INSTITUTIONAL ASPECTS OF INTEGRATED QUALITY ASSURANCE OF ENGINEERING STUDY PROGRAMS AT HEI USING ICT

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Abstract. Informatization of Ukrainian higher education institutions is a key priority of the state education policy, one of the directions for improving HEI's IT infrastructure. The paper aims to develop an integrated quality assurance information system to enhance institutional aspects of study programs at higher education institutions. Therefore, there is an urgent need for all stakeholders to develop, at the university level, a service-oriented architecture to assure quality of higher education with mandatory elements, for example, student survey results, student ratings, university teachers' rating, educational programs, results of uniqueness verification for scientific research and qualifying papers, review of educational programs for higher education applicants etc. This will allow us to unify the approaches to electronic resource management and accelerate the integration of multi-level HEI quality assurance resources into a single portal. The paper presents a quality assurance information system, which allows to process students' feedback in order to provide HEI's authorities' decision making.

Keywords: Quality Assurance Management in HEI, Students' Feedback, Engineering Study Programs.

1 Introduction

The primary purpose of using IT in Quality Assurance (QA) management in higher education institutions is to increase the applicants' satisfaction on their learning process by using management information systems (IS).

The use of IT in management is aiming to ensure the quality of HEI education and it should guarantee:

1. In the area of education: development of innovative distributed learning and methodological environment at the university; using service-oriented systems in the educational process; implementation of e-learning management system for all students.

2. In the area of science: presenting scientific research capacity of a University in a global information space using open source data bases; providing access for researchers and students to the scientific information resources; managing the implementation of joint research projects as part and parcel of international consortium.
3. In the area of university management: gathering, storing, and processing information about the participants in the learning process, data collection and analysis; providing the automated follow-up to the decision taken; improving planning process to guarantee quality in education at HEI.

These issues include governmental authority versus institutional autonomy, lack of an internal quality assurance mechanism for individual institutions as performance evaluation [1]. Many Ukrainian and foreign HEIs are trying to solve the problems of implementing the quality assurance management of educational process by using certain computer programs that allow scheduling classes, checking scientific articles for uniqueness, determining the applicants' satisfaction with their learning process. Nevertheless, the techniques are not efficient enough, there is currently still not a single system approach to management in the HEI strategy. Integrated information systems has affected how both students and universities perceive education that focus on management and learning [2]. Different types of software development make it impossible to exchange data accurately, effectively, and consistently. That is the reason why HEIs, as a rule, buy or create an integrated management system that allows synchronization at different levels of quality assurance in HEI. To achieve the goal of successful implementation of an internal quality assurance system at the university it is necessary to solve the following issues:

- to develop the models of management activities and learning strategies to support the quality of university education using information database;
- to establish and maintain IS architecture for student ratings, curriculum, degree qualifications profile, study programs;
- to create and introduce new techniques and methods of quality assurance management at the university based on integrated IS;
- to reduce the time of information assessment and processing in decision making;
- to create a system to predict the university development using key performance indicators (KPI).

The data gathering instrument used by the researchers is the Graduate Tracer Study developed by the Commission on Higher Education [3]. To make decision about architecture of integrated IS (buy or develop) it is necessary to reveal all necessary business processes for quality assurance of education [4].

The paper aims to develop an integrated quality assurance information system to enhance institutional aspects of engineering study programs at HEI.

The paper has the following structure. Part 2 describes a comparison of institutional quality assurance systems; part 3 investigates research methodology for QA using information system; part 4 examines the development, monitoring, and revision of the SP using QA information system; the conclusions is the last part.

2 Literature Review

The change of higher education structure, development of quality assurance systems and mechanisms enabling the dimension of study program flexibility related to the necessary specific subject competences [5] represent arguments for the development of institutional design (ID) models, which based on the relationship between institutional rules, learning process, and learning outcomes. As a process, ID is a curriculum development cycle, a needs assessment, labor market analysis, design, development, implementation, and results.

"Institutional designer" is a person who designs educational courses to fulfill the needs and requirements of external and internal stakeholders. A needs assessment focuses on determining the current state and the desired state and the type of business process to bridge that gap [6].

