problems and selection best notebook for students [69].

### *3.4 Introduction of teacher and applications on decision making approach*

This part of literature reviews the direction of teacher selection process, a brief background about this process. the literature suggested several topics that discuss student selection and evaluation performance in MCDM approaches, and founded during deep research. In this part of literature is conducted by teacher evaluation and selection approaches with MCDM method.

### *3.4.1 Teacher evaluation*

These studies illustrate the performance of lecturer's evaluation in terms of teaching and achievements and the possibility of adopting MCDM in the evaluation process. Evaluation of teacher performance in education institutions is mentioned by [70]. Authors is attempted to construct a hybrid technique FAHP and TOPSIS model to evaluate different teacher performance based on MCDM approach. The expert evaluates the efficiency of the teacher successful. The faculty in the university is attempted to evaluate activities and teaching performance of academic staff [70]. This part of evaluation is conducted by [71], the engineering school of the Technical University of Lisbon approaches uses evaluation of academic staff for their activities and performance, because they are considered the main targets in the development of science and the delivery of science to students. This study proposes a new faculty evaluation model based on approaches multi-criteria decision-making and MACBETH technique. The model presents comparison on academic staff performance reflecting to strategic policy concerns of university management [71]. Another evaluation is conducted by [72], Authors present another evaluation of teacher's performance. Evaluation process based on MCDM method is presented in order to assess the aggregate teaching performance and innovation of a teacher. A hybrid techniques COPRAS and CRA are applied with MCDM approach to evaluate a group of teachers based on a number of evaluation criteria [72]. This study proposed another approach of teacher evaluation according to [73]. This study presents evaluation a group of teacher performance based on MCDM techniques. A hybrid techniques COPRAS and CRA are proposed to overall quality assesses performance level of individual teachers. It can resolve the criteria conflicting and the multiple criteria evaluation problem [73]. Another selection process is conducted by [74], in this study the Chinese College wants to select the best teacher performance to management the college. MCDM and TOPSIS method for select suitable teacher in the college [74].

### *3.4.2 Teacher selection*

This part introduces the academic literature published with the focus of selection process for teacher performance. a few numbers of researchers reveal to visualize the selection. These articles are reported below.

In [75], author (s) is the selection process of new lecturer in this research is consist of stages in particular, academic qualification discussion, teaching performance and face-to-face interview. MCDM within AHP technique can find and solve problem of the selection of teachers [75].

According to [76], In the beginning of a doctor student of her research career is the selection of a suitable supervisor. The purpose of this study is to provide analysis for the selected suitable supervisor based on AHP technique within MCDM approach [76].

## *3.5 Introduction of courses and applications on decision making approach*

This part of literature presents the academic literature of course operations in different approaches and case studies, select courses online, select elective course, select special course, all topic based on MCDM methods and several techniques. course selection on MCDM application is explored by deep research.

### *3.5.1 Course selection*

The selection process is conducted by [17], the objective focus on selection of suitable courses. To successfully develop a several practical courses This study proposes student can select the appropriate the network courses in the department of computer science. In this study is remove the old courses and replaced by new courses. This upgrade can increase the development and innovation

in educational institutions. This continuous improvement is essential to improve the quality of education in relation to the interests of the students' courses. MCDM within AHP techniques is applied, the decision problem is collected as the determinate structural evaluation network using established decision techniques to support the process [17]. In [77], the main objective of this study is to present special education course selection problem of students that who study at secondary schools in one of the cities in order to avoid the difficulties faced in the academic preparation period. The purpose of special course can support the student to gain a wide of knowledge. Private course in education institution is in great effort to bring the successful student. Particularly, it became difficult to decide selection of students to study in education institution. TOPSIS technique within MCDM approach that can support this study and find the ideal solution [77].

### *3.6 Introduction of e-learning and applications on decision making approach*

This part introduces the academic literature published with the focus on E-learning approaches special based on MCDM applications particularly, e-learning evaluation, e-learning selection and e-learning activities. The objectives are mentioned below to investigate the available e-learning framework, tools and techniques in various way. E-learning has become an important part of society today, all the studies mentioned below are explored increasing and growth performance of e-learning approach. E learning includes several benefits that make it easier for the learner to teaching course online.

#### *3.6.1 Evaluation of e-learning*

Previous studies can be applied to create more deep analysis for E-learning evaluation using more study cases, different E-learning approaches and different multi-criteria analysis techniques.

This study proposed evaluation of web based e-learning system based on learner fulfilment and its application according to [78]. This evaluation investigates learner's perceptions of decision criteria based MCDM methodology with AHP technique. This study carried out questionnaire analysis based on several students test process [78]. In [79], this study introduces evaluation of a course website quality. This evaluation of important criteria across different e-learning model. This study is developed an evaluation model to enhance the course website infections. MCDM method is utilized in this study and FAHP techniques for evaluating course website quality [79]. Another evaluation in [80], this research aim to evaluate e-learning system effectiveness in all commercial activities and teaching organization. There are a huge of effort are made regarding to learning system effectiveness evaluation. a novel hybrid MCDM approach with a hybrid techniques DEMATEL, AHP and Fuzzy are applied to evaluate intertwine effects in e-learning and find ideal solution [80]. In evaluation [81], the main purpose of this research evaluation of the criteria and effectiveness of e-learning system and can provide the teacher and decision maker in school in order to improve e-learning practice in the future. The AHP techniques and Fuzzy with MCDM approach can help to evaluate a set of criteria evaluation [81]. Another evaluation e-learning system based on artificial intelligence and fuzzy algorithm is conducted by [82], this study describes a web based decision support system that can be easy be utilized over the internet anywhere in the world and at any time [82].

