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Integrating expert system in managing basic education: A survey in Ghana

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ABSTRACT

Management of basic education in developing countries like Ghana is a major challenge as resources are not adequately available for effective teaching and learning in schools. Careful planning and prediction using available data is also a major challenge as there are inaccuracies and inconsistencies in the available data. An investigation into the use of an Expert System for easy management of the resources is carried out in this research to know the level of readiness to accept an ES to assist in management. Stakeholders of education are contacted to solicit their views. With 216 districts for managing education in the country, a minimum of 3 participants were selected from each district to constitute a sample for the survey. In all 648 participants data were analyzed. The unstructured interview was also conducted using 9 members of an executive position in management. A thematic analysis was done on the responses and presented in diagrammatic form. The Acceptance Model for Educational Expert System (AMEES) is also presented. The results showed the majority of respondents agree with the use of an Expert System (ES) to assist in managing basic education. The use of data mining techniques to filter the data in an ES and help in easy prediction for decision-making accuracy is a necessity.

1. Introduction

The application of technology to identify problems and predict solutions is a modern trend in research. This assists in research work to easily solve problems that require a longer duration within a shorter time. Education as the foundation for growth and development in a country requires special attention, especially at the basic level. Leveraging success from the basic level of education to a higher level is the easy means to achieving quality education. Challenges to basic education strongly affect education in a country at all levels. In this regard, addressing the challenges of education at the lower level is a necessity. Access to quality education starts from the availability of resources for effective teaching and learning (Inusah, Missah, Najim, & Twum, 2022). These resources should be adequate for all manner of learners to enhance inclusivity and equity. In Ghana, the management of educational institutions however has challenges with the provision and utilization of resources due to improper policies and inaccurate data from schools. According to Inusah et al. (2021) an already existing system for educational data collection and management in the country is the Educational Management Information System (EMIS) which is under the Ministry of Education. Educational data in Ghana is characterized by errors in data, resulting in inaccurate decisions. A system to address these challenges is a necessity(Inusah et al., 2023). Related literature available such as (Etsey et al., 2009) proves that researchers use reporting and simple graphs and tables to present the challenges of education and educational management as a whole. These methodologies do not provide accurate solutions to the problems of basic education in the country therefore mismanagement of the limited resources. According to MOE (2018), over 33% of the expenditure for education in the country is from basic education which is the foundation for growth and development in the country. The use of expert systems to solve related challenges proves a success. In Zhou et al. (2021), a survey conducted on a Belief Rule-based ES (BRB ES) revealed that the BRB ES has attracted a lot of users. As indicated by Chang et al. (2016), it is good for both qualitative and quantitative data as it is used for the classification of weight calculation procedures. Optimization of the structure and parameter of BRB ES is considered (Zhu et al., 2021). The BRB ES is however good for uncertain situations and also good for handling complex problems. As the challenges of education are connected to the availability of resources, the solutions can easily be predicted using resource availability. This liking can easily be presented in the form of a neural network accompanied by rules.

The readiness and willingness of a system to be used to solve a problem by the users is a necessity. A user acceptance survey is, therefore, necessary to help in investigating the zeal of users to accept and use the system. A survey on ES development by Jabbar and Zaman Khan (2016) revealed the importance of domain experts in the develop-

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ment of ES. It also highlights the integration of social science methodologies to enable an easy understanding of concepts by non-experts. In addition, the adoption of a system to change should be considered. In Arya and Tiwari (2016) a survey on ES for breast cancer diagnosis and the key features of ES for breast cancer management have been explored. In Sayed (2021), ES application in educational decision-making revealed an improvement in managing education when the various components of the ES are properly used in the development process. The goal of this paper is to ascertain the readiness and willingness of educational management to accept and use an expert system in managing basic education. The following research questions guide the research

- How ready is the educational management in Ghana to accept an expert system?
- What are the expectations of users on the proposed expert system?

The remaining part of the research work is organized into related work which comprises available literature of importance to the research, the methodology which spells out how the research was carried out, presentation of results gathered from the tools and techniques applied in methodology, discussion of the findings from the results, implications and the conclusions drawn.

2. Related work

The application of ES in managing basic education is a novel area with few publications to assist in literature. The paper (Inusah et al., 2021) used data mining techniques to identify the challenges of basic education in Ghana. This was done using already existing data from the EMIS in Ghana. A conscious effort in presenting the challenges and solutions of basic education is proposed by (Inusah et al., 2022) using an agile expert system. Larger databases across the globe require more technical tools to filter out errors and refine information for further processing. In Neogi et al. (2021), larger data gathered from social media sentiments are analyzed to determine protest sentiments shared at international levels. In a related paper, Mishra et al. (2022) used Natural language processing to process data from tourism which is of international importance to both nations and individuals. Also, social media data collected from micro-blogging sites to understand the tourism sector during covid-19 employed detailed analytical tools to handle the data (Mishra et al., 2021). In R et al. (2021), technological artefacts supported by intelligent systems are used by the banking sector to support financial management. The application of AI in human resource management as a domain is reviewed in the literature (Votto et al., 2021a). salient factors include; management of discipline, recruitment procedures, best practice analysis, performance evaluation, capacity building, compensation, and development systems that have increased in the use of AI. The reasons behind students' adoption and use of the Learning Management System (LMS) are presented in Al-Mamary (2022). The Technology Acceptance Model (TAM) was tested with a structural Equation Modeling (SEM) and the learner attitude and intention towards the use of LMS was very positive due to the efficiency in usage. In Unhelkar et al. (2022), supply chain management in decision support systems using industry 4.0 is presented. This shows higher efficiency in saving time and reducing costs. In related work (Deepu & Ravi, 2021), the digitization of the supply chain is integrated into the MCDM approach to enhance efficiency in the Inter-Organizational Information System (IOIS) which has become the backbone of the modern supply chain. Another decision support system by Ali et al. (2022) is used in the global and local supply chain. The value-at-risk analysis is used to assess supplier risk and revenue impact which proves the effectiveness of the supplier risk profile. To assist businesses in financial decision-making, an expert system is used (Inusah & Amponsah, 2018). These pieces of evidence point to the strength of the application of technology in solving real-life problems. Relating this to the basic education sector in Ghana is therefore a necessity.

2.1. Basic education in Ghana

As indicated by Inusah et al. (2021), the educational system of Ghana starts from basic education through secondary education to higher education. The core of education is basic education which comprises a two-year kindergarten, six years of primary education and three years of Junior High education. In the paper (Darvas & Balwanz, 2014), the progress of basic education in Ghana, as well as the challenges hindering the growth of education in Ghana, are presented. Several interventions have brought improvements in basic education but challenges such as resource inadequacy affect the growth of education leading to dropouts, especially in rural areas. The paper (Mensah et al., 2020) looks at the factors to consider in strengthening basic education in Ghana. Paramount among these factors is the provision of resources to enable all manner of learners to have access to basic education. This will help in reducing the dropout rate and retain learners in school to improve the quality of education in the country. The paper looks at the interventions taken by Ghana to retain children of school-going ages in school. This intervention stresses the provision of resources such as learning materials and school uniforms. The trajectories of basic education in Ghana can be traced to the policies of education. The politics of Ghana strongly affects the education system. Educational reforms and policies to make the reforms work keep changing as different governments come and go. Ghana seems not to have a stable development plan due to this. This affects resource availability in basic schools and affects the quality of education in the country. As indicated (Akyeampong, 2009), the provision of the resources of basic schools requires a public-private partnership. This however cannot be done if the stakeholders of education cannot plan for the provision and utilization of resources in schools. In examining the prospects and challenges of both education and health in Ghana, Abukari et al. (2015) point to the policies and interventions that drive the two sectors. Notable among these is the availability of grants and the provision of resources for basic schools. The access to basic education in Ghana (Inusah, Missah, Najim, & Twum, 2022) points to the availability of resources as a major factor affecting the enrolment of learners. In a learning environment where there are limited resources, challenges in education are common. The report (Ministry of Education Ghana, 2019) estimated the budget for education in Ghana with a noticeably higher expenditure at the basic education level. This means that the majority of funds dedicated to education in the country go to basic education. Despite all these interventions, basic education in the country still has challenges due to improper planning and provision of resources.

