International Journal of Computing and Digital Systems
ISSN (2210-142X)
Int. J. Com. Dig. Sys. 15, No.1 (Feb-24)

http://dx.doi.org/10.12785/ijcds/150161

A Systematic Literature Review of an Advisory System

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Received 27 Aug. 2023, Revised 26 Jan. 2024, Accepted 30 Jan. 2024, Published 1 Feb. 2024

Abstract: The growth of Artificial Intelligence (AI) driven technologies has been proposed as a means to improve the standard of people's lives. The advent of the advisory system has manifested itself as a significant element in Artificial Intelligence, effectively helping people in various fields. This research presents a systematic literature review of an advisory system. This research initially presents 472 articles by examining the literature between 2015 and 2023. After a meticulous review process, the studies were filtered down to 67 articles for full analysis. This review provides significant contributions to the exploration of advisory systems, specifically in the existing framework of advisory systems, the techniques applied in advisory systems, the domain in which the Artificial Intelligence technique is being applied in the advisory system, and the validation technique used in validating the advisory system. Ultimately, this review contributes to a deeper understanding of an advisory system's role in Artificial Intelligence and in various domains for optimising an advisory system application.

Keywords: : Advisory System, Advisory System Framework, Artificial Intelligence, Systematic Literature Review

1. INTRODUCTION

In recent years, there has been a discernible and ongoing progression and emphasis on technological innovations that have propelled human progress [1]. Artificial Intelligence (AI), a scientific and technological field, is concerned with the development of intelligent computer systems and software programs that do activities that previously needed human intellect [2]. Therefore, a significant aspect of AI that receives considerable interest is its capacity to perform a wide array of tasks that resemble human actions. To attain outstanding performance in specific tasks, AI utilizes employs relevant sources of information and spans different sub-fields such as voice recognition, machine learning, large data analysis, and natural language processing to achieve excellent performance in particular tasks [3], [4].

Advisory system is a computer-based tool that provides recommendation to improve decision-making processes [5]. Variety of domain can gain benefit by using an advisory system as it can increase the efficiency of decision making. In addition, an advisory system has the capability to offer specialized knowledge and expert advice without the need for direct interaction, thereby saving time [6] and minimizing emotional attachment. An advisory system can be classified as an expert system [7] due to the shared architectural pattern. However, there are notable distinctions between the advisory system and expert system in terms of their methodology and decision structure [5].

A Systematic Literature Review (SLR) is a method that employs a precise, transparent, and explicit approach, encompassing several phases [8]. This approach is designed to ensure that the literature process maintains a high level of rigor and transparency [9]. In addition, conducting a Systematic Literature Review enhances the credibility and reliability of the research for it transparency and also provide an insight of the findings in the context of the research objectives. In accordance with this approach, the aims of this Systematic Literature Review are to identify the existing frameworks, techniques and domains applied in advisory system. The organization of the paper is structured as follows: It begins with the presentation of the methodology used in the Systematic Literature Review. This is then followed by an exploration of the findings and discussions derived from the review. Finally, the paper concludes with a summary of the research's outcomes.

2. RESEARCH METHODOLOGY

This research is done by adopting the approach proposed by [8] as shown in Figure 1:

