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Categorization of Decision Support Systems in the Field of Education

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Abstract

The development in technology and internet increased the amount of options that the decision maker can choose from. The more options a decision maker has, the more likely it will lead to poor decision making. This is called the paradox of choice. In order to avoid this paradox, one can get help from software systems. These systems are generally called Decision Support Systems (DSS) and they assist decision makers to make the best decision. DSS are used in education sector both by the administrators and the teachers in addition to the students. This study analyzes the articles related to DSS in the education sector and classifies them accordingly. As a result, there are two major categories. One of them is "Management Oriented DSS" and the other one is the "Student Oriented DSS". Management-oriented decision-making systems assist managers in make crucial strategic decisions about the future, such as fixture selection, research and development and laboratory requirements, and personnel and financial resource planning. Student-centered methods improve the efficiency of learning activities and make school-university choices easier. Model and system development studies that aid decision-making in the education ecosystem from the perspectives of schools, teachers, and students were investigated in depth and presented in light of solution recommendations brought up by education stakeholders.

Keywords: decision making, decision support systems, educational technology, paradox of choice

1. Introduction

The great developments in computer and software technologies opened up a slew of possibilities for decision-makers in businesses and institutions. Before making a decision, all options should be explored, and the best option that meets the decision maker's needs should be selected (Chakraborty, 2011). It has been shown that having more than a few options can lead to paralysis and poor decision-making, as well as lower satisfaction with the choice (Oulasvirta et al., 2009). More options, especially if they are highly relevant and personal achievement is crucial, will lead to poorer decision-making and lower satisfaction (Schwartz, 2004). This is called paradox of choice. Software systems can help preventing this paradox of choice by lessening these choices. When making crucial judgments, decision makers, especially primarily C-level executives or senior management, frequently refer to software systems. These systems are known as Decision Support Systems (DSS), and they take particular data as input, analyze it, perform the necessary computations, and then output the best option.

DSS has the following benefits:

• time savings by lowering decision cycle time, boosting staff productivity, and giving more timely information

• increase efficiency so that management may make better judgments

• Improve interpersonal communication by encouraging decision-makers to communicate and collaborate more.

• give the company a competitive advantage

• lowers costs by lowering operating and labor expenses

• Improve decision-maker satisfaction by lowering frustration.

• promote learning

• Improve management understanding of business activities to improve organizational control (Power, 2009).

DSS, on the other hand, has the following drawbacks:

• gather data from a variety of sources and integrate data analysis, statistics, econometrics, and information systems into one system, which can be expensive to set up;

They place an excessive emphasis on decision-making since DSS do not account for social, emotional, or political aspects. It solely takes into account the sensible factors.

• hypotheses about relevance "Once a computer system has been built, it is difficult to resist the presumption that the things it can deal with are the most relevant things for the manager's attention," Winograd and Flores (2008) write.

• power transfer by entrusting the final choice to software

• unintended consequences: DSS overburdens decision-makers with data, potentially reducing their decision-making abilities.

• Objectivity issues may arise since using a computerized system does not guarantee that individuals will make objective and rational decisions, therefore decision makers seek to blame DSS for bad decisions.

• Fear of losing prestige; some decision-makers are concerned that the DSS will take their job and that they will be forced to do just administrative tasks.

• overabundant data: DSS requires a large number of inputs in order to do computations, which might lead to information overload in other parts of the system (Power, 2009).

Information management systems, which help decision-making by analyzing data and produce effective information, started to generate very useful information in parallel with the developments in hardware and software technologies. This information makes it easier for decision makers to make strategic decisions regarding immediate routine work or for the future. Despite these advantages, decision support systems are still not at the level of being able to work independently of humans as the sole decision makers. This dependency also puts the objectivity of the decisions at risk. In addition, the education level of the decision maker, the socio-cultural environment in which s/he grew up, personality traits such as taking risks and courage may also cause the decision maker to move away from the objective solution of the concrete problem in choosing the right decision among the alternative decisions offered by a computer system. For this reason, although decision support systems are technologically perfect systems, they are systems that interact with humans and have limitations in terms of human-specific features. As a result of this situation, decision makers with different personality traits who benefit from the same system do not make the same decisions necessarily.

