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# QUALITY MANAGEMENT MODEL FOR HIGHER EDUCATIONAL INSTITUTIONAL

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# МОДЕЛЬ УПРАВЛІННЯ ЯКІСТЮ ОСВІТИ ДЛЯ ВИЩИХ УЧБОВИХ ЗАКЛАДІВ

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Abstract. This article reports the conceptual design of QMM-HEI-SP: a Quality Management Model for Higher Education Institutions (HEIs) Students' Performance. This model has been theoretically founded on recommendations from the ISO 9001 IWA 2:2007 international guidelines for HEIs. Higher education services contribute to the economic and social progress of countries, and therefore, the quality control of provided services from HEIs demands a relevant group-based decision-making activity to be properly performed and supported. The QMM-HEI-SP model is represented with a System Dynamics modeling approach. System Dynamics models have been used previously in the literature for similar purposes, but none has been founded on the ISO 9001 IWA 2:2007 guidelines. This research, thus, review exemplary related studies, and presents the conceptual design of QMM-HEI-SP. We end the article with recommendations for its implementation as a group-based decision making support system (GDSS), and for further research.
Keywords: Higher Education Institution (HEI); quality management system (QMS); ISO 9001 IWA 2:2007; HEI students' performance; system dynamics; group-based decision support system (GDSS); conceptual design research.

Резюме. У статті представленна модель управління якістю освіти для вищих навчальних закладів (ВНЗ)) концептуальний дизайн QMM-Hei-SP: модель управління якістю для вищих навчальних закладів (ВНЗ). Ця модель (не була, а просто) розроблена відповідно рекомендаціям, які представлені в ISO 9001 IWA

2: 2007 міжнародних керівних принципів для вищих навчальних закладів. Як відомо, що від рівня якості вищої освіти залежить економічний і соціальний розвиток будь-якої країни, і, отже, контроль рівня якості надання освітніх послуг та управління ними потребує ретельного аналізу в процесі навчання та у випадку необхідності корегування ними. Модель HEI-SP QMM розроблена на основі підходів щодо моделювання складних динамічних систем, системного аналізу та теорії прийняття рішеня. За допомогою розробленої моделі можна здійснити оцінювання рівня якості надання вищої освіти ВНЗ, тих кого навчають в залежності від зміни параметрів, що характеризують освітні послуги, спрогнозувати та скорегувати сам процес для забезпечення їх рівня не нижче заданного.
Ключові слова: ВНЗ, система управління якістю, ISO 9001 IWA 2:2007, системна динаміка, ситеми підтримки прийняття групових рішень, концептуальне дослідження.

## 1. Introduction

High quality education services are considered part of the forces for country competitiveness in the current knowledge-based economic environment (CEE, 2003). Well-developed economies (such as from USA, UK, Germany, Japan, France and Canada countries, among others) are recognized by having HEIs listed in the top 500 best universities in the world by several international rankings (Blanco-Ramirez and Berger, 2104; Rauhvargers, 2011). These rankings, while are accepted with inherent methodological limitations, are widely considered by national regulation agencies for funding assignations. As Rauhvargers (2011, pp. 7) reported: «the arrival of global rankings over the last few years has focused considerable attention on higher education, and put the spotlight on universities that are increasingly being compared nationally and internationally». For achieving high quality education services in public and private HEIs, national regulator agencies have elaborated standards and guidelines (Doherthy, 1997; EAQAHE, 2005). Consequently, HEIs are encouraged to satisfy and fulfill such expected nationwide regulations. Nevertheless, a strong movement towards a service-dominant logic (Vargo and Lusch, 2004) and a service science (Spohrer et al., 2007), in contrast to a good-dominant one and an industrial science, has been reported in some disciplines (Lusch et al., 2008; IfM and IBM, 2008). This fact has been fostered by the recognition of the services sectors as the main generators of the gross domestic product (GDP) in OECD economies (IfM and IBM, 2008). Thus, the general problem of achieving a high quality in HEIs can be conceptualized as the problem of designing an adequate educational service system which can deliver high quality education services. This service system must consider: 1) the quality of the education requirements (goals, standards and regulations); 2) the quality of the operand resources (e.g. students and their attributes such as previous preparedness, financial situation, intrinsic motivation, among others); 3) the quality of the

