



A System Dynamic Model of Student Enrolment at the Private Higher Education Sector in Syria

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Abstract

This paper investigates the dynamics of student enrolment in the Syrian private higher education sector. The paper adopts a system dynamics approach, to construct suitable simulation models that could be used to examine the complex and dynamic interactions between student flows, staff ratios and investments in plant and facilities. The study involved interviews with key university personnel, focus groups with university staff, a survey of student perceptions and personal observations of key departments at the university selected for the study. Further interviews were held with members of staff of all the other private universities in Syria. The simulation model developed in this study has provided insightful and meaningful exploration of data whose practical applicability is not necessarily restricted to the Syrian university, but broadly encompasses all educational sectors, whether private or public. The model designed in this research is a decision support system, one that is a flexible tool to design measures that might help to improve student enrolments. University management can use the simulation model to create different future scenarios, involving changes in student numbers, staff student ratios or investment in plant and facilities.

Keywords: system dynamics, enrolment management, higher education, Syria, student choice, decision support systems.

Introduction

Decision Support System (DSS) has often been introduced into higher education (HE) management (Hidalgo et al 2013) and the use of system dynamics for modelling of HEIs has proved a more suitable approach (Kennedy 1998). System dynamics models are different from statistical models in the sense that they are not only providing control and forecast, but they also suggest clarifications and an understanding of the relationships between the dependent variable and numerous exogenous and endogenous variables (Sahay & Kumar 2014). The utilization of the system dynamics model helps in development of high-leverage policy associations that will enable an effective understanding of how the universities can manage the development of value addition in their standard courses (Dahlan & Yahaya 2010). Such a system can be characterized by interactions of closed chains or feedback loops that, when combined, define the structure of the system and hence how it behaves over time (Kennedy 2011). Galbraith (1999) suggests that we need to consider building models that can address the question as to what factors may influence future growth, rather than simply extrapolating from the past.

This study aims to use Systems Dynamic Modelling (SDM) as a tool to make effective decisions concerning enrollment as part of strategic planning of university expansion and growth. Specifically, the study aims at identifying possible variables and the relationships that affect the investment decisions made by university management to increase enrollment, designing a process for modelling this management process, and creating dynamic simulation models for student enrolment.

Literature

Competition in the HE sector

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3 Market forces are increasingly influencing the HE sector (Altbach and Knight 2007). Many
4 higher education institutions (HEIs) have begun to adopt market-oriented strategies. This
5 competitive environment is driven by several factors, including the growth in corporate and for-
6 profit institutions, a buyers-market for students, and advanced telecommunications-delivery
7 systems (Leland & Moore 2007). HEIs status grows from historical reputation, aggregate student
8 demand and student entry scores, scholarly standing and research performance (Marginson 2011,
9 Altbach 2004). Maringe (2006) found that HE has been transformed from a domesticated,
10 centrally funded nonmarket wise entity to a highly marketwise and competitive atmosphere.
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14 Kotler & Armstrong (2009) argue that choice simply means more than one institution becomes
15 available for patronage by consumers. Competition assumes some response by other suppliers
16 and suggests suppliers compete for similar students based on product differentiation and price.
17 Student choice is becoming an important factor in determining the sustainability of the sector
18 (Briggs 2006). Global financial constraints have forced universities to investigate different
19 methods and modes to increase student enrolment (Hemsley-Brown & Oplatka 2015).
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22 *Competition for financial resources*

23 Universities compete for the revenue provided by institutional customers or the students, alumni,
24 employers, corporations, governments, and private individuals (Brewer et al. 2005). Melguizo &
25 Strober (2007) noted that donors provide additional resources to the university to build and
26 support enhanced student, faculty, and research amenities. Furthermore, well-regarded
27 institutions with a quality student body, attract well-known and talented faculty members who
28 want to teach bright students. The combination of bright students and well-known faculty attract
29 new donors who want to be associated with universities that are thought to be prestigious.
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33 The main source for procurement of funds for private universities is the tuition fees that the
34 students pay (Kelchen 2016). If students cannot or do not graduate, this leaves the university in a
35 deficit which cannot be overcome during the academic year, thus developing bottom-line losses
36 (Jaquette et al. 2016). Cost of attendance and financial aid are the most researched institutional
37 factors in university-choice research, although there are conflicting results on their influence
38 (Kitsawad 2013). For example, some researchers point to the cost of attendance and financial aid
39 as being one of the top concerns and most influential factors in the university choice process,
40 while other studies show cost as a much smaller influence, especially in relation to achievement,
41 availability of program, and quality of the institution (Watamura et al. 2011). The development
42 of any university depends on how the growth is managed (Harrington 2016). The institutions
43 need to be able to attract students to provide funding to cover the various expenses incurred
44 (Smith & Sheppard 2016).
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48 *Student choice*

49 Bounded rationality presumes that people make decisions per goals and preferences, within
50 which their decisions are positioned in a mystery “black box” that we cannot see into (Bredo
51 2009, Jabbar 2011, Wilson 2014). Bounded rationality has been used to explain the interrelated
52 nature of student characteristics and environmental characteristics in the information processing
53 steps leading to a final decision (Jonassen 2011, Koc 2011). Additionally, current literature has
54 recognized this effect, although researchers have not referred to it as bounded rationality, but
55 instead have alluded to the interrelated influence of student characteristics and environmental
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3 characteristics in the university-choice process of students (Jonassen 2011, Watamura et al
4 2011).

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7 University managers should fully understand the precise nature of the factors that affect
8 enrolment to their university (Manoku 2015). A review of past international studies shows a
9 variety of choice factors important to students when selecting HEIs. These factors can be
10 grouped into three broad categories: socioeconomic characteristics, environmental
11 characteristics, and institutional characteristics (Wiese et al 2009). The literature shows that
12 socioeconomic characteristics such as parental education, academic ability, educational
13 aspirations, and gender all have an impact on the university-choice process of incoming students
14 (Qu & Dumay 2011, St. John et al. 2005, Smith & Sheppard 2016, Maxey & Kezar 2015,
15 Emmanouil et al. 2013, Lee & Morrish 2012, Schotter 2011). Environmental characteristics in
16 the university choice process include parent and family influences, high school counsellors,
17 teachers, peer influences and influences based on cultural and social capital (Webster 2012,
18 Valenzuela & Dornbusch 2014). Institutional characteristics can be classified into fixed
19 characteristics and running efforts to communicate or make contact with students. Fixed
20 characteristics include cost and financial aid, quality and rankings, technology available,
21 location, and undergraduate program availability (Stoddart 2015, Goglio 2016, Kinzie et al.
22 2011, St. John et al. 2005, Jaquette et al. 2016, Tomlinson 2008). Efforts to communicate or
23 contact students include web and Social Media (Nicholls et al. 2009, Bryer & Zavattaro 2011,
24 Hew 2011, Simões & Soares 2010, Unipod 2013), promotional materials (Selingo 2013, Carter et
25 al 2012, Armstrong & Lumsden 2000, Spaulding 2010, Soutar & Turner 2012) word of mouth
26 (Smith et al. 2005).

