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Research paper



Planning, Conducting and Reporting the Review of Employability using Data Mining and Predictive Analysis

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Abstract

A new research involves the collection and analysis of several research papers and it requires systematic methods of identifying the gaps and generating reliable evidence as a whole. Research questions can be drawn through the results of a systematic study that summarizes the overall research thoroughly. This paper aims giving an exposure on the systematic review used in the study of graduates' employability using data mining techniques and predictive analysis. Three main processes; (i) planning, (ii) conducting and (iii) reporting the review have been conducted to answer the research questions on predictive analysis conducted on the problem of employability among the fresh graduates. The methods of the review and specifies the research questions described through a review protocol involving three main databases; (i) Scopus, (ii) ScienceDirect and (iii) Web of Science. A total of 120 journal articles are classified into three main categories through taxonomy analysis. The results of the study are discussed in three main aspects; (i) challenges, (ii) motivations and (iii) recommendations while the research interest of the analysis results is critically formulated under critical review.

Keywords: *Data Mining; Predictive Analysis; Review Protocol; Systematic Review; Taxonomy Analysis*.

1. Introduction

There are six main areas detected as high graduates of unemployed graduates from applied science, human resource management, business administration, social science, accounting and arts. The case was reported by Higher Education Minister Datuk Seri Idris Jusoh based on statistics released by the Graduates Survey Detection System (FNS). According to the statement, a total of 54,103 unemployed graduates compared to 238,187 graduates who graduated in 2016. Various initiatives have been undertaken by the ministry to produce competitive and skills' graduates. One of the initiatives is to introduce a work-based learning and introduce cumulative grade point average (iCGPA) at university level. The initiative introduced by the ministry is according to the Malaysia Education Blueprint 2015-2025 (Higher Education) which encourages the production of holistic graduates before entering the field of employment. Apart from initiatives taken by Ministry of Education, researchers also play a role in helping the ministry to realize the desire to reduce the unemployment rate in Malaysia, especially among graduates. Through a growing collection of data, researchers used data mining methods in educational fields [1] [2], business fields [3] [1], biological science field [4] and some other fields. It combines computer learning techniques, statistics and visualization to discover and extract knowledge in such a way that humans can easily interpret [1]. The current trend of enhancing the capabilities in generation data and accumulation has resulted in an urgent need for data mining applications, also known as knowledge discoveries in databases. Conventional, only large corporations use data mining because it needs to collect a large amount of data and processes for compile them into usable information. However with low barriers and virtually free costs and the growth of internet usage and web-based technology, a small company today should also benefit from data mining to achieve its targets [4].

This paper propose a systematic review that interpreting all researches relevant to a topic area, specifies research questions or several related phenomena. There are three main phases in systematic review ie planning, conducting and reporting the review [5]. In the planning the review phase, review protocols were developed based on three types of questions in the issue of predictive analysis in employability among fresh graduates; (i) investigate the existing factors that significantly cause fresh graduate students to be employed or unemployed, (ii) identify the relationship within the attributes of employability among fresh graduates, (iii) determine the suitable prediction model in predicting trend whether fresh graduates will be employed or unemployed. There are several stages in conducting the review phase such as research identification, studies selection, assessment on study quality, monitoring progress and data extraction also data synthesis. Hence, this study aims to illustrate issues pertaining to data mining in various prediction studies. The main keywords used in this study is "data mining" and "predictive analysis". The sources of the literature conducted from three main digital databases; (i) ScienceDirect. ScienceDirect is a website that provides access to database of scientific, medical and technical research databases, (ii) Scopus is a database that featuring abstracts and citations for educational journals, scientific journals, books and court proceedings that contains worldwide research related to medicine, science, technology, social sciences, arts and humanities (iii) Web of Science is another database used in this research which is an online subscription-based website that provides multiple access to multiple databases for search of quotes related to science, social science, art and humanity. The rationale for selecting the source database because it provides access to the fields of science, social sciences, humanities, engineering and technology in terms of technical,

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theoretical and disciplinary effort of researchers around the world. All stages in conducting the review phase were summarized under review protocol and taxonomy analysis. The results of a systematic review were reported in the format either in the section of the thesis or in the conference or journal paper. All insights are summarized under critical review discussions.