operant resources (e.g. professors and their attributes such as formal preparation, didactical skills, intrinsic motivation, among others), infrastructure such as classrooms, laboratories, libraries, dinning rooms, sport and recreational installations, and others; and 4) the quality of the educational processes (teaching, research, community interactions, and management (Kisil, 2005). Finally, in order to a service system can deliver the expected quality of services (educational in this analyzed case), its system design must include an adequate Quality Management (and Control) System (QMS) (ISO, 2003). We design the QMM-HEI-SP model by using a conceptual design research approach (Hevner et al., 2004). A conceptual design research approach proposes methodological recommendations for investigations where a new artifact (a construct, a model, a method, or a system instance) is elaborated. The general research question in conceptual design research (Mora et al., 2014) can be established as follows: can the artifact X be designed by using the components Y1, Y2, ... which has the following attributes A1, A2, ... ? In turn, the generic research hypothesis in conceptual research design can be established as follows: H1: the components Y1, Y2, ... are useful for designing the artifact X and fulfilling the X's attributes A1, A2, ... . In this research, thus, the main research questions and research hypotheses can be stated as reported in Table 1.

Table 1. Research Questions and Hypotheses

| *ResearchQuestions* | *ResearchHypotheses* |
|---|---|
| RQ.1 Can be QMM-HEI-SP modeled adequately by using a System Dynamics Approach? | (H1) System Dynamics will provide adequate modeling mechanisms for designing a conceptual adequate QMM-HEI-SP model. |
| RQ.2 Is the QMM-HEI-SP System Dynamics model valid? | (H2) The QMM-HEI-SP System Dynamics model will have sufficient face and functional validity. |
| RQ.3 What are the perceptions on the usefulness, ease of use, compatibility, value and intension of use perceived by a panel of international experts on HEI on the QMM-HEI-SP System Dynamics model implemented as a GDSS? | (H3) The perceptions on the usefulness, ease of use, compatibility, value and intension of use on the QMM-HEI-SP System Dynamics model will be at least moderate (value of 3.0 in a Likert Scale from 1 (low) to 5 (very high)). |

The ISO 9000 Quality Management System standard (ISO, 2005) defines the concept of quality as the set of all features of a product or service which are required by the customer. In turn, a Quality Management System (QMS) (ISO, 2005) is defined as what the organization does to ensure that its products or services satisfy the customer's quality requirements and comply with any regulations applicable to those products or services. For the ISO 9000 standard, a QMS must be organized with a systems and process approach. A process is defined by the ISO 90000 standard as a set of interrelated or interacting activities which transform inputs into outputs. The ISO 9001 IWA 2:2007 guidelines

provide guidance to educational organizations for implementing an effective QMS. Based on the generic ISO 9001:2000 standard, this ISO 9001 IWA 2:2007 guidance offers a set of specific main quality management principles for educational organizations. These are the following ones:

1. Process approach - educational organizations should adopt a process approach when developing and implementing a quality management system;
2. Understanding core competence - includes various enablers to ensure competitive advantage of the educational organization. These enablers include technology, skill, expertise and educational organization's culture;
3. Total optimization (systems approach to management) - enables each operational process to achieve its objectives from an administrative standpoint;
4. Visionary leadership - establishes vision, creates policy to realize the vision, and leads the educational organization in responding promptly to change in the education environment;
5. Factual approach to decision making - ensures administrative decisions based on clearly understood facts and not on convenient speculation;
6. Collaboration with partners - is important to obtain optimal wisdom, skill, and creativity to achieve learner value;
7. Involvement of people - to achieve its objectives, to facilitate involvement of all people in the educational organization, and to make a maximum use of its people's competence, wisdom, skill, and creativity;
8. Continuous improvement of the educational organization's learning process and the learner's personal learning enables educational organizations to keep creating values;
9. Creating learner value to encourage learners to feel satisfied with the value they are receiving;
10. Focusing on social value means attending to how learners and other interested parties feel about ethics, safety, and environmental conservation;
11. Agility - is essential to sustained growth in a drastically changing education environment;
12. Autonomy is based on circumstance analysis and self-analysis. The educational organization should make its own value decisions and take actions on its own, free from stereotyping.