2.2. Current technology for managing basic education in Ghana

The EMIS is the main source of information for stakeholders in managing basic education in Ghana. This system is managed by the Ministry of Education (MoE) which is in charge of education in the country. It is used in Moses Azerimi Azewara et al. (2021) to know the true picture of teacher distribution in basic schools in Ghana which puts the rural schools at a disadvantage. The availability of educational data through this system is however characterized by inaccuracies of data (Inusah et al., 2021). This makes it difficult (Votto et al., 2021b) for the management of education in Ghana to plan and predict the resources needed in managing schools. There is no known system to assist stakeholders in managing basic education except the data and the reports in charts and tables produced by EMIS. As many of these stakeholders are not management experts, there is a serious challenge posed.

2.3. Technological acceptance model

A literature review of the technology acceptance model (Marangunić & Granić, 2015) sees the acceptance or rejection of technology as a question many users still find difficult to answer. The paper stresses the Technological Acceptance Model (TAM) introduced by Fred Davis in 1986. In e-learning, (Salloum et al., 2019) analyzed literature from about 120 research papers over about 12 years. Findings revealed that external factors for TAM range from perceived usefulness to the actual usefulness of the technology. In Granić and Marangunić (2019), a systematic literature review on TAM revealed two variables; perceived ease of use and usefulness as the core variables affecting the acceptance of technology. This is a clear indication that user perception and acceptance of the usage of a system is a requirement before system development. In a related review, Williams et al. (2009) looks at the trend in accepting and disseminating IT research which reveals that TAM is widely used by researchers. This proves the quality of the methodology in research. Also, Williams et al. (2015) reviewed the willingness of users to accept technology and realized STEM and TAM as commonly used in research. In extension. Tamilmani et al. (2021), reviewed papers on the acceptance and use of technology which reveals higher interest and citation in the use of UTAUT2. Accepting and using innovation is of higher interest to many researchers (Kapoor et al., 2022). Many factors influencing the choice and use of technology are centred on zeal and willingness. The adoption and use of m-commerce also prove user acceptance as a major factor before choice (Chhonker et al., 2018). The early adoption of AI improves the efficiency of work in many environments. In Kar and Kushwaha (2021), both exploratory and confirmatory studies confirmed the factors necessary for the adoption of technology to improve innovation and the general quality of products through quality personal and organizational attributes. Faster adoption of technology also enhances speeded development (Asrani & Kar, 2022). However, there are regional variations in technology adoption which supports the assertion that social systems impact technology adoption.

2.4. Importance of expert system

The relevance of ES in education is noticeable in Sayed (2021) and Zhang and Aslan (2021). To Supriyanto et al. (2018) and Khosravi et al. (2022), the application of ES in education spans various aspects of quality education. This can help in improving the quality of education which can be leveraged to achieve success at higher levels of education. As indicated in (Shahriar et al., 2022), the training of employees can easily be done using a web-based ES. This will help in easing the pressure on teachers and also enable learners to learn at their own pace. Both theoretical and practical applications of ES and the gaps in the literature are captured in Chen et al. (2020). The necessity of using ES in management is presented (Dašić et al., 2011). Strategic management critically examines alternative factors before making a choice. These alternatives can be put into rules in an ES for easy decision-making. Administrative decisions can be improved through ES (Gaber & Fahim, 2018). The effectiveness of management can be determined through ES (Mavaahebi & Nagasaka, 2013). As indicated by Votto et al. (2021a), the prevalence of AI is a result of the efficiency in enhancing effective management. The prediction of early warning skills in the hiring of educators is seen in Yazdanian et al. (2022). In the history of education, the ability of students to write in linguistics and complexity analysis is presented in Bertram et al. (2021). To improve the management of projects and reduce delays in the construction sector, an ensemble predictive model is used in the paper (Egwim et al., 2021). A data-driven decision-making aimed at improving port logistics for the physical movement of resources across the globe grouped the barriers into clusters (Sarkar & Shankar, 2021). The evolution of ES and its functionalities (Wagner, 2017) can be seen in the trends of ES development over the decades of its existence. In the management of road traffic, the use of ES can be seen in its use to enhance traffic management through the use of digital maps (Gong et al., 2020). In easing agile practice adoption, the use of ES has helped in enhancing efficiency (Kiv et al., 2022). As the gaming approach in computing gains more attention, the support of knowledge engineering in ES has helped in improving reliability (de Rosa et al., 2019). It is these numerous factors of evidence proving the efficiency of ES that makes a lot of industries use ES to improve efficiency in solving their problems. The use of ES in management and decision-making is therefore paramount for effective business and boosting profit (Castelli et al., 2017). The use of ES is therefore a necessity in education in solving problems the human expert finds difficult to solve. This helps in increasing efficiency and effectiveness in educational management. The case of basic education is not an exception.

2.5. Survey on systems

In Mason and Rich (2020), the attitude of elementary students towards coding is surveyed to know the efficiency of students. Structural Equation Modeling (SEM) was used to analyze and present the findings. The use of AI to solve problems in education is also surveyed in the paper (Cheng et al., 2018). In this survey, the ability of robots to assist in teaching and helping learners to acquire social skills is presented. A related paper (Raffaghelli et al., 2022) used a survey for a techno-pedagogical innovative AI system for early warning of students. SEM is used again for the analysis to present the findings. The views of managers and vendors in an E-exam in Norwegian higher education from the digital ecosystem perspective are also presented in Chirumamilla and Sindre (2021).

3. Methodology

As the challenge of basic education is cancer, this survey uses both qualitative and quantitative data collected from stakeholders of education in Ghana. The constituents of the participants of the qualitative aspect are thirteen (13) officers from various sectors in managing basic education in Ghana. Three members of the Ministry of Education (MoE); two from the EMIS team and one from the Basic Education Division. Four members of the Ghana Education Service (GES); one member from the Head Quarters, one member from the regional offices, one member from the district officers, and one member from schools. Two members of the National Schools Inspectorates Authority (NaSIA); one member from the administrative and finance team and one member from the Inspectorate Board. Four members of the system development team; System analyst and designer, the first system supervisor, the Second system supervisor, and the third system supervisor.

3.1. Population and sampling

The quantitative data was gathered from heads of basic schools and schedule officers in educational management. Simple random sampling was used to select the respondents of the survey. For easy access to participants, all 16 regions in Ghana making up the 216 districts had at least 3 respondents each. In all, 648 respondents were selected as the sample which constitutes 3 respondents each from a district. The district statistics planning officer and two headteachers from basic schools were the participants from each district for the 16 regions. The data was analyzed using thematic analysis with an inductive approach.

3.2. Data collection

Data for the research was collected from the sampled participants who responded to both the survey and the interview. The responses from the interview are qualitative data while the survey responses are quantitative. This mixed method gave the research detailed responses from the various stakeholders of education who are directly involved in the decision-making process. The survey data was made of both string and numeric types with a maximum of 16 characters for a response. These responses were further coded to numeric variables using SPSS for the quantitative analysis. A sample of the data is presented in Fig. 1.

3.2.1. Data collection instruments

Specifically, two instruments were used for the research; an interview guide and a survey questionnaire. The instruments were carefully designed to avoid biases in response. These two instruments were tested to know their validity and reliability before use.