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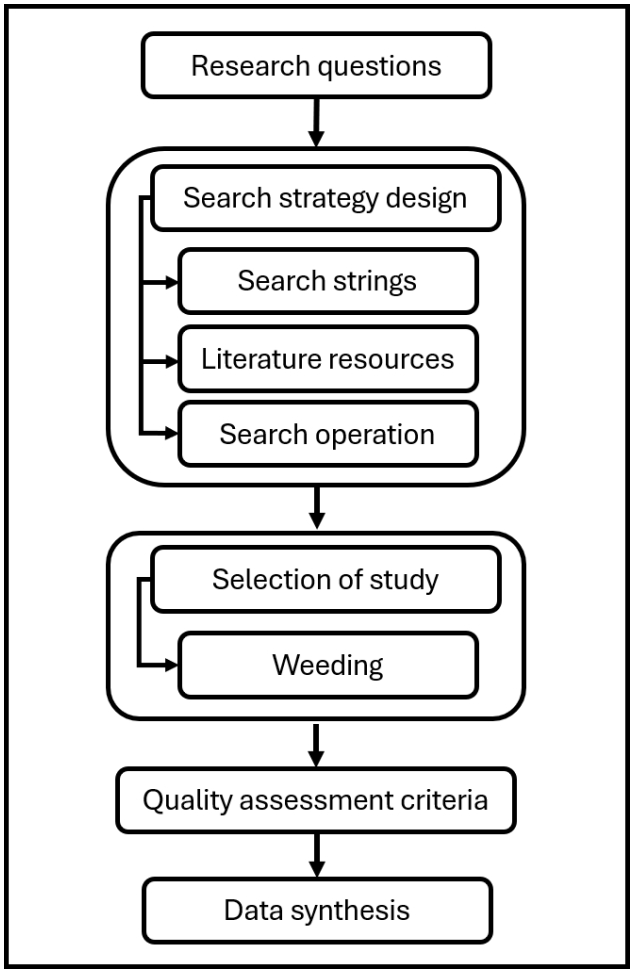

Figure 1. Review phases

Based on the Figure 1, this research is conducted in five phases. Firstly, research questions were constructed based on the aim of this research. The second phase involves developing a search strategy aligned with the formulated research questions, comprising search strings, literature resources, and search operations. The third phase is the study selection, wherein all gathered data are processed using a weeding technique to ensure relevance to the research objectives. In the fourth phase, all selected data undergo evaluation using quality assessment criteria. The fifth and final phase entails data synthesis, wherein all relevant and selected data are analyzed.

A. *Research Questions*

This SLR is conducted in order to gain a deeper understanding of the advisory system and the techniques it requires. The aim is to provide a summary and pinpoint areas within the advisory system and its techniques that require further research. In order to achieve this aim, four Research Questions (RQs) were constructed to guide the exploration within the context of the advisory system:

- What are the existing frameworks for advisory system? (RQ1)
- What are the existing techniques applied in the advisory system? (RQ2)
- In which domain is the AI technique being applied in the advisory system? (RQ3)
- How to validate the advisory system framework? (RQ4)

B. *Search Strategy Designs*

The design of search strategy adapted in this research are search strings, literature resources and search operation.

1) *Search Strings*

The stage of the building the search terms are as follow [8], [10]:

- Derive the major terms from the constructed research questions.
- Synonym and alternate spellings are identified.
- Usage of the Boolean AND or OR.

The example of Boolean usage is followed: (Advisory system) AND (technique/OR method/OR approach)

2) *Literature Resources*

Data search encompasses published journal papers, conference proceedings, book chapters, workshops, and symposiums, targeting keywords in titles, abstracts, and index terms. Data for this research are extracted by using five electronic database resources which are IEEE, Google Scholar, Springer Link, ScienceDirect, and ACM Digital Library.

3) *Search Operations*

Comprehensive search from all relevant and trusted sources is the essence of the Systematic Literature Review. For this research, the search operation implemented are detailed in Table I.

- Retrieved data: A research is done thoroughly in the selected electronic database and 472 studies are managed to be extracted and retrieved as shown in Table I.
- Selection round 1: The pre-selected papers are reviewed based on the inclusion criteria. As a result, included papers are 102 papers and excluded papers are 370 papers.
- Selection round 2: All the relevant papers from selection round 1 are being re-reviewed and being consider by the inclusion and exclusion criteria once more and as a result, 67 papers are selected and 35 papers are excluded as shown in Table I.