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29 There is a need for HEIs to gather accurate information regarding the preferences of students for
30 courses and field of studies. Traditional methods for evaluating what potential students look for
31 in a degree, tend to be descriptive, and while informative, do not assess the strength of students'
32 preferences; and how important they are relative to each other, and hence where efforts and
33 investments may best be targeted (Smith & Sheppard 2016).

34 35 36 *Enrolment management*

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39 Accordingly, many institutions are using marketing concepts and theories, to acquire a share of
40 the global market (Lee & Morrish 2012, Attanasio & Kaufmann 2012). According to Williams
41 (2002), enrolment management refers to the traditional task of setting and meeting the goal of
42 assembling a student body that comprises a predetermined and advantageous mix of students in
43 terms of quality, number, and diversity in all its forms. Enrolment management would be helpful
44 in managing institutional activities such as coordinating issues and local trends among groups of
45 people with an aim of supporting and enhancing educational activities countrywide (Emmanouil
46 et al. 2013). By the mid-80s, surveys showed that approximately 60 per cent of colleges and
47 universities had incorporated some form of enrolment management (Penn 1999). By the mid-90s,
48 enrolment management had become common place in private and public institutions (Kinzie et
49 al. 2011). There is a relationship between student enrolment and the ratio of the size of the
50 private sector to the collective HE (Beffy et al 2012).

51 52 53 *System Dynamics (SD) in HE*

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3 SD is a set of conceptual tools and perspective critical to the understanding of the dynamics and
4 structure of complex systems (Meadows et al. 2012). Forrester (1994,1998) observed that a
5 complex system is said to be dynamic if characterized by a complex causal structure that is
6 subjected to feedbacks. In such complex systems, actions result in effects which differ from
7 desired outcomes and expected results even though decision makers often attempt to adopt
8 rational decisions (Sterman 2000). SD is described by Meadows & Donella (2013) as a powerful
9 tool that facilitates and enhances learning about competitor, company and market. It is a
10 powerful tool that helps understand complex issues using delays, feedback and nonlinearities
11 (Harris & Williams 2005). SD assumes that dynamic behavior is common in all systems.
12 Feedback means a process where one factor impacts another factor until the last factor has an
13 influence on the first factor, completing a cycle of influence (Capra 1997). Although the review
14 of literature on SD modeling is rich with usage in various fields, not many works on SDM have
15 been published so far (Alfeld 2012).
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20 The first attempts to implement simulation models for educational resource management date to
21 the 1960s (Levine 1976). Enthusiasm for such models increased in the 1990s, apparently
22 encouraged by the overall advancement of information technology. There are a few researchers
23 using SD currently working on models of university management systems (Frances 1995, Green
24 1994, Galbraith 1998, Sandrock & Weinhardt 2005, Strauss & Borenstein 2015).
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27 A university system can be defined as dynamic, complex, non-linear system. Such a system is
28 characterized by interactions of close chains (or feedback loops) that, when combined, define the
29 structure of the system, and hence, how it behaves over time. Therefore, one should look at the
30 system from a holistic point of view instead of dividing the system into small parts. The tools
31 offered by SD could allow academic decision-makers to better keep under control the complete
32 university system and to explore the consequences of policies and decisions that academic
33 management are currently taking (Barnabe 2004). Per Kennedy and Clare (1999), the statistical
34 linear models and spread sheets that university management normally rely on are no longer
35 adequate for appropriate decisions. They argue that the problem with most input-output models
36 is that they adopt static linear views. Such models ignore both dynamics' interactions between
37 the input-output factors and the nature of the transformation taking place and are thus of little use
38 when considering process improvement. In HE management, as Galbraith (1999) points out, we
39 look toward targeting research activity, excellence in undergraduate teaching and education,
40 community relations, or resource management. What often goes unsaid is that these goals may
41 compete against each other, and their individual pursuits may lead to unintended consequences.
42 Galbraith argues that using the SD method will simulate and assess such situations in HEIs.
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47 **The Syrian HE System**

48 *General overview*

49 HE in Syria is provided at universities and colleges named as higher institutes, and technical
50 institutes. In the first decade of this century, the Syrian HE sector has seen major changes in the
51 curricula, re-qualifying and retaining teachers and constructing more new schools and universities
52 (Ayoubi et al. 2016). Many educational changes and 'reforms' came about, and there has been a
53 shift to place more attention on younger generations in professional and educational areas (Al-
54 Fattal 2010). As the population in Syria increases, the number of students graduating from high
55 school and attending HEIs is also increasing (Abdul Wahed 2004).
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The Syrian Government controls and supervises the HE system through the Ministry of HE (Ayoubi 2013). The private universities do not receive government financial aid but are subject to ministry regulations. From 2003 Syria began to allow private universities, which helped alleviate some of the pressures on public universities (Kabbani & Salloum 2011) to contribute, together with existing public Syrian universities to raising the level of HE, scientific research and increasing university learning opportunities (Al-Hessan et al. 2016). Private HEIs governed by the Presidential Decree No. 36 of 2001, are regulated and structured differently than public ones (Ayoubi et al. 2016).

Private universities in Syria

Private universities in Syria could attract students due to the lower school exam marks required by these institutions (Immerstein & Al-Shaikhly 2016). The private universities offer only undergraduate programs. The Ministry of HE (MoHE) is mandated with responsibility of ensuring that private universities adhere to the standards of a university (Ayoubi et al 2016). Currently there are 20 registered private universities, and until 2012, private universities in Syria have notably increased owing to the growing demand for HE and a subsequent strain on public universities to handle this demand (MoHE 2016).

All Syrian private universities operate as for-profit institutions, and are totally funded by student tuition payments (Kabbani & Salloum 2011). Students pay tuition fees much higher than those at public universities. In 2015, tuition fees ranged from 500 to 2500 EUR per academic year (Ayoubi et al 2016). However, the existence of this part of the HE sector has created a competition in student recruitment and many HEIs are working very hard to improve quality and facilities to attract the largest number of students (Al-Hessan et al 2016). Although there is a huge demand for HE in Syria, applicants are reluctant to apply due to the high fees especially in the private universities. Other key grounds behind recruitments' challenges are lack of credibility, loyalty and customer confidence, which are major considerations when selecting the best university. Nonetheless, prospective students have a wider variety of offers and providers to choose from, whether private or public. Previous literature reveals key factors that are important and which shape the Syrian students' thinking before selecting a university (Prugsamatz et al 2007, Bruce & Edgington 2008, Al-Fattal 2010, Al-Fattal 2012, Ayoubi et al. 2017). Chitty (2009) explains that these issues were relative and particularly varied to many personal, societal, institutional and psychological factors. Information gathering process was vital when determining students' university choice (Ayoubi & Ustwani 2014).