	A	B	C	D	E	F	G	H	
1		sex	Which level are you tea	How long have you beir	Indicate your role in you	Are the	Are the	1 Data collection	1 Data
2		Female	KG	less than five(5) years	School head	No	No	strongly agree	agree
3		Male	Educational manageme	5-10 years	Scheduled officer	Yes	Yes	agree	agree
4		Male	Educational manageme	11-15 years	Scheduled officer	No	No	strongly agree	some
5		Female	Educational manageme	16-20 years	Scheduled officer	Yes	No	agree	strong
6		Male	Educational manageme	5-10 years	Scheduled officer	No	No	disagree	some
7		Male	KG	5-10 years	School head	No	Yes	strongly agree	strong
8		Male	Primary	11-15 years	School head	No	No	somewhat agree	some
9		Male	Primary	5-10 years	School head	No	Yes	strongly agree	strong
10		Male	Educational manageme	16-20 years	Scheduled officer	No	No	somewhat agree	some
11		Female	JHS	5-10 years	School head	No	Yes	strongly agree	strong
12		Male	Educational manageme	16-20 years	Scheduled officer	No	Yes	agree	agree
13		Male	Educational manageme	11-15 years	Scheduled officer	No	Yes	somewhat agree	strong
14		Male	KG	11-15 years	School head	No	Yes	agree	some

Fig. 1. Sample Data of Responses.

3.2.2. *Validity and reliability*

The instruments for the survey were tested using University for Development Studies Faculty of Education postgraduate students. The university is located in the Sagnarigu Municipality of the northern region of Ghana and the students are Master of Philosophy students in Educational Administration, Educational Training and Development and Educational Measurement and Evaluation. These students are mostly people in managerial positions in educational institutions who are preview to educational data and the challenges of basic education in the country. The nine-member consulting team is selected as the domain experts to give the necessary advice on the nature of the resources and the managerial decisions that are to be taken on the availability and provision of such resources in schools. The integration of AI into the system for effective management of basic education can best be achieved with the support of various stakeholders. Four members of the expert development team; a system analyst and designer and three supervisors are in charge of the development. All these stakeholders are actively involved in the development of the system.

3.3. *Data analysis*

The quantitative data were analyzed in SPSS AMOS and Structural Equation Modeling was used to know the relationship between and among responses which shows the strong zeal or willingness to use an ES to support decision-making. The aspect of challenges, mitigations and the integration of the system for effective decision-making is considered in presenting the results of the SEM regarding the variables linked to them. The qualitative data was analyzed using thematic analysis. This method is both powerful and flexible for the analysis of the responses to the interview. The six-step framework for thematic analysis by Braun & Clarke (2006) was used. The structure of the quantitative analysis is presented in Fig. 2 and that of the qualitative thematic analysis is presented in Fig. 3

3.3.1. *Quantitative data*

As user acceptance is a requirement in developing a system, representatives of various stakeholders were contacted in knowing the challenges with the current system and the readiness in using the new system. To cater for all possible responses in the user acceptance survey, responses of the users were coded from the seven-point Likert scale from 1 to 7 with 1 as strongly disagree, 2= somewhat disagree, 3 = disagree, 4 = as neutral, 5= somewhat agree, 6 = agree and 7 = strongly agree. This constitutes the quantitative data for the study.

3.3.2. *Qualitative data*

A thematic qualitative analysis of responses from the various members of the development team was done to know the nature of the problem for a sustainable solution. Inductive analyzes of the responses are

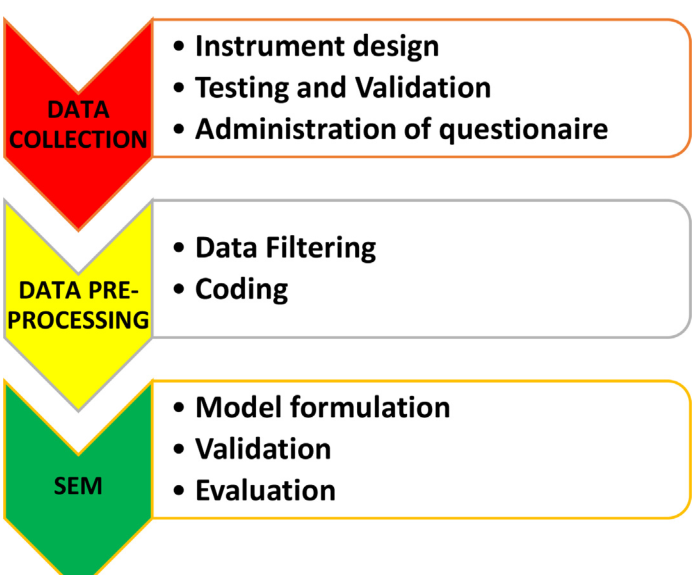

Fig. 2. steps in quantitative data analysis.

Fig. 3. Six-Step Thematic Analysis. (Source: (Braun & Clarke, 2006)).

used in concluding to get the final plan for the development of the system to avoid propaganda. These themes are further compared to the result of the survey to get the common responses of the stakeholders in other to get the true needs of the users of the system.

4. Results and findings

The results and findings of the study are presented in two sections based on the research questions and the instruments used in data collection. A survey questionnaire was used in collecting data from respondents to answer the first research question; how ready is the educational management in Ghana to accept an expert system? The second research question (What are the expectations of users on the proposed expert system?) was handled by the interview conducted with the domain experts as indicated in Table 2. The data gathered was analyzed using inductive thematic analysis to identify the challenges, mitigations and integration of the system to real life.

Table 1
Constituents of the Team for the System Development.

No	Role	Sector
1	Senior Data Officer	MoE-EMIS
2	IT Officer	MoE-EMIS
3	Director of Basic Education	MoE- Basic Education
4	Representative of Director-General	GES
5	Representative of Regional Directors	GES
6	Representative of District Directors	GES
7	Representative of Schools	GES
8	Admin and Finance member	NaSIA
9	School Inspectorate Member	NaSIA
10	System Analyst and designer	IT Expert
11	First Supervisor	IT Expert
12	Second supervisor	IT Expert
13	Third Supervisor	IT Expert

4.1. Survey results

The responses of the membership of stakeholders revealed the challenges of basic education concerning the data on resources and decision-

Table 2
Sample Interview Questions for Domain Experts.

1.	Introduction
1.1	Where do you get data on basic education in Ghana?
1.2	What are your most important challenges in managing educational data for decision-making?
1.3	Which reasons account for your challenges?
2	**Data Gathering**
2.1	Do you get your data from schools through EMIS?
2.2	Do you accept data mining in processing your data?
2.3	Are your decisions supported by the data?
2.4	Do you believe in the ability of a system to make or assist in making decisions?
3	**Analysis**
3.1	Which data analytical tools do you use in processing your data for prediction or forecasting of future information?
3.2	How do you analyze your information?
3.3	Do you sometimes use intuition to do your analysis and interpretation?
4	**Generalization**
4.1	Do you judge information using your experience, knowledge or environment?
4.2	Do you frequently use DSS for decision-making?
5	**The future use of ES in Decision-Making**
5.1	Indicate the stage in DM at which you will like ES to support you. a) Data gathering b) Analysis c) Generalizing
5.2	If an ES can do everything in decision-making, what will you like it to do?
5.3	Given the chance to use ES in decision-making, will you trust the system?

Table 3
Summary Results of the Responses from the Survey.

