



Modelling Higher Education Quality Based on Information System Quality

Sarah Aouhassi¹(✉), Khalid Oqaidi², and Khalifa Mansouri²

¹ Laboratory M2S2I ENSAD, University Hassan II of Casablanca, Casablanca, Morocco
haouhassi@gmail.com

² Laboratory SSDIA, ENSET of Mohammedia, University Hassan II of Casablanca,
Casablanca, Morocco

Abstract. Quality assurance in higher education continues to be a serious challenge even the significant efforts that have been done to this end. Major strides have been made by Moroccan universities in this field especially since instituting the national agency for evaluation and quality assurance in higher education and scientific research (ANEAQ). However, information system quality (ISQ) is not getting much of officials' attention while it is a major vehicle of higher education quality (HEQ). This paper aims to present a theoretical model able to link ISQ to HEQ, using the five IS components namely human resources, hardware, software and applications, procedures and data and the three major parts of HE namely Education, Research and Governance. Each of the five IS components and the three HE parts have a set of measuring quality indicators expressed via the surveys' questions. Perspectives of all HE intervening are taken into account in order to have more accurate findings on HEQ. For this purpose, adapted surveys for each type of HE intervening are designed. The outcome of this paper is hence an evaluation model with a set of indicators to quantify the quality level of education, research and governance through the measurement of the quality level of the IS 'components.

Research Contribution: The interest of this research is to raise awareness about the major role played by ISQ within HE institutions and to describe theoretically the impact of ISQ on enhancing HEQ.

Keywords: Higher Education · Information System · Quality · Measuring indicators · Hierarchical Model

1 Introduction

Higher Education Quality is a topic that retains a lot of attention from the research community, that's related primarily to the researcher's affiliation to universities and their wild knowledge of its problems. Information System in higher education institutions and the quality of both IS and HE are the subject of the literature review processed for this article preparation. We were seeking a close relationship between ISQ and HEQ, but it was not that obvious.

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In fact, as shown in the related works section, we found that neither IS nor HE are considered as a whole, every paper covers only a tiny part of the two topics.

Thus, we are proposing a new approach based on hierarchical model for both ISQ and HEQ, the first model is already elaborated and tested on Moroccan universities within the project TEMPUS MISSION and the second one took its foundations from the project TEMPUS RECET and will be detailed on Our Model section.

The Discussion section is about demonstrating how ISQ can impact HEQ by using the lower levels of both models and finally the conclusion where we summarize our research results and open for future works.

2 Literature Review

2.1 Related Works

This article focuses on education quality as one of the three parts of higher education quality. The authors use surveys for all higher education intervening's namely students, professors and staff to have a full view on education quality regarding the indicators set used on the questionnaire. The subject is not about ISQ specifically, but it relies heavily on the data from IS in order to have an efficient quality management system for education [4].

The use of Artificial Intelligence as a substitute for the manual method for universities accreditation in Indonesia for ranking and quality assurance ends is the main idea that this article emphasizes on. The use of data from the university datacenter has a crucial impact on the higher education quality [5].

Towards evaluating higher education institutions in Colombia, the researchers perform this assessment by considering four parts in HE namely general, teaching, employment and research. They tried afterward to compute the efficiency of each higher education institution in order to categorize them according to the efficiency of each part. Data was collected from national institutions in charge of higher education as the government department [6]. This article develops mainly the barriers of quality in higher education in Kenya, including resources, governance and pedagogical culture. It cites information and communication technologies (ICT) as an important leverage for education [7].

Analysing the causes of IS failure projects in public universities in Iran is the topic of this article. It demonstrates that this failure is caused mainly by the lack of organization management, lack of top management support, user's resistance to change and inadequate training of users, insufficient IT infrastructure and complexity of projects misfit of IS software. These barriers are related to the governance in HE and to the human factor involved in IS in universities [8].

This article is about using the business intelligence (BI) tools to gather heterogeneous data in order to offer a dashboard for managers. This approach can accelerate the process of decision making and enhance thereby the HEQ [9].

Researchers in this article focuses on the role of IT governance in higher education institutions and how it impacts governance on universities. They find that Involvement senior management IT has a positive impact on IT governance effectiveness and IT governance on IT innovation. These results get closer to those we are seeking but they

remain insufficient since they are covering a specific part of ISQ and its impact on HEQ [10].