In [83], this study presented evaluation of the activity processes of e-learning system based on AHP technique and MCDM method. questionnaires process is applied in this research a written set of questions that are given to thirty teachers in order to collect opinions about e-learning system and its benefits. They attempt to judge the e-learning process according to multiple criteria analysis technique. The results appeared a reference for further development and innovation performance of e-learning system is considered as a basic of the e-Learning process management [83]. Another

evaluation is conducted by [84], this study presents evaluation models for e-learning system. The objective of this research is to adopt AHP within MCDM approach on evaluation process. In this study proposes a model to describe the selection and evaluation of the best e-learning platform from a wide range of platforms [84].

the purpose of the study presents web-based e-learning system in by [17]. The objective of the study presented network course online. Multi-criteria analysis techniques are suitable approach for evaluation network course online based on AHP technique. It can resolve the criteria conflicting and the multiple criteria evaluation problem [17]. In [85], the objective of the study evaluation learning students on different issues of study in the Faculty of Civil Engineering at Vilnius Gediminas Technical University. The research presents e-learning module based on MCDM approach and evaluation technique in order to evaluate students learning studies. The form of a questionnaire process is selected, and a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from students. This research is utilized the features of Viber online questionnaire to obtain the data collection online and the require as much effort from the questionnaire as telephone surveys. MCDM and AHP technique is applied to find the ideal solution [85]. The purpose of the study presents another evaluation of e-learning process according to [86]. This study presents the advantages of e-learning in education, it helps students in learning of courses and subjects online. But students have difficulty in selecting suitable websites. This study is proposed for evaluation e-learning system based on hybrid techniques GRA, AHP and Fuzzy techniques and GMCDM approaches which are help to find suitable criteria that can evaluate e-learning system [86].

### *3.6.2 E-learning selection*

In [87], this study presents e-learning decision support system and selection algorithm with EL-PLCP is utilized to analysis a set of data was collected from the questionnaire analysis from students. The main purpose of the study presents PLCP that allow students in easy way to select suitable English courses online they desire. MCDM and AHP technique is applied to find the ideal solution [87].

Author presents selection process is displayed by [88]. This study presents content selection for teaching course online. AHP within MCDM approach is applied in this study to develop of efficient performance model and methodology in order to work decision maker. AHP technique is utilized to provide a best solution by communicating a decision hierarchy [88].

### *3.6.3 E-learning creativities*

The approaches of these studies explored by the e-learning process is a way of delivering educational information through the internet instead of physical classroom. The previous studies are applied different E-learning approaches and different multi-criteria analysis techniques. This study presents another approach of e-learning selection according to [89]. This research introduces teaching physic course online at the University Defense / Czech, and realize some of the achievements of e-learning system process. Physics course at university was unattractive to students. E-learning system can help the students at university teaching course and better understand the subject matter. MCDM method is based on mathematical modelling [89]. This study introduces of develop and enhance model of e-learning system according to The purpose of this research is to develop a new analytical model to improve the quality of e-learning service using GRA method within MCDM approach to increase the quality of education and analytical model of e-learning system [90].

### *3.7 Introduction of R and D applications on decision making approach*

Research and development (RND) are team for universities activities in connection with government innovation and performance. it is considered as a part of education environment. This area of Research and development (RND) covered the academic publication based on applications of multi criteria decision making approaches in deep research.

#### *3.7.1 Project evaluation*

These studies have made evaluation and selection of best projects in the educational institutions and teaching organizations. In [91], the aim of the study present decision making to begin a new project application in Ministry of Higher Education and Scientific Research. This study is applied AHP techniques within MCDM approach to solve a complex decision making problem to solve the problem of project selection [91].

#### *3.7.2 Project selection*

In [92], The purpose of study presents to evaluate proposals for Educational Innovation is presented. FAHP within MCDM method is applied to help the Polytechnical University of Valencia to select the best project [92].

### *3.8 Introduction of software applications and applications on decision making approach*

This section introduces the academic literature published with the focus of software application in MCDM approaches. Software application is considered as one of educational environment. The previous studies have applied different software application approaches and different multi-criteria analysis techniques.

#### *3.8.1 Software evaluation*

Evaluation is an important component of developing educational software. Several published examples are utilized in previous study to illustrate different evaluation methods. there are a wide range of evaluation study designs and explore increasingly evaluating educational software. The Microsoft excel is a software for solving multi criteria decision making techniques. Microsoft excel is one of the most popular and most widely used methods because of its simplicity. The software has multi propose in particular, evaluation the weight of each criterion and variants, decision mathematical analysis, fixed with different multi criteria decision making models and techniques. MCDM methods are applied to various application in educational field. SANNA (DEA, AHP, WSA, TOPSIS, ELECRE 1, PROMETHEE I, II, MAPPAC) is a system work with a standard Microsoft excel worksheets, that can help the decision maker to select the best solution technique for solving their problems depending on the objective of the evaluation according to [93],[94], [95], [96], [97]. Computerized Adaptive Tests (CAT) are tools for evaluation student's performance according to [98]. The software uses a mobile operating system based on android. this study used electronic questionnaire to allow students access on their mobile devices to evaluate student's competencies, which requires a selected response answer to a series of questions in order to evaluate the student performance. The study suggested using Fuzzy algorithm as the best multi-criteria analysis techniques to solve student's evaluation performance and find best solution [98].

