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RESEARCH ARTICLE

DECISION SUPPORT SYSTEMS AND SYSTEMS THINKING: ADMISSION IN SAUDI UNIVERSITIES

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ABSTRACT

In order to improve the efficiency of the admission system in the Saudi universities, this paper will recommend applying modern approaches related to Decision Support Systems (DSS) through systems thinking. Some of the limitations in the traditional Saudi admission system are discussed and how these problems can be solved through the use of system thinking. The traditional admission system in Saudi universities does not consider the flexible interactions between the individual components of the admission system. This problem generates serious concerns about the overall integrity of the system. The aim of this paper is to develop a framework for designing a proposed admission system for the Saudi universities to solve this problem. This framework will help Saudi universities to analyze the data and make better decisions at each stage of the admission process.

INTRODUCTION

Decision-making in management science or operation research is a very complex procedure based on various data analytics and complexities of the situations and factors that can change the efficiency of traditional decision-making tactics (Yurtseven & Buchanan, 2016). There are various case scenarios in real life fields which present problems to the managers and policy makers. One example of such a domain is the university admission process in Saudi Arabia. National and international students can apply to more than one Saudi university at a time. The universities, on the other hand, have limited funding and resources to support these students. While each university will look for the best applicants, the best students applying in more than one university can get selected by several universities. The selected students will then choose only one university and will reject the others. In this case, the universities that have allocated their time and other resources to screen all the potential candidates would more likely waste these resources because of the students' choices. Similarly, the best universities will have more applications to process because more students apply to these institutes. This situation creates ambiguity and complex case scenarios for admission managers and university employees. The traditional decision-making tactics that have been widely used in Saudi university admission process are mathematical programming, simulation models and game theory (Yurtseven & Buchanan, 2015).

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Yurtseven and Buchanan (2015) explain all these traditional aspects of admission process in detail. All such traditional tactics work strictly in hard problem scenarios where the problem and all its contributing factors are definite and cannot be changed. However, this is not the case with the national admission process in Saudi Arabia. There can be ambiguous problem factors that can produce multiple outcomes based on the choices of students and available funding. The Saudi Arabian universities and colleges need a sophisticated admission system based on modern decision support system (DSS) and system thinking approaches. There are various DSS approaches that have recently been adopted in the complex business organization on national and international levels. One of these approaches is performance monitoring which relies on the performance or capability of each contributing factor of a system to make an effective decision about that system. The contributing factors in the admission system can be students of various categories such as applicants, accepted candidates, enrolled or rejected students, faculty, and departments in universities, fields of study, and the available funding. System thinking is a newer managerial technology that studies the links and relationship between different contributing factors of a system. As it has been mentioned above, there can be various contributing factors in an admission process, and there can be multiple links and relationships between these factors. A sophisticated admission system will try to understand all these links and then decide the best possible outcome according to DSS approaches. These approaches will utilize concepts from mathematical programming, computer sciences, and management sciences or operation research. The basic purpose of this paper is to propose a pathway for the building a new admission system for universities in Saudi Arabia.

The pathway will be mainly based on two theories: DSS and system thinking. Decision support system or DSS will be used to construct all the possible outcomes that can be predicted with the help of system thinking. System thinking will link all the contributing factors of the proposed admission system. Once linked, all the contributing factors can then be evaluated effectively according to their performance and efficiency in a system. There will be some definite theoretical outcomes that cannot be predicted with the help of traditional decision-making approaches, but these outcomes can be predicted using the proposed system. Additionally, the proposed admission system can be evaluated for its overall efficiency based on the modern DSS admission systems of other countries. This paper will propose the pathway and the criteria for evaluation.