This sub-system has the overall function of coordinating the other three sub-systems. It is executed by the HEI's top management group. Its specific functions are: 1) to establish a Management Commitment; 2) to manage with a Customer Focus; 3) to establish a Quality Policy; 4) to plan and document the overall QSM; and 5) to conduct periodical and systematic reviews. This subsystem is responsible for identifying and provisioning the required resources (human, financial, and infrastructure) and an adequate work environment in

order to achieve the expected quality of the educational services. This sub-system has the main following functions: (i) to detect needs of resources; (ii) to perform a short, medium and long term planning of resources; (iii) to conduct assessment on plans; and (iv) to procure the needed resources to teaching staff, administrative staff, general employees and students. This sub-system performs the main primary activities of a HEI. The main functions are: 1) to plan the realization of the educational services; 2) to conduct learner-related processes; 3) to design and develop the educational services;4) to perform purchases; 5) to provide the educational services; and 6) to establish measuring and monitoring devices.

## 2. On Group-based Decision Support Systems

GDSS are defined as «interactive computer-based systems that combine communication, computer, and decision technologies to support unstructured problem formulation and solution in group decision-related meetings» (DeSanctis and Gallupe, 1987). A GDSS provides a decisional group with an arrangement of useful capabilities for information generation and retrieval; informed negotiation and deliberation; and informed evaluation and judgments. According to Mora et al. (2014), the following tools are commonly used for such tasks: agenda writer, idea generator, idea organizer-categorizer, and electronic board system for information generation and retrieval; shared editor, nominal group technique tool and topic commentator for informed negotiation and deliberation; and Delphi tool, voting-ranking tools, MADM/AHP tools, and simulation tools for informed evaluation and judgments. In general, a GDSS is developed under the premise that the collective intelligence of a team outperforms an individual in complex decisional tasks when the group is effectively supported. Thus, without a GDSS, the negative group effects such as monolithic rather than creative groupthink, dominance of high status participants, a null participation of low status stakeholders, group miscommunication, and scarcity of time available for sufficient exploration of alternatives are minimized. In contrast, it is expected that a GDSS helps to generate positive effects such as team creativity, knowledge co-creation, process efficiency, team learning, team satisfaction, and better decision quality (Limayem et al., 2006).

We used the System Dynamics approach with the previously reported five generic activities (Forrester, 1994; Oliva and Lane; 1997; Sterman, 2000; Mora et al., 2012): 1) System Definition; 2) System Modeling; 3) System Simulation Building and Validation; 4) System Model Experimentation; and 5) Group-based Decision Process on Simulation Results. By space limitations, we focus on describing the main issues regarding the application of the System Dynamics Modeling approach to this problem. We focus on a brief but succinct description of the model, its posited GDSS architecture (see Figure 9), and its core components (see Table 2).

## 3. QMM-HEI-SP Model Description

The model pursues to help HEI group-based decision makers in achieving the expected quality levels of their HEIs through the control of the HEI's students' performance. This core output is affected by decision and uncontrolled variables. We are representing all variables (performance scores of students, disturbances, etc) in percents in the scale from 0 to 100. There are five decision variables from D1 to D5. They are not random variables, they describe the amount of influence that the top management of a HEI can exercise. D.1 corresponds to human resource competence score; D.2 corresponds to financial resource score; D.3 corresponds to infrastructure and work environment score; D.4 corresponds to normative-legal minimum score; and D.5 corresponds to educational traceability minimum score.

Variables from I1 to I5 are internal results generated by the model. Variable I.1 corresponds to the overall comprehensive guarantee level. This variable concentrates all effects of the five decision variables D1-D5. Variable I.2 accounts for the student's performance which integrates his/her individual and initial performance score (the parameter P.1) with the overall effect I.1 of the five decision variables, a known disturbance effect on performance score (the uncontrolled variable E.1), and the managerial influence (variable I.5) on the final student's performance score. This last effect calculated in time K, will be used in the next K+1 time slice of simulation. Variable I.3 accounts for the managerial influence estimated during the student's educational process. This variable I.3 is calculated by using I.2 (the student's performance), and two parameters: P.2 level of managerial influence, and P.3 performance score threshold, which is the minimal score permitted to students. Variable I.3 applies a managerial influence effect only when the student's performance score is lower than the indicated threshold (P.3), otherwise there is not managerial influence effect on variable I.3. Variable I.4 presents the delayed effect of the variable I.3, whose delay is controlled by the P.4 parameter of learning duration. Two main output variables O.1 and O.2 correspond to the estimated student's performance score, and to the employer's satisfaction level with the hired student. O.1 is calculated directly with the I.4 variable (delayed student's performance score by managerial influence) and the uncontrolled variable E.2 (unknown disturbance on final student's performance score). O.2 applies a conditional statement on a minimal value of the final student's performance score. In case of achieving the minimal, none feedback is sent to I.5 (managerial influence based on final student's performance). In opposite case, a feedback signal is sent to I.5 variable.