QUESTION	SA	A	SWA	N	SWDA	DA	SDA
Data Collection Challenges							
Data requested by EMIS overloaded	**162** 25%	**229** 35.3%	**131** 20.2%	**35** 5.4%	**38** 5.9%	**44** 6.8%	**9** 1.4%
The time needed for data is too short	**200** 30.9%	**227** 35%	**110** 16.9%	**27** 4.17%	**35** 5.4%	**39** 6.0%	**10** 1.5%
High cost of providing information	**122** 18.8%	**148** 31.6%	**165** 25%	**28** 4.3%	**56** 8.6%	**89** 13.7%	**40** 61.7
Accuracy of the Data							
The information seen is a true reflection.	**252** 38.9%	**242** 37.3%	**102** 15.7%	**28** 4.3%	**10** 1.5%	**11** 1.7%	**3** 0.5%
Attempts to influence information	**85** 13%	**169** 26.1%	**161** 24.9%	**71** 11%	**33** 5.1%	**68** 10.5%	**61** 9.4%
There are some errors in the data.	**111** 17.1%	**205** 31.6%	**169** 26.1%	**62** 9.6%	**38** 5.9%	**35** 5.4%	**28** 4.3%
Challenges misrepresented	**124** 19.1%	**204** 31.5%	**155** 24%	**50** 7.7%	**30** 4.6%	**59** 9.1%	**26** 4%
Using Information System							
The structured information system will improve the management of data	**315** 48.6%	**266** 41%	**54** 8.3%	**8** 1.23%	**3** 0.5%	**2** 0.30%	**0** 0.0%
Trust a decision based on the data	**238** 36.7%	**291** 45%	**90** 14%	**14** 2.1%	**9** 1.4%	**4** 0.60%	**2** 0.3%
Accept application for accuracy.	**267** 41.2%	**293** 45.2%	**55** 8.5%	**19** 3.0%	**13** 2%	**0** 0.00%	**1** 0.1%
Updating data online.	**289** 44.6%	**262** 40.4%	**65** 10%	**16** 2.5%	**8** 1.2%	**4** 0.60%	**4** 0.6%
Integrating the System for Effective Decision-making.							
EMIS combined with other applications will help	**275** 42.4%	**284** 44%	**66** 10.1%	**10** 1.5%	**3** 0.5%	**6** 0.90%	**4** 0.6%
Privacy affects data	**207** 32%	**235** 36%	**132** 20%	**29** 4.5%	**16** 2.5%	**18** 2.8%	**11** 1.7%
A good system improves the effectiveness	**292** 45%	**271** 42%	**54** 8.3%	**16** 2.5%	**6** 0.9%	**6** 0.90%	**3** 0.5%
Using ES for Educational Decision-Making							
Trust of Expert System	**258** 40%	**305** 47%	**65** 10%	**13** 2.0%	**3** 0.5%	**3** 0.50%	**1** 0.1%
Accepting ES results	**226** 35%	**293** 45.2%	**93** 14.4%	**19** 2.9%	**8** 1.2%	**8** 1.20%	**1** 0.1%
Transparency for accepting results	**253** 39%	**286** 44%	**82** 12.7%	**17** 2.6%	**5** 0.8%	**1** 0.10%	**4** 0.6%
Availability of domain expert	**208** 32%	**303** 46.7%	**85** 13%	**23** 3.5%	**9** 1.4%	**13** 2.0%	**7** 1.0%
Not confident with ES results.	**93** 14.4%	**164** 25.3%	**182** 28%	**62** 9.6%	**42** 6.5%	**75** 11.6%	**30** 4.6%
Advantages of ES in Management Decision-making.							
Believe in ES speed.	**279** 43%	**269** 41.5%	**73** 11.3%	**12** 1.9%	**10** 1.5%	**4** 0.60%	**1** 0.1%
Believe in ES accuracy	**224** 35%	**314** 48%	**91** 14%	**12** 1.9%	**2** 0.2%	**3** 0.50%	**2** 0.2%
ES avoid emotions and personal interest	**242** 37%	**269** 42%	**94** 15%	**21** 3.2%	**9** 1.4%	**13** 0.2%	**0** 0.0%
Disadvantages of expert systems in decision-making							
7.1 The human intelligence and feeling of knowing will be missing	**155** 24%	**264** 40.7%	**156** 24%	**22** 0.3%	**18** 2.8%	**27** 4.2%	**6** 0.9%
Results of ES may be misused	**126** 19.4%	**248** 38%	**159** 26%	**44** 6.8%	**25** 3.9%	**37** 5.7%	**9** 1.4%
The system will misclassify irrational situations.	**129** 20%	**218** 33.6%	**175** 27%	**50** 7.7%	**25** 3.9%	**40** 6.0%	**11** 1.7%
Human ES Decision-making Structure							
Delegation expert system	**157** 24%	**262** 40%	**150** 23%	**30** 4.6%	**20** 3.1%	**22** 3.4%	**7** 1.1%
Results of ES suggest approval.	**183** 28%	**319** 49%	**101** 15.5%	**22** 3.4%	**10** 1.5%	**7** 1.1%	**6** 0.9%
Rule-Bases ES for integration	**200** 31%	**302** 46.6%	**96** 15%	**19** 3.0%	**14** 0.21%	**12** 1.9%	**5** 0.8%
Task Delegation to ES							
ES to identify specific challenges.	**226** 35%	**285** 44%	**99** 15%	**15** 2.3%	**4** 0.6%	**13** 0.2%	**6** 0.9%
System to propose a course of action	**181** 28%	**291** 45%	**120** 19%	**21** 3.2%	**13** 0.2%	**16** 25%	**6** 0.9%
System to select the best options	**172** 27%	**255** 40%	**143** 22%	**24** 3.7%	**17** 2.6%	**26** 4.0%	**11** 1.7%
System to teach implementation	**164** 25%	**267** 41%	**133** 21%	**28** 4.3%	**17** 2.6%	**23** 3.5%	**16** 25%
Roles for expert system							
System to give recommendations on progress in decision-making.	**274** 42%	**287** 44%	**47** 7.3%	**14** 2.2%	**11** 1.7%	**14** 2.2%	**1** 0.1%
ES to teach the procedure	**274** 42%	**287** 44%	**47** 7.3%	**14** 2.2%	**11** 1.7%	**14** 2.2%	**1** 0.1%
System to have an explanatory component.	**295** 46%	**275** 42%	**47** 7.3%	**14** 2.2%	**7** 1.1%	**5** 0.80%	**5** 0.8%

making. The various aspect of human decision-making and the errors associated with the human aspect such as inaccuracies are indicated. The major source of educational data is the EMIS and the dominant challenge of educational data is inaccuracies as a result of human errors for which the reasons are attributed to errors at the point of data entry. In the data gathering for decision-making, all respondents get data through EMIS, and claim to filter data to minimize errors but do not use technical tools in data mining. Also, decisions are claimed to be supported by the data. They however believe their decisions can be assisted by the use of the software. Common among all the data processing tools for respondents is Microsoft Excel through charts and tables and the intuition of the user is applied in making a judgment. In general, the major issue is the application of experience as the number of working years is considered a factor by the respondent. The use of a DSS however is on the mere application of the data for decision-making by humans.

On readiness to use ES in decision-making, 157 respondents representing 24% strongly agree, 262 representing 40% agreed, 150 representing 23% somewhat agreed, 30 representing 4.6% are neutral, 20 representing 3.1% somewhat disagree, 22 representing 3.45% disagreed, 7 representing 1.1 strongly disagree. This overwhelming response shows the zeal to use an ES to address the challenges barring unforeseen circumstances. Table 3 presents a summary of the results of the survey.

