Recommendation System for Smart LMS Using Machine Learning : A Literature Review

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Abstract - *This paper presents the result of Systematic Literature Review (SLR) on Recommender System (RS) topic as a preliminary toward a further study on designing a smart Learning Management System (LMS) for online learning which adopts Natural Language Processing techniques. As a foundation to a broader study on smart LMS, this study focused on analyzing prominent study reports on recommender systems in general and online learning in particular. The SLR method analyzed papers published in the range of 2013-2018. Out of the 109 papers this study analyzed in-depth 42 papers. The study findings confirmed that most of RS studies still focused on e-commerce, movies, tourists, and more whose most popular RS methods were collaborative filtering and content base. Some studies in RS for online education were mostly focused on scheduling, recommendations for courses, books, prospective students and others. The results of this study found that there are still much opportunities to develop methods and approaches for RS in online learning. This study findings gives foundation of our future research to develop a model of conscious contextual recommendation system using Machine Learning based on smart LMS for online learning.*

Keywords: *Recommender System, smart LMS, distance learning, online learning, machine learning.*

I. Introduction

Online learning (also known as distance learning or e-learning) is a term refers to training provided via a computer or other digital device. In the last ten years, online learning in higher education has been widely accepted in many countries as an alternative learning mode from conventional or face-to-face learning. This learning mode were expected to reduce geographical Barier (e.g. the students can learn from anywhere) and time barrier (e.g. students can learn in their convenient anytime). In contrast to conventional ways of learning, communication between students and lectures in e-learning is not face-to-face but is facilitated by a software called Learning Management System (LMS). In general, LMS is a web-based platform used to automate and centralize the administration of online learning activities such as registration, learning material delivery, tracking and reporting on learning progress. An LMS also provides functionalities such as: user management, course organization, shipping only, online assessment, question handler, reporting, communication and collaboration services. Effective LMS must provide a learning environment to learners, so administrators can use to easily manage users and manage other online learning services [1].

In Indonesia, since 2014 the Government of Indonesia set out an online learning initiative for higher education to increase student access to quality courses typically provided by qualified colleges or lecturers. The particular objectives of this initiative were to address several general issues such as: (i) limited access and capacity of high quality colleges which are mostly concentrated in Java and (ii) limited quality education resources. The program which was initially called Open and Integrated Indonesian Open Learning (PDITT) later called the Indonesian Online Learning System (SPADA Indonesia). By using the SPADA Indonesia system, students enrolled in any university in Indonesia can take available

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online courses from the chosen universities and the credit obtained will be accepted by the college where the student enrolled.

In order to achieve these objectives, the universities as online learning organizers (providers) are required to foresee all necessary management and technical aspects of online learning services. Although looked easy, online learning service is a challenging service. One of the issue is how to design an effective LMS which provides convenient functionalities for online learning students but a reliable back-end system for online learning management. On the other hand, despite its widely used, to the best of our knowledge, most of LMS in many universities are designed and operated as a merely learning repository. The LMS users are required to access various functionalities to store or access the required information causes learning monitoring becomes inefficient. This condition has raised a problem namely: how to design an LMS with automated analytic functionalities using textual/voice documents available in LMS repository and students-lectures dialog forum as its input in such away that the LMS is not only able to respond to any inquiry but some information can be pushed automatically to the recipients.

Although much research has been done on the recommendation system; but as far as the author's knowledge, most researchers focus on the accuracy of recommendation systems in predicting recommendations rather than knowledge acquired by students. In contrast, there is not much research done on the design and measurement of learning system whose design embedded with RS. As part of addressing this issue, this paper presents a preliminary study to on a broader research objective which is designing an intelligent LMS which adopts the advent of Natural Language Processing (NLP) technologies such as recommender system. As the first step to address that wide issue, this paper presents the results from analyzing previous and related studies on the online learning issue. The remaining of this paper is organized as follows. Chapter 2 describes some related works. Next, chapter 3 described Research Method followed by Study Result and Discussion in chapter 4 and Conclusion in Chapter 5.

II. LITERATURE REVIEW

A recommender system or recommendation system (RS) is a term refers to a computer-based system designed to provide recommendations to the wearer. According to Zaiane [2], a recommender system in education context is a system designed to provide intelligent recommendations to learners (known as item) namely: the steps / processes to be performed, study program, reading materials (courses, books, articles, website, assessment, exercises), or sources of information relating to the topic / subject based to the choices previously made by participants of learning. In providing such recommendations, an RS employed a statistical model that is trained in a supervised or unsupervised manner with a learning algorithm based on input from the previous learning participants.

