PERFORMANCE MEASUREMENT SYSTEM FOR HIGHER EDUCATION BASED ON BALANCED SCORECARD FRAMEWORK

by

Orkun Kozanoğlu

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ABSTRACT

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In this study, the Excellence Model of European Foundation for Quality Management (EFQM) has been restructured for higher education institutions and integrated with Balanced Scorecard (BSC) management system and ABET (Accreditation Board for Engineering and Technology) 2000 Model to develop a quality model for engineering schools. The proposed model in this study has three main components, namely, support processes, core processes, and resources. These main components are surrounded by "integrity" concept which represents the culture and values of the institution. The model is driven by the mission and vision of the institution; and feedback for all processes of an engineering school is collected at the "results" component. The role of BSC management system in the proposed model is to deploy the vision and strategic objectives of the institution and provide a concrete structure for clarifying faculty members' and administrative staffs' accountabilities. This is performed through the generic strategy map for academic departments which reveals the cause-and-effect relationships between strategic objectives. This study also proposes a departmental scorecard that involves a list of generic performance measures which serve as an input for "results" component of the proposed model. By using this generic departmental scorecard, faculty scorecards may be constructed. ABET 2000 evaluates only the engineering programs with its less prescriptive nature compared with the previous ABET model. Thus, with the help of Quality Function Deployment approach, ABET 2000 has been used in the proposed model for deploying the program outcomes into the course learning objectives, modes of delivery and assessment methods. After developing a quality model; analysis of historical information, and information gathered by two surveys performed in Boğaziçi University School of Engineering (BUSoE) has been carried out to determine the perceived strengths and weaknesses of BUSoE.

ÖZET

YÜKSEK ÖĞRENİM KURUMLARI İÇİN DENGELİ PUAN KARTI TEMELLİ PERFORMANS ÖLÇÜM SİSTEMİ

Bu çalışmada Avrupa Kalite Yönetimi Vakfı (EFQM) Mükemmellik Modeli yeniden yapılandırılıp Dengeli Puan Kartı yönetim sistemi ve Mühendislik ve Teknoloji Akreditasyon Kurulu Modeli 2000 (ABET 2000) ile bütünleştirilerek mühendislik fakülteleri için bir kalite modeli geliştirilmiştir. Bu modelin üç ana bileşeni, destek süreçleri, temel süreçler ve kaynaklardır. Bu üç ana bileşen, kurumun kültür ve değerlerini kapsayan "bütünlük" kavramı ile çevrelenmiştir. Model, misyon ve vizyon ile yönledirilmekte ve tüm süreçlerin geribildirimi "sonuçlar" bileşeninde toplanmaktadır. Dengeli Puan Kartı yönetim sisteminin bu modeldeki rolü, kurumun vizyon ve stratejik hedeflerininin yayılımı ve öğretim üyeleri ve yönetim kadrosunun sorumluluklarının daha iyi anlaşılır hale getirilmesi için somut bir yapı sağlamaktır. Bu, stratejik hedefler arasındaki neden-sonuç ilişkilerini ortaya koyan, akademik birimler için tasarlanmış genel strateji haritası aracılığıyla gerçekleştirilmektedir. Bu çalışma, ortaya konulan modelin "sonuçlar" bileşenine girdi sağlayacak olan ve genel performans ölçülerini içeren bir akademik birim puan kartı sunmaktadır. Bu genel akademik birim puan kartı kullanılarak öğretim üyeleri puan kartları oluşturmak mümkündür. ABET 2000 sadece mühendislik eğitimini değerlendiren ve bir önceki sürümüne göre daha az reçete şeklinde olan bir kalite güvence sistemidir. Böylelikle, önerilen modelde ABET 2000 ve Kalite Fonksiyonu Yayılımı (QFD) yaklaşımı kullanılarak program çıktılarının ders amaçları, ders biçimi ve değerlendirme yöntemlerine dağlımı sağlanmıştır. Kalite modelinin geliştirilmesinin ardından, yapılan iki anketten elde edilen veriler ve geçmiş veriler değerlendirilmiş ve Boğaziçi Üniversitesi Mühendislik Fakültesi'nin algılanan güçlü ve zayıf yönleri belirlenmiştir.