2. Review Protocol

The selection of the study conducted for the last six years latest starting 2012 until 2017. Google Scholar were used as a guide in the search for early review of the literature. The options of the search engine scope does not include books and types of report and it is only limited to the search journal and conference papers based up to date and proper scientific work. The details query use "OR" and "AND" operator to combine the entire keywords and translated in the flowchart as in figure 1.

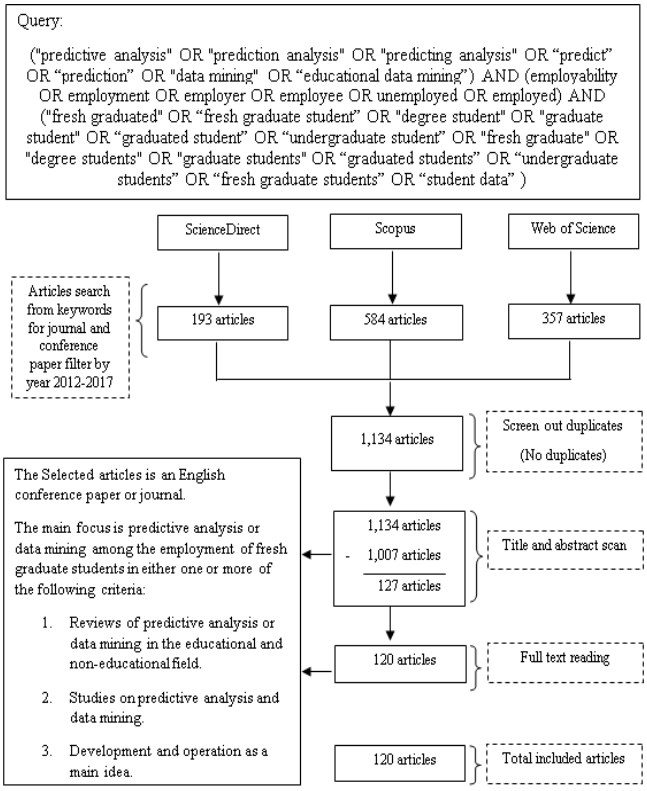


Fig. 1: Flowchart of Study Selection

3. Taxonomy Analysis

As an early process of gathering the articles, all search articles have been incorporated into a single file. Full text reading was carried out to categorize the scope of the study into the form of taxonomy that was easier to see the scope of the research conducted by previous researchers. The keywords are selected based on the scope of predictive analysis and data mining and were combined with deeper sub-topics that relate to the employability among the graduates. Initial findings of search results from three major databases result is 1,134 articles where 193 articles from ScienceDirect, 584 articles from Scopus and 357 articles from Web of Science. When all articles were in merge, no duplications of articles are identified. Then, researchers was screening the title and abstract, resulting in 1,007 articles were excluded.

The number of articles remaining was 127 articles. After full reading on 127 articles, there are only 120 articles included to get ideas for new studies. Most articles (105/120, 87.5%) are articles that refer to the study in the form of analysis/evaluation. Developmental articles (11/120, 9.17%) where the study paper discusses the development of models and framework. From the large number of article search, review articles (4/120, 3.33%) were studied in the prediction area in different field of study. The articles obtained are translated through a bar chart where the number of articles obtained is illustrated based on different categories of review, development and analysis / evaluation as shown in figure 2.

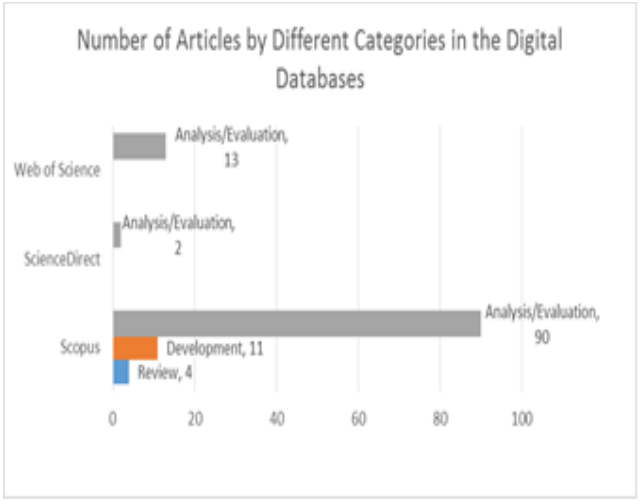


Fig. 2: Bar Chart of Summarization Number of Articles by Different Categories

From the overview of research articles, the results show a pattern of articles category. These articles are categorized according to the taxonomic literature as shown in Figure 3. The main focus for this research is about data mining and predictive analysis. The category of the articles decomposed into several sub-categories from the 3 main classes which are review articles, development and analysis/evaluation.