When employing a DSS, it's important to consider both the benefits and drawbacks. In this study, the articles in the education sector that are linked to DSS are categorized and examined. As a result, two main categories become apparent; "Management Oriented DSS" and "Student Oriented DSS".

2. Educational Decision Support Systems

The Decision support systems, which are used to assist people's decision-making, are very beneficial for administrators of educational institutions, teachers, and students, who are the stakeholders of education, in finding solutions to the problems encountered. When the studies in the literature are examined, decision support systems in the field of education can be classified under the following headings. In order to classify the studies, an analysis is done using the Google Scholar database using the keywords “education” and “decision support” together. A total of 50 articles are downloaded. Out of these 50 articles, only the related 26 articles are analyzed and classified below.

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2.1 Management Oriented Education Decision Support Systems

Educational institutions are institutions that provide education and training services to the students at different levels from primary education to university level. In order for the education and training activities to be carried out smoothly, the tactical and strategic level decisions to be taken should be made effectively by the managers of these institutions and strategic planning should be made in line with these decisions. Education Management covers many business processes such as selecting the relevant administrators, measuring the activities and performances of teachers and academicians, researching success of students, monitoring and controlling all school-student-teacher components, and providing guidance services. In addition to these business processes, critical strategic decisions about the future, such as the determination of fixtures, research and development and laboratory needs, and the planning of human and financial resources, should be made by the relevant managers.

When the studies in the literature are examined, it is seen that there are decision support systems developed in response to the administrative needs of the educational institutions listed above. Dong et al. (2006) proposed a decision support system related to education by using the data warehouse created from student and school data and online analysis techniques. Ehlers et al. (2009) developed a decision support system for research management at the University of Stellenbosch in South Africa, using data mining to determine the focus, intensity, and synergy of research. While creating the dataset, the researchers integrated the electronic repositories of master's and doctoral theses, human resources employment data, corporate research projects and elite research heads with accompanying projects. Researchers, in one way, carried out a bibliometric analysis related to their research areas in their own institutions. Using the findings, they emphasized that the managers of the research unit will make the distribution of budget and other resources more efficient and effective while making strategic plans. Gulce (2010) developed a student decision support system that predicts the academic achievement of students according to various attributes, using the data warehouse created from the data in the student affairs automation system of Pamukkale University, which the university administration will benefit from in strategic decision making. The researcher determined that female students were more successful than male counterparts in the related university with the decision support system that has been developed and revealed the status of gender in academic achievement. In addition, with the developed system, the success of each program was evaluated separately, and the programs with high and low academic performance of the students and their grade levels were analyzed in detail.

Baloglu (2014) proposed a model using the analytical hierarchy process (AHP) method to be used in the selection of administrators for educational institutions. In the researcher model, different scenarios were developed by using sub-criteria groups such as the educational level, professional experience, technical, managerial and communication skills of the managerial

candidates. Cil et al. (2014) developed a web-based decision support system to provide guidance services electronically and to monitor students' academic and self-development. In the developed decision support system, it is aimed to apply the guidance services more effectively by applying guidance tests and questionnaires to the students in the online environment. Saptarini and Prihatini (2015) developed a decision support system for a vocational education institution in Bali to determine scholarship students. Researchers used the AHP method to determine the weight of the criteria to be used in the selection of scholars, and the TOPSIS method to rank the students according to the criteria and criterion weights. Bondarev and Zakirov (2015) presented an example of the use of decision support systems in education by analyzing the scores of university students from the courses using a data warehouse on the Hadoop platform. Yoruk (2017) conducted qualitative research to define a theory for a decision support system consisting of an evaluation/monitoring system for schools, students and teachers, based on electronic services such as e-School, MEBBİS, EBA and KurumNet used in schools affiliated to the Ministry of National Education. The researcher proposed a comprehensive decision support system model consisting of an efficient user interface, collective participation-based monitoring system and statistical reporting sub-models.