### *3.9 Introduction of review paper and applications on decision making approach*

This part of literature survey presents the academic literature of review paper in different approaches and case studies in particular curriculum and MCDM in education. The review paper

based on MCDM methods. Review papers usually refer to a review of personal items, which have been selected for numerous papers and articles that can be based in the educational field.

#### **4. Decision making methods and application in education**

In [8], the author provides a number of methods and techniques for helping decision making with multi objective. The result explores 62 papers for the management of higher education. [99] proposes on objective to survey MCDM approaches in higher education management process. This study classified a number of previous studies since the year 1996 to 2005 years. There are theoretical and methodological contributions to a particular multi criteria decision making methods and application in education environment. The AHP is a decision support technique which can be utilized to solve complex decision problems.

##### *4.1 Distributions by publication journal*

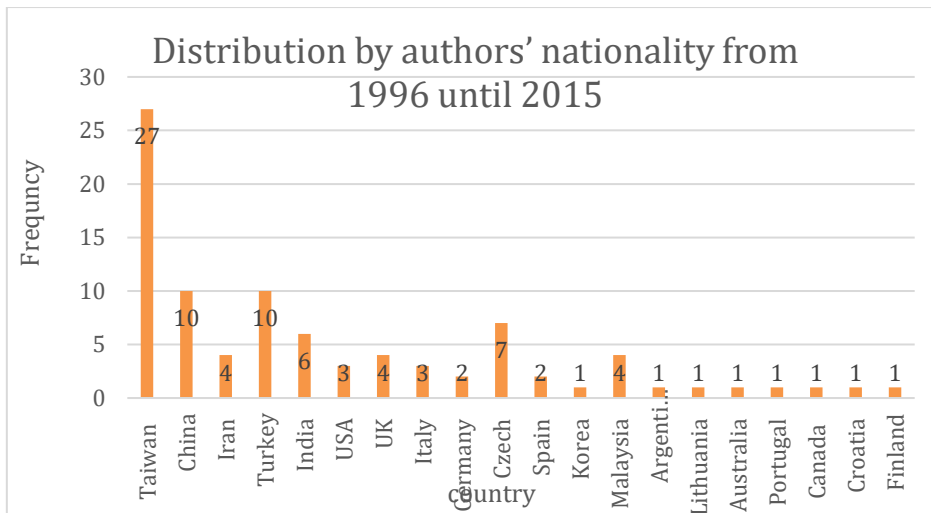
Table 1 shows the distributions journals showing the number of percentage distribution of papers. Ninety (90) of papers and journals are reported. The expert systems with applications which respectively published twelve 12 papers. The computers and education published six (6) papers. The Journal of Hospitality, Leisure, Sport and Tourism Education, Evaluation and Program Planning, Applied Soft Computing, European Journal of Operational Research, Omega and Information Sciences published two study for each.

The conference paper is the most articles poplar avenue. As it has published 30 papers of the total MCDM papers in particular, International Workshop on Education Technology and Computer Science, Symposium on Humanities, Science and Engineering Research, World applied sciences journal, Computers and Operations Research, Measurement, Journal of Cleaner Production, Prioritizing service quality indicators, Technological Forecasting and Social Change, Fuzzy Sets and Systems, Pergamon, Thinking Skills and Creativity, Education for Chemical Engineers, Studies in Educational Evaluation, Group Decision and Negotiation, Information Management and Engineering, Intelligent Tutoring Systems, E-Thesis The National Institute of Technology, Science Journal of Applied Mathematics and Statistics, Advances in Engineering Software, Journal of Business Economics and Management, Education and Information Technologies, Management Information Systems, International Journal of Selection and Assessment, one publish for each.

##### *4.2 Distribution by authors' nationality*

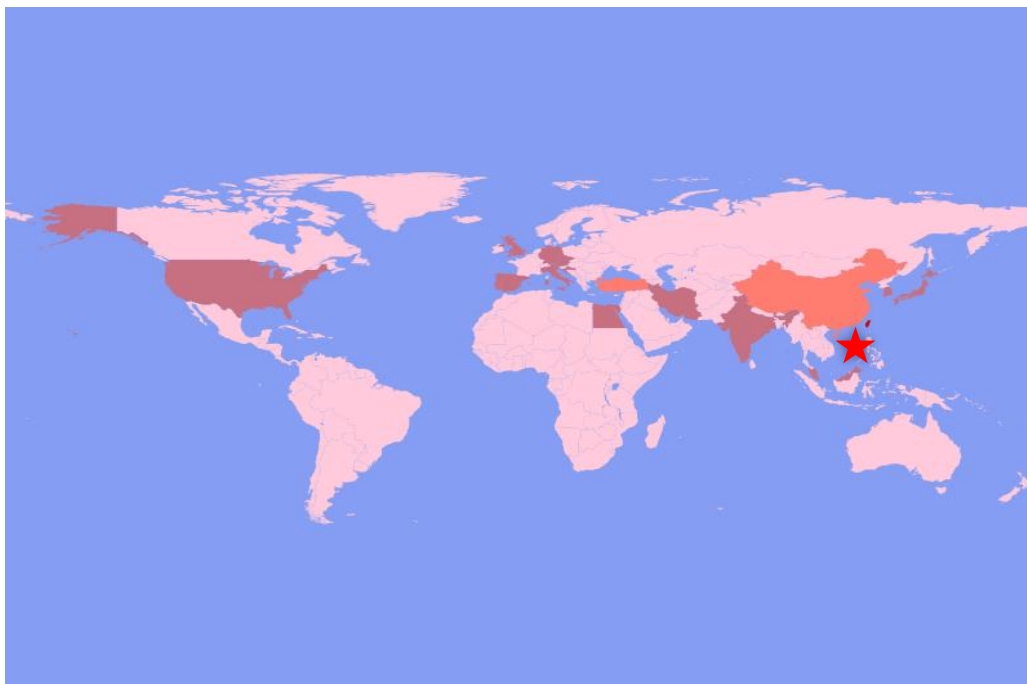
Table 2 shows that 20 countries and nationalities participated in MCDM based on educational environment. we observed that the results of the literature studies are either from certain countries are covered a study case in these countries. The value ( $n = 90$ ) In particular, the geographical distribution of the MCDM papers in both numbers and percentages shows that most productive authors are from Taiwan have twenty-seven study cases for each, China and Turkey have eleven study case for each.