In Table 3, the responses from the survey questionnaire were collated and presented in both frequency and percentages using SPSS. With more than 75% of respondents being males, close to 70% of respondents having more than a decade of experience, and over 61.7% being administrative headteachers who are detached from teaching purposely to manage the schools, one would have been expecting a better exhibition of managerial skills to improve the schools. 16% are scheduled officers to the management of education in the education offices, and about 15% and 6.8% are subject teachers and classroom teachers respectively combining teaching with administrative work. As an indication of improper management, close to 90% of respondents said resources are not adequate for effective teaching and learning in schools. Close to 62% of the respondents also feel the decisions made are not accurate enough to solve the problems in the schools. This may be due to a lack of managerial skills as the leadership in managing schools are often teachers who can rise through the ranks in the Ghana Education Service (GES) (Figs. 4–9).

As indicated in Table 3, the use of the Seven-point Likert Scale gives respondents the chance to accurately present their views. A larger number of the respondents admit there are challenges with data collection regarding the quantity of data needed concerning time and cost. Regarding the accuracy of the data, the majority feel there is an attempt to

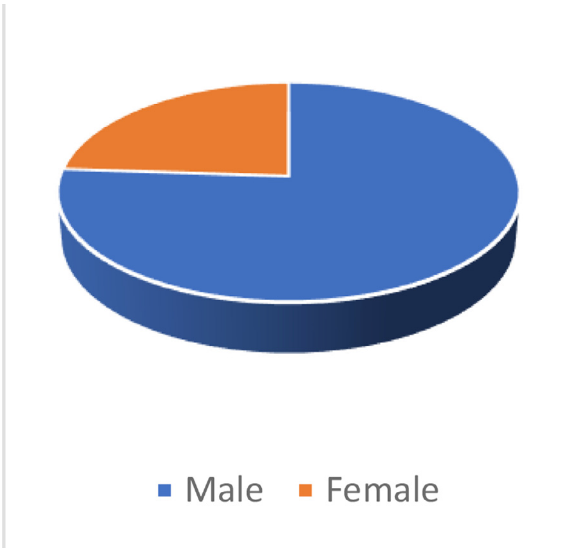

Fig. 4. Sex of Respondents.

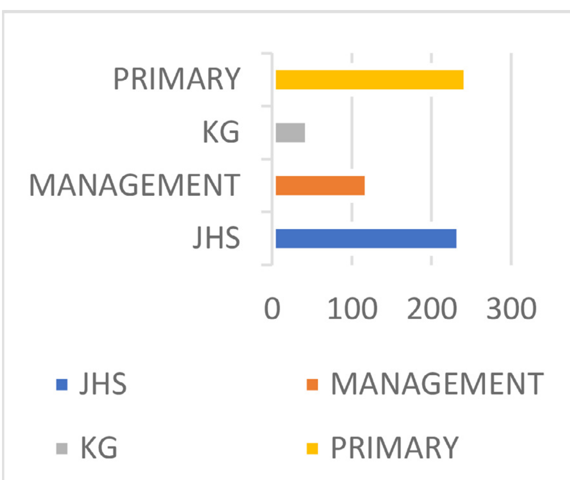

Fig. 5. Level Managing.

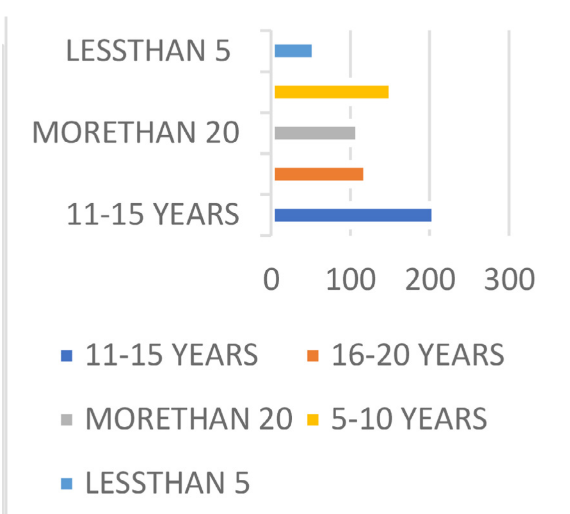

Fig. 6. Duration in Service.

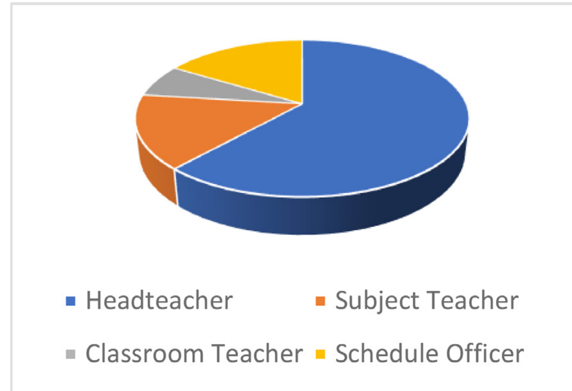

Fig. 7. Managerial Role.

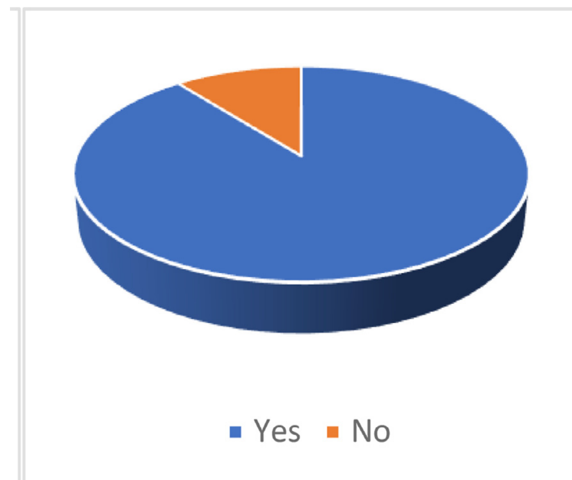

Fig. 8. Resource Adequacy.

influence the results due to human interest because the information does not represent the true picture of their schools which shows a clear admission of errors. For the aspect of information system usage, the majority agree the use of a system will help. They pledge to support by accepting an application to manage the situation, provide data online and also trust the system results. On integrating the system, the majority believe the system should be integrated into the EMIS and the data should be properly validated taking into consideration the privacy of users. On the aspect of using ES for decision-making in education, the majority said they will accept and trust the results of ES if there is transparency and domain expertise to help in building trust. This is due to their belief in ES speed and accuracy in decision-making which also reduces inconsistency and personal interest. They however noted that the human feeling of knowing will be missing, the fear of misuse of the system will appear and the system will misclassify irrational situations. The overwhelming majority pledge their support for ES which can integrate the rules in decision-making and seek their approval of decisions. They expect the system to identify specific challenges, know the course of action, suggest the best solutions and also teach the implementation procedure. Roles proposed by the users for the ES are; recommendations on progress in decision-making, the teaching of procedure and explanation of decision results. It is prudent with this information to get a more robust system that can assist in decision-making as the users of the proposed system expressed interest and willingness to use the system. Components of the expert system to be considered in the development are the rule-based inference engine to cater to the rules to generate a decision result, a knowledge base which considers the professionalism of basic education

Table 4
Regression Weights for Challenges, Mitigations and Integration.