Private universities focus on increase in enrolment by the students because, since students are required to self-finance, this increases the revenue stream of the organizations. This in turn requires the private sector universities to increase their overall diversity within the available courses and an effective marketing mix that would increase the likelihood of increasing the student base through greater enrolments (DesJardins et al. 2006). This in turn creates a cycle which would allow the universities to utilize the finances gained to increase the value of the education provided and increase their research. How private HEIs in Syria can deal with market dynamics and attract and manage students would be better understood by SD approach. The SD approach integrates overall decision making and increases the supporting capacity of the data development of complex systems in future decision making. Therefore, this study will investigate the feasibility of

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3 introducing DSS using SD approach into the private HE sector in Syria.
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6 **Methodology**

7 *Why SD?*

8 SD was adopted by the authors to address the aims of the study as SD looks at the whole system
9 and examines how various choices fit within the whole; it elaborates, and gives more
10 comprehensive answers to stated questions, by examining the interaction between various factors,
11 rather than simply examining each factor in isolation (Bess & Dee 2008). Furthermore, the HE
12 system in Syria is questionable in terms of quality, and the challenge needs to be addressed by all
13 the stakeholders, so good causal models will involve a multiplicity of views from all stakeholders
14 and thus offer a more comprehensive view of the problem which will help explaining what factors
15 influence Syrian universities growth, and how they can be prioritized. The SD models are simple to
16 understand, and use. They simplify complex situations, such as a HE system, and allow decision
17 making based on both qualitative and quantitative data (Kennedy 2011).
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21 So, the authors will identify the important factors involved in the enrolment process and look at
22 their interactions via a Causal Model. This will help in building up an SDM which will be used to
23 simulate the consequences of allocating a limited amount of money to obtain future growth and
24 quality improvement. Two further considerations need to be considered when drawing up an SDM.
25 First, key factors may involve different time scales before having an impact on the growth or
26 development of the university. Second, several factors can have a direct or an indirect influence on
27 each other. Hence the model that is eventually devised needs to consider such complexities.
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30 *Research approach*

31 In the interpretive philosophy research, various scenarios are considered which involve socio-
32 economic, cultural, personal differences and their effect on individuals (Saunders et al. 2003),
33 consequently, there are various meanings which are true of one statement or event (Weaver &
34 Olson 2006). Because of the complex nature of this study, it is important to combine the
35 interpretive paradigm, using qualitative methods, together with the positivist paradigm, using
36 quantitative methods. In this study, the interviews that were conducted were used to capture
37 qualitative data, whereas the questionnaires were analyzed as quantitative data. Finally, to
38 supplement the data collected from these methods, a documentary review was conducted.
39 Qualitative research offers the flexibility to the responders to answer the question according to
40 their frame of reference which can vary significantly from other respondents (Denzin & Lincoln
41 2005). The quantitative paradigm is a positivistic scientific tradition that uses statistical tools and
42 mathematics to obtain the results (Sarantakos 2004).
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47 The study is based on the principles of action research. In education, action research is any
48 systematic inquiry conducted by teacher researchers, principals, school counselors, or other
49 stakeholders to gather information about how their schools operate, how they teach, and how well
50 their students learn (Mills 2003). Action research is a collaborative activity among colleagues
51 searching for solutions to everyday, real problems experienced in schools, or looking for ways to
52 improve instruction and increase student achievement (Ferrance 2000). A typical critique of action
53 researches would be that they are not rigorous or systematic enough. It is situation specific and
54 therefore the sample is not representative (Elliott 2011).
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Case study

The data in this study was mainly collected from one university. A case study is a common research strategy in different disciplines (Yin 2009). De Vaus (2002) highlights that selection of one case requires extensive case screening before actual cases are finally selected. MUST University in Syria was selected as the case study for this research because the university is a middle size university and it is seeking to expand. The university represents a typical private university. The behavior concerning enrolment at MUST is very similar to any other private university in Syria, only the data set is different. Abductively, the authors can claim that the findings across the sector will differ but the model itself is perfectly applicable. Further, all the documentation and archival records can easily be obtained free of charge based on work experience at the university for one of the authors, where this allows a first-hand account on the overall processes and efficiency.

As a case study, the research relies on a multiple source and method of evidence, with data needing to converge in a triangulation fashion. Multiple sources of evidence are highly recommended for case studies as the research findings will be better supported and are ultimately more convincing (Yin 2003). For this case study, two focus groups were conducted with members of staff. The purpose of the first focus group was to help determining the top priorities for each process; a second focus group was conducted with four staff directors, at the end to approve the loops and relationships between the model variables. To analyze the concepts and perceptions about the research model, the second phase of semi structured interviews was conducted with the participants to collect feedback on various situations. Complementing these interviews, another set of interviews was conducted with the directors of the university and then the faculty and rest of the staff which included marketing, admission and finance. In addition to the interviews, 60 pages of enrolment-related materials were analyzed. The documents analyzed were program brochures used for marketing and recruitment at MUST academic programs. These materials represent documents regularly used during the recruitment phase of the enrolment management process. Finally, as a single case study may not allow generalizations (Yin 2003), thirteen emails were sent to selected other private universities in Syria requesting the necessary information, followed by telephone conversations.

MUST University

Since 2003, the MoHE in Syria granted MUST the right to award degrees, which are considered as equivalent to the degrees awarded by the public universities (MoHE 2016). MUST provide undergraduate programs in the areas such as Banking and Finance, Business Administration, Computer Science, Computer Systems Engineering, Marketing and E-Commerce, Telecommunications as well as English Language and Literature. Degrees in Accounting, Hospitality Management, Agricultural Engineering, Petrochemical Engineering, French and Literature, Media, Advertising, and Interior Design are planned. In 2012, the university has more than 100 full-time professors, lecturers and instructors, assisted by a similar number of part-time professors and lecturers. The average student-to-staff ratio at MUST is around 30:1, which enables the staff members to ensure efficient participation in all educational, cultural, social, athletic, and technical activities. The biggest share of MUST capital revenue comes from student tuition fees. The university rarely benefits from donations from local stakeholders; such donations only play a minor role in the overall budget. In its first 4 years, MUST grew very fast in various areas, with the number of students rising to 4000, alongside student numbers available facilities and infrastructure

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3 have also grown. Yet, although new universities have strategic plans and development plans to
4 shape the future of their facilities, these plans are not accompanied by any long-term strategies.
5 Lastly, when the need for new construction arises, university managers simply ask the board of
6 trustees to give permission to fund such projects. The university's facilities and infrastructure have
7 grown rapidly until 2012. Furthermore, MUST requests for funds to build new structures from the
8 board of trustees, have been routinely approved. As with any university, MUST wants to grow, and
9 at the same time, the investors in the university also want a high return on their investment.
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12 13 14 *Phases of data collection*