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LIST OF ABBREVIATIONS

ABET	Accreditation Board of Engineering and Technology
BSC	Balanced Scorecard
BUSoE	Boğaziçi University School of Engineering
CHEA	Council for Higher Education Accreditation
EAC 2000	Engineering Accreditation Criteria 2000
EFQM	European Foundation for Quality Management
EQA	European Quality Award
GMAT	Graduate Management Admission Test
GPA	Grade Point Average
GRE	Graduate Record Examination
HEI	Higher Education Institution
ICoI	Istanbul Chamber of Industry
IT	Information Technology
MUFE	Marmara University Faculty of Engineering
PEO	Program Educational Objective
PO	Program Outcome
SPE	Student Placement Exam
TOEFL	Test of English as a Foreign Language
TQM	Total Quality Management

1. INTRODUCTION

Higher education is one of the most important activities organised in modern societies. It creates a demanding environment in which individuals may realise their creative and intellectual potential. Through high-level training across the disciplines, it equips people with the necessary knowledge, skills and values to play a wide range of social roles and to become effective citizens. Through research and the production of knowledge, higher education provides a society with the capacity to innovate, adapt and advance.

The ability of any higher education system to perform these functions - to meet people's learning needs, to develop and transmit appropriate skills, and to create relevant and useful knowledge - is a key index of a society's cultural, social and economic vitality and well-being. There is a high correlation, globally, between excellent higher education and overall national achievements in development, growth, competitiveness and welfare.

In this thesis, EFQM Excellence Model (EFQM, 1999), ABET 2000 Criteria (ABET, 2000) and Balanced Scorecard (Kaplan and Norton, 1992) framework were analyzed and synthesized in order to develop a quality model for engineering schools to improve the quality of their output. The performance measurement system proposed in this thesis is specific for engineering schools and it can be easily used as a basis for benchmarking an engineering school with another.

The Balanced Scorecard management system enables organizations to clarify their vision and strategy and translate them into action. It provides feedback around both the internal business processes and external outcomes in order to improve strategic performance and results continuously. In this study, Balanced Scorecard has been used as a support for the proposed model for deployment of vision and strategic objectives and communication of results.

In adapting the Balanced Scorecard as a systematic tool for deployment of vision and strategic objectives and gathering and communication of performance results, four layers

of activity has been defined. First and second layers of implementation are university and engineering school as administrative units with leadership roles, and determining vision and strategic objectives as a whole. Third layer involves the academic departments where the three key functions of the higher education institutions (teaching, research and public service) are taking place. This layer is the primary layer in setting the performance measures associated with the core processes of engineering schools. Fourth layer is the faculty (academic staff) layer. In this layer, the activities performed by faculty members are considered and performance measures associated with those activities are determined.

The proposed model aims to link faculty members' and administrative staffs' performance to Balanced Scorecard of the university. While strategic objectives and targets are communicated down from university top management to faculties, academic departments and faculty members; the performance levels of each member are communicated to the academic departments they are working in, and the performance levels of the academic departments are communicated to engineering school administration Therefore, faculty is responsible for contributing to the objectives of academic departments, and this contribution is measured by using personal scorecards of the faculty members. Similarly, Balanced Scorecard of an academic department is composed of performance measures which reflect that department's contribution to the strategic objectives of engineering school. As a result, two-way communication is maintained in between four layers. This process can be seen in Figure 3.5.

ABET (Accreditation Board for Engineering and Technology) 2000 Criteria and accreditation process provides quality assurance in engineering schools. However, ABET 2000 Criteria are more concerned with the teaching processes performed in academic departments and it assures quality only at the program level. In the proposed performance measurement system, ABET 2000 Criteria is used for determining the performance measures for educational processes, including design, delivery and assessment processes.

The structure of this thesis is organized in five chapters: In Chapter 2, a detailed survey on EFQM Excellence Model, Balanced Scorecard management system, ABET 2000 Criteria and accreditation process is given. In Chapter 3, the proposed quality model is introduced. In Chapter 4, performance of Boğaziçi University School of Engineering is

analyzed based on historical data and two surveys designed to measure the satisfaction level of faculty and self-evaluations of 2001 graduates. Chapter 5 concludes the thesis and states future areas of research.

2. PERFORMANCE MEASUREMENT, QUALITY MANAGEMENT AND ENGINEERING EDUCATION

Performance measures are used to communicate a university's strategy similar to industry and service companies. This means a university must develop a strategy and determine what each academic or administrative unit must accomplish to execute it. This requires establishing a university's strategic objectives and then breaking them down into lower level objectives and corresponding performance measures but this is not enough. Everyone in each academic unit must understand how their performance measures are linked to the university's strategic and operational objectives.

These processes may be performed for higher education institutions by implementing various management tools and techniques presented in Total Quality Management approach. Balanced Scorecard management system as a strategic planning instrument or the self-assessment efforts carried out as a preparation for an accreditation process are all closely related to TQM philosophy. In this chapter, these three approaches for measuring and improving performance will be analyzed and discussed in detail.

2.1. Total Quality Management

Total Quality Management (TQM) is a structured system for satisfying internal and external customers and suppliers by integrating the business environment, continuous improvement, and breakthroughs with development, improvement, and maintenance cycles while changing organizational culture.