3.1 Review

Overall, review articles is a summary of current understanding or formulation of previously published studies related to the subject or topic of the study. Through review articles, researchers can identify a number of things such as new findings and progress, gaps in research, people involved, debated about some issues and new ideas that can be highlighted for future research.

Basically there are four review articles comprising study on trends Science, Technology, Engineering and Mathematics (STEM) in career development in education [6], postdoc employment [7], physical changes in adults [8] and substance abuse and substance used [9].

3.2 Development

Development is one of the methods of effective research that consists of real or abstract forms such as mathematical formulas, sketches or diagrams. Development in this research were split into two categories which are development on Model and Framework. The Model is a mental framework used to analyze or describe a system. There are two categories of Model development which are Prediction and Evaluation. The Prediction is a system description using statistics to predict unknown issues, events or outcomes. Predictive used in academic and research area are usually linked to machine learning while in commercial areas, prediction models are known as a prediction analysis.

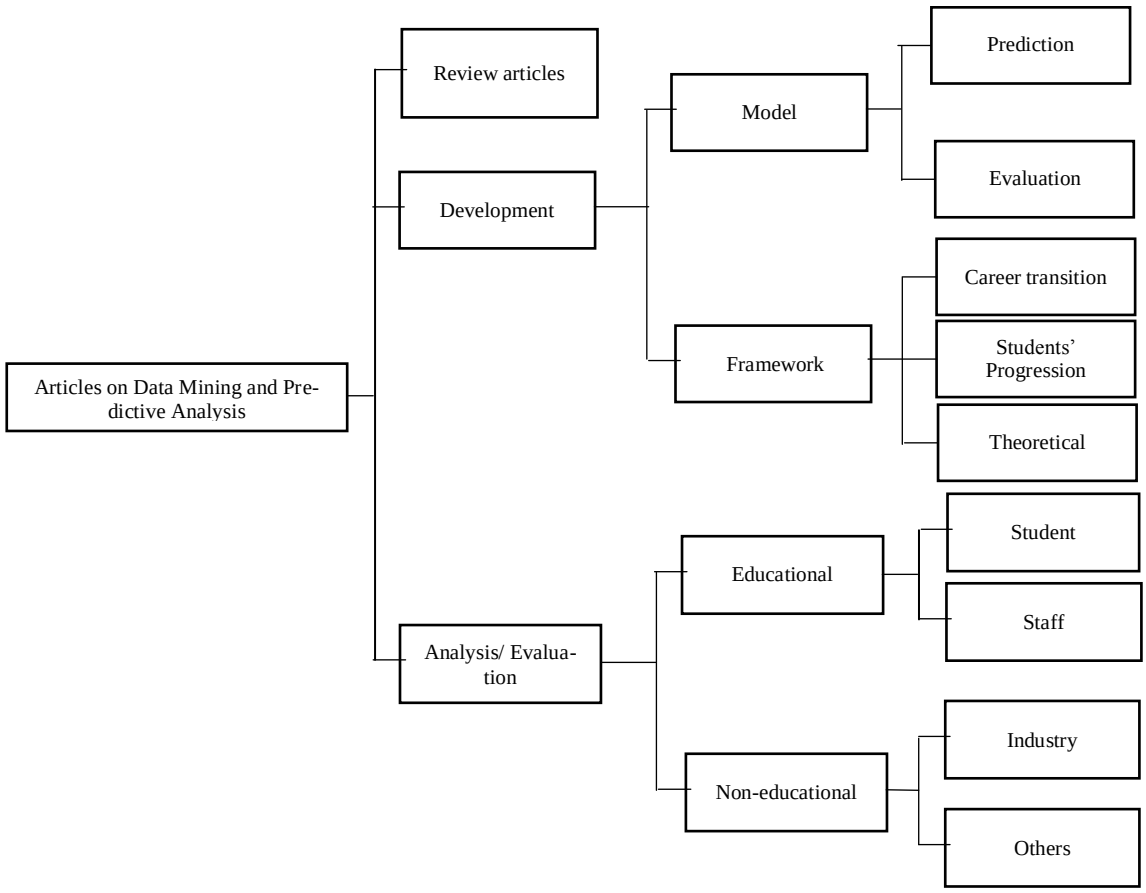


Fig. 3: Taxonomy of Research Literature on Data Mining and Predictive Analysis

Evaluation is valuation approach that was used for program improvement. Predictive model have developed for predicting achievement of students' academic from Mara University of Technology (UiTM), Malaysia using surveys and interviews [10]. In order to predict the commitment of institutional in influencing online of 831 students at a South Eastern University using institutional commitment (IC) scores obtained from Student Experience Forms and College Persistence Questionnaire (CPQ), mathematical equations have developed [11]. Assessing the parameters that influenced the academic quality of the faculty in the career of students, Support Vector machines (SVMs) have been used in model learning by using universal kernel function (linear, radial, sigmoid, polynomial and Pearson based on kernel functions (PUKF) [12]. Predictive model based on theory of planned behaviour was developed to predict student responses to the use of mobile learning using Structural Equation Modelling (SEM) technique such as partial least squares (PLS) [13]. Decision tree algorithm and Logistic regression are multidimensional professionalism evaluation model used to identify the personal needs of professionalism [14].

Framework is the development of a basic conceptual structure for solving problems and can help define a service component that can be used consistently. Based on the framework, it is classified into three main areas: framework related to career transition which discussed about the exchange of fields or working conditions, students' progression discussed about the achievement and performance and theoretical framework related to the development of the framework based on theories related to the field of study such as theory of behavior and theory of learning. The scope of the predicting study was further expanded through the provision of computational framework where Multi class Support Vector Machine (SVM), Linear Regression and Logistic Regression used to predict the level of workability [15].