15 Data was collected from winter 2010 to summer 2011. The *first phase* consists of focus group
16 meetings with president, vice president and members of management board staff at MUST. The
17 findings of this phase would yield the most important processes and issues on which the study
18 should focus and would help in designing the causal loop to be examined during the later phase of
19 the study. The *second phase* of the research consists of interviews with 4 key directors from
20 MUST, those are directors of admissions, marketing, human resources and financial resources.
21 Hence, this phase examines the patterns emerging from the issues raised at the meeting with the
22 university managing team in the first phase, and to understand university processes in more detail.
23 The findings from this phase will provide the key variables and sequences of the dynamic process
24 and so help in formalizing the causal loop, stock and flow diagrams. The *third phase* of research is
25 collation of the findings. The aim of this phase is to enhance the data from the first and second
26 phases, as well as finding any missing links between some of departments not already captured in
27 the first two phases. The *fourth phase* is a survey to 216 students, to measure the relative
28 importance of university facilities to choose the five main important facilities upon which the
29 model should be based. The *fifth phase* involves 13 interviews with senior staff from other
30 universities to measure the importance of these facilities for each university, as well as to examine
31 student staff ratio, and university fees, in addition to the market share comparisons to other
32 universities. Rejection rates were discussed at this phases, and findings will fill the gap in the
33 variables by helping to measure the regression of probability of rejection of the university chosen
34 as a case study compared to other universities. The *sixth phase* is the final collation where all the
35 data is gathered together, and a focus group was conducted with members of staff from MUST to
36 formalize the causal loops.
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42 Through this research design, each phase is feeding into the next phase in a logical progression and
43 sequence. Moreover, each phase is linked to concerns and issues raised in previous literature on
44 dynamic processes associated with HE and enrolment management.
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47 **Results**

48 *Phases One, Two and Three*

49 The feedback structure in Figure (1) contains three dominant feedback loops. While the sign (+)
50 represents a direct relationship, whereby a modification in one variable causes a similar change in
51 the second variables; a (-) represents a direct relationship whereby a change in one variable causes
52 an opposite change in the second variable.
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55 This feedback offers a useful basis for research in HE growth and investment issues since it
56 provides a theoretical analysis of the factors that determine this relationship. It shows the
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interaction and relationship of variables using cause and effect analysis to determine the behavior of variables over time. The model has eight major variables (student population, rate of enrolling student, tuition revenue; investment in facilities; investment in staff salary share; probability of rejecting applications, university rank, and actual number of applications). Three feedback loops are presented in Figure (1), namely the investment in facilities (R1), investment in staff salary share (R2) and university rank loop (R3).

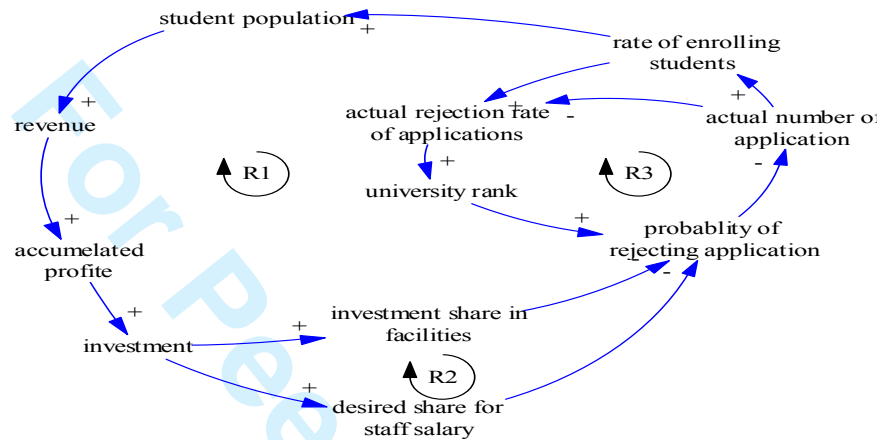


Figure (1): Dynamics of university growth

Loop R1 in Figure (1) articulates that an increase in number of enrolled students will increase student population and that will increase revenue and accumulated profits and in turn impact investment, so the university will be able to invest more in facilities. Better university facilities will attract more applications, which will enable more applications to be rejected by the university, as the university now will have a greater pool of applicants and could increase student numbers without compromising rejection rates, thereby maintaining its ranking while still expanding. Loop R2 is similar to R1, but instead of investing only in facilities, the university would invest also in increasing the share of staff to student ratio. In Loop R3, as to the actual applications reject rate, there will be pressure on ranking to increase, which might involve rejecting a higher ratio of applicants; yet if more students keep on applying, then the university's rejection rate could still increase, while maintaining, and if possible increasing, the number of enrolled students. Therefore, university's ranking is maintained while students' enrolment and numbers have increased.

Phase Four

Table (1) presents what students consider the most important factors that affect their decision to choose a university, where the main five important facilities will be chosen for the model. These were: technology in class, library, foreign staff, accommodation, and research Centre.

	Very important	Important	Moderate	Low	Extremely low	Rank	Mean
Convenience of attendance	54	81	54	18	9	10	3.708333
Foreign teaching staff	100	55	40	18	3	6	4.069444
Library	108	90	18	0	0	2	4.416667
Sport facilities	99	54	36	18	9	7	4
Research centre	108	63	36	9	0	3	4.25
Accommodation	99	72	27	9	9	5	4.125

Transportation	72	81	36	18	9	8	3.875
Catering service	63	72	54	9	18	9	3.708333
Technology	162	45	9	0	0	1	4.708333
Tuition Fees	110	60	28	9	9	4	4.171296

Table (1): Survey results about facilities preferred by the students

Phases Five and Six

1. Student Population Loop

Figure (2) illustrates the dynamics of student population and student enrolment. It shows the major feedback loops that dominate the behavior of the student population. The size of the student population desired by management forms the main parameter that strongly affects the increase and decrease in the number of students.

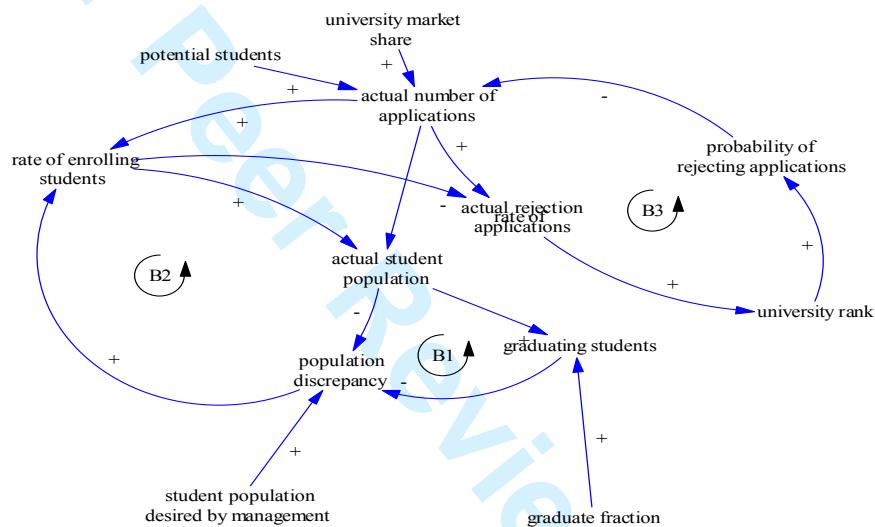


Figure (2): Student population loop

Loop B1 in Figure (2) illustrates the rate of graduating students, which depletes as the student population rises and falls according to the size of the student population, thereby regulating it. In Loop B2, as the student population decreases, the population discrepancy with respect to the desired number of students will increase, and this increases the students needed to fulfil management goals and increasing the rate of enrolling students to bring the student population close to the desired number of students. Finally in Loop B3, as the university's rank increases, the probability of rejecting applications for the university, compared to other universities, will increase and that will increase the actual number of applications, which will impact increasing actual rejection rates to bring the university's rank up.