The GDSS Architecture of QMM-HEI-SP Model is illustrated in Figure 1. This model reports the five decision variables (from D.1 to D.5), the two environmental uncontrolled variables (E.1 and E.2), the four parameter variables (P.1, ..., P.4), the five internal variables (I.1, ..., I.5) and the two output variables (O.1, O.2). Table 2 describes the variables grouped by type (decision, uncontrolled, parameter, internal result, output).

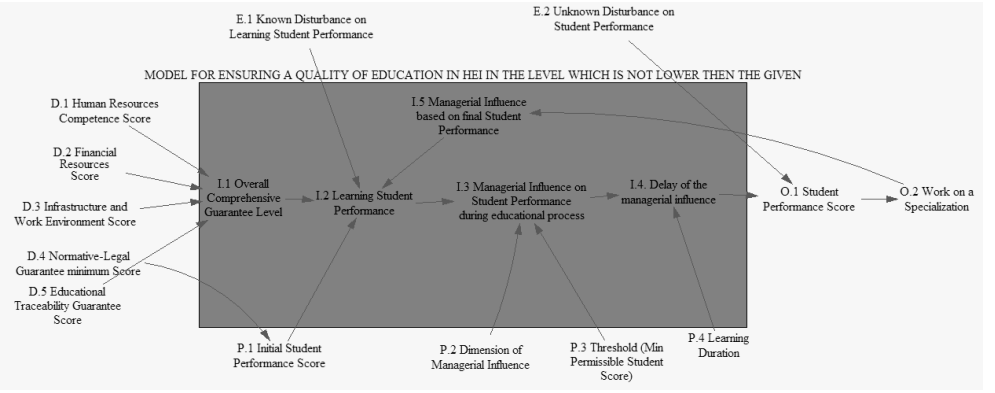


Fig. 1. GDSS QMM-HEI-SP Model

Table 2. Core Components of the QMM-HEI-SP Model

| Type and name of variable | Description | Scale | Equation | REFs |
|---|---|---|---|---|
| **Input Decision Variables** | | | | |
| D.1 Human Resources Competence Level | The HEI top management must provide employees with an adequate level of competence, awareness, and training aligned with their responsibilities, authorities, and academic-administrative activities. This variable describes the extent of influence of the human resources competence dimension on the end quality of education services provided by a HEI. | 0 .. 100% | Value assigned by decision maker | IWA 2: 2007 |
| D.2 Financial Resources Level | The HEI must provide sufficient financial resources and they must be managed efficiently to deliver the expected performance on education services. | 0 .. 100% | Value assigned by decision maker | IWA 2: 2007 |

| Type and name of variable | Description | Scale | Equation | REFs |
|---|---|---|---|---|
| D.3 Infrastructure and Work Environment Level | The HEI must identify the specific infrastructure, facilities, environment and equipment needed to support the teaching-learning processes, as well as the education services. | 0 .. 100% | Value assigned by decision maker | IWA 2: 2007 |
| D.4 Normative-Legal Guarantee minimum Score | The HEI must establish a well-documented procedure to identify educational services as well as final outcomes, which are non-conforming to established design, statutory and regulatory requirements, or organizational objectives and curriculum. The minimal normative-legal score (a set of estimates) for approving the educational program. | 0 .. 100% | Value assigned by decision maker | IWA 2: 2007 |
| D.5 Educational Traceability Guarantee Score | The HEI must provide adequate and efficient procedures for tracing the student performance evolution. Educational and methodic guarantee (for example of academic documents). | 0 .. 100% | Value assigned by decision maker | IWA 2: 2007 |
| **Input Parameter Variables** | | | | |
| P.1 Initial Student Performance Score | Results of external evaluation (Ukraine) or final secondary school examination (Germany) for enrollment in the bachelor educational program. | 0 .. 100% | x(t) = k | IWA 2: 2007 |