The framework was developed to identify whether the career transitions factors such as (1) freedom, (2) support, (3) confidence, (4) readiness, and (5) control can be predicted by career adaptability such as (1) concern, (2) control, (3) curiosity and (4) confidence [16].

3.3 Analysis/Evaluation

Analysis/Evaluation is a process use to understand the big picture of a phenomenon, define an important features and to study the nature of something using data while evaluation is a more unique, more specific technique and can be defined as a standard social research that involves the process of data collection and statistical collection that lead to practical application. Analysis/Evaluation studies are categorized into two main areas; educational and non-educational. Studies in the field of educational are classified into two categories: student-related studies such as students' achievement, students' attitudes, students' behaviors and students' progress while staff-related studies discuss about staffs' behaviors and staffs' intentions involving academic and non-academic staff.

The non-educational deal with industry field that discussed the used of prediction in many issues related to manpower and services also deal with others field consisted social field, health and medical field.

The literature review found that 90 articles related to prediction studies in the field of education have been discussed. In the field of education, previous researchers were studied about the predictions of behavior, perception, skill, attitude, performance or achievement, emotion, and motivation among the students, staffs and support groups. Previous researchers studies about prediction of behavior among 239 undergraduate students from the United States and 242 participants from introductory psychology class in a university in the United States by using regression analysis in order to examined the correlation between behavior and well-being [17]. Logistic regression was used to examine interaction between deceptive behavior and honesty [18]. Confirmatory factor analysis and theoretical research model were used in the predic-

tion study of self-regulation in e-learning environment based on satisfaction and knowledge in e-learning [19]. Other prediction study on behavior, [20], [21], [22], [23], [24] and [25].
Fifteen articles of non-educational field consisted the collection of prediction study in the field of industry and other fields. Regression analysis was widely used in predicting studies. Regression analysis is a statistical process that includes techniques of modelling for estimates the relationship between the variables. Research studies about workplace safety using correlation and multiple regressions to study the relationships between variables and the effects of variables on safety at work [26], prediction on user satisfaction using Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) [27], prediction on job performance [28], project proprietary study of implied knowledge inventory officers (POTKI) [29] and prediction on career adaptability used regression analysis to determine the predictor variables [30] and prediction study related to technical performance also used regression analysis [31]. The research on correlation between general health and happiness with spiritual intelligence where the predictor of the study was identified using multivariate regression [32].