Czech Rep have seven study cases for each, India has sex study cases for each, Turkey, United Kingdom, Iran and Malaysia have four study cases for each, United State and Italy have three study cases for each, Germany and Spain have two study cases for each, and the last Argentina, Lithuania, Australia, Portugal, Canada, Croatia, Finland and Korea have one study case for each. See Fig. 3.



**Fig. 3.** Distribution by authors' nationality

Figure 4 is generated from the published articles distributed according to the country, the map depicted that us of 183 countries, there are as few as 20 countries applied multi-criteria decision making in educational applications.



**Fig. 4.** GIS image for published articles distributed according to the country

### 4.3 Distribution by publication year

The distribution by publication years shows in

Table 3 and Figure 5 which involves some information related to the frequency distribution by publication year. Since 2015, there was a considerable growth in the number of papers published on MCDM. Almost (20%) of the total number of papers were published since 2015.

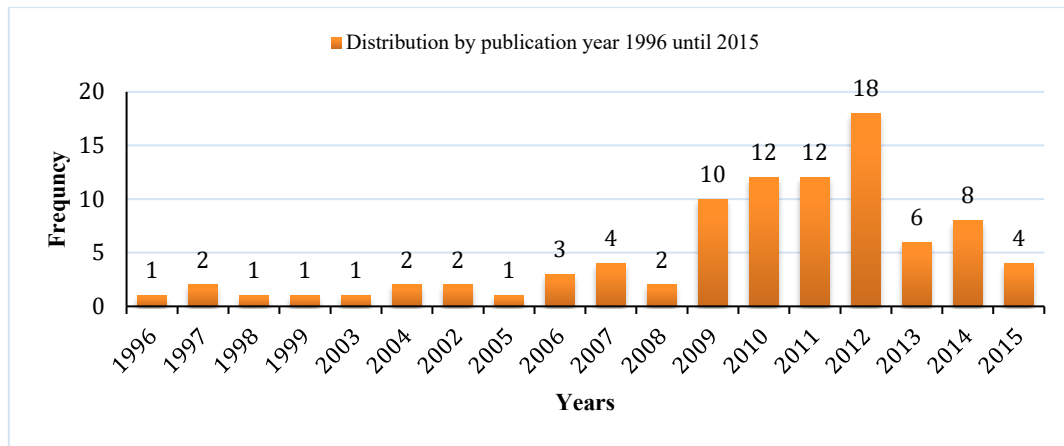


Fig. 5. Distribution by publication year 1996 until 2015

### 5. Multi criteria decision making methods used in educational environment

Multiple criteria decision making (MCDM) methods are applied in educational environment to various applications and find the best solution to select the best alternative in highly complex Figure 6. Figure 6 shows the Hierarchical structure of MCDM methods. According to Figure 7, the MCDM methods are utilized in many domains, while Figure 8 shows the distribution of MCDM methods based on the number of citations. The widely used MCDM methods are described in the following draw. Important items in multi criteria decision making consisted of:

- i. Alternatives: It is MCDM selection of the best from a set of alternatives, each of which is evaluated against multiple criteria.
- ii. Criteria that will impact the selection of alternative.
- iii. Weights these estimates relative importance of criteria another means each criterion is given certain points in rating scale by a team of experts or decision makers rate each criterion.
- iv. Decision makers these are experts who are assigned with the task of weighing each criterion
- v. Decision matrix it is used to objectively make decision about making selection from a range of options, Decision maker rates each criterion of each alternative.