Gamification is considered in this article as a tool to enhance quality of education via motivation and engagement of students. This tool as we know is based mostly on the development of software and applications dedicated to that end, so good features and high quality of these software are required to achieve the anticipated outcome [11]. Evaluating the audience response system as a tool to improve the students' experience in large size classes is the subject of this paper. This tool combines hardware and software, and the evaluation was made from a student's perspective. This topic covers a part of ISQ which contributes to enhancing education quality [12].

This article tries to answer the question "What does HEQ mean?" To do so, the researchers designed adapted questionnaires to students, employers and staff. The HEQ is perceived mainly as its output is professional integration and cooperation with the industrial sector [13].

This article tries to answer a question which seems like that of this one; "Is there a role for computerized Management Information Systems requirements in improving the quality of administrative decisions in the Palestinian Ministry of Education and Higher Education?" by using data from the governmental department in charge of higher education in Palestine, the main results related to our topic are that there is a correlation between the physical requirements available for the use of administrative IS and the quality of administrative decisions in the Ministry of Education, a relationship between the software requirements available for the use of Management IS and the quality of administrative decisions in the Ministry of Education, a relationship between the human requirements available for the use of Management IS and the quality of administrative decisions, a relationship between the quality of administrative decisions and the use of administrative IS in the Ministry of Education.

The recommendations delivered from this paper are that, for the ministry, to be able to cope with the rapidly changing external environmental changes and the limited time available for the collection and analysis of information, administrative information systems should be used, and to increase the interest and support of senior management to implement and use the Management IS in the ministry effectively and provide all necessary to achieve this, for its important role in accomplishing the work accurately and proficiency and access to quality decisions [14].

This article points out the tight relationship between IT governance and the quality of service in Portuguese and Brazilian universities, which reveals the impact of ISQ via "IT governance" on HEQ via "service quality" [15]. Universities' ranking is the topic of this article, but the approach adopted is different from the usual one. The authors try to create composite indicators of excellence and quality that are more general than the HE context, including the economic situation, GDP, population and budget allocated to research and development [16]. Results of this research study show that higher levels of relational coordination at a university lead to higher levels of the quality of education, from a student's point of view about online education, that naturally relies heavily on information and communication technology [17].

2.2 Comments and Critics of the Literature Review

The recent literature review brought out an ambiguous relationship between the ISQ in an academic context and the HEQ as a whole. Several studies were conducted all over the world to prove directly or indirectly the impact of a high quality level of IS on one or more domains of HE, notably education and governance.

The topics of these studies are undoubtedly wide-ranging, but none of them has dealt with the relationship between ISQ and HEQ in a comprehensive manner. Our model emerges with a perspective to gather fragments from research, conducted here and there, in order to suggest a deep insight to this question.

3 Methodology

It is about linking ISQ with HEQ, 25 indicators for the five IS components with the four intervening categories namely IS managers, technical staff, functional staff and users and 22 references for the three domains of HE including professors, staff and students point of views.

We already elaborate the ISysQ model which allows to give a score to a given university according to its ISQ level [1]. This allows to localize each university regarding others, to prioritize the IS' components with the less quality score and also to consider this level from whom point of view i.e. IS managers, technical staff, functional staff or users. The same methodology will be applied to the HiEdQ model, proposed on the following section, for higher education qualification, where the score will be computed from the set of indicators/references from the three HE domains namely education, research and governance.

We aim to prove that the HE three domains are relying mostly on IS regarding their quality level, so increasing HEQ comes back to increase ISQ.

3.1 Information System Quality: The ISysQ Model

In a previous work on ISQ [2], a hierarchical model was realized containing a set of indicators for each IS component as shown on Fig. 1.

The ISysQ model is based on the five IS components namely human resources, hardware, software and applications, procedures and data 'Appendix 1'. It is about giving for each IS component, a set of indicators measuring quality, not to mention taking into account all IS intervening, who are IS managers, technical staff, functional staff and users. The four intervening types are implicated only in a subset of the original set of measuring indicators.

The sub set of measuring indicators are selected on the basis of information availability and suitability of area of expertise of considered IS intervening [3], which leaves us with 21 indicators for IS managers sub model, 16 for the technical staff one's, and 11 indicators for each of functional staff and users sub models. The four subsets are expressed through several questions on adapted surveys for each IS intervening type.