Zhu (2018) presented the prototype of a data-based education decision support system to be used in teacher education. Aydemir (2019) has proposed a decision support system in which academic performance can be measured at the level of personnel departments, units and even different universities, according to the academic promotion criteria of universities and the criteria for associate professorship. Sriyanto et al. (2020) evaluated the performance of teachers working at primary education level, which is the most important stage of education. Researchers have developed a decision support system that measures teachers' performance according to six criteria using the multi-factor evaluation process method and ranks teachers according to this performance value. Makki et al. (2022) developed a decision support system using goal programming and mathematical modelling for capacity planning in student admission and enrolment in higher educational institutions. Researchers emphasized that with the proposed methods, a capacity planning decision support system can be applied in universities in areas such as human resources, course load, faculty-student ratio, laboratory requirements and finance.

2.2 Student-Centered Education Decision Support Systems

When we look at the educational decision support systems centered on students, it is understood that the studies in this field date back to the 1990s. The school-university selection, which students and parents encounter as a problem in their decision making, constitutes the first student-oriented decision support systems encountered in the literature. Wu et al. (1992) proposed a decision support system for college selection for the United States, which has more than 1000 alternatives. Kostoglou et al. (2014) developed a web-based decision support system to help students determine their job and professional expectations to

be used in the selection of institutes in the Greek higher education ecosystem. In their study, the researchers provided decision support to students with functions such as searching institutes/schools by department, city and according to the distance from their locations with the help of interactive maps. Pardiyono and Indrayani (2019) developed an AHP-based decision support system that makes selections based on various criteria for students among 555 private universities in Indonesia.

Along with the developments in computer and internet technologies, systems have been developed that facilitate learning rather than only solving specific problems, and where the teacher can follow the learning levels of the students. These systems are created with the help of clinical decision support systems in medical education, which is a challenging educational process and requires lifelong learning. When the previous studies on decision support systems that support learning are examined, Aiken et al. (1994) showed that more than 500 undergraduate students at the University of Mississippi have used group decision support systems in their education since 1991, and that group decision support systems can be used as an effective tool in teaching by interpreting certain content and discussing it in class. In addition, the researchers contributed to the education of the students on this subject by performing simulations such as multi-criteria decision making, ranking, and proportioning through these systems in certain departments. Godin et al. (1999) developed The Stanford Health Information Network for Education (SHINE) as a web-based solution for use in medical decision support and medical education. Together with SHINE, medical students and doctors had the opportunity to improve their medical knowledge within the scope of the need for continuous learning. Fuzzy cognitive maps are a soft computation method that provides close to human decision making through taking human reasoning as an example. Georgopoulos et al. (2014) presented a methodology that will expand the use of fuzzy cognitive map-scenario-based medical decision support system for education and training by using scenario-based learning approach. Willis et al. (2016) with the pilot training program applied to 34 volunteer students receiving radiology undergraduate medical education; presented an opportunity in the radiology education curriculum in terms of clinical decision support, appropriate use of imaging, patient safety, and cost-effective patient care. The results of the research showed that many of the students were willing to include this education in their curriculum. Chou et al. (2017) developed a visual-based computerized diagnostic decision support system to be used in dermatological medicine education in a study conducted on 13 patients with 1 consultant dermatologist and 51 medical students at the Chinese Medical University Hospital. The researchers, who defined the consultant's diagnosis as the standard response, showed that the diagnostic accuracy could be increased by 18.75% by using a visual-based computerized diagnostic decision support system. Malmgren et al. (2019) implemented a program of educational access, decision support, feedback, and small reward versus antibiotic use in the treatment of two different bacterial diseases in a pediatric emergency in Sweden. The results of the research offer an alternative to the rational use of antibiotics.

3. Discussion and Conclusion

In this study, a research on decision support systems in the education ecosystem has been made and the studies have been systematically classified and presented. When the studies on educational decision support systems are examined, the studies performed primarily to provide decision support to the administrators of educational institutions draw attention. These studies cover almost all the decisions that a corporate manager should make at the tactical and strategic level. Some of these decisions are choosing a manager, measuring and evaluating the academic activities and academic performance of the employees, determining the needs of the institution correctly in order to use the resources efficiently, determining the right target audience for social services such as scholarships and guidance. In these studies, it has been found that there are solutions developed for almost all the relevant decision-making problems for the administrators of educational institutions. There are also decision support systems centered on students. These systems increase the efficiency of learning activities and facilitate decision-making for school-university selection.