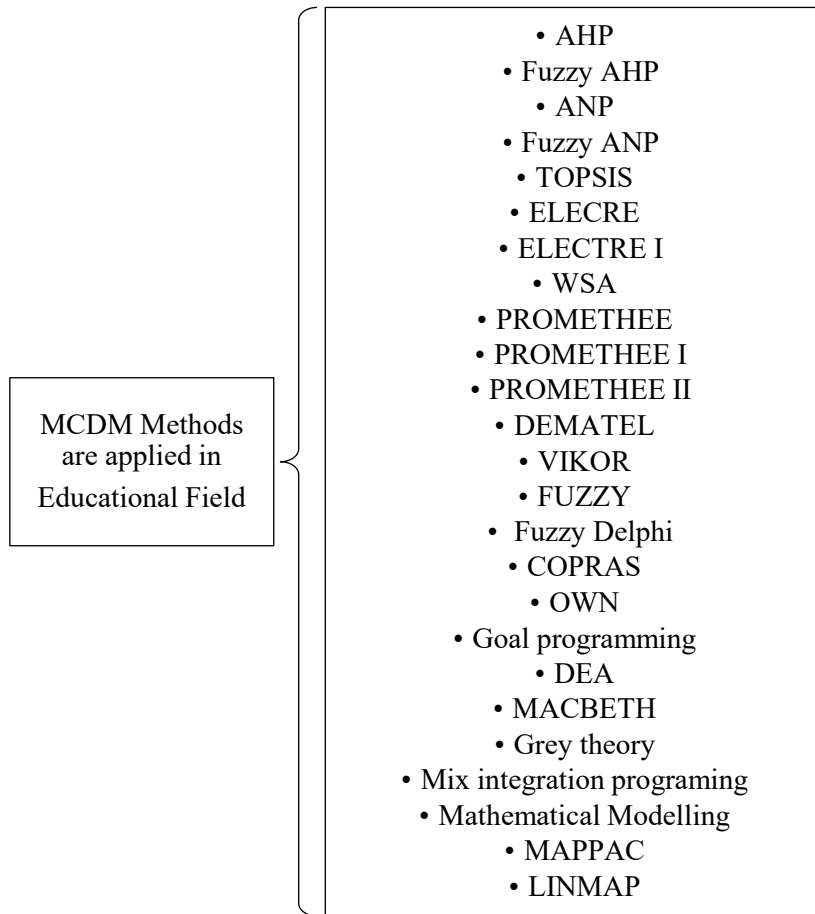


Fig. 6. Hierarchical structure of MCDM methods

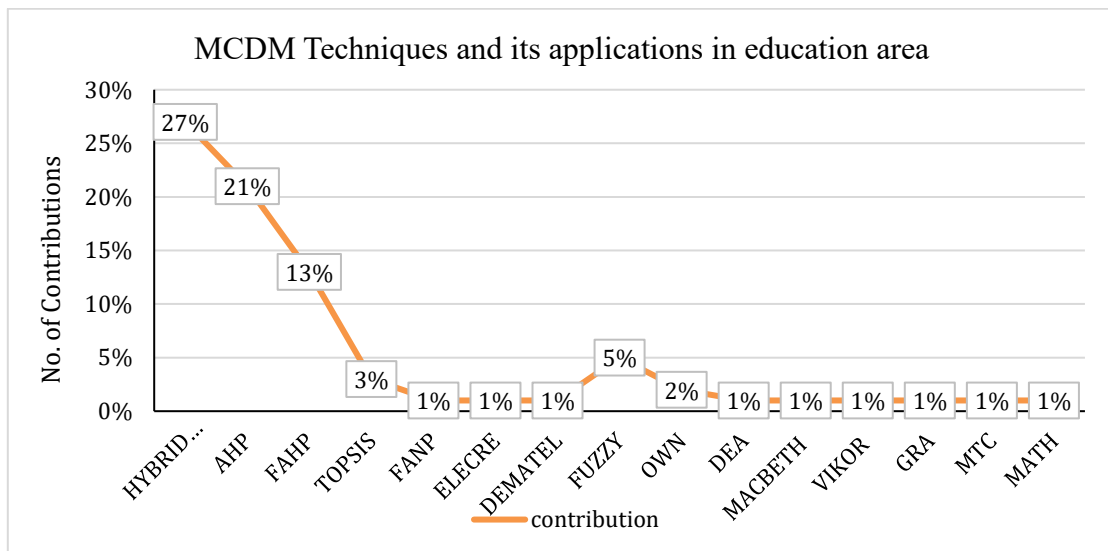


Fig. 7. MCDM techniques and its contributions

Note: Hybrid techniques involve (ANP, DEMATEL, VIKOR) and (COPRAS, GRA) two study cases for each. And another hybrid techniques involves (TOPSIS, FUZZYLINMAP), (Fuzzy Delphi, AHP), (FANP,

FAHP, GRA), (ANP, DEMATEL), (TOPSIS, DEMATEL, FANP), (AHP, VIKOR), (FAHP, VIKOR), (TOPSIS, IPA), (TOPSIS, FSE), (FAHP, AHP), (AHP and Goal programming), (FAHP, FDM), (WABL, FSE), (FSE, CRA), (FAHP, DEMATEL), (TOPSIS, MAEA), (AHP, SAFW, TOPSIS), (AHP, TOPSIS), (AHP, FAHP), (OWA, AHP), (FAHP, TOPSIS), (DEMATEL, AHP, FSE), (Fuzzy, GRA, AHP) and (DEA, AHP, WSA, TOPSIS, ELECRE 1, PROMETHEE I, II, MAPPAC) one study cases for each.