Variable	Challenges					Mitigations			Integrations			
	C1	C2	C3	C4	C5	M1	M2	M3	INT1	INT2	INT3	INT4
Estimate	1.00	1.10	1.36	0.88	0.75	1.00	1.45	1.46	1.00	1.08	0.86	0.74
SRWE	0.64	0.71	0.71	0.54	0.44	0.56	0.72	0.65	0.72	0.75	0.63	0.44
Intercept	5.42	5.58	4.73	5.11	5.09	6.35	6.20	6.20	6.21	6.23	6.15	5.94
SE	0.06	0.06	0.07	0.06	0.07	0.03	0.03	0.04	0.04	0.04	0.03	0.05

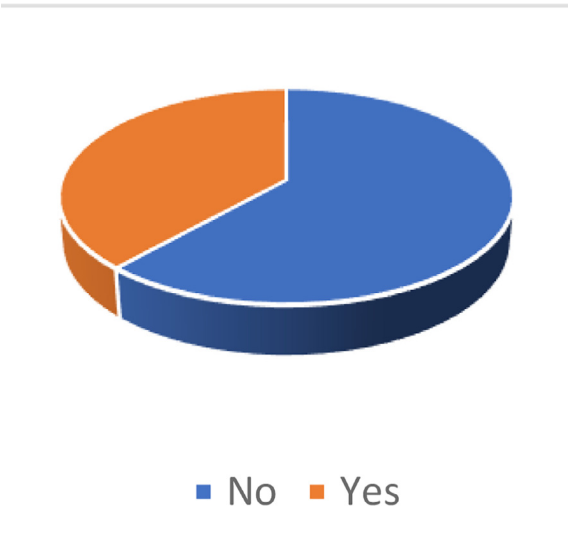

Fig. 9. Decision Accuracy.

and an explanation subsystem to assist users to understand how the system works. Admittedly, few respondents had descending views. These minority groups felt the ES is not necessary for addressing the challenge. They see the addition of more work to management since they now have to consult a system before making a decision. They also believe that the human expert is more reliable than the ES. This notwithstanding places the majority view as the best alternative to address the challenge since the system will not replace the human expert but rather assist in decision-making.

4.1.1. Structural equation modeling (SEM) results

As indicated in the methodology, the responses from the survey were coded to the numeric value for quantitative analysis. SPSS Amos was the software used and the tool applied in the analysis is the SEM. To establish the degree of willingness and acceptance for the ES, there was a need to know the relationship between users' responses in the survey. Major factors under the challenges, mitigation and integration were selected for this purpose. The variables under challenge are data overload (C1), time (C2), cost (C3), errors (C4) and Misrepresentation (C5). Under mitigation, the use of a structure information system (M1), combining EMIS with the application for filtering errors (M2) and updating the data online (M3) are the variables. Integration has four variables; linking ES to EMIS data (INT1), validation and verification (INT2), ensuring transparency (INT3) and user support (INT4). A recursive model was generated from the results which shows the relationship between and among the variables, with a larger sample size (648). The results presented in Tables 4–6 show the various relationships, estimates, Standard Regression Weights Estimates (SRWE), Intercepts and the Standard Error which depicts a very strong relationship between the various variables used. Fig. 10 is the SEM for the challenges, mitigations and integrations.

The regression weights in Table 4 and the corresponding standardization in Table 5?" clearly indicate a strong relationship among the variables. This shows a clear indication of the zeal to accept ES for decision-making. Intercepts for the variables as well as the co-variance show strengths in values with corresponding strong positive correlation estimates even though the variance shows a wider dispersion. The factor scores weights in Table 6 show a strong impact or contributions of the various variables to the groupings in the challenge, mitigation and integration.

4.2. Thematic analysis results

A thematic analysis of the responses from the interview was done and presented in an illustration for easy understanding. To avoid propaganda, inductive analysis was employed to make meaning from the responses and put them into themes. Six major steps were used in arriving at the theme; familiarization, coding the data, generating initial themes, reviewing the themes, naming and defining the themes, and writing up the reports.

4.2.1. Steps in the thematic analysis

The responses from the interview and the survey which are in qualitative form were first scrutinized and thoroughly read for better understanding. Transcription of the data was done after listening to the responses of the interviewees in the opened ended interview and the survey. This was done to have a logical view. Coding of the information was done so that labels can be assigned to the various categorizations. Initial themes were generated by grouping the responses to the most prioritized based on the number of respondents who responded to that theme. These themes were later reviewed to follow the order of hierarchy in system requirement gathering by beginning with data collection through challenges to the solutions. The themes were then named; ES decision nature, challenges, mitigation, implementation and evaluation. A summary report of each theme is as follows. In all, five themes were identified; nature of decision-making, challenges of the ES, mitigations for the challenges, implementation of the decision from the system and evaluation of the system for better performance. The nature of the decision-making was based on the type of resource to be selected for the decision-making which influences the components or features to be included in the decision-making and the need for an interactive interface for friendly use. At the backend, the rules for generating the results are considered by looking at the locality type regarding the population and adequacy of resources to link the challenges to the solutions for better improvement. The ES challenges consist of confidentiality, user behavior and authentication in the use of the system. This affects the trust of the system by users in the aspect of misrepresentation, ethical and professional issues and the ability of the results to meet the expectations of the users. Mitigation of the challenges includes training the users, authorization of users through credentials, monitoring user activities and reporting misuse of the system. The clarity of the explanation subsystem, regular updates and patches, consideration of educational policies and a confirmation of the results with the reality are all measures to help. The implementation of the system consists of the administrative aspects; delivery approach, decision control and the rules or guidelines. This is done with a motivation of usage which consists of the faster provision of resources, quicker response to issues and accurate interventions to the challenges. A corresponding system management guide in the form of a

Table 5
Correlation, Variance and Co-variance for the Variables Selected.

Variable	INTEGRATION<–> CHALLENGES	CHALLENGES<–>MITIGATIONS	INTEGRATION<–>MITIGATIONS
Variance	0.948	0.191	0.454
Co-variance	0.15	0.091	0.262
Correlation	0.228	0.214	0.892
SE	0.035	0.024	0.027

Table 6
Factor score weight for the Challenges, Mitigations and Integrations.

	INT4	INT3	INT2	INT1	M3	M2	M1	C5	C4	C3	C2	C1
MITIGATIONS	.023	.054	.088	.075	.104	.153	.093	.001	.002	.002	.003	.002
CHALLENGES	.004	.010	.016	.014	.008	.012	.007	.072	.107	.167	.207	.159
INTEGRATION	.057	.137	.222	.189	.085	.126	.077	.002	.003	.005	.006	.005

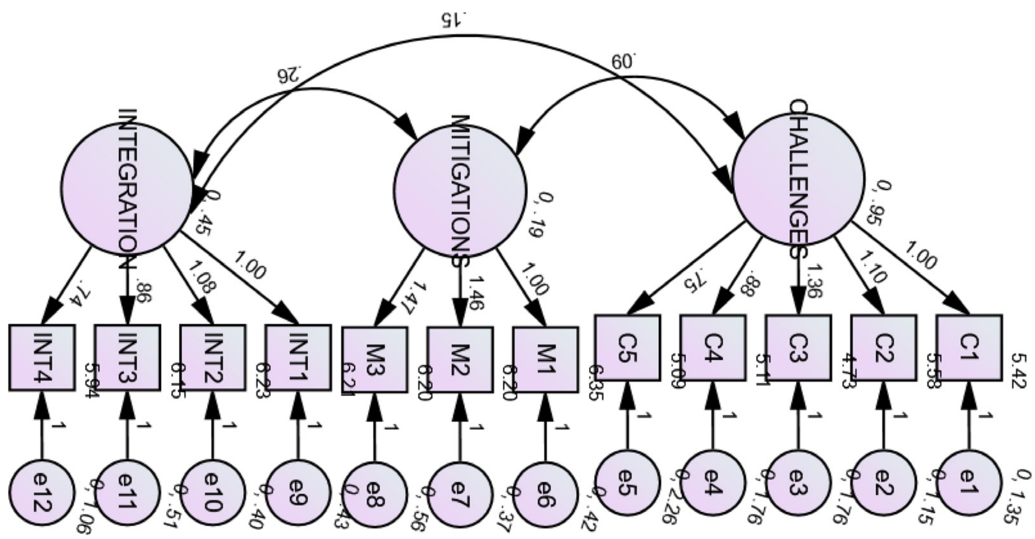

Fig. 10. SEM of the Challenges, Mitigation and Integration.