The study by Kong, Boll & Heuten [3] on RS for vocational education suggested that an RS should emphasize on supporting the transfer and knowledge sharing process that facilitates the diversity of objectives of the learning activities. This study followed by [4] [5] [6] suggested that RS should not only provide suggestions for usefully items to users but also serves to filter information filtering based on user preferences, interests, or observed behavior about the item.

The study by Kumar [7] on RS for marketing purpose concluded that RS is an effective tool to provide recommendations on products / services to certain consumer. Google, Amazon, and Netflix experiences show some evidences that well-designed RS can give good and accurate recommendation system to a large number of customer. Despite many successful experiences, the study by [7] also concluded that the remained problems of RS were: (1) cold start, (2) Scalability of approach, (3) Accuracy of Suggestions, (4) Changing datasets, (5) Impact of context awareness, (6) Loss of neighbor transitivity, (7) Sparsity, (8) Privacy issues, (9) Recommend items in Long tail.

Ricci, Rokach and Shapira [4] added some open issues in the recommendation system namely: (1) scalability with Big Data and real world data, (2) proactive recommendation system, (3) conservation of privacy, (4) diversity of items recommended for target users Integration of user preference long, (5) short term in the process of building a list of recommendations, (6) generic user models and cross-domain recommendation systems, (7) distributed recommendation systems that operate on open networks, (8) recommenders that optimize the order of recommendations, (9) recommenders designed to operate on mobile devices and (10) the context of use.

The recent studies on RS by Onah & Sinclair [8] proposed a collaborative screening framework for the design of a recommendation system for online learning in the form of Massive Open Online Courses (MOOC). Adomavicius & Tuzhilin proposed the concept of a conscious contextual recommendation system [5]. Dey, Abowd & Salber [10] proposed Context-aware recommender system is a term for recommendation system designed to provide users with recommendations on some items (eg reading material relevant to the topic under discussion) taking into account the context. In this RS type, the term context is defined as "any information that can be used to characterize an entity's situation. Entities may be places, objects, or persons deemed relevant to the interaction between users and applications, including users and self-applications." In this RS type, an RS can be represented by a function F:

$$F: user \times item \times context \rightarrow r \qquad (1)$$

Where: user be a learning participant, item be the recommended object, and the context be the assessment of the user condition/situation in the ongoing learning process, and r is the recommendation index of the item.

Adomavicius & Tuzhilin [6][7] divided further the conscious contextual recommendation system into three types according to its function: (1) Contextual early processing, (2) Post-contextual filtering, and (3) Contextual modeling. Based on the ability of the recommendation system to accommodate the profile and learning styles of online learning participants, Belghis-Zadeh concluded that the recommendation system could support the personalization of online learning [8]. The results were validated by Hassan & Hamada who also concluded that, in order to be more effective in supporting the online learning process, the recommendation system

should be designed to be able to provide recommendations to the learning participants according to their own learning style [9].

III. METHODOLOGY

In order to conducts a comprehensive literature review of studies on RS utilization in online learning, the main method of this study is systematic literature review (SLR) methodology [10]. The main focuses of this review were: keyword patterns for paper search process, initiate inclusion and exclusion criteria, data mining, and analysis of findings to answer research questions.

Systematic Literature Review (SLR) is a prominent method which can be defined loosely as a systematic method for literature appraisal. The study by Mulrow published in 1994 [11] and Davis et al. in 1995 [12][13] were among evidences that SLR has become a common method on health care research domain. Kitchenham et al. [14] defined SLR as a secondary study method to analyze previous research which is focusing on finding, critically evaluating and aggregating numerous important of previous research papers and relevant to the research topic or questions of interest.

Despite different definition, the common objective of this methodology is to ensure that the review is unbiased, rigorous and auditable. Although previously practiced in evidence-based medicine area, in the past several years, this method has widely adopted in various research domains including computer science, economics, psychology, social science and health care. The advantage of this method, among others, are to facilitate rational decision making, selecting a large number of information, and keep up to date with evidence accumulating in field and to practice evidence-based medicine.

In this study, SLR was specifically aimed to investigate the extent to which the use of RS on online learning education and what methods are most frequent and appropriate to use. The current trend, the high interest of writers to continue to explore the RS to online learning can identify the different models, methods and approaches used. Based on this, this research will be identified as a new model in the utilization of RS for online learning.