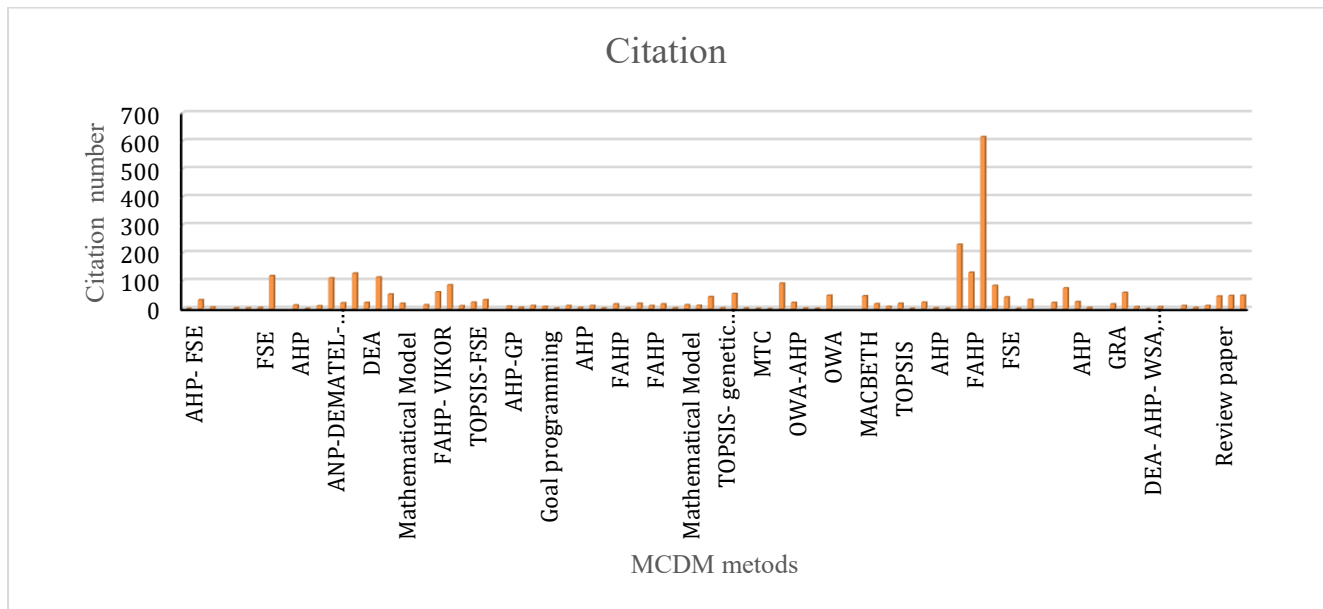


Fig. 8. Shows the distribution of MCDM methods based on the number of citations

## 6. Discussion and results

In this section, several aspects related to multi-criteria decision-making analysis and applications in the education area have been investigated. The current study provides a conceptual and informative review of the literature on multi criteria analysis and application in education, and is designed to achieve objective one. The idea of This section is to present the various issues related to finding appropriate literature and finding ways to aid in searching for dependable and valid literature relevant to decision making approaches in education area. This Section discussed a variety of concepts of the decision-making approaches in education area which was led by systematic review methodologies. The work completed for this Section led to the development of a taxonomy of schemes and precise about the decision-making analysis and application in education area, which is considered the correct step in the search steps to find the gap. The result of this Section is to investigate, analysis and classifies the previous studies on the evaluations using multi criteria analysis on education area. The result obtained from this Section aimed to contribute such an insight through surveying and classifying the previous studies into several categories depending on systematic review methods. This is considered in further detail in the next Section as the second part of the literature review. classification shows the summary of academic articles which classify the MCDM methods in different aspects of education.

**Table 1**  
Distribution by publication journal

No.	Country	No.
1	Conference paper	30
2	Expert Systems with Applications	12
3	Computers and Education	6
4	Journal of Hospitality, Leisure, Sport and Tourism Education	2
5	Evaluation and Program Planning	2
6	Applied Soft Computing	2
7	European Journal of Operational Research	2
8	Omega	2
9	Information Sciences	2
10	International Workshop on Education Technology and Computer Science	1
11	Symposium on Humanities, Science and Engineering Research	1
12	World applied sciences journal	1
13	Computers and Operations Research	1
14	Measurement	1
15	Journal of Cleaner Production	1
16	Prioritizing service quality indicators	1
17	Technological Forecasting and Social Change	1
18	Fuzzy Sets and Systems	1
19	Pergamon	1
20	Thinking Skills and Creativity	1
21	Education for Chemical Engineers	1
22	Studies in Educational Evaluation	1
23	Group Decision and Negotiation	1
24	Information Management and Engineering	1
25	Intelligent Tutoring Systems	1
26	E-Thesis the National Institute of Technology	1
27	Science Journal of Applied Mathematics and Statistics	1
28	Advances in Engineering Software	1
29	Journal of Business Economics and Management	1
30	Education and Information Technologies	1
31	Management Information Systems	1
32	International Journal of Selection and Assessment	1
33	International Journal of Engineering Research and Applications	1
34	International Journal Productivity and Quality Management	1
35	International Journal of Doctoral Studies	1
36	International journal of innovation and learning	1
37	International journal of Quality and Quantity	1
38	International Journal of Emerald Group Publishing Limited	1
39	International Journal of Global Business and Management Research	1
Total		90

**Table 2**  
 Distribution by authors' nationality

No.	Country	No.	Percentage
1	Taiwan	27	30%
2	China	10	11%
3	Iran	4	4%
4	Turkey	10	11%
5	India	6	7%
6	USA	3	3%
7	UK	4	4%
8	Italy	3	3%
9	Germany	2	2%
10	Czech	7	8%
11	Spain	2	2%
12	Korea	1	1%
13	Malaysia	4	4%
14	Argentina	1	1%
15	Lithuania	1	1%
16	Australia	1	1%
17	Portugal	1	1%
18	Canada	1	1%
19	Croatia	1	1%
20	Finland	1	1%
Total		90	