System thinking: Among various duties of managers and process administrators, the analysis of the whole system is the most important one because of its implementation of the final decision-making process. Traditionally, these managing persons look at the individual components of a system and how these components perform their assigned function correctly. For example, in a university admission system, the individual components are students, university programs, subjects and funding agencies. All such components take part in the determination of overall admission process. However, these components do not only perform their function but also interact with one another. The traditional thinking approaches in the analysis of a system do not consider these interactions in the determination of the final output. There are various traditional thinking approaches such as interpretive thinking, functional thinking, emancipatory thinking, and post-modern thinking (Yurtseven & Buchanan, 2015). All these traditional thinking systems implement some of the digital technologies such as data collection and visual analysis. However, a compact system thinking approach, which is the main focus of this paper, is different from all these approaches in the fact that it establishes the interactions between individual components. Therefore, a system thinking model will not only analyze the individual components and their functions but will also have a look at the whole system holistically.

Various theorists have categorized the systems according to the capability of human beings to understand these systems. The most common categories, in this regard, are known, knowable, complex and chaos (Yurtseven & Buchanan, 2015). The known and knowable system are the ones which can be solved using traditional thinking approaches which assume that these systems are not flexible to be changed during the processing. The complex and chaotic system are however different because they tend to change considerably during the processing. For example, the student who applied for a particular program might change his mind during the admission process to apply to another program or university. In such cases, the whole rigidity of the university admission system collapses, and the need of system thinking arises. System thinking can be applied in the university admission process through a number of ways. The basic purpose is to establish a connection between the individual components of the system which are students, universities, and funding agencies. The system thinking model can be applied to a country's university admission system through the effective planning, designing of the proposed software programs and the overall implementation and adoption of this model by all the components of the system.

System Thinking and Decision Making: System thinking represents an entire field to management discipline that studies the interactions and links between the components of a system. The sciences of system thinking have been developed over the last few decades due to the need of the solutions of the problems that could not be solved through classical sciences or hard research operations (Yurtseven & Buchanan, 2016). The hard research operations require a high amount of rigidity in the scenarios that are under investigation. However, this type of research does not give satisfying results for the complex problematic situations that are presented in a holistic manner. However, each stage of a component of such situations can affect equally on the outcome of the whole problematic situation (Kurtz & Snowden, 2003). While the research on system engineering as an independent field has been conducted for several decades now, the most important development was made in 2005 with the help of International Council on Systems Engineering or INCOSE (Yurtseven & Buchanan, 2016). Several subject areas and hypotheses have been proposed in the meetings held by INCOSE. Among these subject areas, the concept of objectivity has always been a controversial topic to discuss. According to traditional sciences and hard research operations, the objectivity is the main purpose of any system, individual or the component of a system. However, this idea has seriously been challenged by system engineers that provide a more realistic approach for the actual purpose of the system and its component in real-world scenarios where nothing can be predicted, and every component of a system can have its different perceptions and preferences about the whole outcome.

The system engineers propose to utilize help from the field of genetics and evolutionary sciences to understand the concept of objectivity and its impact on the outcome of the research. Among all the dynamic systems that must be understood in the light of newer concept developed by system thinking, the academic institution is the most important field because of its impact on the whole lives of the students and the quality of the education that is being presented in the system (Bresfelean, Ghisoiu, Lacurezeanu, & Sitar-Taut, 2009). Therefore, it is extremely necessary to understand the academic admission system in the light of complex problematic situations that can arise due to the adoption of hard research operations. There are multiple concepts of system thinking that can be applied in decision-making process. Daellenbach et al. published a book titled as "Management Science: decision-making through systems thinking" (Daellenbach, McNickle, & Dye, 2012). The book discusses the applications of soft system research and methodologies in decision making. This book also proposes some frameworks for system modeling using soft and had system engineering approaches. Various business organizations across the world use such mixed approaches in decision making and have verified the positive effects of such approaches. The Application of modern decision support systems has not yet been acknowledged in the real-time problems such as admission system of universities.