4. Discussions

The main objective of this research paper is to provide a systematic review on the use of data mining techniques and predictive analysis that can be used by various parties in determining the employability among the graduates using existing students' records. Predictive studies have been extended and the findings of the study found that this study is widely used in educational and non-educational fields of study. An overview of literature studies found that research-related trends more focused on studying the strengths of the correlation of the variables to the effects or outcomes. In the field of education, the previous researcher examines students' performance and achievement, students' behavior, perception, attitude and motivation. In the non-educational field researcher discussed about user satisfaction, intention job performance, safety and spiritual factor. Researchers used a questionnaire as an instrument of data collection. In terms of data analysis, many researchers used regression analysis either linear or multiple analysis and use exploratory and factor analysis. However, in a small numbers there were researchers who also used machine learning algorithms in their prediction studies. There are three aspects discussed under this section namely challenges, motivation and recommendation related to the used of data mining and predictive analysis area.

4.1. Challenges

These challenges are classified into four sub-sections: concern to the data collection, concern to the lack of resources, concern to the lack of techniques and concern to the sample size. Researchers were concerned with the challenges related to the use and application of predictive and data mining. Some challenges were identified through written by the previous researchers for readers' reference in identifying the original proposal and resolution measures to address the issues and challenges that will come.

4.1.1. Concern to the Data Collection

The findings from previous studies found that there were weaknesses and challenges in the study conducted related to data collection methods. Variables from single questionnaire [33], student self-assessment [34] and [35] and the version of an instrument used does not follow the sensitivity of the IT learning context [36]. Challenges in non-target group engagement [37] while full health questionnaire (GHQ) were used rather than using clinical interviews for health screening [38]. Techniques and approaches needed diversified for data collection activities [30].

4.1.2. Concern to the Lack of Resources

Lack of online-program research was also a challenged in studies related to the commitment of institution in online learning [11]. Limited resources in practical applications cause the approaches used cannot measure behavior more efficiently [17]. In a prediction study on student creativity there was no study of the relationship between play environment and student creativity [39]. The lack of research has led to barriers to the implementation of simplicity tests on gender samples to predict behavior [40]. In research on the effectiveness of ICT utilization, Fazilat-pour [32] could not ensure the correlation between social communication and the effectiveness of ICT utilization. Studies conducted on the transition work of veteran student do not have completed information in determining career options [16].

4.1.3. Concern to the Lack of Technique

A good research must evolves in tandem with technological developments. Various techniques can be used to provide a quality research and can be referred by other researchers. Study of predicting the attitude of librarians towards the used of new technology found that the challenges faced related to the various techniques need to be used in predicting librarian behavior [41]. The used of more laboratory tests was suggested in anticipation of recovery time after working [42].

4.1.4. Concern to the Sample Size

There was a difference in size of samples used in the previous study. This sub-section compiles several studies that faced challenges in terms of sample size used in the study of whether the sample size is limited, the sample size is too small or the sample size is too large. The Challenges faced were due to the sampling used limited to the degree of Electrical Engineering at Faculty of Electrical Engineering UiTM only [10]. The bias in data analysis can occur due to the small sample size [43]. Studies on correlation and effects cannot be accurately measured if the sample size was used outside the specified sample [44]. The limited sample size in perceptions' study can be a barrier to researchers in determining the relationship between perceptions and educational success [45]. The simple sampling technique causes the number of participants involved were limited [46]. Non-random sampling was selected from the real population where only two schools involved will cause limited used to the statistical modeling [47]. Non-random sampling in the student population of the Midwestern University has led to the prediction of project appropriateness of the staff being less precise [48]. The study on prediction of mathematical efficiency cannot be tested according to differences age because only 15-years-old students were used as the samples of the study. User sampling was appropriate for the analysis of experimental data and cannot be used for analysis of actual studies [49].

4.2. Motivation

The benefits of a predictive study in various areas of study clearly show its importance in looking at potential based on certain indicators. This section discusses three categories of benefit on prediction research according to the educational and non-educational fields.