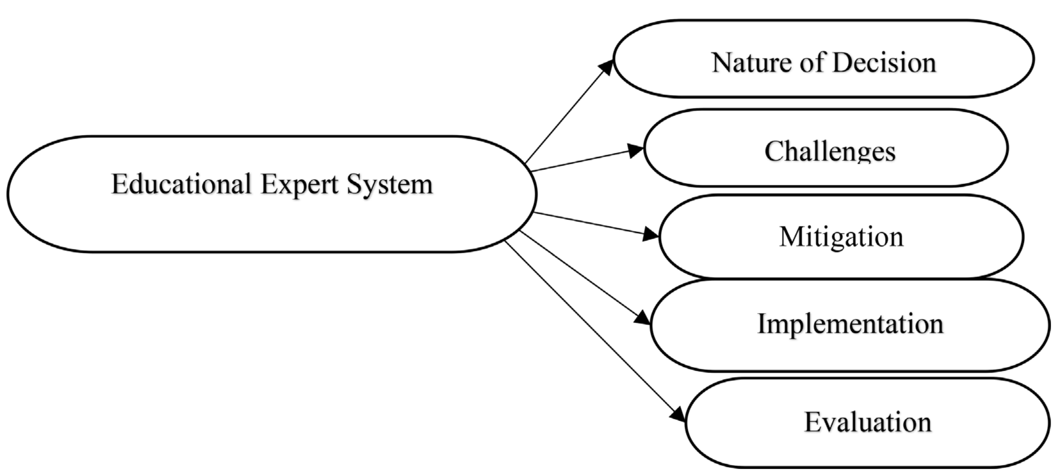

Fig. 11. Thematic Framework of Educational Expert System.

learning model, functionalities of the system and the user activities instruction are enhanced. On the evaluation of the system, user acceptance or agreement goes with the attributes of the users and their learning process which can be done through surveys, questionnaires and reflective feedback. Fig. 11 is the thematic framework for the Educational Expert System and Fig. 12 is the results of the thematic analysis presented in diagrammatic form.

4.2.2. *Acceptance model for educational expert system (AMEES)*

The ability of a system to withstand the test of time strongly depends on its usefulness and efficiency. These are the two major factors considered by users before accepting a technology. The nature of the task the system will be handling, the challenges users have and the mitigations to the challenges are what the users consider as the perceived usefulness of the system. A simple task with a complex system to handle will

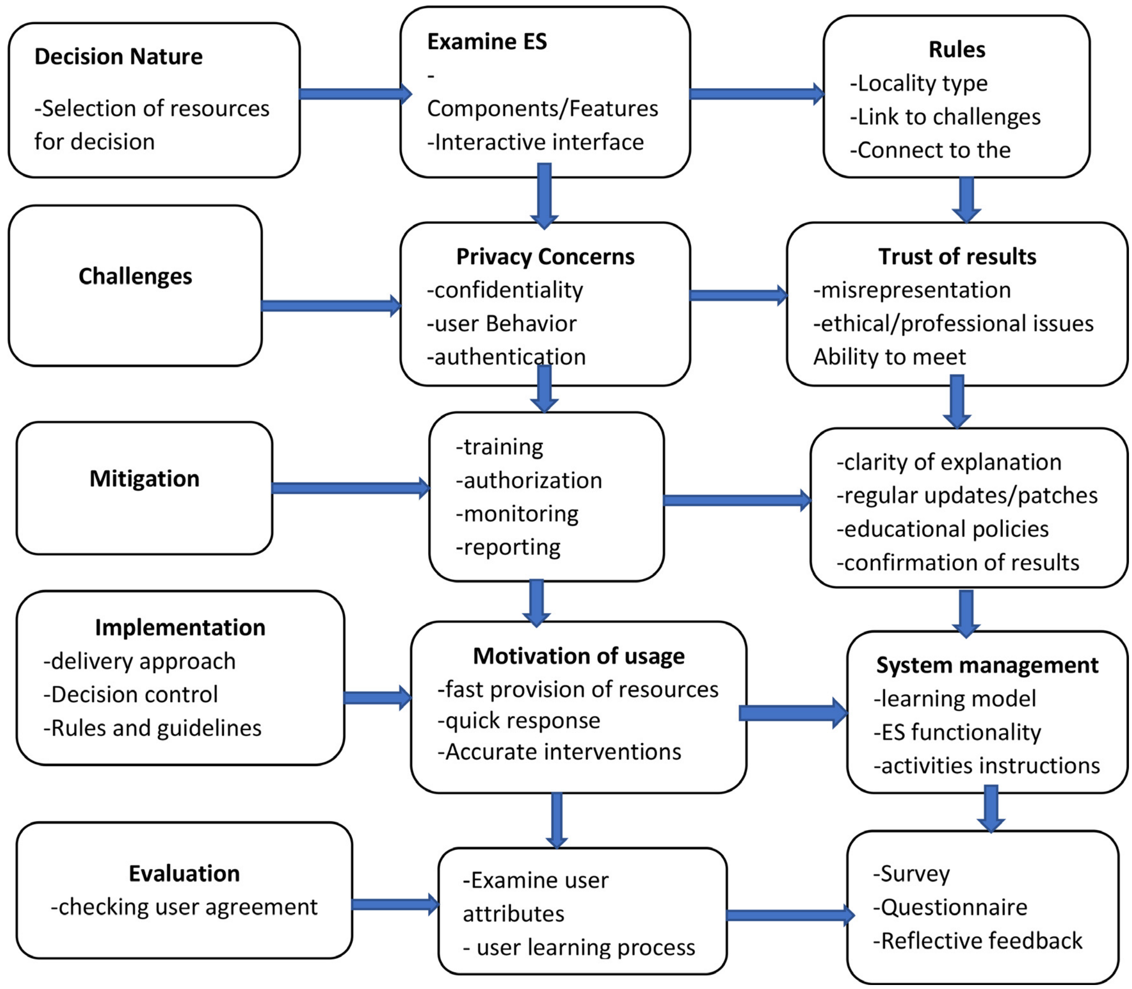

Fig. 12. Diagrammatic Representation of thematic analysis.

pose challenges as users' confidence in the system will be high and their readiness to delegate tasks to the system will also be very low. This will affect the trust users have in the system. It is common to find users abandoning the system and applying manual interventions. To mitigate the challenges, proper training of users on how to use the system as well as strict monitoring to ensure usage is necessary. Users' judgement of the efficiency of a system is based on its speed, accuracy and ease of use. These factors will make the system better than the manual system. A combination of the perceived usefulness and perceived efficiency will determine the attitude of the users towards the system which will finally determine the actual acceptance of the system by users. The acceptance model for the educational expert system is presented in Fig. 13.

5. Discussion

5.1. Contribution to literature

As indicated in the literature, methodologies used in the analysis of data from EMIS such as (Moses Azerimi Azewara et al., 2021) and (Votto et al., 2021b) are primitive with little application of modern technology such as AI. An attempt made by Inusah et al. (2021) to identify the challenges of basic education through the EMIS data however reveals that the major problem of the data is inaccurate information at the point of data entry which necessitates the use of ES to handle the information. Acceptance of a system by users however is vital before its development. The use of TAM to test the level of user acceptance in this work proves that features such as the nature of the task and the challenging nature of a task strongly determine or influence the user to accept a system as indicated in Fig. 10. This serves as an update to the TAM as used in Salloum et al. (2019) and Granić and Marangunić (2019) projecting perceived ease of use and usefulness as major factors in accepting technology.