2. Staff Population Loop

Figure (3) illustrates the dynamics of staff population and staff recruitment. It shows the major feedback loops that dominate the behavior of the staff population. The desired recruitment levels of staff are the main parameters that strongly affect the increase and decrease in the number of staff.

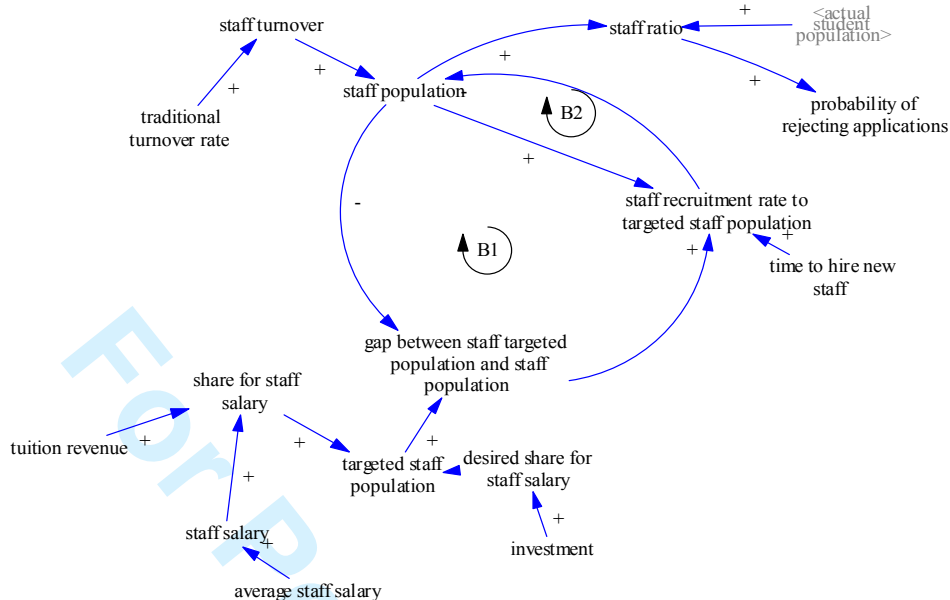


Figure (3): Staff population loop

In Loop B1 in Figure (3), as the staff population increases, the gap between staff targeted population and staff population lessens; the staff adjustment rate will decrease so that the staff population will get closer to the desired value of staff population targeted. In Loop B2, as the staff population gets closer to the number of desired staff, the staff adjustment rate will drop, and vice versa.

3. Financial Loop

Figure (4) illustrates the dynamics of investment decisions and their consequences for university's growth.

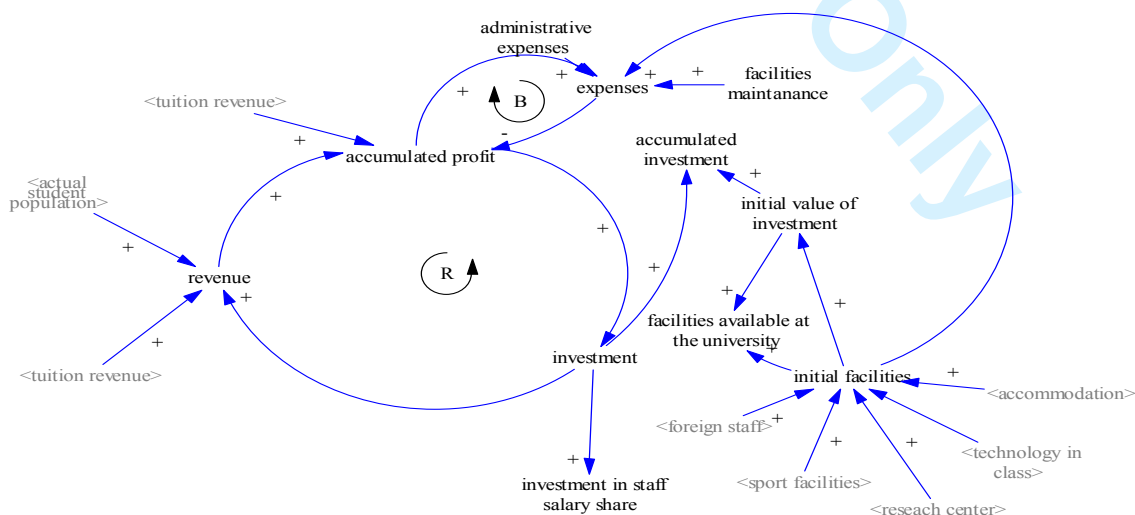


Figure (4): Financial loop

Figure (4) presents one reinforcing loop. Reinforcing Loop R illustrates that increasing revenue will increase accumulated profit, which will increase investment and that will increase revenue.

System dynamic simulation system for student enrolment in HE

The SDM was built based on the field study results which provided a descriptive input on which the SD conceptual feedback structure could be developed. The feedback loops were used to develop a feedback structure consisting of stocks, flows and so forth, in accordance with the simulation of SD. The simulation model discussed in this section involves five elements: student population (*how students flow into and out the university?*); the mechanism of competition among universities (*how the university under investigation faces up to competition from other providers and what the effect of such competition might be on university growth?*); staff population (*what is the rate of staff recruitment and turnover at the university?*); university facilities (*what are the effects of available and planned facilities on university growth?*); and financial element (*what are the revenue, expenses and investment policies?*).

Student population dynamic model

To develop the student population model, it is important to know the number of students at the university, and how the management decisions and investment strategies will affect student population dynamics and growth. To incorporate these principles into a “stock and flow” model, the first stock would be ‘student population’ chosen from student causal loop diagrams. The student population in this model is stock because the purpose of this model is to study the behavior of student population over time, and the dynamic consequences of other variables on student population. Related to the stock are the flows showing students going in and out of the stock. Figure (5) represents the student population system dynamics model.