Following et al., [10], the SLR method used in this study undertook an automated search in internet-based digital sources and indexing services including:
1. IEEE Xplore Digital Library (http: /ieeexplore.ieee.org)
2. Direct Science (www.sciencedirect.com)
3. Springer Link (link.springer.com)
4. Emerald Insight (www.emeraldinsight.com)
5. Google Scholars (https://scholar.google.co.id)
6. Wiley Online Library (onlinelibrary.wiley.com)
7. ACM Digital Library (dl.acm.org)
8. Elsevier (https://www.elsevier.com/)

The search strings used for all sources comprises of some strings as follows:
1. (recommender system OR RS) AND (context-aware OR machine learning) AND (recommendation system OR e-learning)
2. (context-awareness recommendation OR personalized learning) AND (issue OR framework)

3. (content-based AND collaborative filtering) OR (recommender system AND collaborative)) AND (recommender system OR learning analytic)
4. (e-learning personalized OR sentiment analysis) AND (context-awareness OR learning style)
5. (recommender system OR machine learning) AND (context-aware OR e-learning)

The search exclusion criteria in this study were namely:
1. This paper is based on the date of their publication between 2013-2018
2. The complete paper structure, which means all identities (journal / conference, author's identity, etc.) are mentioned on paper.

Duplicate paper from the same study will not be included and removed from the SLR Data Extractions.

IV. RESULT

A. Publishing outlets

The source of publication for this study can be summarized in the following table categorized by its title, paper type and year of publication.

Table. 1. Source of Publication

Title	Year	Type	Title	Year	Type
Personalized E-library:	2017	P	A General Framew [16]	2017	J
An Analysis of Social [17]	2016	J	A Survey on Method[18]	2014	J
Toward a New [17]	2015	J	A tag based learning [19]	2013	J
Recommender sys[6]	2015	J	Exploratory Exam [20]	2013	J
A Survey on Linked[21]	2014	J	Reliability Quality [22]	2018	J
TF -ID uF: A Novel[23]	2017	J	Improvisation of [1]	2017	J
Designing and Exp [24]	2017	J	A recommender [25]	2017	J
A Multi-Stage Appr [26]	2017	J	Recommender Sy [27]	2018	J
Recommender Sys [28]	2017	J	Designing and Exp [24]	2017	J
PLORS: a personalized [8]	2016	J	PCRS: Personalized	2018	J
Collaborative Filtering [29]	2015	J	A Sentiment Analysis [30]	2017	J
Improvisation of lear [1]	2017	J	Recommender [6]	2014	J
Incorporating Proa [31]	2013	J	Recommender Sys [6]	2015	J
Implementation of [32]	2016	J	Recommendation[33]	2015	J
Performance and Qu [34]	2015	J	Towards an Intell [35]	2017	J
A Framework for [36]	2017	J	A Personalized E [18]	2016	J
Towards Guided [37]	2014	J	Recommender [38]	2016	J
Recommendation [39]	2016	J	A Multi-Stage [26]	2017	J
Academic Decision [40]	2016	J	Open Problems in[4]	2017	J
A privacy-preserving [41]	2018	J	A Framework for [36]	2017	J

Stakeholders Analysis[42]	2018	J	Learning Object [43]	2016	J
Total			42		

Note: J be journal and P be proceeding.

As can be seen from Table. 1, it can be concluded that there is a significant increase in the interest of researchers in RS especially in the context of education, shifting from ecommerce to education. With the publication of their papers in reputable journals it is known that there is still considerable interest for researchers to continue to explore their research in this field. Of course, this becomes an opportunity for the development of appropriate models and references to hospitals with e-learning especially distance learning systems.

In this study, SLR was used to analyze 109 papers from all sources and criteria. Out of those papers, based on titles and abstracts related to research questions, 55 papers were selected as study candidates. After further study, there are only 42 papers that can be used for further analysis due to its strong correlation with this research as seen in Table 2.