Modern decision support system can be approached with the help of three basic branches of system thinking: heuristic system thinking, evolutionary development of the system, and holistic group decision making (Yurtseven & Buchanan, 2015). While the research on the implementation of the all of these three branches in business decision making has been a slow process, the recent developments in the soft research operations can be used to propose a model for the academic

settings which do not have to be totally rigid. The applications of such systems can be evaluated by assessing the perceptions of the participants at the end of the decision-making process.

Background: The number of Saudi students, who apply to the national universities after passing the secondary school examination, has increased significantly in recent years (Welmond, 2006). In addition, international students have also been shown to have increased interest in Saudi universities due to the scholarship benefits such as living allowance, health insurance, and a monthly reward that can be around 215 Dollar for some universities ("Ministry of Education, Kingdom of Saudi Arabia," 2005). There are many government and private universities that have recently gained international recognition for the better quality of education in this country (Welmond, 2006). The subject preference and cultural resistance have always been two most prominent factors in the underdevelopment of the academic industry in Saudi Arabia. People want to send their children only in the higher rating fields such as medical, pharmacy or engineering without giving too much thought about the development of other fields such as arts, banking or writing. This problem functions as the base of an uneven number of admission applications in each field. University administration has to solve such problems while screening the best potential candidates.

A number of solutions have been applied in recent years to solve the problem mentioned above. One example is the solution adopted in King Saud University that requires the students to have one year of basic academic course before applying to any major in the university. The university management services report the efficiency of this procedure in the effective screening of potential candidates for each subject that is offered in the university. While this procedure has its positive impact on the admission system, it causes excessive burden on the students who have to take an extra year of education after passing their secondary school examination and before getting into a college major. This perquisite is necessary for a number of subjects including humanities and arts' subjects. Another problem in the current Saudi education system is the differentiation of quality education in the government and private institutes. While the government universities provide more financial support as compared to the private universities which often have high tuition fees that have to be paid by the students, the admission in the government universities is more difficult. Students who could not get admission in the government universities tend to apply to private universities if they want to continue their education. The problem in the levels of quality admission can arise due to the trend of differentiation in the university admission system.
Another problem is the grading criteria for the admission system. As it has been mentioned above, a large number of international students apply each year to Saudi universities. These international students can have different educational systems and grading systems in their countries. Additionally, the same problem can arise in the regional private schools and colleges that can have a grading system different than of the government high secondary schools. Current Saudi university admission procedure does not take the complex system situations into account. The example of complex system situation can be the preference of the students for different fields of study and universities. Another can be the grading system of the schools and colleges. The third situation is the ambiguity in the students' decision to go for a particular university if he or she has been accepted to more than one university. Another problem can be the lack of the funding opportunities for the specific fields that have not been explored extensively by the parents and children. All the problems that have been mentioned above can be solved with the help of an admission system that utilizes the help of system thinking and decision support systems.

Related Work: The improvement of university admission system has been a major research trend in the management sciences for the last two decades. Eliman (1991) proposed a decision support system for university admission procedure that was exclusively based on the decision markers and the individual component of the decision system. The example of decision marker is if a student has passed a test that was necessary to take for a course. The individual components are the factors such as date of enrolment and other university criteria of student placement. This system was one of its kinds in that time because it applied the decision support system for redefining the policies in an admission system through statistical support. Eliman developed the system by considering the three major components of an admission procedure which are the performance analysis, graduating trends and the allocation model for different fields. While this method provided new insights for the applications of decision support system in making new admission policies, it did not give a comprehensive framework for the implication in the decision-making process of a university.

