

Process Modelling and Analysis of a Quality Management System for Higher Education

Basma El-Sharef and Khaled S. El-Kilany

Abstract— Universities across the world are undergoing an extensive process of reform, aimed at generating profound transformations in academic institutional activities. Different quality management principles are adopted to improve the educational process and to meet or exceed customer requirements; where, all over the world there is an increasing interest in quality and standards, reflecting both the rapid growth of higher education and its costs to the public and the private sectors. This work is a result of a study carried out in a college that uses quality management system for all its educational functions. The quality management system that is currently in use includes over fifty management procedures that are directly related to the educational process. These procedures are interrelated to each other, which makes its flawless implementation difficult. Business process modelling and analysis can be used to identify the processes needed for a quality management system. It can also clearly define the interaction and sequence of these processes. Specifically, this methodology can show the interrelationships between the different quality management procedures and can clarify the impact of changing and or updating any of these procedures on the remaining ones. One of the widely used techniques for such an analysis is IDEF0 (Integration DEFinition level 0) which is used as functional modelling methodology of all activities that affect the educational process. The work presents the use of IDEF0 to completely analyze, develop and describe a quality management system for higher education in order to improve its usability by faculty members and to improve the quality of education perceived by the students.

Index Terms— Process modelling and analysis, higher education, quality management system, IDEF0

I. INTRODUCTION

Universities have seen the provision of higher education to become a product and have been driven by competition to examine the quality of their services, to redefine their product and to measure customer satisfaction in ways that are familiar to service marketing specialists. Universities have realized that their long-term survival depends on how good their services are and that quality sets one university apart from the rest [1].

Following national requirements or voluntary adaptation,

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many higher education institutions throughout the world have implemented or are in the process of creating their own quality management systems, with the aim of securing and improving teaching and learning [2].

Educational institutes chose quality management to distinguish itself better from its competitors and to compete better in the market-place [3].

ISO 9000 standards provide a framework for quality management in organizations. The challenge to the organization is to invest in the monitoring of quality in such a way as to improve profitability and effectiveness. Although this quality management system was designed for manufacturing, ISO 9000 standards have also become a popular choice also for educational systems worldwide [4].

Generally, in order to secure ISO 9001 registration, an educational institute must develop and use quality management systems conforming to the requirements of ISO 9001. A quality management system must include all the organization's policies, procedures, plans, processes, and delineation of responsibility and authority, all deliberately aimed at achieving product or service quality levels consistent with customer satisfaction and the organization's objective [5].

This work presents a study carried out in a college that uses a quality management system (QMS) that satisfies the requirements of ISO 9001:2008 for all its educational functions. A complete analysis of the quality management system is carried out for the purpose of improving its usability by faculty members and for improving the quality of education perceived by the students.

The quality management system that is currently in use includes over fifty management procedures that are directly related to the educational process. Due to the great number of these procedures and the strong interrelationship between them, flawless implementation of a QMS with that size and complexity is to some extent difficult.

Consequently, process modelling and analysis is needed to identify the major functions required to guarantee the implementation of such a management system properly. One of the widely used techniques for such an analysis is the IDEF0 (Integration DEFinition level 0), which is used as functional modelling methodology for the analysis and development of systems.

This paper starts by a brief literature review on quality and education, business process modelling and analysis, and IDEF0 function modelling method. Then, the QMS under study is presented followed by modelling of the major functions of the proposed QMS using IDEF0. Finally, the conclusions drawn from this work are presented.

II. LITERATURE REVIEW

A. Quality and Education

Applying principles, tools and techniques of quality management, to solve industry related problems has been used very successfully, because of this success, higher education institutions in the late 1980s, began to adopt and apply quality management to academic problems and opportunities [6]. Principles of quality management leading to standardization have been applied to education, as it has an impact on the delivery of the education process and the successful improvement of the learning programme [7].