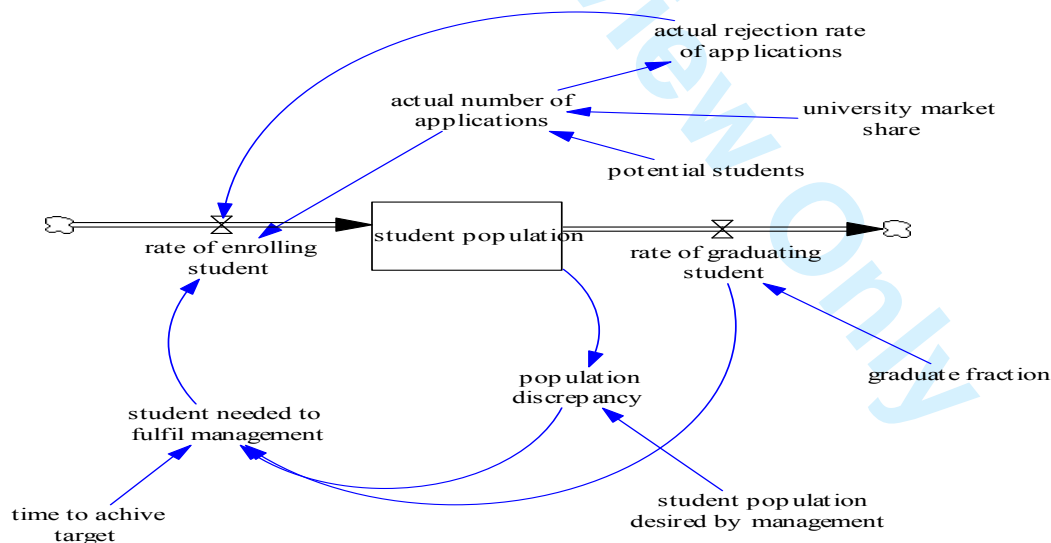


Figure (5): Student population system dynamics model

In Figure (5), the student population desired by management' variable is exogenous and could be changed by university management. The population discrepancy variable is the gap between the number of desired students and already enrolled students. The population discrepancy variable is a

function of student population and desired students as follows “population discrepancy = student population desired by management - student population”. The students needed to fulfil management variable has been added to the model in order to calculate what is needed to fulfil the growth plan made by management. The rate of enrolling students variable is the actual results of minimum number of students need and actual applications as follows “Rate of enrolling students = $\min(\text{student needed to fulfil management, actual number of applications})$ ”. Once the size of the desired students’ population is determined, a series of calculations based on probability of rejecting applications variable will allow admissions officers to estimate the number of students from the current potential students. A probability of rejecting applications variable was added to the model. This variable will play an important role as it will determine the number of applications that MUST rejected compared to other universities and MUST would like to increase this number in order to increase the university’s rank. Several variables will affect the probability of rejection applications variables such as facilities available at the university, staff ratio, fees per student and university rank.

It is important to note that not only the chosen university in this study is trying to improve its position, all the other universities are equally trying to improve theirs, so there is a general competition to recruit the best students. This competition is explained in the next section.

The competition among universities dynamic model

The proposed competition dynamic model explains the impact of competition on university’s rank and the relations between university’s rank and probability of rejecting applications. The model will help to understand how policies could affect ranking and how it will change over time, so university rank variable has been chosen as a stock. Figure (6) represents the proposed dynamic model of competition and the effect of such competition might be on university growth.

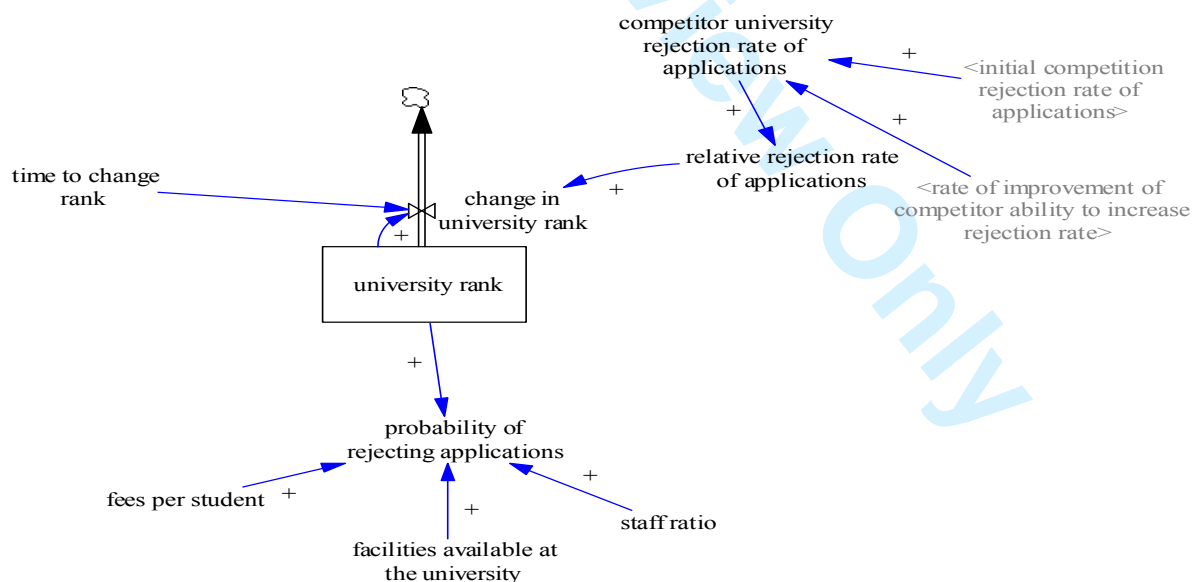


Figure (6): Competition among universities dynamic model

In Figure (6), the rejection applications rate usually depends on different factors such as university capacity and university selectiveness in order to increase student quality. In order to study the

change in ranking over time, change in rank variable was linked to the stock university rank where change on rank variable depends on the time to change rank and the actual value of university rank itself. The relative rejection rate of applications variable is the gap between what the university rate is and what the other private universities rejection rate is; if the university has a higher rejection rate compared to the competition, it will have a positive impact on its ranking. In contrast, the competitor university rejection rate of applications variable is a function of initial competition rejection rate of applications plus rate of improvement of competitor ability to increase rejection rate over time.

Staff population dynamic model

One of the factors that will affect probability of rejecting applications is staff ratio. This variable is a function of the number of available staff and the number of current students. Based on the staff population loop, the authors proposed a staff population dynamic model presented in Figure (7).