The study conducted by Sanyal (1995) is also important to discuss here for providing the efficiency of computerized information system in the education management. Sanyal (1995) proposed a one-time data entry procedure that can be utilized at all the stages of the decision-making and university management. All the universities must use one platform to access the information provided by students for the admission. This platform will provide detailed information in the form of organized files that will be common for the all the students. The sub-division and cross-referencing of the files would be an automated procedure available to all the stakeholders of the system including students, faculty members and the university management. While the implication of decision support system has strictly been a topic of interest in management sciences, its adoption in the computerized information system for education management by Sanyal(1995) can be used to give hints about its early development for university admission systems. Decision-making in any business organization is comprised of the analysis of large amounts of data presented in an organized fashion (Mansmann & Scholl, 2007). The modern decision support systems in management sciences tend to utilize the same concept through the application of the information system sciences and system thinking. Therefore, a comprehensive framework of an efficient university admission system would tend to understand all the educational trends such as students' preference for a given course according to their marks and their preferences for particular universities by analyzing the computerized data of the students and their fields of study. Various scholars in the past have applied different analytical approaches to check the efficiency of national or international admission procedures. For example, Westkamp (2013) analyzed the traditional admission system of German medical colleges. Westkamp (2013) introduced the Boston Mechanism of allocating available seats to the most eligible students on merit. Westkamp (2013) found the traditional approaches less effective in dealing the complexities of the flexibilities of the admission system.

It is interesting to note that Westkamp (2013) analyzed the system on the assumption that the students and colleges have a limited number of choices in the admission process. However, this is not true in the real life where the number of students and available seats change every year. The traditional admission procedure in Germany is distributed in to different operation batches where the outcome of the one batch is not dependent on the other. This is the most basic limitation of the traditional admission procedures which can be solved using DSS and system thinking. A typical university admission system does not comprise of the screening of the applications in one batch. The principals and chairmen of the universities should also know the overall trend in the development of an educational field based on the students' preferences in that field. For example, Hamdan (2005) reported a sudden rise in the number of female students studying humanities in Saudi Arabia. However, the sudden rise in only one field of study can hint toward the alarming situation of inequality in the distribution of the students in different fields. It is unclear that the preference of male students to study science and engineering was a major factor in this sudden rise or the female students were more inclined to study humanities. While Sanyal (1995) and Eliman (1991) provided the solution of the same problem through different fields of study, the application of information system in the decision making of a university admission procedure has been presented by García-Cascales and Lamata (2009). They emphasized on the use of databases to store students' information in a comprehensive manner for evaluation at later stages. In addition to the use of databases to store the information about students, García-Cascales and Lamata (2009) also insisted on the development of university ranking systems. Similar to the study conducted by García-Cascales and Lamata (2009), the study proposed by Bresfelean et al. (2009) has the implication of digital information technologies in university admission procedure. Unlike other university systems where database administration has been adapted in many ways, the admission processes require a systematic human input for making decisions so these admission systems cannot become completely automatic. Additionally, the admission process of a university is a dynamic system that can change considerably within one year. Therefore, the adoption of digital systems for admission processes has been a slow process.

Most of the work in the field of DSS in university admission procedure was theoretical before 2009. Dahlan and Yahaya (2010) proposed several key factors that could have been applied in the application of DSS in a university admission system. These key factors were the number of applying students, lecturers, facilities provided by the program and department of a university. It can be noted that all of these factors effect on the university ranking which indirectly reflects efficient management of available resources. There are many country-specific studies on the application of computerized information systems in the decision-makingprocess for the planners and policy makers. For example, the study conducted by García-Cascales and Lamata (2009) was for Spanish educational institutes. On the other hand, the study conducted by Bhatti and Adnan (2010) was for the implementation of modern information management tactics in developing countries. The use of computerized information system for the management of data across the nation can be a difficult task in the circumstances such as the poor technology adoption which is the case with Saudi Arabia. Unlike many developed countries, Saudi Arabia has been very slow in adopting digital technologies in their professional and academic systems. Several factors have been analyzed, which play an important role in this trend of technology adoption, and the most prominent have been the traditional and cultural origin. The development of sophisticated and comprehensive DSS for university admission process would not only help in the better screening of the admission applications but it will also help in the better policy making. The resource management has always been a controversial issue regarding the trend of university admission and overall demand of the educational program. This is the because university always has to support the students on merit and need bases. Therefore, they often have limited funding and can only adopt a particular set of scholarship programs for which a large number of students apply. The policies for student admission has been assessed by Vohra and Das (2011) who found a special linkage between better decision making and anoverall understanding of the data. The data analysis can be a very tedious task in the absence of an intelligent IT support system. Information Technology or IT has always been an active contributor to the development of better applications in the field of education. The utilization of IT in making better policy will ensure better development of theeducational sector in Saudi Arabia.