Total quality management is an evolving system, a never ending journey towards excellence aiming to continuously improve the quality of life as an ultimate goal. This is accomplished through success in industrial and service sectors, for continuously improving products and services to increase customer satisfaction in a rapidly changing world. TQM concepts and practices have been developed over many years by companies seeking to improve the quality of their products and services. TQM is not an abstract philosophy.

Neither is there a single correct way to implement TQM. It must be customized to each company's culture and history.

Three revolutionary but lean principles of TQM in management thinking are as follows:

- TQM companies focus on customers and on satisfying their needs. Therefore, they must be able to react fast to changing customer needs and to focus their limited resources on activities that satisfy customers.
- TQM companies seek continuous improvement of the product that lead to higher quality products and services. Continuous improvements of the processes that lead to higher quality products and services. The notion of continuous improvement involves using a scientific approach to make improvements (analyze facts, base actions on facts, test results empirically), doing step- by- step improvements to get the market fast and acquire real experience, and doing iterative improvement to reach ever-higher levels of quality.
- TQM companies seek total participation of their staffs. All capabilities of all company members must be used if companies are to make continuous improvement and to seek customer satisfaction.

2.1.1. The European Quality Award and the European Foundation for Quality Management (EFQM) Excellence Model

The European Quality Award (EQA) is administered by the European Foundation for Quality Management (EFQM), with the support of the European Commission and the European Organization for Quality (EOQ). The award was developed in 1991 as a means for supporting the successful management of total quality in European companies.

The European Model for Business Excellence - now called the EFQM Excellence Model - was introduced in 1991 as the framework for organizational self-assessment and as the basis for judging entrants to the European Quality Award, which was awarded for the first time in 1992.

The EFQM Excellence Model was introduced at the beginning of 1992 as the framework for assessing applications for The European Quality Award. It is the most widely used organizational framework in Europe and has become the basis for the majority of national and regional Quality Awards.

The EFOM Model is a non-prescriptive framework that recognizes there are many approaches to achieving sustainable excellence. Within this non-prescriptive approach there are some fundamental concepts which underpin the EFQM Model (EFQM, 1999). These are as follows.

- Results Orientation
- Customer Focus
- Leadership and Constancy of Purpose
- Management by Processes and Facts
- People Development and Involvement
- Continuous Learning, Innovation and Improvement
- Partnership Development
- Public Responsibility

The EFQM is committed to researching and updating the Excellence Model with the inputs of tested good practices from thousands of organisations both within and outside of Europe. In this way, the model remains dynamic and in line with current management thinking.

The last major revision was launched in April 1999. This revision included a new scheme for evaluating performance against the Model, best described by its acronym RADAR (Results, Approach, Deployment, Assessment and Review).

According to EFQM Excellence Model, Excellent results with respect to Performance, Customers, People and Society are achieved through Partnerships and Resources, and Processes.

The EFQM Model is presented in diagrammatic form below in Figure 2.1.

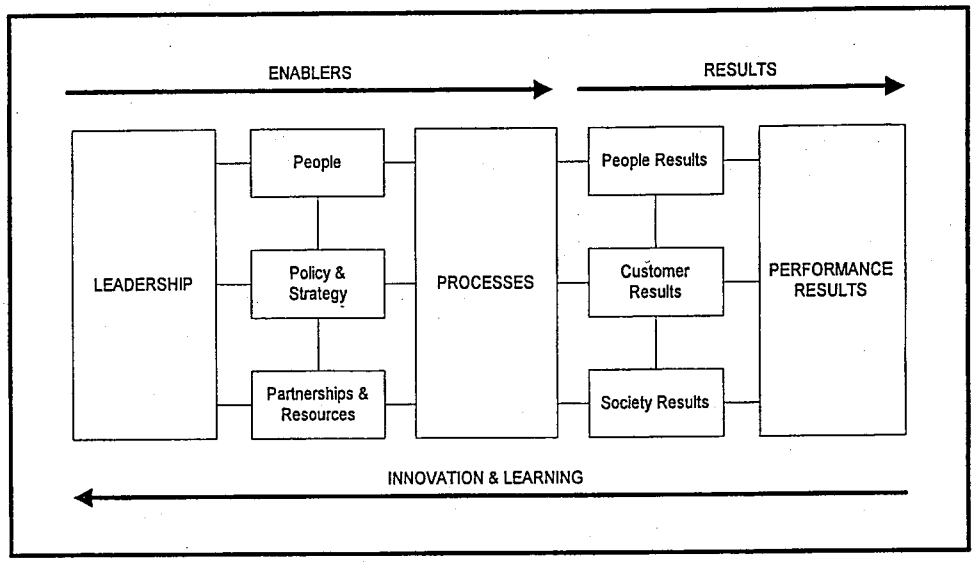

Figure 2.1. EFQM model, EFQM (1999)

The Model's 9 boxes, shown above, represent the criteria against which to assess an organization's progress towards excellence. Each of the nine criteria has a definition, which explains the high level meaning of that criterion. To develop the high level meaning further, each criterion is supported by a number of sub-criteria. Sub-criteria pose a number of questions that should be considered in the course of an assessment.