| Type and name of variable | Description | Scale | Equation | REFs |
|---|---|---|---|---|
| P.2 Dimension of Managerial Influence | Dimension of managerial influence which is acting if real learning student performance is lower than the assigned P.3 threshold. | 0..2 | Constant value fixed by expertise | IWA 2: 2007 |
| P.3 Threshold (Min Permissible Student Score) | Minimal score that a student should receive for not to be excluded from university according to the normative-legal documentation of HEI management. | 0 .. 100% | Constant value fixed by expertise | IWA 2: 2007 |
| P.4 Learning duration | Duration of an educational program in months that is determined by a kind of a study in HEI (bachelor, master, PhD studies) and according to normative-legal documents of HEI. | 1-48 months | Constant value | IWA 2: 2007 |
| **Uncontrolled Environmental Variables** | | | | |
| E.1 Known Disturbance on Learning Student Performance | Undesired and uncontrolled situations that directly affect the performance of the student in the HEI, but that can be estimated in advance. | 0 .. 100% | RANDOM NORMAL (-0.5, 0.5, 0, 0.2, 1) | IWA 2: 2007 |
| E.2 Unknown Disturbance on Student Performance | Undesired and uncontrolled situations that directly affect the performance of students in the HEI, and that cannot be predicted. For example: personal emergencies, diseases, financial problems, family problems, alcoholic and drugs problems, and depression problems. | 0 .. 100% | ABS (RANDOM NORMAL( 0.1, 2, 1, 0.2, 0)) | IWA 2: 2007 |

| Type and name of variable | Description | Scale | Equation | REFs |
|---|---|---|---|---|
| **Internal Output Variables** | | | | |
| I.1 Overall Comprehensive Guarantee Level | This internal output represents the overall level guaranteed by considering the previous D.1 to D.5 input decision variables. | 0 .. 100% | -LN(1-(D.1*0.3+ D.2*0.4+D.3* 0.2+D.5*0.1) /100) | IWA 2: 2007 |
| I.2 Learning Student Performance | Combination of the performance of the students influenced by their performances and the performance influenced by decision variables. | 0 .. 100% | -LN(1-P.1/100)*I.6 *I.1 | IWA 2: 2007 |
| I.3 Managerial Influence on Student Performance during educational process | HEI's feedback managerial action when the student's performance score is less than expected. | 0 .. 100% | IF 100*(1-EXP(2))<P.3 THEN I.2*P.2 ELSE I.2 | IWA 2: 2007 |
| I.4 Delay of the managerial influence | Delay of information by the learning period. | 0 .. 100% | DELAY FIXED (I.3, P.4,0) | IWA 2: 2007 |
| I.5 Managerial Influence based on final Student Performance | HEI's feedback managerial action when the employers' evaluation is negative on the student's score performance. | 0 .. 100% | IF O.2>0, THEN 1.2, ELSE 1 | IWA 2: 2007 |
| **Main Output Variables** | | | | |
| O.1 Student Performance Score | The main output for being estimated in this model. All efforts and decisions on the HEI are finally expected to improve the students' performance score. T | 0 .. 100% | 100*(1-EXP(-"I.4. Delay of the managerial influence"* "E.2 Unknown Disturbance on Student Performance")) | IWA 2: 2007 |
| O.2 Work on a Specialization | The main output for being estimated in this model. All efforts and decisions on the HEI are finally expected to improve the students' performance score. T | True /False | IF(O.1 >60) THEN 0 ELSE O.1 | IWA 2: 2007 |

## 3. Conclusions

In this article, we have reported conceptual design of QMM-HEI-SP: a Quality Management Model for HEI Students' Performance. This QMM-HEI model has been theoretically founded from the international standard ISO 9001 IWA 2:2007 guidelines recommendations, and the insights gained on a literature review on related research. Our research aim is to elaborate a GDSS for helping HEI managers to support and lead towards adequate quality management decisions with the ultimate goal of achieving satisfactory students' performances. To achieve it, the QMM-HEI-SP model accounts for decision-making variables, uncontrolled environmental and internal variables, which interact for generating expected output variables: O.1 student performance score, and O.2 a boolean status on the a satisfactory or unsatisfactory student preparation for working settings. This QMM-HEI model was designed with a System Dynamics approach, which has been used previously in similar studies in the literature.

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