The Current System of Admission in Saudi Universities: The current educational and grading system in the high secondary schools of Saudi Arabia has some inconsistencies which lead to the inaccurate university admission. There are more than 10,000 teachers in the Saudi Arabian schools that teach and grade their students independently due to the absence of a standardized system of grading for the whole educational system (Ministry of Education, Kingdom of Saudi Arabia," 2005). There is also a lack of the secondary tests that assure some standardized skills in a student. There are many successful university admission systems in the American and European countries that can be used as references to implement a better university admission system in Saudi Arabia. For example, SAT standardized test is a compulsory test for all the graduating high school programs in the USA. In addition, the SAT subject tests are required for some specific subjects such as molecular biology, chemistry, etc. Most of the international students in these countries require taking a standardized English test to assure their ability to communicate in the local language. Arabic is the national language is Saudi Arabia but the major mode of communication in higher education institutes is English for international students. The two most important standardized tests for English are TOEFL and IELTS. The IELTS test is required for getting an admission in a British university while TOEFL is also acceptable. On the other hand, TOEFL is required by most the American universities. Aside from the inconsistencies in the grading system, the availability of the slots in a particular program and department can become ambiguous when students apply and get accepted to more than one university. Due to the relatively limited number of universities in Saudi Arabia, the ambiguity of slots can create problems that would not occur in countries with relatively large amount of universities like USA. This is perhaps the most important issue in the current university admission system in Saudi Arabia. Better solutions for this problem can be approached with the help of effective data management in an online platform through which all the students will apply and all the universities will assess these applications.

The Framework and New System Proposed: This paper proposes a special pathway which can be used to develop an online platform for university admission system in Saudi Arabia. It must be noted that, if implemented, this system will replace the traditional individual application system and should be applied to all the university across the country. The new system will also need some technical and educational resources for its effective implementation. The technical resources include a fully functional national website which can be accessed by students and university administration through their authorized accounts only, a relational database, and software packages to develop and maintain the online platform.

The prototype of the framework: A prototype is a rough draft of the pathway or the procedure that can be adopted to develop a proposed system which is the online platform for university admission system in Saudi Arabia which utilizes DSS and system thinking for screening the admission applications for all the universities in the country.

The prototype consists of the following parts:

- A website which can be accessed by students to make an online account
- The database which will contain information of each applying student including his or her name, address, previous educational records and the results of standardized tests
- The university administration system that will be connected to the database and each university can access this system through their registered accounts.

Framework Design: The framework design of the university admission system having DSS and system thinking as its major principles can be built in terms of the responsibilities of students, faculty members or university administrators and database administrator, who will organize, develop and maintain the online platform. The responsibilities of all of these participants actually represent the interactions or relations of different components of a system in a system thinking approach. The role of one participant will determine and facilitate the role of other participants in the system. The responsibilities of each of the participants are described below.

The Students' responsibilities: The students must access the website using their personal computers. It is highly recommended that students do not continue the procedure on a public computer due to the privacy of the data. After accessing the website, the student must log-in on the first time use of the system. The log-in detail will also help in the online saving of all the information that is entered by the student. Once saved, the student can access this information as many times as he or she wants. After giving the basic biographic information, the student must upload the transcripts and certificates of the previous educational level. The scanned versions of the attested certificates will be accepted only by the system. After adding all the basic and academic information, the student will enter the preference for the program and the university that he or she wants to apply in. It must be noted that at this stage, the student can enter multiple preferences. However, he or she must also categorize all these universities and programs according to their level of preference which means that student will indicate his or her final choice in case if he or she is accepted in more than one university. This will enable the system to recognize the final option of the student. The student can access his account anytime to check the status of the applications, and the universities' decisions will also be emailed to him or her.