Numerical value for each indicator is computed from related questions consolidated on adequate equations and formulas [2], then the value of the component is computed

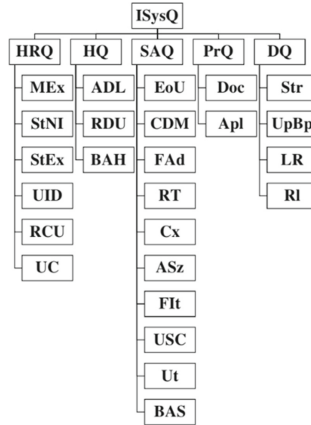


Fig. 1. Indicators of the ISysQ model

from related indicators [3] and finally a standardization of the component's values is performed in order to have the same scale for all.

This model provides the HE institution with a tool to measure the ISQ fully and thoroughly on the component's level as well as the IS intervening level. ISysQ offers quantitative information for the ISQ level in a given university, likewise numeric values for the quality of IS components and the measuring indicators.

Numerical values of measuring indicators enable firstly an objective diagnosis of the ISQ in any organization, secondly they help the comparison of the ISQ level within organizations, and finally they allow to highlight the elements with the lowest quality level to find adequate solutions.

The questionnaires were conceived and adapted to all IS intervening, in order to gather more data in each organization. From this multidimensional qualification, ISQ can be associated henceforth with a numerical value for any organization via the responses aggregation [2] by questioned type on one hand and data consolidation by organization on the other hand. ISQ standardization enables firstly points of failure properly, then it allows a factual comparison within organizations included in this study which were Moroccan universities.

To test this model, we collected data from Moroccan public universities within a national project on information system¹ during a meeting that gathered managers and a group of technical staff.

Standardization is proposed for the purpose of enabling comparison within indicators on the same university and to determine the components values.

Taking human resources quality involved in IS as an example on a given university "Univ i", its value is a weighted average by the indicator number on the corresponding

¹ Establishment of a National Service of an Operational Information System (TEMPUS MISSION).

sub model. For instance, “5” on Eq. (1) is the number of indicators related to HRQ component on IS managers sub model, “2” is the number of indicators related to HRQ component on Technical staff sub model and so on.

$$\begin{aligned} \text{HRQ}_{\text{Univ } i} = & 1/12 \times (5 \times \text{HRQ}_{\text{Managers}} + 2 \times \text{HRQ}_{\text{Technical Staff}} \\ & + 2 \times \text{HRQ}_{\text{Functional Staff}} + 3 \times \text{HRQ}_{\text{Users}}) \end{aligned} \quad (1)$$

Following the same steps for the remaining components, the values taken are computed from those of sub models related to the four intervening types as follows in the equations below:

$$\begin{aligned} \text{HQ}_{\text{Univ } i} = & 1/4 \times (2 \times \text{HQ}_{\text{Managers}} + 2 \times \text{HQ}_{\text{Technical Staff}} \\ & + 0 \times \text{HQ}_{\text{Functional Staff}} + 0 \times \text{HQ}_{\text{Users}}) \end{aligned} \quad (2)$$

$$\begin{aligned} \text{SAQ}_{\text{Univ } i} = & 1/28 \times (9 \times \text{SAQ}_{\text{Managers}} + 8 \times \text{SAQ}_{\text{Technical Staff}} \\ & + 6 \times \text{SAQ}_{\text{Functional Staff}} + 5 \times \text{SAQ}_{\text{Users}}) \end{aligned} \quad (3)$$

$$\begin{aligned} \text{PrQ}_{\text{Univ } i} = & 1/5 \times (2 \times \text{PrQ}_{\text{Managers}} + 1 \times \text{PrQ}_{\text{Technical Staff}} \\ & + 1 \times \text{PrQ}_{\text{Functional Staff}} + 1 \times \text{PrQ}_{\text{Users}}) \end{aligned} \quad (4)$$

$$\begin{aligned} \text{DQ}_{\text{Univ } i} = & 1/11 \times (4 \times \text{DQ}_{\text{Managers}} + 3 \times \text{DQ}_{\text{Technical Staff}} \\ & + 2 \times \text{DQ}_{\text{Functional Staff}} + 2 \times \text{DQ}_{\text{Users}}) \end{aligned} \quad (5)$$