TABLE I. Included and excluded data

Electronic database	Retrieved	Selection Round 1		Selection Round 2	
		Included	Excluded	Included	Excluded
IEEE	113	30	83	25	5
Google Scholar	110	18	92	16	2
Science Direct	111	15	96	12	3
Springer Link	102	12	90	7	5
ACM Digital Library	36	27	9	7	20
Total	**472**	**102**	**370**	**67**	**35**

C. Selection of Study

All 472 prospective papers were extracted from the research, with relevant studies identified through titles and abstracts. Therefore, any papers not aligning with the discussion topic were excluded from the research. The set for inclusion and exclusion criteria in extracting and determining the papers that have high possibility of inclusion is summarized in the Table II.

TABLE II. Inclusion and exclusion criteria

Inclusion criteria
All papers published in English language. Relevant papers that published from 2015-2023. Published papers with potential to answer at least, one research question.
Exclusion criteria
Papers that are not published in English language. Unrelated papers to the research questions. Duplicate papers.

1) Quality Assessment Criteria

In the second round of selection, the chosen papers were evaluated using quality assessment criteria. Quality assessment involved scoring the relevant and selected papers based on how well they answered each research question. This quality assessment question is presented in the Table III. Three scores were used: “0”, “0.5”, and “1”. If the paper is considered related and suitable with the research question, “0.5” and “1” can be used to score the paper and if not, the score will be “0”. The selected papers that are being considered with the acceptable quality rate are those with quality score of 2 and greater which make up half of the percentage score.

TABLE III. Quality assessment questions

(Q1) Is the framework in the research is clearly described?
(Q2) Is the technique/approach clearly described?
(Q3) Is the research/framework validation method appropriate?
(Q4) Is the research within the psychology domain?

D. Data Synthesis

This section synthesizes data from the 67 selected papers to address the research questions. The data from the selected papers were studied thoroughly to get the precise answer for the research questions.

3. FINDINGS AND DISCUSSION

This section discusses the findings from the final selection of papers, structured around the research questions.

A. What are the existing frameworks for advisory system? (RQ1)

The aim of this research question is to identify the existing framework in the advisory system. Based on the 67 selected papers from this research, 39 included a framework in their study, while 22 did not, as shown in the Figure 2.

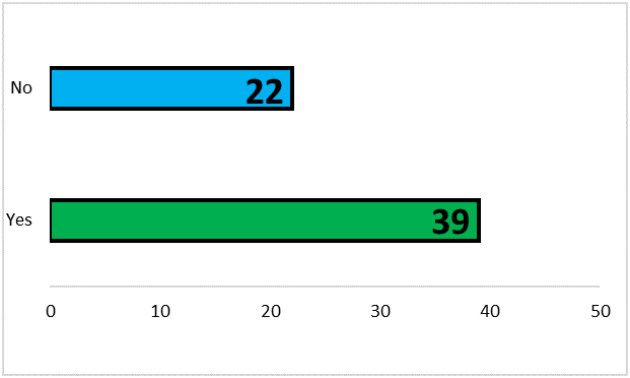

Figure 2. Existing framework in the advisory system

The framework in the study can be either a new developed framework or an existing framework that has been applied in the study. For instance, [11] had developed an automated course sequence recommendation system that can adjust to students’ background and performance on their selected program as it claimed that the framework can shorten the time for graduation of students and improve their CGPA. This framework also learns from the student’s previous record and personalized depending on the student’s selection. This study [12] proposed a layered architecture

with learning analytic to boast decision making in academic advising. However, this proposed framework is primarily suitable for big data applications, as it stores numerous databases to distribute extensive data collections across the network. [13] also proposed a layered framework for big data implementation that can predict crop yield for cotton crop. Another framework, proposed by [14] , suggests music to users while running to stabilize their heart rate and enhance run effectiveness. [15] proposed a framework that can advise user with a suitable speed for the electric bicycle for energy consumption.