The responsibilities of the faculty members or admission committee of a university: Each government and theprivate university will be assigned an authorized institute account through which the employees of the universities can access the information entered by the students. The responsibilities of the faculty members include checking the grades and testing results of each student and trying to decide on each candidates soon as possible. The access to the system will be restricted to the authorized persons in the university only. The admission committee can also have information about students' priorities and the status of his or her application for other universities. Once a decision is made for a candidate, the admission committee can also contact the student directly and can also assign a due date for the student's response to the decision.

The responsibilities of the database administrator team: The database administrator team will organize and develop this whole online admission system. They will also maintain the database after its online publication and access to the other stakeholders of the system. They will have the full access to the accounts of the students and universities. The website will be created using HTML and scripting languages. The database will be created using MySQL.net or any other registered database management package.

The DSS in the proposed framework: The decision support system will be actually ensured with the help of some specific interactions between the system's components. For example, the students' priorities for each university will create a theoretical outcome for each of the outcomes in the later stages. The university admission committee will not only check the students' potential holistically but they will also be able to check their priority level for other universities as well. This will enable them to allocate resources for as many students as possible in the shorter time. After making thedecision for each student, the university committee will upload that decision on the website which will then be accessed by other universities. The student must choose one university from all the universities that have accepted him or her. Once the student made a decision, he or she will enroll in that program immediately through the same online platform. The platform will then inform the other admission committees about student's decision and hence other universities will discard their acceptance for that particular student and will give chance to some other candidate. Thus the limitations of Boston Mechanism presented by Westkamp (2013) can be solved considerably. Other models of admission procedures such as of knowledge and data driven frameworks can also compared to this proposed framework Vohra and Das (2011). However, the fact remains that the integration of system thinking through DSS generates better solutions for the problems in the traditional admission systems. Another responsibility of the online program is to collect the data of all the candidates, enrolled students and universities at the end of each admission cycle. This data will be forwarded to the education ministry for making necessary changes in the policies or estimate the possible costs and funding options for each program and university. Resource allocation will become easier along with the better decision-making tactics.

This framework is the solution to all the problems that have been discussed in the current admission system.

Possible problems in the proposed framework: While the proposed framework shows promise to solve the current problems of the university admission system in Saudi Arabia, the real efficiency of the framework can only be evaluated through the perceptions of the stakeholders about the newer system. There is no doubt that the paper-based admission procedure has many flaws that can be addressed through this online platform. However, there are some specific case scenarios where the stakeholders would prefer the traditional system. The absence of an internet connection or a fully working on the computer can be one problem for the students. Another problem can be the privacy of the data of the candidates that would be accessed by the database administrators along with the university admission committee. All such problems can be solved with the help of effective training of the students and admission committee about the use of the modern system.

Conclusion

The implementation of an online admission system that will ensure system thinking and DSS in the admission procedures and the policy development has become the most important task to solve the current complex situations of the university admission systems. The implementation of IT technologies in the field of education management is necessary because university admission system is a complex system that involves many unpredictable stages and case scenarios. DSS is a special branch of management sciences that utilizes the IT technologies to analyze the available data in digital form. On the other hand, the digital data would also help the decision makers in understanding the relationship and interactions between each component of the system. The proposed framework ensures the effective communication and interaction between the students, admission committee and policy makers. Therefore, it is highly recommended to apply this framework in the national admission system of Saudi Arabia. The implementation of an online admission system has become a necessity in the growing sector of education of this country. With the help of the online platform to assess the students' potential and credibility, the universities can also avail more resources for the current and future students.

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