The final formula that gives the numerical value of the ISQ on a given organization is reported on Eq. (6)

$$\begin{aligned} \text{ISQ}_{\text{Univ } i} = & \frac{1}{25} \times (6 \times \text{HRQ}_{\text{Univ } i} + 3 \times \text{HQ}_{\text{Univ } i} \\ & + 10 \times \text{SAQ}_{\text{Univ } i} + 2 \times \text{PrQ}_{\text{Univ } i} + 4 \times \text{DQ}_{\text{Univ } i}) \end{aligned} \quad (6)$$

where the weights 6, 3, 10, 2 and 4 are the number of indicators for the components HRQ, HQ, SAQ, PrQ and DQ respectively. We divide by 25 which is the sum of the weights in order to get back to the same scale.

3.2 Higher Education Quality: The HiEdQ Model

To model Higher Education Quality, we will apply the same approach as on ISysQ model, which is subdividing HE into several parts and assign for each part a set of measuring indicators for quality. HE is composed of three major domains which are Governance, Education and Research. Governance can cover besides the organization and management aspects, all that concern openness of the institution to its environment. Education is about everything related to students, from their admission and enrolment to their graduation and employment without forgetting students' life and education engineering. Research includes its policy, organization, production, development, evaluation and promotion besides doctoral studies and scientific cooperation.

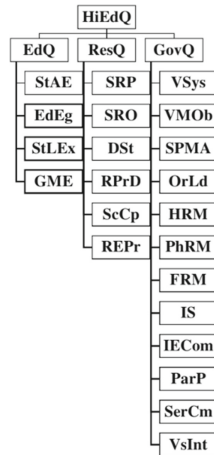


Fig. 2. Indicators of the HiEdQ model

This HE breakdown took its cue from the Tempus project RECET (Strengthening capacities on institutional evaluation)² on Moroccan universities with the partnership of four European universities from Spain, Portugal Belgium and Romania. RECET's aim is to develop the quality assurance culture of Moroccan higher education by skills building on institutional evaluation, assisting thereby the creation of the national agency for evaluation and quality assurance in higher education and scientific research (ANEAQ).

The measuring indicators for the HiEdQ are the references (Fig. 2) established on the practical user guide for the self-assessment standards. These references are specified on several criteria and each criterion is sub-divide on proofs turned into questions. Similarly, as mentioned earlier on the ISysQ model where questionnaires were designed to adapt all IS interventions, here they will be adapted to THE intervening namely students, professors and staff member.

4 Discussion

The aim of this paper is to prove the impact of ISQ on HEQ which comes to answer the question “can we enhance HEQ by improving ISQ in universities?” We could give a comprehensive response by specifying in the first place what ISQ means. By going back to the ISysQ model described above, ISQ is computed from the quality level of its five components then the quality level of each component is computed from the four sub models corresponding to the four IS intervening. So to be more specific on how ISQ can improve HEQ, we have to replace the former question, for illustrative purposes, with “how does the quality of Human Resources involved on IS -*which is the first component on the ISysQ model*- can improve HEQ”. This question remains nonetheless generic, that's why more specifications are required. HEQ is defined by the HiEdQ model as the quality of its three domains, each domain has a set of indicators/references that includes

² <https://sites.google.com/a/uhp.ac.ma/recet>.

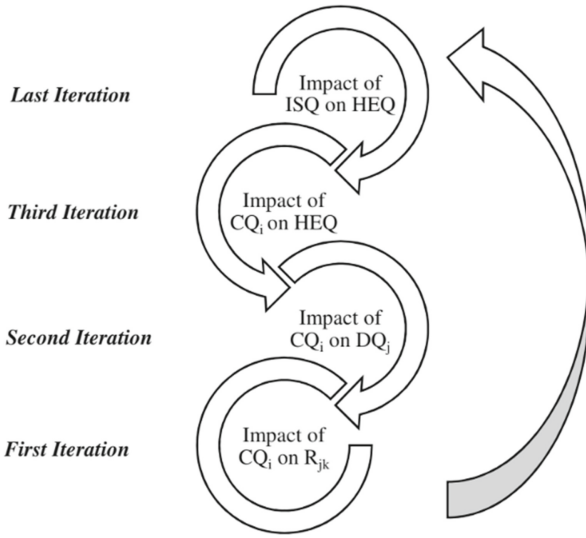


Fig. 3. Iterations to prove impact of ISQ on HEQ

several criteria and proofs as established by the RECET project. Thus, the third iteration of the question above becomes “how does the quality of human resources involved in IS can improve Research quality ? - which is the second domain on the HiEdQ model-”. Following the same path, the last iteration to be more specific is replacing the domain by one of its references, so the question becomes “how does quality of human resources involved on IS can improve Research Production and Development - which is the fourth reference for the research quality-” ‘Appendix 2’.