Network embedding layer architecture is proposed by [16] to utilize recommendation and share similar preferences for the user and their circle and also dividing the user's preferences to item and social based preferences. Prediction framework is proposed by [17] to assist faculty for teaching strategies to improve their teaching experience and for the students improving their learning experience. [18]proposed an effective personalized content recommendation framework (PCRF) that use content from Wikipedia as an informal learning and compare the result for student that used personalized support with the student who used the Wikipedia without any recommendations and prove that student with the recommendation had visits more relevant pages and information than the students without recommendation. This proposed framework can also be used in other environments and can also be improved in a hybrid model in a different category. A tool is developed based on the service-oriented architecture for adaptive healthcare system by [19] to provide depression's assessment and how to manage it among adult. [20] proposed an Internet Delivered Psychological Treatment (IDPT) model, utilizing Information Architecture (IA), detailing adaptations required for the IDPT system and offering guidelines for its development. They also provide a guideline on how to develop an IDPT system and also proposed a system that can adapt to the patient behavior. [21] develop a recommender system that used Moodle platform and adapt with the user and suggest the user what to ask during session in the platform. It also helps with the overload information in the platform as an adaptive platform tend to store many information. Conceptual framework is proposed by [22] to measure mental distress that cause by economic recession. However, the author claimed that it does not include empirical outcome to prove the framework effectiveness in real life. [23] using a chat bot and comparing the effectiveness of each technique used by the chat bot to show the effectiveness and limitation of an Artificial Intelligence technology in monitoring a mental health patient. Data science is used to proposed a waterfall style framework [24] that can be used by health care professional to understand more about mental health. It is called a waterfall style framework as it structured to plan from beginning to end of a project. [25]proposed a framework for cultural sensitivity in a mobile application for mental health and programmer can used the framework to make their application sensitive to a cultural issue. [26] proposed using machine learning technique to detect a mood disorder such as depression and bipolar disorder and combine the properties into the mobile application. It shows that using Artificial Intelligence technique, it can reduce the time and can detect an early episode of mental disorder. Evaluation framework is proposed by [27] in making sure that the evaluations of technology mental health interventions are more extensive to the people involved.

A web framework is proposed in [28] as an expert system that can detect, monitor and compare soccer athlete in an effective ways. This expert system can also be applied in any other sports and can be used by the coach and athlete. [29] proposed a general framework for Intelligent Recommender System (IRS) that extend from the classic recommender system. They claimed that IRS not only recommend but also take user needs into consideration to recommend item. The differences of IRS from the classic recommender system is that IRS have four main elements and the quality of the recommendation is better from the aspect of knowledge representation, and its reasoning and learning mechanism. A new method and framework that is called meta association rule for generate adaptive rule is proposed by [30] for recommender system. This method is proposed as it can combine many databases that have the same attributes in the rule mining process, however it cannot combine with a different attribute and is not proven it can collaborate well with recommender system. A hybrid recommender system is proposed by [31] to recommend a suitable movie to user. This hybrid system used recommender system and expert system in the architecture for the recommendation process. This system also can detect emotion and recommend movie based on it. [32] proposed a recommender system for a disabled person to use in their home for a quality and easier life. This system uses an Artificial Intelligence technique and also IoT to function. The user will utilize the Artificial Intelligence's voice to control the home appliances and through client-server framework, it sends an action to the server. If it matches, it connects to Arduino and order it to operate the household appliances. This system will make user's daily life easier and they can live without totally depending on others.