Table 2. Number of papers from selected sources

Source	Founded Studies	Candidates Studies	Selected Studies
IEEE	20	2	**15**
Science Direct	16	5	**1**
Springer	12	10	**7**
Emerald	8	2	**0**
Google	22	14	**10**
Schoolar	8	6	**0**
ACM	10	6	**0**
Wiley	13	10	**9**
Elsevier	**109**	**55**	**42**
Total			

B. Most prolific authors

As can be seen from the perspective of the author's analysis, there are 163 authors who have written 42 papers. There are 29 authors (18%) who are consistent in writing about RS on education. Other authors on average write only 1 paper in the 2013-2018 timeframe. Interestingly, publication numbers in total increased significantly in the past 5 years (2013-2018)

C. Most productive institution

Most sources of papers that we used were published in indexed journals. The most productive institutions are Delhi Technological University, Department of Computer and Information Science, Ekiti State University, Federal University of Technology, University of California, and University of Ibadan by publishing 2 papers. Other institutions were only produced one paper each.

In terms of authors' college affiliation, Delhi Technological University published more than 1 paper followed by Department of Computer and Information Science, Ekiti State University, Federal University of Technology, University of California and University of Ibadan. Likewise, this university sequence also related to the number of authors who published more than 1 paper.

D. Publication trends

Frequency of papers published between 2013-2018 can be seen in the figure. 2. There was a significant increase in RS

publication. Most publications in 2017 (17 papers) and 2016 (8 papers). And by 2018, as of April 2018 we have found 6 papers on RS for this education.

E. Authors Country

Figure. 2 informs the author's home country. This table provides information on the origin of the colleges of the authors. It appears that the average author who published more than 1 paper came from India RS [34][18][1][44][33][38][28], USA[26][20][26], Spain[31][40][22][45], Palestine[46], Canada[8][36] and Indonesia [47].
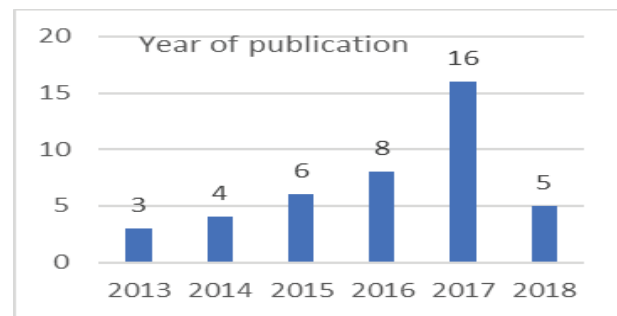

Fig. 2. Distribution of publication year

Based on Fig. 3, it can be concluded that India is the country with the highest level of research in RS research. Particularly in some papers, the focus of their research is on e-learning RS [34][18][1][44][33][38] , library and utilization of RS on big data [28]. How about Indonesia? The government of Indonesia through Kemenristek DIKTI has opened up opportunities for the implementation of distance education that will be controlled directly by the government. This is certainly an opportunity as well as a challenge to organize a good distance education and quality. Each university in Indonesia will standardize each other while improving their quality and quality in various sectors of education. LMS as a standard media in the implementation of this remote learning system should be maximized with the use of technology, such as a recommendation system that will help the education provider in managing its learning and we call it smart LMS using RS with a context-aware approach.
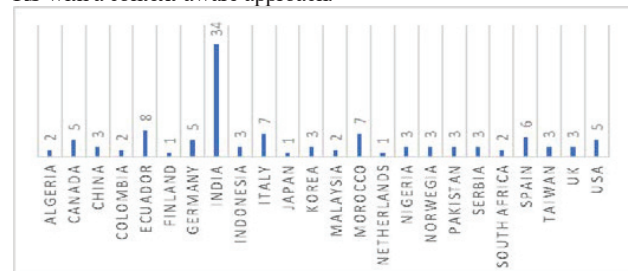

Figure. 3. Country of author origin

F. Authors academic background

Most RS papers was written by researchers from computer Science, information technology and information systems fields. That is, the researchers have the ability in the field of information technology and this of course helps researchers to further explore the utilization of technology especially recommendation system

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that can then be developed with other technologies such as machine learning. Interestingly year 2017 is the peak year for RS research in the education domain although RS research in other areas such as beauty, tourists, health, transportation and others are still continue.

G. Keywords analysis

Table. 3 informs the keywords used by the authors in their papers. This keyword was found on 42 papers in eight sources. This data shows that the most commonly used keywords are "recommender system", "collaborative filtering" and "online learning/e-learning". We also found other keywords among the papers namely, "Learning Analytic", "data mining", "hybrid", "sentiment analysis", "MOOC", but we also find interesting keywords to learn more is the word "internet of thing".

This explains that there is still a great opportunity to develop a recommendation system suitable for education especially distance learning.