When educational decision support systems are examined, it is seen that these are systems that make it easier for education administrators or students to make decisions such as determining or choosing the best among alternatives. These educational DSS are based on models built on mathematical and statistical analysis and methods similar to other DSS used in other fields. However, systems that do not consider the human factor as a stakeholder in the decision-making problem cannot go beyond making rational decisions and only listing alternatives with certain mathematical models. DSS evaluating the human factor should benefit more from artificial intelligence techniques. Since artificial intelligence is based on designing intelligent systems that think and act like humans. In the classical sense, DSS, which only lists the alternatives by modeling, does not directly present the solution to the problem, but offers the best possible solutions among the alternatives to the person as a decision maker. The main decision rests with the human being to decide which of these alternatives to consider as a solution. For example, if we think that we are doing a search from the google search engine, the phrase we are looking for does not always come first, and sometimes we try to find what we are looking for within dozens of pages by scrolling through them. So is decision making with computer systems. Only the possible solutions to the problem are listed and the person is expected to make a decision among them. For this reason, it is necessary to develop decision support systems and design systems that deal more with the human factor. In the field of education, in terms of teachers, administrators and academicians, it is necessary to make as objective decisions as possible and to minimize the risk of making mistakes. For students, designing decision support systems that evaluate emotional intelligence by considering personal characteristics, rather than just listing the best school-university options, will facilitate making more effective personal decisions.

In the study, model and system development studies that facilitate decision-making in the perspective of schools, teachers and students in the education ecosystem were examined in detail and presented in the light of the solution proposals brought according to the

stakeholders of education. This study has the feature of guiding the new studies in the future by considering the issue with a holistic perspective on educational decision support systems.

References

Aiken, M., Martin, J., Vanjani, M., & Sexton, R. (1994). "Group decision support systems in higher education", *Journal of Educational Technology Systems*, 23(1), 3-12. https://doi.org/10.2190/7EHF-DBHV-C5G1-Q3FE

Aydemir, E. (2019). "A decision support system suggestion in academic personnel performance evaluation", *Journal of Information Technologies*, 12(2), 131-140. https://doi.org/10.17671/gazibtd.484509

Baloğlu, N. (2014). "The selection of administrator for educational institutions: Analitical hierarchy process as a decision support system", *Ahi Evran University Journal of Kırşehir Education Faculty*, 15(2), 297-313.

Bondarev, A., & Zakirov, D. (2015, September). Data warehouse on hadoop platform for decision support systems in education. *In 2015 Twelve International Conference on Electronics Computer and Computation (ICECCO)*, pp. 1-4. IEEE. http://dx.doi.org/10.1109/ICECCO.2015.7416884

Chakraborty, S. (2011). "Applications of the MOORA method for decision making in manufacturing environment", *The International Journal of Advanced Manufacturing Technology*, 54(9), 1155-1166.

Chou, W. Y., Tien, P. T., Lin, F. Y., & Chiu, P. C. (2017). "Application of visually based, computerised diagnostic decision support system in dermatological medical education: A pilot study", *Postgraduate Medical Journal*, 93(1099), 256-259. http://dx.doi.org/10.1136/postgradmedj-2016-134328

Çil, İ., Tokat, M. A., Türkan, Y. S., & Doğan, N. (2014). "E-guidance and counseling decision support system in elementary and high schools", *H. U. Journal of Education*, 29, (29-2),34-56.