As EFQM is a non-prescriptive framework, it can also be implemented in higher education institutions. In Turkey, Marmara University Faculty of Engineering (MUFE) has performed their first self-assessment study and started to apply TQM principles in 1995. After the announcement of EFQM Public sector Award in 1996, MUFE has started to adapt EFQM Excellence Model and announced the decision of applying to European Quality Award 1999. This application resulted in a site-visit and MUFE became award finalist. In the same year, MUFE became a EFQM member.

EQA process in MUFE has provided the following benefits:

- It has increased the involvement of stakeholders,
- Acceleration of improvement activities,
- Objective evaluation of the system,
- Feedback report to determine the areas of improvement,

- Dissemination of quality culture and tools,
- High quality student intake,
- High quality academic staff recruitment,
- Higher income for its people,
- More resources for investments,
- "Role Model to other public sector and educational units",
- Motivation through reward and recognition system,
- Empowerment and effective communication,
- Success and involvement through team work,
- Positive work environment,
- Satisfied students, competitive graduates,
- Better industry relations and satisfied employers of graduates and
- Effective process management system.

2.2. Balanced Scorecard

Recognizing some of the weaknesses and vagueness of previous management approaches, Balanced Scorecard; a new approach to strategic management, was developed by Dr. Robert Kaplan and Dr. David Norton (1992) to provide a clear prescription as to what companies should measure in order to 'balance' the financial perspective.

Kaplan and Norton (1992) define the Balanced Scorecard as a management system (not only a measurement system) that enables organizations to clarify their vision and strategy and translate them into action. It provides feedback around both the internal business processes and external outcomes in order to improve strategic performance and results continuously.

Kaplan and Norton (1996a) mention that the Balanced Scorecard retains traditional financial measures. However, they express that these financial measures are inadequate for guiding and evaluating the journey that information age companies must make to create future value through investment in customers, suppliers, employees, processes, technology,

and innovation. The Balanced Scorecard complements financial measures of past performance with measures of the drivers of future performance.

Kaplan and Norton (1992) mention that, the Balanced Scorecard (BSC) translates mission and strategy into objectives and measures, organized into four different perspectives: financial, customer, internal business process, and learning and growth. The scorecard provides a framework, a language, to communicate mission and strategy; it uses measurement to inform employees about the drivers of current and future success. By articulating the outcomes the organization desires and the drivers of these outcomes, senior executives hope to channel the energies, the abilities, and the specific knowledge of people throughout the organization toward achieving the long-term goals.

The four perspectives of the Balanced Scorecard, illustrated in Figure 2.2., permit a balance between short and long-term objectives, between outcomes desired and the performance drivers of these outcomes, and between hard objective measures and softer, more subjective measures. While the multiplicity of measures on a Balanced Scorecard may seem confusing, properly constructed scorecards, contain a unity of purpose since all measures are directed toward achieving an integrated strategy.

There is a few applications BSC for education institution in the literature. Ho *et al.* (2001) proposed a performance evaluation model based on Balanced Scorecard. They compared the Balanced Scorecard with other performance evaluation models and they defined the performance measures for higher education institutions from four perspectives of the Balanced Scorecard based on a survey with department heads.

2.2.1. Four Perspectives of the Balanced Scorecard

2.2.1.1. Financial Perspective. The BSC retains the financial perspective since financial measures are valuable in summarizing the readily measurable economic consequences of actions already taken. Financial performance measures indicate whether a company's strategy, implementation, and execution are contributing to bottom-line improvement. Financial objectives typically relate to profitability – measured, for example, by operating

income, return-on-capital-employed, or more recently, economic value-added. Alternative financial objectives can be rapid sales growth or generation of cash flow.

2.2.1.2. Customer Perspective. In the customer perspective of the Balanced Scorecard, managers identify the customer and market segments in which the business unit will compete and the measures of the business unit's performance in these targeted segments. This perspective typically includes several core or generic measures of the successful outcomes from a well-formulated and well-implemented strategy. The core outcome measures include customer satisfaction, customer retention, new customer acquisition, customer profitability, and market share in targeted segments. But the customer perspective should also include specific measures of the value propositions that the company will deliver to customers in targeted market segments (e.g. short lead-times and on-time delivery, innovative products). The customer perspective enables business unit managers to articulate the customer and market-based strategy that will deliver superior future financial returns.