This has drawn the attention of a number of researchers; where, a number of recent publications addressing the quality of education, specifically higher education, ascertain the need for adopting different quality management principles to improve the educational process and to meet or exceed customer requirements; where, all over the world there is an increasing interest in quality and standards, reflecting both the rapid growth of higher education and its costs to the public and the private sectors [8-11].

Other researchers examined the differences and similarities between the manufacturing and higher education industries and despite opinions that regard TQM as “the latest in a series of fads urged on higher education” it seems that there is solid reasoning behind introducing the total quality philosophy in universities [12]. The electronic literature on TQM in the higher education industry is vast; where, a review of the literature revealed the potential for TQM applications in several areas in higher education, such as administration of university functions, curricula and core learning processes and teaching methods, research activities, and non academic functions [13].

Recently, the implementation of the ISO 9000 quality management system into education institutions became an international trend in the area of educational improvement. The purpose of ISO 9000 is to provide a quality framework, without changing how the organization operates [14].

Identifying processes is one of the main requirements of the ISO 9001 standard. The standard requires the organization to identify the processes needed for the quality management system and their application throughout the organization. In addition, the standard requires the organization to determine the sequence and interaction of the identified processes [15].

Furthermore, Mullin and Wilson [16] stressed the need to analyse existing learning systems in undergraduate education and that such analysis usually results in design of a better system; quoting Deming’s words “*Improve constantly and forever the system of production...*”. Thus, it is important to continually review the quality management system to improve the quality of education.

B. Business Process Modelling and Analysis

Business process modelling and analysis can be used to identify the processes needed for a QMS. It can also clearly define the interaction and sequence of these processes. Finally, identification of the processes helps in understanding these processes and; ultimately, helps in improving these processes.

Business process modelling enables a common understanding and analysis of a business process. A process

model can provide a comprehensive understanding of a process. An enterprise can be analysed and integrated through its business processes; hence, the importance of correctly modelling its business processes. Using the right model involves taking into account the purpose of the analysis [17].

Process mapping is one of the process improvement methods that offers a “visual aid” to process analysis and improvement. Process mapping is not data flow diagrams or flowcharts. It is a framework that shows relationships between the activities, people, data and objectives. Like all other process improvement tools, process mapping has been used by both manufacturing and service organizations and proves to be beneficial [18].

C. IDEF0 Function Modelling Method

As a business process model, IDEF0 is used to produce both descriptive and analytical models that support process development and design. The two primary modelling components used in IDEF0 are:

1. Functions (represented on a diagram by boxes).
2. Data and objects that inter-relate those functions (represented by arrows).

IDEF0 describes any process as a series of linked activities, each with inputs and outputs. External or internal factors control each activity, and each activity requires one or more mechanisms or resources [19]

Figure 1 illustrates generically how IDEF0 is used to depict activities, inputs, outputs, controls, and mechanisms.

- Inputs are data or objects that are consumed or transformed by an activity.
- Outputs are data or objects that are the direct result of an activity.
- Controls are data or objects that specify conditions that must exist for an activity to produce correct outputs.
- Finally, mechanisms (or resources) support the successful completion of an activity, but are not changed in any way by the activity.

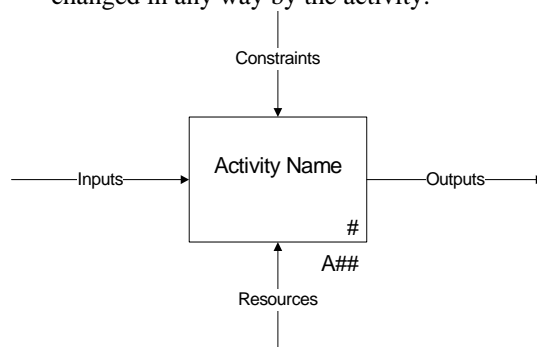


Figure 1: IDEF0 building block.

A complete description of the IDEF0 modelling language can be found in the “*IEEE Standard for Functional Modelling Language—Syntax and Semantics for IDEF0*” [20].