This study [33] proposed an IoT-based smart school counselling system with diverse capabilities to help students choose a career. This solution comprises IoT-school guidance system contact anytime, anyplace, on any device. It also combines career counseling with psychometric tests with modern approach and also identifying trend of each students. This research [34] proposed a tool and framework that can efficiently develop a recommender system by using components-based design process and also cover all the steps until the deployment of the recommender system. To extract and encode the knowledge in medical publications, [35] proposed a knowledge acquisition and used the knowledge in the proposed decision support system framework. This research is done to acquire knowledge from an unstructured data to act as a secondary evidence

for decision making in a clinical scope. [36] proposed a smart virtual assistant to assist psychiatrists in the diagnose process. It also can be used by the assistant as a training when psychiatrists are not available. The proposed expert system will give questionnaire to the patients and analyze the answer to identify the exact disease of the patients. [37] use an expert system architecture in diagnosing mental health especially in depression cases and also tracing the system to give accurate diagnosis to the patients. [38] proposed using an expert system to manage a critical care patient during Covid-19 pandemic. This Artificial Intelligence-based system can help in decision making and managing of patient in the critical care.

To help with the assessment of heart disease, [39] proposed a genetic algorithm fuzzy system to aid in heart disease assessment, demonstrating that this hybrid system effectively manages the vagueness of knowledge in such evaluations. [40] proposed a new approach of an adaptive model in a modern e-learning environment. This system is proposed to provide students with the best and suitable learning materials with the students' preferences. Personalizing course advising system by students' interests is possible by [41] as this study proposed an intelligent personalized course advising model that can save more time and efficient for both students and teachers in advising process. This study [42] review an adaptive e-learning system and the concept of adaptive learning. It also summarize the component in the adaptive system architecture and the mechanism in the concept of contextualization. [43]proposed a new perspective for recommender system by incorporates a knowledge graph into recommender system. This study aims to predict either user has an interest in an item that user had no interaction before. This study [44] proposed an anonymous recommendation system framework based on hybrid recommendation model for context aware digital signage in urban area with an anonymous viewer target. The findings for this research question provide differences module in the framework for Artificial Intelligence based system. The modules can be adapted in the framework in accordance with the proposed objective of the system. However, there are modules in the framework that can never be replaced which are inference engine and knowledge based modules for the framework to be claimed as Artificial Intelligence system.

B. *What are the existing techniques applied in the advisory system? (RQ2)*

The aim for this research question is to identify the most prevalent and frequently utilized techniques in the advisory system as shown in the Table IV. Based on the selected papers, fuzzy logic is frequently the technique used in the study alone and also combined with other techniques such as rule based and collaborative filtering as it used to handle ambiguous information [45]. Algorithm is also among the favorite techniques used in selected papers. However, the papers do not explain in detail about the algorithm.

Upon researching various technique in advisory system from the selected studies, it could be seen the limitations of hybrid technique to be applied. Among the selected studies, six employed a hybrid combination of techniques in their proposed systems. The application of fuzzy logic in a wide range of scenarios, from simple decision-making processes to complex systems with ambiguous data proving its efficacy in enhancing decision accuracy of an advisory system. Machine learning algorithms, such as neural networks, demonstrate their predictive power in pattern recognition and predictive modeling and the efficiency of specific algorithms, such as the Greedy Reranking Algorithm and Anytime Algorithm, is highlighted for their ability to provide optimal solutions in real-time advisory systems. Collaborative and content-based filtering approaches are useful for personalizing recommendations to specific users, increasing user happiness and engagement. In summary, the existing techniques in advisory systems are varied and complex, ranging from fuzzy logic to advanced machine learning algorithms. Each technique has its unique strengths and is chosen based on the specific needs of the advisory system.