2.2.1.3. Internal Business Process Perspective. In the internal-business-process perspective, executives identify the critical internal processes in which the organization must excel. These processes enable the business unit to:

- Deliver the value propositions that will attract and retain customers in targeted market segments,
- Satisfy shareholder expectations of excellent financial returns.

The internal business-process measures focus on the internal processes that will have the greatest impact on customer satisfaction and achieving an organization's financial objectives.

The internal-business-process perspective reveals two fundamental differences between the traditional (e.g. Business Process Reengineering) and the BSC approaches to performance measurement. Traditional approaches attempt to monitor and improve existing business processes. They may go beyond financial measures of performance by incorporating quality and time-based metrics. But they still focus on improvement of

existing processes. The scorecard approach, however, usually identifies entirely new processes at which an organization must excel to meet customer and financial objectives. For example, a company may realize that it must develop a process to anticipate customer needs or one to deliver new services that target customer value. The BSC internal-business-process objectives highlight the processes, several of which it may not currently be performing at all, that are most critical for an organization's strategy to succeed.

The second departure of the BSC approach is to incorporate innovation processes into the internal-business-process perspective. Traditional performance measurement systems focus on the processes of delivering today's products and services to today's customers. They attempt to control and improve existing operations that represent short wave of value creation. This short wave of value creation begins with the receipt of an order from an existing customer for an existing product (or service) and ends with the delivery of the product to the consumer. But the drivers of long-term financial success may require an organization to create entirely new products and services that will meet the emerging needs of current and future needs. The innovation process, the long wave of value creation, is for many companies a more powerful driver of future financial performance than the short-term operating cycle.

The internal-business-process perspective of the BSC incorporates objectives and measures for both long-wave innovation cycle as well as the short-wave operations cycle.

2.2.1.4. Learning and Growth Perspective. The fourth perspective of the BSC, learning and growth, identifies the infrastructure that the organization must build to create long-term growth and improvement. The customer and internal-business-process perspectives identify the factors most critical for current and future success. Businesses are unlikely to be able to meet their long-term targets for customers and internal processes using today's technologies and capabilities. Also, intense global competition requires that companies continually improve their capabilities for delivering value to customers and shareholders.

Organizational learning and growth come from three principal sources: people, systems, and organizational procedures. The financial, customer, and internal-business-process objectives on the BSC typically will reveal large gaps between the existing

capabilities of people, systems and, procedures and what will be required to achieve breakthrough performance. To close these gaps, businesses will have to invest in re-skilling employees, enhancing information technology and systems, and aligning organizational procedures. These objectives are articulated in the learning and growth perspective of the BSC. As in the customer perspective, employee-based measures include a mixture of generic outcome measures – employee satisfaction, retention, training, and skills – along with specific drivers of these generic measures, such as detailed, business-specific indices of the particular skills required for the new competitive environment. Information systems capabilities can be measured by real-time availability of accurate, critical customer and internal process information to employees on the front lines of decision making and actions.