Table. 3. Most frequently used keywords

Keywords	#papers				
	IEEE	Science Direct	Springer	Google Scholar	Elsevier
E-Learning	2	0	5	3	0
recommender systems	15	1	6	5	9
Machine Learning	1	0	0	0	0
Collaborative filtering	2	1	0	6	6
Content based	1	1	2	1	5
Recommendation system	1	0	0	4	0
Context-aware	1	0	0	0	0
Learning style	0	2	0	0	0

From the SLR results, the three most commonly used RS methods are collaborative filtering, content-based and hybrid. Whilst, the most frequently used approaches in RS are: learning analytic, sentiment analysis, data mining and utilization RS on big data. This is in line with the research of Nitin and Kumar [4] who identified Issues in RS domain research as show in table. 4:

Table. 4. Issues in the RS domain research

Challenges	Collabora tive RS	Content-Base RS	Demogra phic RS	Hybrid RS	Domain Base	Knowled ge Base
Cold Start Problem	?	√	√	√	?	√
Scalability of	√	√	√	?	X	X
Big Data	√	√	√	?	X	X
Privacy Concern	√	X	√	√	√	√
Sparsity	X	√	X	√	?	?
Recommending The Item in The Long Tail	?	√	√	√	?	√
Accuracy of The Suggestions	?	√	X	?	X	X
Changing Data Set	√	√	X	√	√	?
Impact of Context-Awareness	?	√	?	√	√	?

Based on the table. 4 it is known that there are still opportunities to further develop the RS on distance learning using machine learning, there are still some methods that can be explored further utilization.

H. Methods already in use

Of the 42 papers that we have studied, there are several methods used by previous researchers on the recommendation system on online learning, ie Collaborative-filtering, Content-based, Demographic, Utility-based, Knowledge-based, Community-based, Hybrid-approach (mix method). From several methods and approaches it is known that the most frequently used is the method of content-based and filtering collaborative. Based on that, in our next study we will conduct an experimental test from a data set that will test the same methods and algorithms and then compare the results. Previous research by these researchers will be a reference for our next research. From several methods and approaches it is known that the most frequently used is the method of content-based and filtering collaborative. Based on that, in our next study we will conduct an experimental test from a data set that will test the same methods and algorithms and then compare the results. Previous research by these researchers will be a reference for our next research.

The success of the e-commerce recommendation system is measured by increasing customer satisfaction and sales figures, included improvement of system capabilities and services [46]. The success of the recommendation system can be measured by the increasing interest in learning and the results of student learning outcomes. Sometimes, the amount of information we get about students will affect the number of teaching learning experiences that can be adapted for them. Analyzing student habits will also greatly help teachers predict student behavior. So that the learning process can continue to be improved as the learning process progresses.

Based on the papers we searched for, we found the fact that system recommendations were also needed in education, especially online learning. System recommendations are needed to provide learning references according to the needs of students [33]. Student needs can be seen from student profiles such as learning styles, characteristics [39], interests [1], to their habits. So that the instructors can continue to improvise with learning materials to adapt the style of students [2]. The recommendation system in the context of e-learning can be interpreted as a warehouse of soft-warehouse agents who "intelligently" provide recommendations to students based on the actions of previous learners. This recommendation can be in the form of online activities such as problem exercises, reading messages posted, or running on-line simulations.

Distance learning, in this case what we mean is online learning for distance learning, encouraged to utilize resources and actively participate in various learning activities. However, it is not easy for teachers to know and measure the success of student learning. An activity that is quite difficult to evaluate the effectiveness of the learning process.

V. CONCLUSION

Recommender System (RS) has become a revolutionary concept facing the big data era. Recommendations in the form of advice for users, is very useful to support achieving student using online learning environment. Many of the techniques provided by the recommendation system used of collaborative filtering and content-based filtering. For online learning it is possible to use both techniques and also to use other techniques such as hybrid, knowledge-based and so on. This study results showed that research RS still gained research interest for various research communities. Interestingly, the SLR results pointed some research opportunities in RS for online learning domain including:

1) Collaborative filtering methods: cold start, recommendation for item in long tail, and impact of context-awareness.
2) Demographic RS: impact of context-awareness.
3) Hybrid RS: Scalability and accuracy of recommendations.
4) Domain based RS: cold start, recommendation for item in long tail, and sparsity.
5) Knowledge based RS: Sparsity, changing dataset, and impact of context awareness.

The success of system recommendations in other fields such as e-commerce, cinema and others, we believe will also succeed in online learning.

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