**Table 3**  
 Distribution by publication year

No.	Year	Articles No.	Percentage
1	1996	1	1 %
2	1997	2	2 %
3	1998	1	1 %
4	1999	1	1 %
5	2003	1	1 %
6	2004	2	2 %
7	2002	2	2 %
8	2005	1	1 %
9	2006	3	3 %
10	2007	4	4 %
11	2008	2	2 %
12	2009	10	11 %
13	2010	12	13 %
14	2011	12	13 %
15	2012	18	20 %
16	2013	6	7 %
17	2014	8	9 %
18	2015	4	4 %
Total		90	

**Table 4**  
 Summary of academic articles classification

No.	Authors / years	Description	Techniques	Citation
1	Geng and Xu, (2011)	Evaluation: - Network curriculum	AHP, FSE	1
2	Chen and Tzeng, (2011)	Evaluation: - Teaching material	ANP, DEMATEL, VIKOR	32
3	Tang, (2014)	Evaluation: - English curriculum in MICE industry	AHP	6
4	Uysal, (2015)	Evaluation: - Curriculum quality in education	ELECTRE	0
5	Xiaomei and Yajun (2009)	Evaluation: - English textbook	AHP	3
6	Noroozi (2009)	Evaluation: - IT curriculum in teaching learning process	TOPSIS, FUZZYLINMAP	3
7	Parker (2010)	Evaluation: - evaluate software tools for IS/IT curricula	FSE	4
8	Beynon (2005)	Selection: - Select best curriculum textbooks	Fuzzy Delphi, AHP	118
9	Kam and Fung (2012)	Selection: - Network curriculum	AHP	0
10	Hsieh (2013)	Planning and Design: - Curriculum planning of MICE	AHP	13
11	Erkan and Rouyendegh (2014)	Planning and Design: - Engineering curriculum	AHP	1
12	Tang (2011)	Planning and Design: - English curriculum	AHP	10
13	Wu, Lin and Chang (2011)	Evaluation: - Education centre in universities	ANP, DEMATEL, VIKOR	110
14	Chen and Chen (2012)	Evaluation: - System operational performance	FANP, FAHP, GRA	21
15	Tseng, (2010)	Evaluation: - Private university	ANP, DEMATEL	127
16	Chen and Chen (2011)	Evaluation: - Quality of Taiwanese university	DEA	22
17	Chen and Chen (2010)	Evaluation: - Innovation and operation in university	TOPSIS, DEMATEL, FANP	113
18	Wu, Chen and Zhuo (2012)	Evaluation: - Ranking universities	AHP, VIKOR	52
19	Köksalan and Büyükbaşaran (2010)	Evaluation: - Ranking universities	Mathematical Model	19
20	Ray and Jia-Ling (2010)	Evaluation: - Education Quality of University	DEMATEL	0
21	Waheed and Khan (2011)	Evaluation: - Higher education in Canadian University	FSE	14
22	Wu and Chen (2010)	Evaluation: - Innovation of Taiwanese Universities	FAHP, VIKOR	60
23	Lee (2010)	Evaluation: - Performance contribution in a university	FAHP	85
24	Sooreh and Salamzadeh (2011)	Evaluation: - Evaluation Iran Universities	TOPSIS, IPA	10
25	Jamali and Sayyadi (2009)	Evaluation: - library service quality in university	TOPSIS, FSE	23
26	Lupo (2013)	Evaluation: - Evaluation of education quality in Italy	AHP, FSE	32
27	Wongsathan, Khaothawirat (2014)	Evaluation: - Evaluation of education quality in Thailand	FAHP, AHP	0
28	Ho, E. Higson (2007)	Evaluation: - Evaluation of educational performance	AHP and Goal programming	9
29	Hsu and Shen (2015)	Evaluation: - Evaluation of technology transfer	FANP	5

Curriculum

University

No.	Authors / years	Description	Techniques	Citation
30	Chen and Chen (2012)	Evaluation: - Evaluation of Taiwanese innovation	VIKOR	11
31	Tangian (2004)	Evaluation: Evaluation of Redistribution of university budgets	Goal programming	8
32	Rouyendegh and Can (2012)	Evaluation: - to increase the success level of creativity for the Engineering students.	AHP	2
33	Wu et al. (2014)	Evaluation: - to explore the key factors affecting the creativity development of college students.	FAHP, FDM	11
34	Othman and Hady (2012)	Evaluation: -Evaluation and selection best engineering student work at Technical University in Berlin.	AHP	4
35	Nasibov and Kinay (2009)	Evaluation: - evaluation of student performances in student-cantered learning.	WABL, FSE	11
36	Certa and Enea (2015)	Evaluation: - evaluation of postgraduate student course at University of Palermo in Italy.	FAHP	2
37	Kwok and Zhou (2007)	Evaluation: - evaluation of student group project	FAHP	17
38	Ni-Di and Yi (2010)	Evaluation: - evaluation capacity of college student	FAHP	3
39	Duanning and Jian (1999)	Evaluation: - evaluation of student group project	FSE	19
40	Chen and Hsieh (2015)	Evaluation: - evaluate the teaching performance for students.	FAHP	11
41	Tay and Lim (2011)	Evaluation: - evaluation of student performance	FSE, CRA	17
42	Do and Chen (2013)	Evaluation: - evaluate the teaching performance for students.	FAHP	3
43	David Meyer (2009)	Evaluation: - evaluate student project	Mathematical Model	14
44	Shakouri and Tavassoli (2012)	Evaluation: - evaluation and selection special sort of students' requests based on different criteria.	FAHP	12
45	Chen and Chen (2010)	Evaluation: - evaluate and improve operational performance to acquire a competitive interest to attract more students at Taiwan universities	FAHP, DEMATEL	43
46	Cheng and Chang (2006)	Evaluation: - evaluation of student 'essay	TOPSIS, genetic algorithm	3
47	yeh (2003)	Selection: - Scholarship student selection	AHP, SAW, TOPSIS	54
48	Kousalya and Reddy (2002)	Selection: - select a student from an Engineering college.	AHP, TOPSIS	2
49	Ketkar and Vaidya (2014)	Selection: - select best students for MBA program	MTC	1
50	Rouyendegh and Erkan (2011)	Selection: - select best students for MBA program	AHP, FAHP	0
51	Smolíková and Wachowiak (2002)	Selection: - select best PHD student	OWA	91
52	Full'er (1997)	Selection: - doctoral student selection problem.	OWA, AHP	22
53	Rouyendegh and Can (2012)	Selection: - Selection of working area for industrial engineering students.	FAHP	2