4.2.1. Benefit to Educational Field

Prediction study on students' progress can help the university manage student's achievement more holistic and effective [50]. It is very important for students who wish to pursue a college or university to undergo a standardized entrance test to provide students who are truly eligible to continue their studies [51].
The selection criteria can be modelled to predict the success of the selected student enrolment [52]. Student entry approaches are

based on past academic achievement to predict future academic achievement [53]. In order to achieve a more standardized level of academic achievement of students, the test score and student achievement grade should be adjusted to a more appropriate standard to create a more conducive environment in terms of learning and achievement assessments [54]. The role of teachers plays an important role in creating a better learning environment for student learning [55]. Students' perception can open opportunities for students to experience more advanced learning experience [56]. The early achievement of students can be used to predict the final achievement of the students and the results can help students overcome the student's interest [57]. Career awareness should be applied to students and religious bodies mandated by academic management in building such awareness [12]. Some competencies have been implemented through the International Student Assessment Program (PISA) to provide students with some approaches before entering the labor market [58]. Job literacy studies can help students improve themselves in the workplace [14]. Student academic performance is a measure of the excellence of an educational institution. The student's prediction of performance can affect the reduction and increase in student shift rates after graduation [10]. The used of learning management system (LMS) is one of the development of information technology in the educational system that provides the learning environment of unlimited time and place [59]. The implementation of the online program among students can provide a faster response to information dissemination and demonstrate student commitment in the programs planned by the institution [11]. An internationally recognized postdoctoral assessment of job demands can illustrate the trend of international post-graduate workflows [7]. Through the theory practice used in the study, comparison of cultures with understanding between students and teachers can be explained [60]. Self-regulatory investigation by e-learning environment for post-academic and academic achievement [19]. With the advancement of internet technology, students are able to explore valuable knowledge and information to generate student creativity [23].

4.2.2. Benefit to Non-Educational Field

Perceptions of job hobbies can simplify the compromise effect on career practices through various career strategies [61]. Student transition studies from military service to college management provide preparatory and early learning of students before career shift [16]. A researcher's career opportunity open early career opportunities prospective researchers in the public or private sector [62]. Scholars have recognized Career decision self-efficacy (CDSE) through CDSE, career counselors can increase persistence, the ability to endure stress, increase student self confidence in career choices [63]. The mentorship method can build career training and generate professional skills for career path, psychosocial as well as professional socialization [64]. For the study of selection of implicit knowledge inventory officers (POTKI), self-preparedness to be an effective, efficient and successful police officers [29]. Research related an information technology has also affected the results of predicted research conducted by past researchers. The usage of e-book among professionals was able to expand the scope of innovation-related research in information technology such as consumer attitude studies on acceptance of technological developments primarily on the use of e-books [65] The study on attitude among librarians on the use of m-service technology can illustrate the acceptance of librarians on technology development [41]. Internet satisfaction survey among the general public can help improve the various aspects of life such as culture, social and economic as well as enhance the development of individual skills and productivity [27].

4.3. Recommendation

An important recommendations from the literature review related to the data mining and prediction analysis in various field of research have been summarized for the improvement of a predictive study that will be undertaken by future researchers. This section discusses about the recommendations from previous researches that categorized into three main categories, recommendations about variables, recommendations about techniques or methods and recommendations about other matters.

4.3.1. Recommendation to Variables/Samples

For improvements to previous literature review, some of the previous researchers have suggested to use other variables or samples other than those used in the previous study. The researchers described the used of other variables or samples could affect the accuracy of the prediction value for every research problems. This sub-section lists some researches that suggest enhancements in terms of variables or samples that need to be used. The variables used in the study of student progress predictions should be examined to evaluate the differences in the use of each variant used [50]. Other variables related to the function and quality of the e-portfolio to verify the Subjective Norm (SN) involved in the research have to be used [56]. Additional numbers of librarians from other countries as samples or variables should be used to involve more variables [41]. In order to develop a more effective group work environment, future studies should add learning approaches and more effective impact factors [66]. The classroom environment aspect should be identified in verbal assessment among students [67]. Suggestion the use of institutional data can be expanded to examine the relationship between variables in making strategic planning [68]. The samples size of the study needs to be increased because the large sample size can represent the actual target population as well as identify more sources and job demands in the lecturer's work involvement in the distance education course [43]. Gender differences may be used in the model to see the implications of academic performance relationships with emotional states [69]. Additional features can be entered through results of more than one test score [70]. Involvement of samples from other departments will be used to determine the faculty performance factor for the department being used as the sample of the study [12]. Gender, immigration and ethnic backgrounds are additional features that may be considered for use in further studies [58]. Sex differences in non-cognitive factors need to be focused on criterion differences and on test [51]. Physical self-concept involves the theory of self-determination to be more tested [44]. The aspects of transitional elements such as military culture should be considered to see the differences or similarities of veteran students with overall students from military to college to test specific aspects of the job shift [16]. The samples of the study should be further expanded through the use of samples from a list of colleges across the country [71]. The results of the study can be confirmed through samples of additional study from other universities compared to only use samples from three universities in Taiwan [55]. The study of direct and indirect relationship of emotion, motivation and cognitive process requires a larger samples to run a path analysis [72]. Students' motivation for learning IT should be focused on achieving IT learning goals [36]. The model should be tested using samples from different universities as well as involving parents, adults and high school students [73].