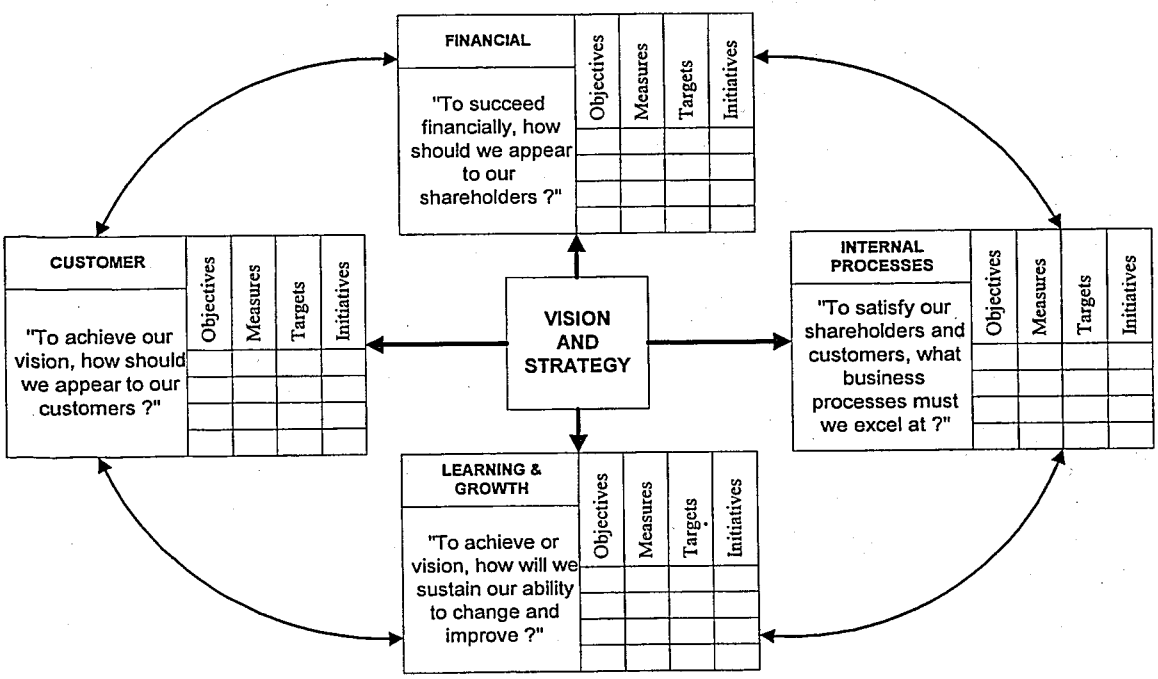

Figure 2.2. Four perspectives of the Balanced Scorecard (Kaplan and Norton, 1992)

2.2.2. Linking the Balanced Scorecard to Strategy

BSC is more than a collection of critical indicators or key success factors. The multiple measures on a properly constructed BSC should consist of a linked series of objectives and measures that are both consistent and mutually reinforcing. Like a flight

simulator, the scorecard should incorporate the complex set of cause-and-effect relationships among the critical variables, including leads, lags, and feedback loops, that describe the trajectory, the flight plan, of the strategy. The linkages should incorporate both cause-and-effect relationships, and mixtures of outcome measures and performance drivers.

2.2.2.1. Cause-and-Effect Relationships. A strategy is a set of hypotheses about cause and effect. Kaplan and Norton (1996b) mention that the measurement system should make the relationships (hypotheses) among objectives (and measures) in the various perspectives explicit so that they can be managed and validated. The chain of cause and effect should pervade all four perspectives of a BSC as seen in Figure 2.3.

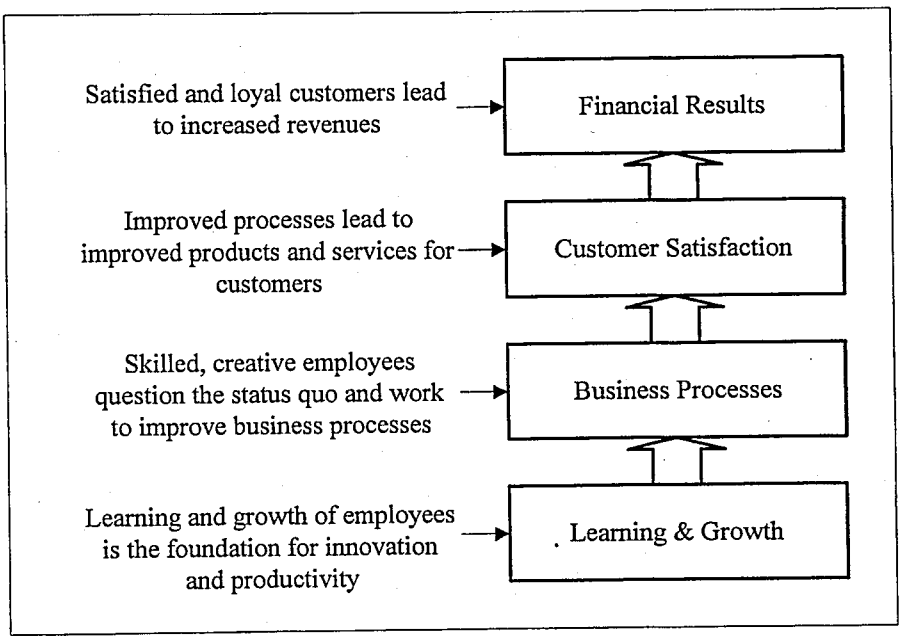

Figure 2.3. Cause-and-effect relationships

A properly constructed scorecard should tell the story of an organizational unit's strategy through such a sequence of cause-and-effect relationships. It should identify and make explicit the sequence of hypotheses about the cause-and-effect relationships between outcome measures and the performance drivers of those outcomes. Every measure selected for a BSC should be an element of a chain of cause-and-effect relationships that communicates the meaning of the business unit's strategy to the organization.

2.2.2.2. Outcomes and Performance Drivers. Balanced Scorecards use certain generic measures. These generic measures tend to be core outcome measures, which reflect the common goals of many strategies, as well as similar structures across industries and companies. These generic outcome measures tend to be lag indicators, such as profitability, market share, customer satisfaction, customer retention, and employee skills. The performance drivers, the lead indicators, are the ones that tend to be unique for a particular business unit. A good BSC should have an appropriate mix of outcomes (lagging indicators) and performance drivers (leading indicators) that have been customized to the business unit's strategy.