Student

No.	Authors / years	Description	Techniques	Citation
54	Önder (2014)	Selection: - Selection of Nursing students as a career	AHP	1
55	Full'er (1997)	Selection: - doctoral student selection problem	OWA	48
56	Kamis and Mohamad (2012)	Selection: - selection of student equipment	TOPSIS	
57	Pavani and Sharma (2013)	Evaluation: - evaluation and selection best teacher	FAHP, TOPSIS	0
58	Bana Costa and Oliveira (2012)	Evaluation: - evaluation activity of academic staff	MACBETH	46
59	Mazumdar and Datta (2010)	Evaluation: - evaluation teacher performance	COPRAS, GRA	18
60	Mazumdar (2009)	Evaluation: - teacher performance evaluation	COPRAS, GRA	8
61	Li and Li (2011)	Evaluation: - teacher performance evaluation	TOPSIS	19
62	Norddin and Ibrahim (2012)	Selection: - selecting new lecturers	AHP	1
63	Ray and Marakas (2007)	Selection: - select suitable supervisor	AHP	23
64	Kam and Fung (2012)	Selection: - select suitable course	AHP	3
65	Organ (2013)	Selection: - special course selection	TOPSIS	1
66	Shee and Wang (2008)	Evaluation: - evaluation of e-learning system. This evaluation carried out a survey of college students	AHP	230
67	Lin (2010)	Evaluation: - evaluation course website quality	FAHP	130
68	Tzeng and Chiang (2007)	Evaluation: - Evaluating complex effects in e-learning programs	DEMATEL, AHP, FSE	615
69	Chao and Chen (2009)	Evaluation: - evaluation e-learning system	AHP, FSE	83
70	Cavus (2010)	Evaluation: - evaluation of Learning Management Systems	FSE	42
71	Chen and Shiang (2012)	Evaluation: - evaluation activities process e-learning system	AHP	1
72	Colace and De Santo (2006)	Evaluation: - Evaluation e-learning platform	AHP	33
73	Kam and Fung (2012)	Evaluation: - Evaluation e-learning course	AHP	0
74	Kaklauskas and Zavadskas (2009)	Evaluation: - Evaluation of e-learning system. This evaluation carried out VIBER online survey.	AHP	22
75	Hwang and Huang (2004)	Evaluation: - evaluation of educational web site	Fuzzy, GRA, AHP	74
76	Jeong and Choi (2012)	Selection: - student select best English learning system	AHP	25
77	Sharma and Banati (2011)	Selection: - selection for an e-Learning course	AHP	4
78	Renata and Jana (2012)	Activities: -Physics teaching through the e-learning system in order to increase student's interest in studying physics	Mathematical Model	0
79	Wu and Lin (2012)	Activities: - increase service quality for e-learning	GRA	17
80	Begicevic, Divjak (2009)	Evaluation: - evaluation project proposal	AHP	58
81	Melón and Aragonés (2008)	Selection: - Project selection in high education	FAHP	7
82	Jablonsky and Urban (1998)	The Microsoft excel is a tool for solving multi criteria decision making techniques, that can	DEA, AHP, WSA, TOPSIS, ELECRE	0

No.	Authors / years	Description	Techniques	Citation	
83	Josef Jablonsky (2014)	help the decision maker to select the best solution technique for solving their problems depending on the objective of the evaluation	1, PROMETHEE I, II, MAPPAC	7	
84	Perzina and Ramik (2014)			0	
85	Jablonský (2009)			11	
86	Perzina and Ramik (2012)			4	
87	Badaracco and Martínez (2013)	Mobile software utilized to student evaluation	FSE	11	
88	Thompson and Stapley (2011)	Systematic review in education: -	Review paper	45	
89	Mustafa and Goh (1996)			Review paper in education: -	47
90	Ho and Dey (2006)			Review paper in education: -	AHP

### Author Contributions

Conceptualization, I.A. and D.T.; methodology, I.A.; software, I.A.; validation, I.A. and S.A.M.; formal analysis, I.A.; investigation, I.A.; resources, I.A.; data curation, I.A.; writing—original draft preparation, I.A.; writing—review and editing, I.A., D.T., and S.A.M.; supervision, D.T.; project administration, D.T.; funding acquisition, not applicable. All authors have read and agreed to the published version of the manuscript.

### Funding

This research received no external funding.

### Data Availability Statement

The datasets generated during and/or analyzed during the current study are not publicly available due to the privacy-preserving nature of the data. However, they can be obtained from the corresponding author upon reasonable request.

### Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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