Dong, P., Dong, J., & Huang, T. (2006, June). Application of data warehouse technique in educational decision support system. *In 2006 IEEE International Conference on Service Operations and Logistics, and Informatics*, pp. 818-822. IEEE. https://doi.org/10.1109/SOLI.2006.328961

Ehlers, K., Joubert, M., Kinghorn, J., & Van Zyl, A. (2009, August). A decision support system for institutional research management in higher education: Data mining to determine research focus, intensity and synergy. *In 2009 International Conference on Computational Science and Engineering*, vol. 4, pp. 885-890. IEEE. https://doi.org/10.1109/CSE.2009.222

Georgopoulos, V. C., Chouliara, S., & Stylios, C. D. (2014, August). Fuzzy cognitive map scenario-based medical decision support systems for education. *In 2014 36th Annual*

International Conference of the IEEE Engineering in Medicine and Biology Society, pp. 1813-1816. IEEE. https://doi.org/10.1109/EMBC.2014.6943961

Godin, P., Hubbs, R., Woods, B., Tsai, M., Nag, D., Rindfleisch, T., ... & Melmon, K. L. (1999, January). A new instrument for medical decision support and education: The Stanford health information network for education. *In Proceedings of the 32nd Annual Hawaii International Conference on Systems Sciences*. 1999. HICSS-32. Abstracts and CD-ROM of Full Papers (pp. 11-pp). IEEE. https://doi.org/10.1109/HICSS.1999.773018

Gülçe, G. (2010). *Developing decision support system for student information system by using data warehouse and data mining technics*. Master's Thesis, Pamukkale University, Turkey.

Kostoglou, V., Ploskas, N., Vassilakopoulos, M., & Tsantopoulou, V. E. (2014). "Analysis and design of a web-based decision support system for choosing higher education studies", *Yugoslav Journal of Operations Research*, 24(3), 399-414. https://doi.org/10.2298/YJOR140411025K

Makki, A. A., Sindi, H. F., Brdesee, H., Alsaggaf, W., Al-Hayani, A., & Al-Youbi, A. O. (2022). "Goal programming and mathematical modelling for developing a capacity planning decision support system-based framework in higher education institutions", *Applied Sciences*, 12(3), 1702. https://doi.org/10.3390/app12031702

Malmgren, A., Biswanger, K., Lundqvist, A., & Zaoutis, T. (2019). "Education, decision support, feedback and a minor reward: A novel antimicrobial stewardship intervention in a Swedish paediatric emergency setting", *Infectious Diseases*, 51(8), 559-569. https://doi.org/10.1080/23744235.2019.1606933

Oulasvirta, A., Hukkinen, J. P., & Schwartz, B. (2009, July). When more is less: the paradox of choice in search engine use. *In Proceedings of the 32nd international ACM SIGIR conference on Research and development in information retrieval*, pp. 516-523.

Pardiyono, R., & Indrayani, R. (2019, April). Decision support system to choose private higher education based on marketing mix model criteria in Indonesia. *In IOP Conference Series: Materials Science and Engineering*, vol. 508, No. 1, pp. 012112. IOP Publishing.

Power, D. J. (2009). *Decision Support Basics*. Business Expert Press.

Saptarini, N. G. A. P. H., & Prihatini, P. M. (2015, October). Decision support system for scholarship in Bali state polytechnic using AHP and Topsis. *In International Conference on Information Technology and Business (ICITB)*, pp. 38-46.

Schwartz, B. (2004, January). *The paradox of choice: Why more is less*. New York: Ecco.

Sriyanto, S., Buchori, A., Handayani, A., Nguyen, P. T., & Usman, H. (2020). "Implementation multi factor evaluation process (MFEP) decision support system for choosing the best elementary school teacher", *Int. J. Control Autom*, 13(2), 97-102.

Willis, M. H., Frigini, L. A., Lin, J., Wynne, D. M., & Sepulveda, K. A. (2016). "Clinical decision support at the point-of-order entry: An education simulation pilot with medical students", *Academic Radiology*, 23(10), 1309-1318.

Winograd, T. and Flores, F. (2008). *Understanding Computers and Cognition*. Boston, MA, USA: Addison-Wesley.

Wu, C. Y., Irazusta, F., & Lancaster, J. T. (1992). "A decision support system for college selection", *Computers & Industrial Engineering*, 23(1-4), 397-400. https://doi.org/10.1016/0360-8352(92)90145-A

Yörük, T. (2017). *Using electronic services offered by ministry of national education in the scope of management information systems as decision support systems: A grounded theory.* Doctoral Dissertation, Akdeniz University, Turkey.

Zhu, Y. (2018). "A data driven educational decision support system", *International Journal of Emerging Technologies in Learning*, 13(11), pp. 4-16.