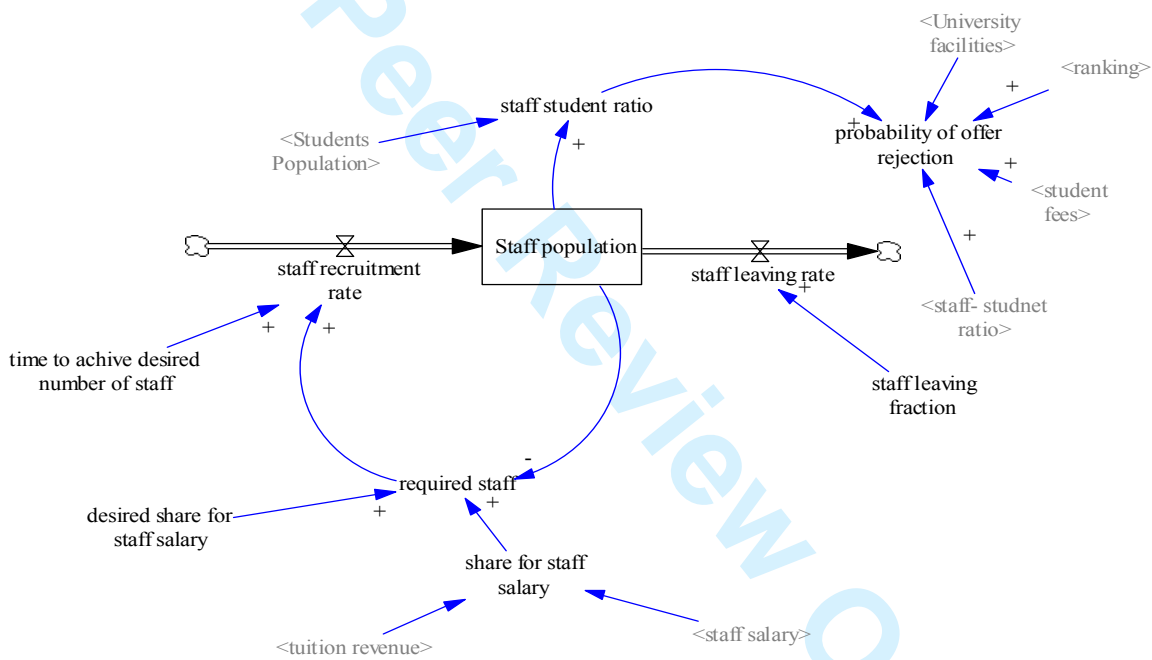


Figure (7): Staff population dynamic model

In Figure (7), the targeted staff population variable indicates the number of staff that is required by the university as a function of its operational and strategic policies. The targeted staff population = (desired share for staff salary/share for staff salary)*staff population. The current operating policy entitled share for staff salary variable was derived from the initial values given for staff salaries, so Share for staff salary= staff salary/tuition revenue. However, the desired share for staff salary variable is a strategic policy since any change in this variable will start to affect other variables such as university rank, actual number of applications, and profit.

Facilities dynamic model

In recent years, there has been an increased concern over the adequacy of higher educational facilities to create an environment that is conducive to learning and their consequent impact on

educational outcomes. Several studies have showed a relation between the facilities available at the university and number of applications submitted to the university (Kabbani & Salloum, 2011). The more a university invests in the facilities, the more number of applications will be submitted to the university and that will allow the university to be selective in the applications and choose only good students so the probability of rejection will increase, and that will increase the university's ranking (see Figure 8).

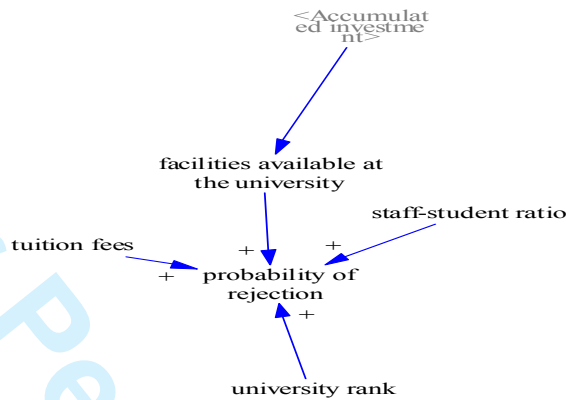


Figure (8): Facilities' dynamic model

Financial dynamic model

This model demonstrates how the university invests and what factors affect investment decisions. It links with the other elements since issues of funding and investment directly determine the existence of a higher education institution. Figure (9) presents the financial dynamic model proposed by the authors.

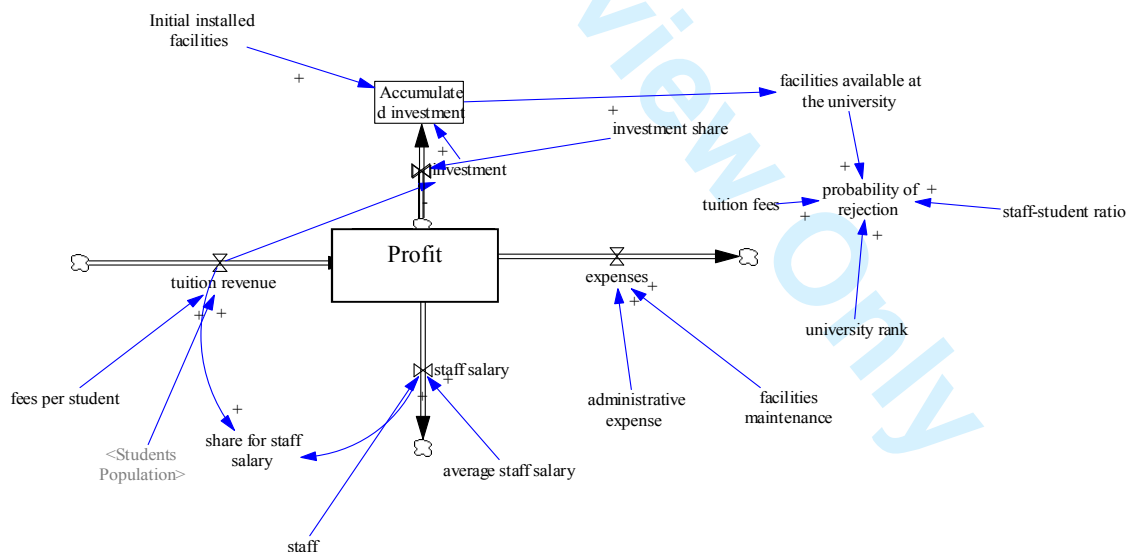


Figure (9): Financial dynamic model

In Figure (9), the accumulated investment will be calculated by investment share and how much the university needs to invest in order to increase the available facilities and that will play an important role in changing the offer rejection rate. However, as 'desired investment share' variable

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3 is a strategic policy, any changes in this area will affect other variables such as ranking, which will
4 then have an impact on the competitiveness of the university. Also as mentioned in the previous
5 section 'desired share for staff salary' variable is also a strategic policy and it will have an impact
6 on the probability of rejecting applications. 'Investment share' and 'staff salary share' variables are
7 exogenous and could be changed by university management.
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10 Discussion