The European Foundation for Quality Management (EFQM) was founded to promote self-evaluation as a key business process improvement. The EFQM Excellence Model is a diagnostic tool, with a set of criteria generally accepted across Europe, which can be used by HEI to evaluate their strengths, weaknesses, opportunities, and threats and to monitor the progress of strategic actions [7-9]. For HEI it provides a framework for continuous improvement (Fig. 1).

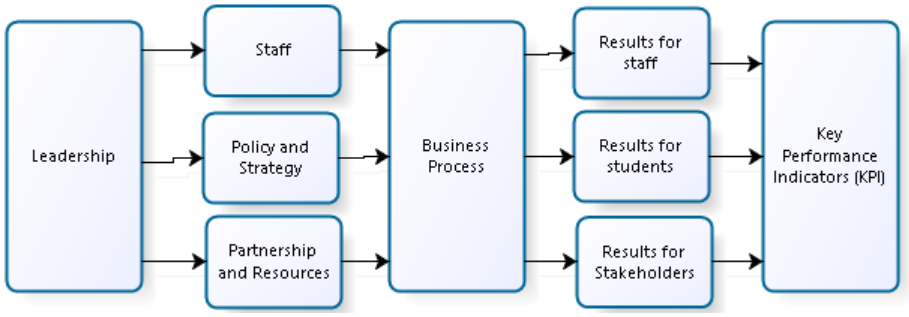

Fig. 1. EFQM Excellence Model.

Criterion 1. Leadership: The ways in which top management of HEI creates additional values of students, are personally involved in the QA management system, and motivate students to increase their capitalization.

Criterion 2. Policy and Strategy: The systems guarantee that the needs of stakeholders (employers, students, alumni, academic staff, local authority, parents etc.) are incorporated in the strategy. The strategy tasks should be developed, deployed, and communicated.

Criterion 3. People: academic staff, a guarantor, a support team are engaged in the student learning process.

Criterion 4. Partnership and Resources: Interconnection of information (databases, e-library, e-repository), material (labs, equipment, technology), and financial resources.

Criterion 5. Business Processes: The methods are used for managing and improving processes, including learning, teaching, R&D process, revising of SP, implementation process of SP.

Criterion 6. Student Results: The KPI of students' perceptions of the organization and other indicators of HEI performance with respect to external stakeholders, including image and the reputation of the HEI's educational services.

Criterion 7. Staff Results: The measures of staffs' perceptions of HEI and other indicators of HEI performance, such as satisfaction, motivation, recognition, involvement, and achievement.

Criterion 8. Stakeholders Results: The measures of the organization's performance to satisfy the expectations and the needs of society (local, national, or international community, accreditation bodies).

USA BQA (Baldrige Quality Award) Criteria Framework is a tool intended to be used by organizations to evaluate their performance and monitor the strategy progress and process changes (Fig. 2).

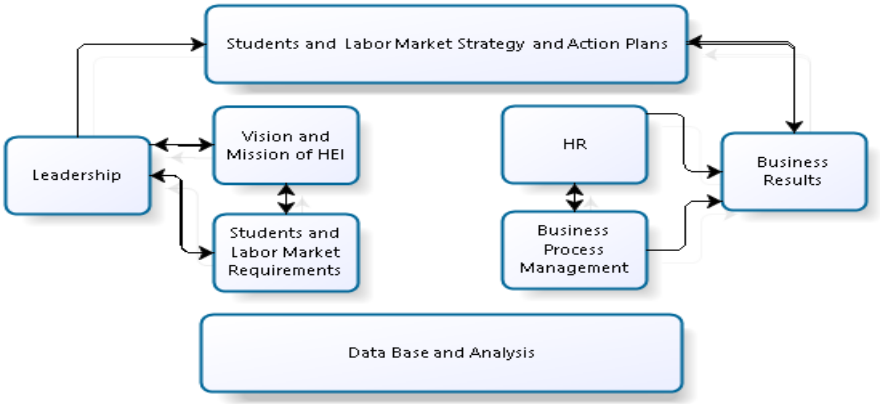

Fig. 2. BQA Criteria Framework.