2.2.3. The Balanced Scorecard as a Strategic Management System

The Balanced Scorecard emphasizes that financial and non-financial measures must be part of the information system for employees at all levels of the organization. Front-line employees must understand the consequences of their decisions and actions; senior executives must understand the drivers of long-term success. The objectives and the measures for the Balanced Scorecard are more than just a somewhat ad hoc collection of financial and non-financial performance measures; they are derived from a top-down process by the mission and strategy of the business unit. The Balanced Scorecard should translate a business unit's mission and strategy into tangible objectives and measures. The measures represent a balance between external measures for shareholders and customers, and internal measures of critical business processes, innovation, learning and growth. The measures are balanced between objective, and subjective performance drivers of the outcome measures. Kaplan and Norton (1996a) mention that the Balanced Scorecard is more than a tactical or an operational measurement system. Innovative companies are using the scorecard as a strategic management system, to manage their strategy over their long run. They are using the measurement focus of the scorecard to accomplish critical management processes as seen in Figure 2.4. These processes are:

- Clarify and translate vision and strategy
- Communicate and link strategic objectives and measures
- Plan, set targets, and align strategic initiatives
- Enhance strategic feedback and learning

2.2.3.1. Clarifying and Translating Vision and Strategy. The scorecard process starts with the senior executive management team working together to translate its business unit's strategy into specific strategic objectives. Because the scorecard is developed by a group of senior executives, as a team project, the scorecard creates a shared model of the entire business to which everyone has contributed. The scorecard objectives become the joint accountability of the senior executive team, enabling it to serve as organizing framework for a broad array of important team-based management processes. It creates consensus and teamwork among all senior executives, regardless of previous employment experience or functional expertise.

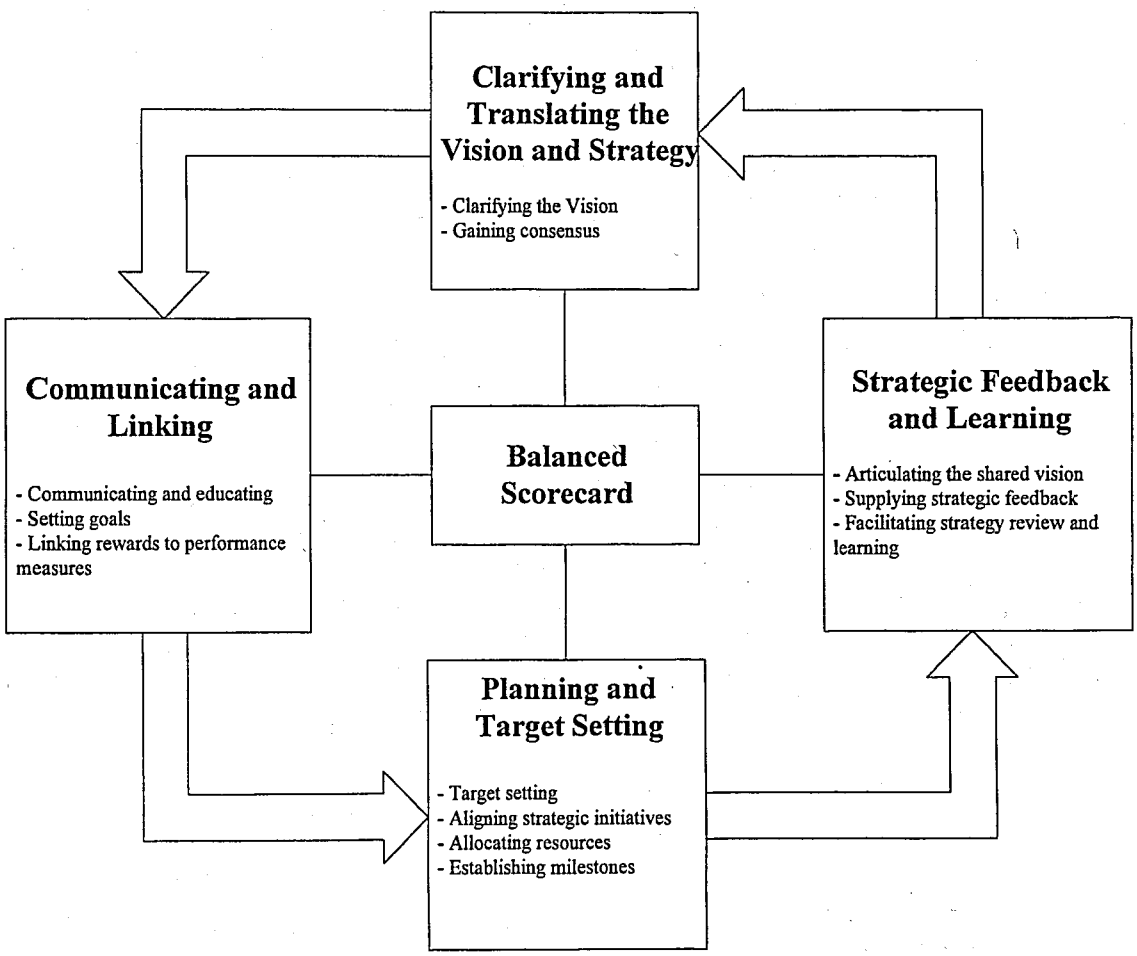

Figure 2.4. Balanced Scorecard as a strategic management system (Kaplan and Norton, 1996a)