The essence of IDEF0 is its hierarchical approach, in which a basic, single-activity description of the process is decomposed systematically into its constituent activities. This decomposition can be to whatever level of detail appropriate for the purposes at hand. IDEF0 can help in describing exactly what is happening in a system and in as

complete a level of detail as desired. The result of applying IDEF0 to a system is a model that consists of a hierarchical series of diagrams, text, and glossary cross-referenced to each other [20, 21].

These characteristics have motivated the use of IDEF0 to show the interrelationships between the different quality management procedures and can clarify the impact of changing and or updating any of these procedures on the remaining ones.

III. QUALITY MANAGEMENT SYSTEM UNDER STUDY

The quality management system (QMS) presented in this paper is used to manage the process of development and delivery of programs of study leading to bachelor degrees in a college; where, all the activities performed in that college comply with the requirements of ISO 9001:2008. The college chose QM to distinguish itself better from its competitors and to compete better in the market-place [3].

To ensure consistent methods of management throughout the college, a suite of documentation has been established. Quality management procedures and codes of practice are two document types that are of particular interest to this work and are briefly addressed here.

A. Quality Management Procedure

These documents describe the key processes within the college. They define responsibilities and methods of control to ensure compliance with the ISO 9001 standards. The QMS under study includes a total of 52 quality management procedures that fall into three categories: core (10 procedures), support (34 procedures), and ISO support (8 procedures).

1) Core Procedures

Core procedures are procedures that directly affect the educational process. Table I presents a list of the procedures (8 out of 10) that are fully analysed in this work; where, a brief description of its function is presented in this section.

TABLE I
MANAGEMENT PROCEDURES - CORE PROCESSES

Doc #	Title
MPC1	Development and Approval of new Programs of Study
MPC2	Detailed Development of Approved Programs of Study
MPC3	Development and Approval of New Courses
MPC4	Delivery of Courses
MPC5	Assessment of Students
MPC6	Written Final Examination
MPC7	Review of Courses
MPC8	Review of Programs

1. *Development and approval of new programs of study*: this procedure is used to ensure that new programmes of study are developed and approved in a consistent manner throughout the college. In addition, it can also be used to amend programmes of study in a consistent manner through a series of

reviews and approvals.

2. *Detailed development of approved programs of study*: this procedure is used to develop approved programmes of study according to the specified requirements of the college and of the accreditation body.
3. *Development and approval of new courses*: this procedure is used in the development and approval of new courses for programmes of study.
4. *Delivery of courses*: this procedure guarantees that courses and lectures are delivered in a consistent manner and that the defined learning outcomes of courses and lectures are achieved.
5. *Assessment of students*: this procedure ensures that student assessments are conducted in a consistent manner and that the grades awarded to students are consistent with their actual performance.
6. *Written final examination*: this procedure is used as a reference for preparing, conducting, and reporting final written examinations in a consistent manner. In addition it is used to ensure that the grades awarded to students reflect their actual level of performance.
7. *Review of courses*: this procedure is used to ensure that courses are reviewed on specified timely basis and that these courses continue to meet the students' and the college's requirements.
8. *Review of programs*: this procedure is used to ensure that each programme of study is regularly reviewed and that these programmes continue to meet the college's mission and objectives.

2) Support Procedures

A number of key support activities have been identified and support procedures have been developed to ensure the effectiveness of the educational process. The following is a list of the procedures considered in this work and a brief description of its purpose.

Procedures for handling and monitoring student appeals, purchasing of textbooks, timetabling, assigning courses to lecturers, and for collecting student's feedback are among the procedures addressed in this work.

3) ISO Support Procedures

ISO 9000 is a set of international quality management standards and guidelines. It was originally published in 1987 by the International Organization for Standardization (ISO), and was revised in 1994 and again in 2000. Its primary concern is "quality assurance," which refers to what an organization does to ensure compliance of its product and service that is consistent with the customer's requirements (ISO, 2004) [22].

In order to fully satisfy the requirements of ISO 9001:2008, the college has developed processes and produced documented procedures for the different support activities that directly affect the implementation and maintenance of the quality management system.