HEI has to continuously improve its study programs to stay competitive in the dynamic and changing environment of education and labor markets. Quality Assurance (QA) is defined as planned and systematic actions implemented within the quality system to provide adequate confidence that educational services will satisfy given requirements for quality (National Qualification Framework and/or Standards of High Education). Quality Management (QA) provides a systematic approach or a model for QA linked with educational quality improvement. [10]. An example of a systems approach is a definition of quality of education as an "ability of students' knowledge to satisfy specified requirements of accreditation bodies, professional societies, employers, etc." [10].

Process input-output satisfaction model with goal and specification makes clear what HEI are required to do and what students and stakeholders can expect in the future. QA protects the interests of all students. QA are required to meet all the expectations of Study Programs. QA indicators are intended to help HEI to demonstrate that

the expectations of SP are being met using regulations, procedures and practices of HEI.

The institutional design of the Process input-output satisfaction model with goal and specification is based on the system approach and includes several elements (Fig.3):

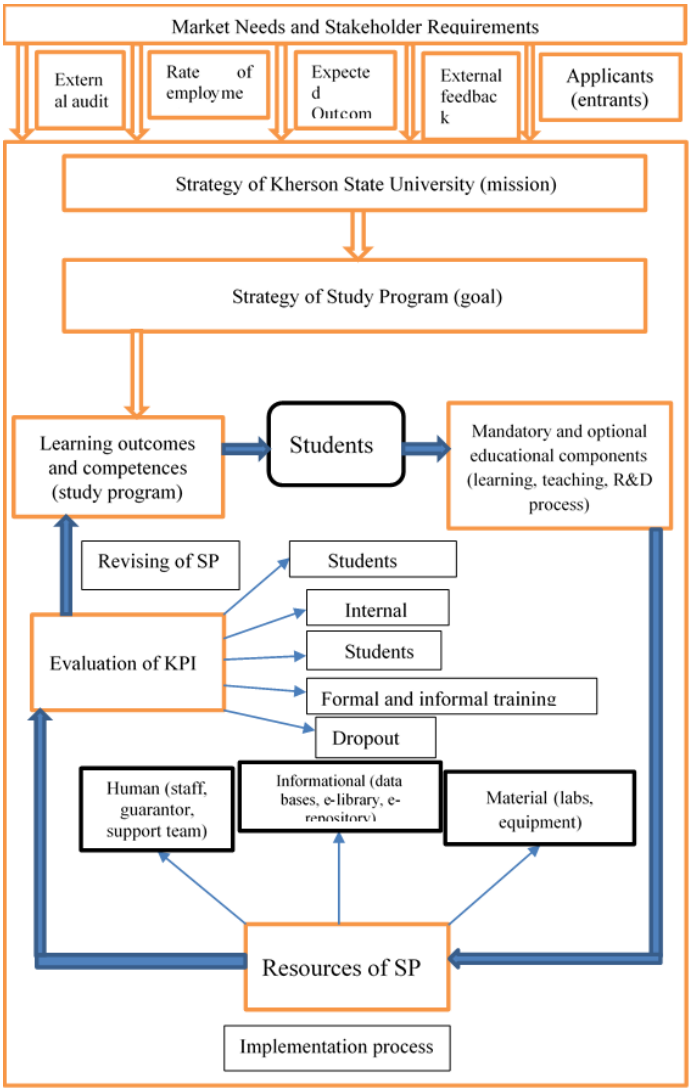

Fig. 3. Institutional design of quality assurance procedures at Kherson State University.

1. goals and specifications of the study program of HEI represent its expected outcomes;

2. to achieve these goals HEI needs to provide all necessary resources, including human, material, information, and infrastructural resources;
3. the resources need to be accumulated to manage and improve the academic and business processes of the study program;
4. the management and improvement of academic processes and achievement of goals can bring satisfaction for the stakeholders under regular monitoring of the SP with the intent of continual improvement.

The evaluation and monitoring of SP can use multiple methods or their combinations; among them are audit, self-assessment, benchmarking etc.

Learning analytics (LA) and tools for intelligent analysis of data accumulated in the IS used by HEIs provide an opportunity to increase the effectiveness of monitoring, management, quality assurance, and evaluation of training for each study program and decision-making. LA tools help managers of HEIs identify courses and programs that more closely match the students' needs and preferences, considering the requirement of the labor market and feedbacks of all stakeholders [11]. Some of the tools are standalone software tools, while the others are modules included in LMS. Each LA tool is based on a model with a set of indicators, the data of which is extracted from the LMS used at the university.