TABLE IV. Technique applied in the selected papers

Technique	Source
The Greedy Reranking Algorithm	[46]
Anytime Algorithm	[47]
Prediction score for nearest-neighbour algorithms	[48]
Collaborative filtering	[49], [50], [51]
Learning algorithm	[43]
Joint modelling of multiple related problems	[52]
Data mining	[24]
Blockchain, Algorithm	[53]
Support Vector Machine (SVM), Multi-view Bi-Clustering, Classification Linear Bayes Normal, Rule-Based Reasoning	[23]
Big data and cloud architecture	[22]
API	[54]
Case based reasoning	[55]
Fuzzy thesauri	[18]
Decision trees, Rule based, and Semantic technologies	[56]
Machine learning algorithm, Data mining	[17], [57]
Neural networks	[16]
Fuzzy logic, Rule based	[15], [20], [58], [40]
Artificial Neural Network (ANN)	[59]
Big data	[13]
Forward-search backward-induction algorithm	[11]
Machine learning	[26]
Fuzzy logic, Collaborative filtering	[31]
Adaptive	[30], [42], [60]
Fuzzy cognitive maps	[29]
Algorithm	[28], [61], [35], [41], [62]
SQL query	[63]
Natural language processing	[32]
Ontology based	[34], [36]
Nearest neighbour	[64]
Content-based filtering	[65]
Bernoullli-Gausian mixture model (BGMM)	[66]
Deep learning, Neuro fuzzy	[67]
Fuzzy logic, Swarm optimization	[39]
Forward chaining, Certainty factor	[37]

C. In which domain that the AI technique is being applied in the advisory system? (RQ3

This research question aims to explore the domains in which Artificial Intelligence techniques are most frequently applied in advisory systems, as indicated by the selected papers. Figure 3 presents the distribution of domains across the selected papers, clearly showing that the Computer Science domain leads with 47 papers, followed by Medical and Engineering, each with 7 papers. Agriculture by 3 papers, Business[68], Psychiatry and other[69] by one paper. Throughout this research, we can see that there are many opportunities in researching Artificial Intelligence technique in other domains.

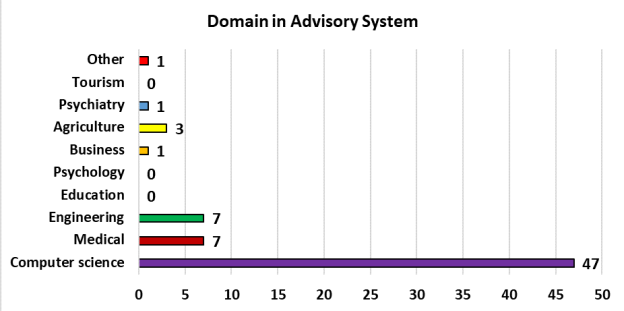

Figure 3. Domain in the selected papers

The research in Psychiatry domain discusses the benefits of AI in detecting mood disorders by using machine learning technique [26]. This research discusses the use of a combination of knowledge-driven and data-driven methodologies in the detection of depression and bipolar illness. In addition, knowledge-driven approaches offer valuable insights into emotional valence. However, data-driven approaches, such as deep learning and language analysis, exhibit potential in capturing more intricate patterns and representations. The aforementioned findings demonstrate the significance of integrating diverse approach and considering language content in order to achieve beneficial and all-encompassing identification of mood disorders. Additional research and experimentation on hybrid methodologies could potentially yield more resilient and efficient detection models.

In engineering domain, the uses of advisory system can be observed in [63], [70], [71], [72] and [73]. [63], investigates a knowledge-based advisory system in the automotive industry, focusing on its potential to enhance knowledge integration and decision-making processes among designers in vehicle design. [70] discussed the value of intelligent transportation as a fundamental component of smart urban areas, with a focus on intelligent and sustainable solutions an proposed a fuzzy logic based wind-aware speed adaptation to optimize energy consumption by adjusting the speed of electric bicycles based on wind conditions. The proposed solution demonstrates encouraging outcomes in terms of energy conservation and metrics related to comfort, suggesting its potential to contribute to the promotion of sustainable and enjoyable cycling in smart urban environments.

Advisory system in computer science domain was found to be overwhelmingly prominent in the research as fundamentally advisory system play a vital role in providing knowledge, decision support, and guidance to users. The computer science domain is rapidly evolving due to the continuous development of Artificial Intelligence techniques, significantly contributing to the advancement of advisory systems. The advancement of Artificial Intelligence technique enables advisory system to enhance in accuracy and effectiveness, making it as an indispensable tool in computer science domain. This research shows the importance and potential of advisory system in various domain to enhance efficiency and facilitate decision making process in a dynamic environment.