Among the ISO support procedures addressed in this work is the control of QMS documents, which guarantees that the management system documents are controlled and distributed to those who are involved in their implementation.

B. Codes of Practice

The codes of practice are designed to ensure consistency through the universal acceptance of the various subject benchmarks. These codes will require higher education institutes to produce quality management documents that firmly address the issues of good practice and the quality of teaching and learning [23].

The following documents are five different documents that provide detailed information regarding standards and criteria which are required for providing the college's services. Students' assessment code of practice is one of these documents, which is addressed in this work and is used to guarantee that all methods of course assessment are prepared and conducted in a consistent manner.

IV. PROPOSED QUALITY MANAGEMENT SYSTEM

A number of modifications have been introduced to the current QMS to update its structure to match actual processes done in the college and to increase its usability by faculty members, administration, and staff. These modifications are in turn introduced to the IDEF0 model, which is used to model the proposed QMS for the college. Modifications introduced to the current QMS aimed at removing unnecessary processes, re-arranging processes to match actual status in the college, or combining similar activities in one single activity.

A. Analysis of Proposed QMS

Figure 2 shows the top level context diagram A-0 the diagram title is "Implement and Use the Quality Management System for Higher Education", the point of view is the system user, and the purpose of the analysis is to facilitate the usage and implementation of the quality management system in the college.

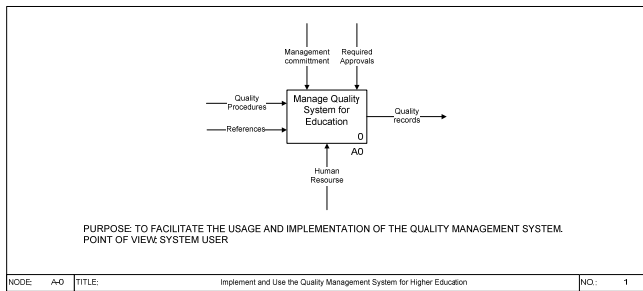


Figure 2: Implement and use quality management system for higher education.

The A-0 diagram is decomposed to the next level diagram; the A0 diagram shown in figure 3. This diagram shows the four main functions of the educational process. These activities match the famous Deming cycle of plan – do – check – improve and are listed as follows:

1. Develop new programme/course.
2. Deliver course.
3. Review programme/course.
4. Amend programme/course.

This new proposed structure helps the user to take the advantage of the quality management procedures without going through unwanted activities and useless functions; where, each activity is decomposed into clear sub-activities.

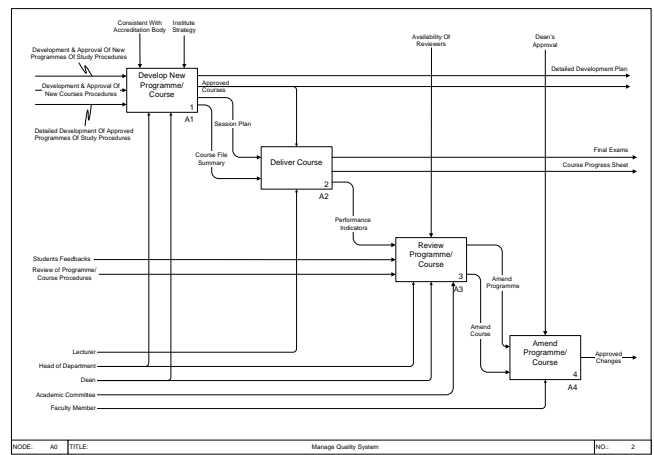


Figure 3: Manage quality system education.

1) Develop new programme/course.

Node A1 is decomposed to three main activities as shown in figure 4. The first activity is develop new programme; where, the faculty member uses the procedures for developing a new programme of study constrained by the institute strategy and the accreditation body to prepare detailed programme description.

Second activity is constrained by the head of department and the academic committee approval, if the new programme is approved, a summary description and a curriculum structure is reviewed and approved. The course developer uses the summary description and the curriculum structure to prepare course file summaries.