3 Research Methodology

The development of feedback evaluation is a complementary tool towards heightening the comprehensiveness of existing quality assurance mechanisms [12]. Focus groups help to ensure that multiculturalism, diversity, and inclusion are central to the discussion agendas in a HEI. A strong correlation between technical/engineering SPs and good quality assurance results were found by authors [13], probably because quality expertise is particularly developed in these disciplines.

The key stage of development, monitoring, and revision of the SP includes the following steps (Fig. 4):

1. **Initiation** – project team (PT).
2. Determining the needs for a study program SP (project team, employers, graduates, Google surveys).
3. **Analysis of requirements and requests**, Professional Standard (PT, specialist profile regarding the employers and graduates' views – list of competencies: LinkedIn electronic competency platform, etc.).
4. **Determining a list of program competences for graduates** of SP – PT, an occupation profile.
5. Compiling a list of learning outcomes (LO) – PT, list of LO.
6. Compiling a list of educational components (EC) – PT, a draft list of the EC.
7. Defining an educational certificate attestation type – PT, attestation types.
8. **Determination of the features of the internal quality assurance system in higher education** (PT, rating, polls, revising of SP, checking for plagiarism).

9. Consultations on the institutional capacity to provide the SP (scientific, financial, academic, logistical base) – PT, HEI administration, management decisions.
10. Development of educational components – PT, staff, descriptions of EC (syllabus, etc.).
11. Feedback of students, teachers, graduates after educational activities – types of educational activities, learning outcomes at ECTS.
12. **Revision of SP** (program competencies, program learning outcomes, educational components).

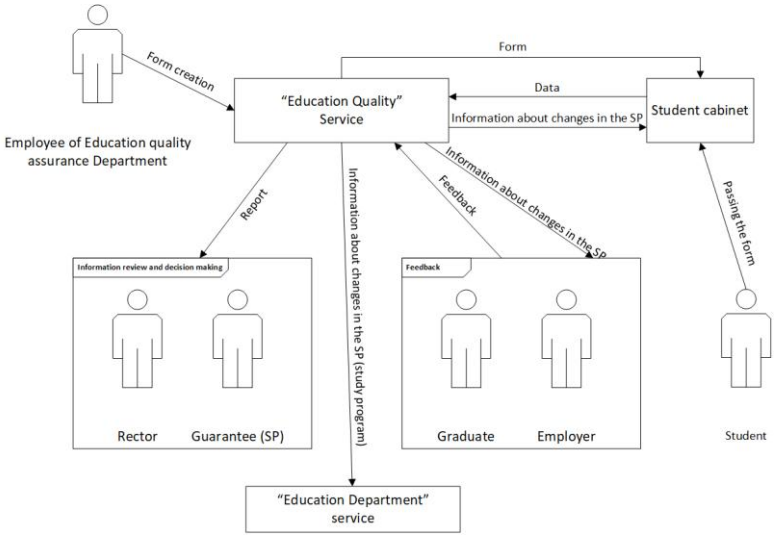

Fig. 4. The procedure of development, monitoring, and revision of the SP.

4 Results

ESG 2015 Standard means that Institutions should monitor and periodically review their programs to ensure that they achieve the objectives set for them and respond to the needs of students and society. These reviews should lead to the continuous improvement of the program [14]. Any action planned or taken as a result should be communicated to all those concerned. Programs are reviewed and revised regularly involving students and other stakeholders. The information collected is analyzed, and the program is adapted to ensure that it is up-to-date. Revised program specifications are published [15].

Measures/procedures

1.1. Monitoring at the level of an individual study component (study program in whole) which provides for:

1. Formation of KPI of quality of study component of the study program:

- quantitative (student achievement results, the average quality of education, the number of expelled students);
- qualitative (feedback from students, teachers, etc.).

2. Determination of indicators' threshold values for which, if achieved (for example, a low percentage of students' quality of education), make it mandatory to monitor the study component at the higher education institutional level.
3. Preparation of a report dealing with the results of course revision.
4. Monitoring the implementation of an action plan to improve the training component.

Informing all stakeholders about changes to the study program based on the results of the review:

- informing students, staff, educational service departments, and external stakeholders about study program monitoring;
- getting feedback after reviewing the annual monitoring reports on a study program;
- publication information about monitoring of study programs.