11 *General conclusions*

12 This research helps to build a simulation model and organizes the university model into five
13 sectors: 1-student population; how students flow into and out the university?, 2-the mechanism of
14 competition between universities; how the university under investigation faces up to competition
15 from other providers and what the effect of such competition might be on university growth?. 3-
16 staff population; staff recruitment and turnover at the university, 4- university facilities; what is the
17 effect of available and planned facilities on university growth?, 5- financial sector; what are the
18 revenue, expenses and investment policies?
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22 The findings of the study recommend adoption and usage of the simulation model for investment
23 in staff and facilities, as to offer a more attractive package to the potential students without
24 significantly compromising on profits. The model can be modified to examine decisions that are
25 relevant at a departmental level, rather than university level. The study recommends that managers
26 of universities should follow the most suitable strategy according to the circumstances surrounding
27 the university; that is to say that a flexible response is encouraged which would take into account
28 what strategies are being adopted by the competition at any given time, as well as other factors in
29 the external environment. A further recommendation is that the university should not change the
30 university tuition fees as in the long term an increase in fees might deter students from applying,
31 while, on the other hand, a decrease in fees might affect the university's reputation in a negative
32 way.
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36 It is imperative to note that the possible limitation of the study concerning its application in a
37 Syrian university context does not restrict either its generalizability or its applicability in a wider
38 context. HE advancement is an evolutionary process and will continue to progress quickly. This
39 study's exploration and recommendations are equally applicable to other universities and are not
40 geographically limited to any specific country. Moreover, it is significant to understand that
41 knowledge itself is difficult to measure and without any reliable and valid measurement metrics, it
42 can be very difficult to establish a widespread knowledge theory that can serve as a practical and
43 definitive guide to the field of knowledge management.
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47 In this research, knowledge is not measured directly, but instead it is inferred and analyzed through
48 verifiable and authentic data, the simulation results of which are genuinely beneficial for the wider
49 exploration of the knowledge management paradigm. In the context of HE, this study is not
50 entirely marginalized or circumscribed to a single educational institute. On the contrary, it is
51 imperative to note that complex systems are intuitively understood as a phenomenon which
52 consists of larger elements comprised in a hierarchical structure of multiple levels where the
53 elements themselves can represent structures. The complex is used to explain the fact concerning
54 the underlying area of HE research which cannot be expressed only in quantitative measures but
55 also in qualitative measures.
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Moreover, the description and inference of the system is dependent upon the researcher's point of view. Nevertheless, although the underlying problem has been considered in the review of literature, there is a unique insight into the observer's opinion in the process of modelling, which reflects the model's simulation capacity to map the consequences of allocating limited funding for future investment in Syrian HE sector's growth and quality improvement.

As per simulation, the exploration of the feasibility of DSS and SD with the purpose of effective management of HEIs in Syria, concerning strategic planning of university's expansion and growth, is empirically analyzed. The study reflects the challenges in the HE sector's growth with respect to the deteriorating geopolitical situation.

Due to the model's complexity, it seems to be challenging to prove the model by statistical data alone. As for future work, theoretical support for inherent assumptions must be statistically explored. There is a need to further collect and aggregate statistically viable data to understand the model's viability and applicability in a context that is beyond the established paradigm of MUST in Syria. More cases need to be analyzed to gauge the entire process of model implementation, adjustment and design.

Collectively, the study is based on the amalgamation of various theories that are linked by the developmental research model. The dynamics involved in modelling is dependent upon user participation and that is the area that needs to be further studied and explored through means of a survey in order to gauge investment decisions and the management's concerns at the grassroots level.

Limitations

This paper raises several interesting issues regarding the operation of universities. However, what is presented in the paper is analytical in nature. The main emphasis has been on investigating, testing and designing policies related to the student enrolment management model. A potential limitation of the study is that the data was collected only from Syria. Therefore, the conclusions can only be justified in that country and to any other country in a similar evolutionary phase of the HE industry. The SDM can be used in other countries but it would need data collected from those countries before confidence could be attached to the results. Another potential limitation is that the study only used a single case study – that of MUST. Again, it can be argued that the difference is in the data, and that authors have built a model that could be used for other private universities.

To keep the model from becoming too complex, the model did not include all the potential factors and variables that might influence the university's environment and so it is possible to extend the model to include further aspects of the university system. For instance, different university expenses such as expenses related to education in addition to staff costs and more detailed representations of variables related to staff such as part time staff, administrative staff, and various distinctions in allocating staff time between teaching and research, could have been included. In modelling the cost of investment in facilities, the authors did not consider the differences that might arise between the various facilities themselves, in terms of cost to build the facility and in terms of the length of time it might take to make the facility ready for use. The intensity of competition clearly has an impact on management responses and decision making. However, we

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3 assumed that any response on the part of management would not significantly alter the nature of
4 competitor behavior. Finally, the study is limited by data collected in 2012 before the current
5 political instability in Syria.
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10 *Future research*

11 One potential means of extending this research would be to build a game's version, which would
12 emphasize several features of the university management system. The interactive model can be
13 used as a laboratory to enable not only debate but also theoretical research on how best to deal with
14 strategic university management problems. The model can be improved to include the nature of
15 different facilities, because some facilities will cost less to build, some facilities will take a longer
16 time to build. Future research can analyze both exogenous and endogenous variables and the
17 relationships that affect the investment decisions made by university management, without the
18 constraints of greater disparity amongst private universities. The study will prove useful in further
19 scholarly work, such as further exploration of DSS using a SD approach in a different context with
20 more stabilized geo-political conditions as compared to Syria. Future research can be based upon
21 gauging the feasibility of introducing DSS and SD approach with respect to decision making
22 processes at State-run or public educational institutions in different countries. A cross-functional
23 and integrated approach concerning both private and public academic institutes regarding DSS and
24 SD approach, can be seamlessly integrated into the study. Due to the volatile situation in Syria,
25 future studies can benefit from enhanced adaptability and flexibility to consider the changes in the
26 environment and also the decision making approach of the end-user. Further studies can focus on
27 the ability of DSS to provide well-structured and concrete answers to problems faced by decision
28 makers, thought leaders, upper level managers, or experts in academia. Future studies should
29 specifically focus on utilizing DSS features in such a manner that it makes the output and
30 interpretation easily discernible by non-technical people in an intuitive manner. Future studies can
31 benefit from utilizing data in highly constructive means in order to create a competitive edge,
32 solidify investment decisions and to automate all managerial processes.
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39 *Final word*

40 Since the work was completed there has been severe political instability in Syria which has had a
41 significant impact on the HEIs and has decimated the university system within the country. Syria
42 had boasted of the largest and most well established system of HE in the Middle East prior to the
43 war. The Brookings institution estimates that 2,000 university professionals and 100,000
44 university qualified students are amongst the refugees (Brookings Institution 2016). Pre-war
45 enrolment suggests that of the 450,000 refugees between ages of 18-22 around 90,000 to 100,000
46 would have been enrolled in universities (Redden 2015). This number may increase considering
47 the increasing duration of the conflict as well as the resultant destruction of infrastructure crucial
48 to developing continuity. This has significantly threatened the larger fabric of the HE system
49 within Syria. Such a loss of academia can have a long term detrimental impact on the overall
50 quality of education and development of continuance, post-conflict. As this study has been
51 conducted before the war started, the insights generated by this research are still valid and could
52 be used when stability returns to Syria.
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