4.3.2. Recommendation to Techniques/Methods

Previous researchers also suggested the use of different techniques and methods for future research. This sub-section discusses the suggestions by previous researchers about the techniques or methods to be used for future research. The use of research designs in addition to statistical controls can be used to determine the effectiveness of variables used such as absenteeism records, behavioral or personal indicators source and size of work demands [74]. For the study of the relationship between wellness and value / goal, the design of experiments is required to complement the existing study [17]. The study of the relationship between the sources of

Internet self-efficacy, Internet self-efficacy and other constructs is recommended using a survey for the exploration of the relationship studies [75]. Self-reporting methods have been used in previous studies and have caused bias due to self-reporting method and recommendations on the use of non-self-reporting methods should be used to prevent biased reporting from respondents [71]. Better research methods should be used to classify the collaborative interaction of nature and individuals [76].

4.3.3. Recommendation to other matters

Various predictions have been made in various fields of study. Each study has different recommendations according to their respective field of study. This sub-section discusses the suggestions by previous researchers about the other matters. A more sustainable and comprehensive long-term development needs to be taken into account in attracting youth to venture into agriculture to reduce business constraints in Ghana [77]. More research is needed to study the relationship between grade point average (GPA) of Master of Accounting (MAC) and variables used in existing studies [78]. Greater use of domains is needed to meet the growing needs of the teen segment [79]. Different studies using post positivist paradigm compared the used of positivist paradigms in previous research can help research assistant solve the problems in prediction organizational [80].

5. Critical Review

Nowadays a lot of studies has been done in the field of prediction the literature review founds that there are lack of research that applying the machine learning algorithm in this experimental study. Most of the prediction studies used a study of correlation and prediction are based on the strength of the correlation between the variables. There were only 2 out of 120 articles that used data mining in prediction studies [12] [14]. 3 out of 120 articles used the machine learning algorithm in the process of data analysis [10] [14] [15]. From all three articles that are using the machine learning algorithm, there is only one prediction study on job competition factors among students but predictive factors are based on student literacy data and student end-employment information. This study used decision tree algorithm and logistic regression for prediction analysis process [14]. From the findings of the literature study, there is no prediction study that involves the employability among fresh graduates in Malaysia. Studies on graduate's employability are very limited and there are only one study that discusses the competition factor of graduates in the job market. The lack of research in this area shows there is a lack of technical, method and data types that can be used in predicting employability among the graduates in the work industry.

6. Conclusion

Predictive studies are widely used in educational and non-educational field. However, through the systematic review conducted on literary studies found 97 out of 120 articles cover prediction in education, 23 out of 120 articles in the non-educational field. The prediction study has become a phenomenon in certain areas to help management make a strategic planning based on the factors that can influenced a decision. This prediction trend shows the several techniques used in predicting things in line with the current technological developments. Researchers express their opinions and suggestions in their respective research papers to solve existing problems or challenges for future researcher references for the improvement process. Future researchers can refer to the diversity of data collection techniques, processing methods, research samples, challenges and suggestions as well as the entire work process for predictive research conducted by previous researchers through a systematic review. The overall, Decision Tree, Naive Bayes, Neural Networks, Logistic Regression, Bayes Network and Averaged One-Dependence Estimators with subsumption resolution (AODEsr), support vector machine (SVM) selected by researchers as a predictive model because of the highest accuracy based on experiments that have been carried out. The use of various machine learning algorithms is indispensable depending on the type of data used. Testing on the accuracy value of an algorithm is very important in order to get a predictive model that is perfectly appropriate for each type of data being tested.

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