Related works in ES such as (Inusah & Amponsah, 2018) failed to examine the impact of embedded errors in the ES results for a decision. This may affect the efficiency of ES. In this paper, the proposal to filter the inputs to refine them using AI can boost the performance of ES and enhance the accurate provision of results. The analysis of factors to ascertain the degree of influence can be seen in Neogi et al. (2021), Mishra et al. (2022) and Deepu Ravi (2021). These analyzes however do not look at the modeling of the factors regarding their relationship and their influence on one another. The use of SEM to know the interoperability among the variables and their groups gives a strong justification for the study's results as presented in Fig. 10.

In Table 1, accurately constituting a team with the representation of both IT and domain experts enhances accurate identification of the problem and technical representation of the problem. It is a mandatory requirement for users to give their suggestions and also accept the use of an expert system before it is developed. This not only encourages user acceptance but increases the potential of leveraging the existing system to achieve a more desirable system. Both technological hardware and software already in use should be accessed and accepted if relevant in building the new system. This will reduce the level of technological obsolesce that many legacy systems users fear. Challenges of the already existing system should be carefully identified regarding the nature of

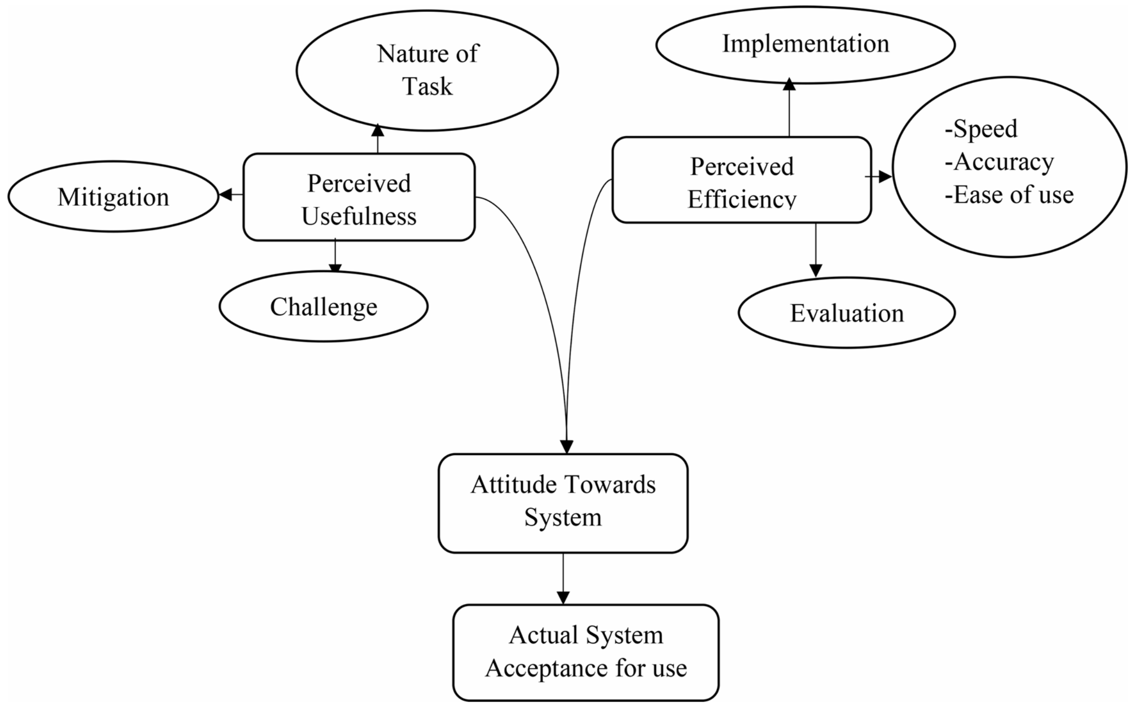

Fig. 13. Acceptance model for Educational Expert System (AMEES).

the task and the needs of the users. The mitigations of the challenges should be carefully done regarding the available resources and the needs of the system. Domain experts are very relevant and should be actively involved so that policies and professional ethics of the domain for that system will not be relegated. Soliciting the views of the domain expert requires detailed and elaborative information for technical representation. The use of open-ended interviews gives domain experts the chance to give detailed information as indicated in Table 2. Apart from the representation of the team for the development, the general view of the majority of users of the system can also be considered in a survey to know the perception and readiness of the users of the system. This helps in broader consultations for a better system. User's acceptance and readiness to use a system in this paper are presented in Table 3. The level of acceptance and readiness is very high and maximum support is promised for the use of the system. With a fair representation of participants, the results proved an overwhelming majority acceptance of the use of ES to assist in decision-making at the basic level. This pledge for support for the system is a result of the challenges stakeholders are having with the human manual system. Varying methodologies for the analysis of data are equally as important as getting data from different users of the system. The use of thematic analysis, as well as graphical statistical representations to get models for the problem, helps in clearly presenting the problem. Careful identification of the themes and enumeration of the features of a system needed in each team gives developers the chance to accurately represent the needs of users in the system. This is presented in Fig. 12. The corresponding modeling of the acceptance of the Educational Expert System gives readers and users of this research the chance to know the difference between Educational ES and conventional ES. Usefulness and the efficiency of the system are the core educational expert system factors to consider before development. This is represented in Fig. 8. Generally, improvement in the decision-making process at the basic level of education will automatically improve the quality of education in a country. As the core for quality and sustainable education in a country, adequate provision of resources at the basic level will give a corresponding quality education in a country and the success can be leveraged to other levels of education which will affect the quality of trained human resources in the country for maximum productivity.

5.2. Implications

This research examines the need and level of preparedness by the users of the system to accept an expert system for decision-making in education. Teachers and educational managers of basic education are used in the survey to gather information on the challenges, the measures to address the challenges and the proposed solutions to the challenges of basic education in decision-making which affect the resource availability in schools. The findings answer the research questions suggesting the need for an ES to assist in managing the resources in basic schools. Educational policymakers and other stakeholders of education who are interested in proper management and resource availability in basic schools can adopt the use of ES to assist in addressing the challenges of education. The findings of this research are in line with (Inusah et al., 2021) which stressed the need for an ES with data mining techniques to manage basic education. Adopting an integrated system with data mining techniques and expert systems by the EMIS is, therefore, a necessity to achieve higher efficiency in decision-making to make resources adequately available.

5.3. Limitations

Despite the overwhelming endorsement by users of the system, there are some limitations. Participants in the survey were limited and not all educational managers were given the chance to respond to the survey. This does not provide a comprehensive response. As some of the respondents were not technical IT persons, their understanding of ES could lure them to respond in the ways they did. Also, since some of the respondents were inexperienced, the possibility of giving biased responses is very high. Teachers' perception of the challenges of basic schools could also be a factor influencing the responses given.

6. Conclusion and recommendation for future work

As seen in the user acceptance survey, the willingness of users to use the system is very high. The efficiency of the proposed system is also guaranteed as speed in identifying and addressing the challenges in school will be increased, accuracy in specifically identifying the problem will also increase and the ease in making decisions to solve the problems is also assured. It will be prudent if the government of looks at the integration of the proposed system into the already existing EMIS to help in boosting the efficiency of educational management in Ghana. Since the success of basic education affects higher levels of education, increasing efficiency in decision-making at the basic level for resource availability will be meant to achieve success at all levels of education. In the end, development in the country will increase as the financial burden on the government will reduce in the education sector due to effective management. This will enable saving funds for other sectors of the economy.

Further, there should be a framework in future research for the adoption of systems into the already existing systems rather than creating an entirely new system. Other aspects of education such as the secondary and tertiary levels should also be considered in the efficiency of managing resources. Latency in decision-making as a result of bureaucratic consultations can be eliminated if efficient and resilient systems are built. Other system development can explore AI areas such as machine learning to help in identifying the trend of educational data in the country to accurately identify the challenges and the appropriate interventions to enhance efficiency in education in the country.

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