The relationship between students' satisfaction of learning process and the quality of their education, for students of mathematical and engineering study programs at Kherson State University, is determined using Google forms. Data are obtained according to the results of processing 432 questionnaires of applicants for the higher education of Computer Science, Physics and Mathematics Faculty (table 1).

Table 1. Feedback of students (1 semester 2019-2020), Kherson State University.

Code	**Study program**	**Rating of Disciplines (RateDisc) min=1 max=5**	**Rating of Staff RateStaff min=1 max=5**	**Quality of education of bachelors QE min=0 max=100**
121	Software Engineering	4,04	4,29	40,5
122	Computer Science	3,67	4,03	37,9
126	Information systems and technology	4,30	4,58	42,9
014	Secondary education (Mathematics)	4,42	4,44	46,2
014	Secondary education (Physics)	3,83	4,19	37,5
014	Secondary education (Informatics)	4,39	4,55	46,7
014	Secondary education (Labor training and technology)	3,60	3,61	21,7

Let's consider dependency between the rating of disciplines (dependent variable *RD*) and the rating of staff (explanatory variable *RS*) $RD = b_o + b_1 \cdot RS + u$ using table 1 data:

$$RD = 0.177 + 0.909 \cdot RS + u\ (R^2 = 82\%) \quad (1)$$

Each unit of RateStaff increases by 0.909 RateDisc (statistically significance, $t(b_1) = 4.74 > t_{cr} = 2.57$). These dependencies are presented in Fig. 5. R^2 means that 82% variation of RD is determined by variation of RS.

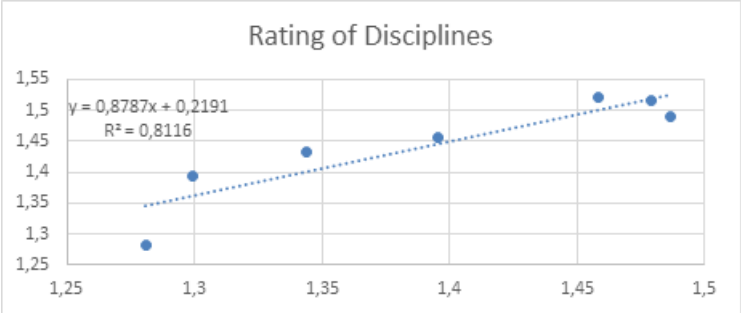

Fig. **5**. Quality assurance for SP.

If we transform absolute values (table 1) in the relative index we can get regression of the following form

$$lnRD = 0.06 + 0.92 \cdot lnRS + u\ (R^2 = 81.2\%) \quad (2)$$

It means that each 1% increasing in the rating of staff will increase by 0.92% rating of disciplines.

At the same time quality of education of bachelors (only good and excellent grades) as a rule depends only on rating of staff:

$$QE = -60.27 - 1.74 \cdot RD + 25{,}07 \cdot RS + u\ (R^2 = 89.9\%) \quad (3)$$

Each unit of RateStaff increases by 25,07 quality of education for bachelors of Computer Science, Physics and Mathematics. In our opinion, the motivation of students to study courses, which covers specific subject competences is determined by the personality of the teacher. Based on the feedback results at KSU in 2021-2020, it is planned to make more optional disciplines.

Key role of IAS and Google forms: collect, store and visualize all the data related to students and their achievements, study programs and individual courses (especially learning outcomes), schedule of classes, and statistics important for university management, financial and quality assurance.

5 Conclusions

The key stage of development, monitoring, and revision of the SP includes initiation, analysis of requirements and requests, determination the list of program competencies for the graduates, determination the features of the internal quality assurance system in higher education, study program review and revision. Programs are reviewed and

revised regularly engaging students and stakeholders. The information collected is analyzed, and the program is adapted to ensure that it is up-to-date.

Using our developed quality assurance information system, we got that each unit of the rating of staff increases on 0.91 rating of disciplines. The rating of staff has a direct impact on the rating of courses, which cover specific subject competencies. Students' motivation to study discipline is determined by the teacher's personality. Based on the results of feedback at KSU in 2021-2020, it is planned to make more optional disciplines.

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