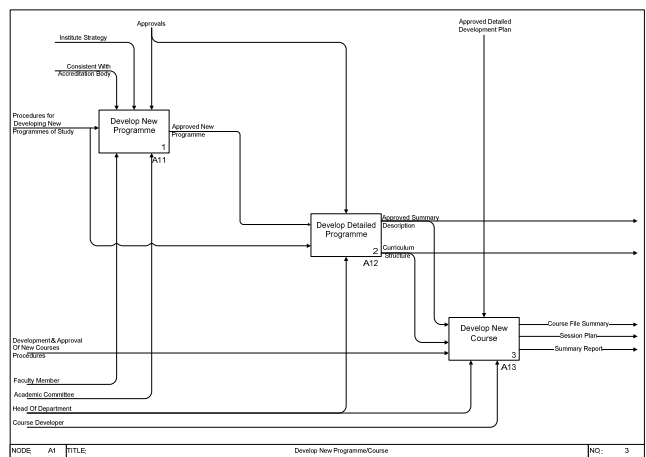


Figure 4: Develop new programme/course

2) Node A2: Deliver Course

The decomposition of node A2 is shown in figure 5, which clarifies the process of delivering a course. The whole process is done through six main activities, these activities is a result of merging three ISO procedures, MPC4, MPC5, and MPC6. First the lecturer uses Approved Course file to help him in preparing each course and session.

When a lecturer arrives to the classroom or the laboratory she/he register students' attendance and after each session she/he has to update course progress sheet and suggest any changes or actions, assessments and grading methods have to be conducted according to the assessment and grading code of practice .

At the end of each semester an academic committee is established to publish examination schedule and administer final examination.

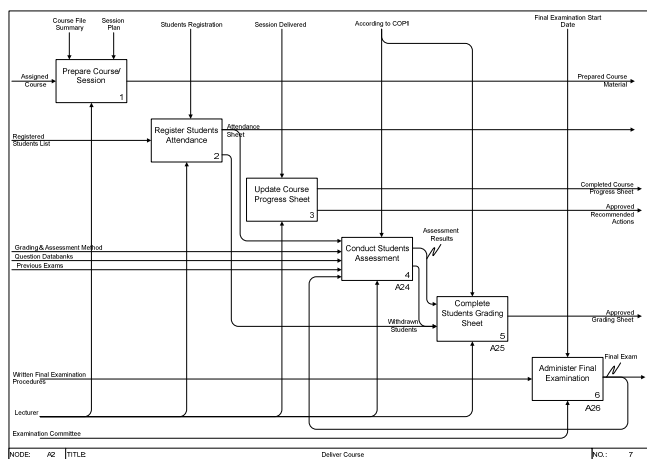


Figure 5: Deliver Course.

3) Review programme/course

The decomposition of node A3 is shown in figure 6, which explains how to review programme/course. The first activity is plan Programme/ course review where the Course Coordinator, Head of Department and Dean use the review management procedures to publish programme review schedule and course review schedule.

Courses are reviewed after the completion of each semester, and programme is reviewed every five years. Any changes or recommendations affecting programme/course are dealt with initiating amendment request

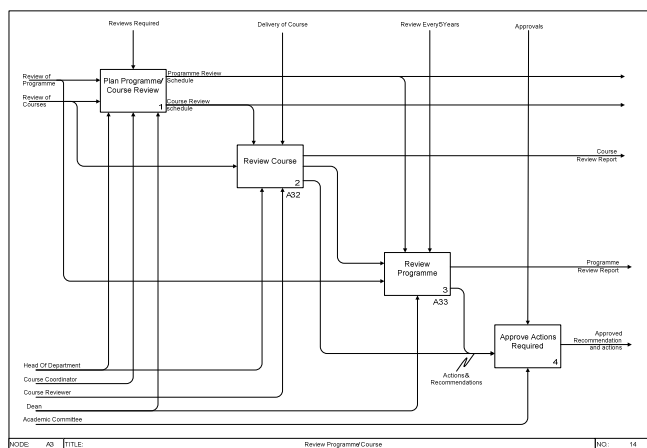


Figure 6: Review programme/course

4) Amend programme/course

Amendment of programme/course is now one of the main activities in the modified model (rather than being embedded in other activities). The decomposition of this function is presented by Node A4 shown in figure 7.