D. How to validate the advisory system framework? (RQ4)

In the context of validation of an advisory system, data-set/method comparison can analyze the performance of the advisory system compare to the existing solutions for its accuracy. Case study experiment is capable to validate an advisory system in a real world scenario by tapping into user interactions and the impact it have for the decision making process. Experts with extensive knowledge of a specific domain can provide significant perspectives which made expert review validation method is crucial in establishing credibility of an advisory system that align with the specific domain requirements. The mixed method validation which are mixing an expert review and case study experiment can ensures a full evaluation of an advisory system by taking into account both technical aspects and user attributes.

This research question examines the validation methods employed by the 67 selected papers in this research as shown in Figure 4. Of all the papers, data-set/method comparison validation is the most used validation method as show in Figure 4. Followed by case study experiment and the expert review. There are also papers that used mixed method which are case study and expert review. However, 17 selected papers did not mention their validation method. It is crucial for researchers to clearly articulate their validation methods, as this establishes the credibility of their research and facilitates more effective evaluation.

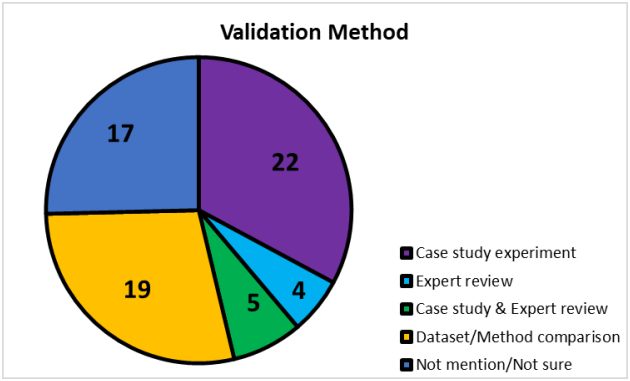

Figure 4. Validation methods in the selected papers

Overall, data-set/method comparison validation dominance as a common practice among the selected papers. The limited use of case study experiments and expert reviews, along with the absence of mentioned validation methods in some papers, raises concerns about the comprehensiveness and transparency of the research. The inclusion of mixed methods indicates the potential benefits of incorporating both quantitative and qualitative approaches to ensure a more robust validation process. Researchers should strive for clarity and transparency by explicitly stating their chosen validation methods, enabling better evaluation of their work.

4. CONCLUSION

This paper analyzed the existing studies about advisory system framework and to determine the domain areas which utilized advisory system. A Systematic Literature Review (SLR) is an appropriate method for reviewing this research, as it answers the research questions and fulfills the research's objectives. The findings of this research indicate the use of advisory system in many domains such as in computer science area (most used), medical and other domain. Additionally, many studies have incorporated Artificial Intelligence techniques in advisory systems, showing a trend towards the integration of complex algorithms such as fuzzy logic. This indicates a shift towards more sophisticated, data-driven approaches. In addition, it is necessary to conduct more comprehensive analysis in understanding advisory system frameworks considering the advisory systems' ability in adapting to the emerging of an Artificial Intelligence technology. Moreover, comprehending and understanding user interactions can significantly contribute to optimizing the full potential of advisory systems to empower a decision support in a various domain for life improvement. However, the review highlights a gap in the validation techniques used in existing studies, suggesting an opportunity for future research to develop more comprehensive validation frameworks. This review provides a thorough analysis of the current state of advisory systems, establishing a foundation for future advancements in this field.

5. ACKNOWLEDGEMENT

Appreciation is also conveyed to University Malaysia Pahang Al-Sultan Abdullah for project financing under UMPSA Matching Grant RDU200751.

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