Once we answer the last question by proving the impact of the quality of a specific component on the quality of a given reference, we can take the opposite path as shown on Fig. 3 and imply that ISQ can enhance HEQ.

Where CQi is the ième ISQ component, $i = (1, \dots, 5)$, DQj is the jème domain of HEQ and Rjk is the kème reference for the jème domain of HEQ.

These steps must be performed for all IS components and their relationships with all references included on HiEdQ model, even if proving the impact of ISQ on HEQ may be sufficient with a group of these relationships.

5 Conclusion

This paper is about modeling HEQ based on ISQ in universities. We tried to build on the ISysQ model that we have already elaborated and tested on Moroccan public universities. The numerical values that we found were very helpful to classify universities regarding their quality degree of IS and of the lower levels of the hierarchical model, i.e. components and indicators. The HiEdQ model, that we present for the first time on this paper, follows the same principle of the ISysQ model on its hierarchical form and on considering all the HE intervening perspectives. Confirming the impact of ISQ on HEQ remains a matter

of data collection through the elaborated questionnaires from all the contributors cited earlier on this paper.

To be exhaustive, the present work must include the full range of relations that may exist between the elements on the ISysQ model and those of HiEdQ as mentioned on Fig. 3, which is a large number that will eventually present some difficulties and limitations to this study.

As development prospects, we suggest to use an assembly of the questionnaires established for the ISysQ model and those used on RECET project with an adaptation to the intervening types on both models, in order to collect data and gather information from a sample of higher education institutions, then we proceed to a comprehensive impact study for the ISysQ's elements on HiEdQ's ones.

Appendix 1: ISysQ Model abbreviations

ISQ Information System Quality

HRQ Human Resources Quality

MEx Manager Experience

StNI Staff Numbers Involved in IS

StEx IS Staff Experience

UID Users Implication Degree

RCU Resistance to Change of Users

UC User Competence

HQ Hardware Quality

ADL Average Duration of Life

RDU Rate of Daily Use

BAH Budget Allocated to Hardware

SAQ Software and Application Quality

EoU Ease of Use

CDM The Code Development Maintainability

FAd Flexibility or Adaptability

RT Response Time

Cx Complexity

ASz The Application/Software size

FIIt Friendly Interfaces

USC Users Specifications Conformity

Ut Utility

BAS Budget Allocated to Software and application

PrQ Procedures Quality

Doc Documentation

Apl Applicability

DQ Data Quality

Str Structure

UpBp Updating and Back up

LR Lack of Redundancy

RI Relevance of Information

Appendix 2: HiEdQ Model abbreviations

HEQ Higher Education Quality

EdQ Education Quality

StAE Students Admission and Enrolment

EdEg Education Engineering

StLEx Students Life and **Ex**tra-curricular activities

GME Graduates **M**onitoring and **E**mployability

ResQ **R**esearch **Q**uality

SRP Scientific **R**esearch **P**olicy

SRO Scientific **R**esearch **O**rganization

DSt **D**octoral **S**tudies

RPrD **R**esearch **P**roduction and **D**evelopment

ScCp **S**cientific **C**ooperation

REPr **R**esearch **E**valuation and **P**romotion

GovQ **G**overnance **Q**uality

VSys **V**alue **S**ystem

VMOb **V**ision, **M**ission and **O**bjectives

SPMA **S**trategic **P**lanning and **M**onitoring the **A**ctions implemented

OrLd **O**rganization and **L**eadership

HRM **H**uman **R**esources **M**anagement

PhRM **P**hysical **R**esources **M**anagement

FRM **F**inancial **R**esources **M**anagement

IS **I**nformation **S**ystem

IECom **I**ntern and **E**xtern **C**ommunication

ParP **P**artnership **P**olicy

SerCm **S**ervice to the **C**ommunity

VsInt **V**isibility and **I**nternationalization

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