Node A4 clearly shows how to amend programme/course through three activities. First, the faculty member initiates amendment request by writing down the details of changes. Then, if the changes have an effect on accreditation then changes need to be dealt with using the “change programme” activity.

On the other hand, if the changes found in the amendment request would not affect the accreditation of the programme, then it is dealt with using the “modify course” activity. Finally, approved changes in programme/course are communicated by Dean and Head of department to the Registry and information centre.

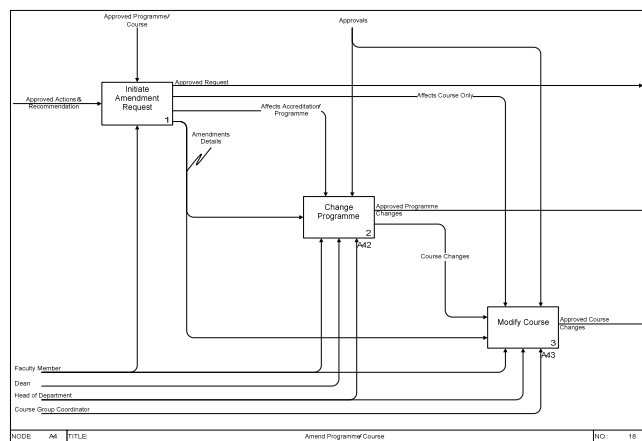


Figure 7: Amend programme/course.

It should be noted that the IDEF0 diagrams presented above are further decomposed to lower levels in order to reveal greater details about the different function that are involved in the core educational process within the college. Figure 8 presents the node diagram of the IDEF0 to give an idea about the level of detail that is involved and the number of functions and activities that are modelled.

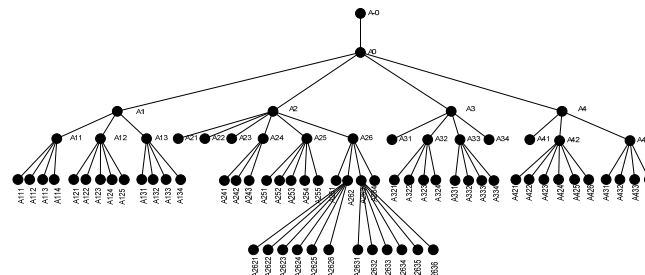


Figure 8: IDEF0 node diagram for proposed QMS.

Analysis using IDEF0 helped in identifying several areas of improvement in the quality management system used by the college. These areas of improvement have been used to develop and/or change the core management procedures (MPCs). The re-designed MPCs are much easier to use and reflect the current process that take place to deliver the educational service in the college.

V. CONCLUSIONS

This paper presented the use of the IDEF0 to completely analyze, develop and describe the QMS processes for higher education it helped identifying the points of weakness and possible areas of improvement for the QMS. The proposed IDEF0 model for the modified college QMS contained much fewer processes compared to the IDEF0 model of the current QMS, indicating that it did actually improve.

Moreover, redesign of all the core management procedures has been done based on the modified IDEF0 model.

This showed that it is important to continually review the quality management system to improve the quality of education and that such analysis can result in design of a better system.

Although the IDEF0 analysis helped in identifying the possible areas of improvement for the QMS; however, developing the IDEF0 models is not a simple task. It is an iterative task that requires a considerable amount of time to build these models as a system analyst may need to redraw

these diagrams more than once either to improve the “looks” of the diagram by re-arranging the boxes, arrows, and/or text; or to include or remove information to a process that has been revealed after decomposing it to its sub-processes.

Also, it would be difficult to use the developed IDEF0 models by any faculty member before being well trained to “reading” these IDEF0 diagrams.

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