2.2.3.2. Communicating and Linking Strategic Objectives and Measures. The objective of any measurement system should be to motivate all managers and employees to implement

successfully the business unit's strategy. Those companies that can translate their strategy into their measurement system are far better able to execute their strategy because they can communicate their objectives and their targets. Thus, a successful Balanced Scorecard is one that communicates a strategy through an integrated set of financial and non-financial measurements.

It is important to build a scorecard that communicates a business unit's strategy because:

- The scorecard describes the organization's vision of the future to the entire organization. It creates shared understanding.
- It creates a holistic model of the strategy that allows all employees to see how they contribute to organizational success. Without such linkage, individuals and departments can optimize their local performance but not contribute to achieving strategic objectives.
- It focuses change efforts. If the right objectives and measures are identified, successful implementation will likely occur. If not, investments and initiatives will be wasted.

2.2.3.3. Setting Targets and Aligning Strategic Initiatives. This process defines specific, quantitative performance goals for the organization across a balanced set of outcomes and performance drivers. The planning and target-setting management process enables the organization to:

- Quantify the long-term outcomes it wishes to achieve,
- Identify mechanisms and provide resources for achieving those-outcomes, and
- Establish short-term milestones for the financial and non-financial measures on the scorecard.

2.2.3.4. Enhancing Strategic Feedback and Learning. The final management process embeds the Balanced Scorecard in a strategic learning framework. This process is the most innovative and most important aspect of the entire scorecard management process. This process provides the capability for organizational learning at the executive level. The

Balanced Scorecard enables senior managers to monitor and adjust the implementation of their strategy, and if necessary, to make fundamental changes in itself.

2.3. Accreditation in Higher Education Institutions

Many European institutions of higher education have already taken part in or even launched some kind of accreditation initiatives, mainly in disciplines which have a high level of internationalisation, like engineering and business education. But even classical institutions, for a range of different reasons, are seeking accreditation by an external agency. Considering the lack of Europe-wide actors in this field, these institutions are contacting U.S. agencies, not only specialised ones for discipline-based accreditation (like ABET for engineering), but also regional ones for institutional accreditation. Central and Eastern European institutions also expect from a European or international accreditation some kind of formal confirmation that they have caught up in terms of so-called European standards, whatever these standards could be. In U.S., this confirmation is performed by other organizations like Council for Higher Education Accreditation (CHEA) or according to international agreements or declarations. The ultimate goal of these confirmations is the internationalization of the universities and maintaining readable and comparable programs.

Sorbonne Declaration on May 1998 stressed universities central role in developing European culture. It was adopted by United Kingdom, France, Germany, and Italy and it urged the creation of the European area of higher education as key to citizen mobility and employability as well as the continent's development. Other European countries were invited to join in this effort. It set the stage for broad participation and consultation that was to result in the Bologna Declaration.

Bologna Declaration of June 1999 by European Ministers of Education convened in Bologna. The ministers agreed to construct a "European Higher Education Area" based on fundamental principles of university independence and autonomy to ensure that higher education and research in Europe adapt to the changing needs of society and advances in scientific knowledge. This is an agreement moving Europe toward comparable degrees and cooperation in quality assurance. The objectives to reach are defined in the Bologna Declaration are as follows:

- Adoption of a system of easily readable and comparable degrees to promote European citizens' employability and international competitiveness of European system of higher education,
- Adoption of a system essentially based on two main cycles; undergraduate and graduate with the second leading to the masters or doctorate,
- Establishment of the system of credits such as the European Credit Transfer System (ECTS) that would be easily transferable to promote widespread student mobility,
- Improve access for students and training opportunities, recognize staff work in Europe,
- Promotion of mobility of students, teachers, researchers and administrative staff,
- Promotion of European co-operation in quality assurance,
- Promotion of necessary European dimension

All these elements were considered and confirmed by the Ministers of Education in Prague in May 2001. Furthermore, they emphasized following points:

- The crucial role of lifelong learning, notably to improve social cohesion, equal opportunities and the quality of life, insisting also on the importance of new technologies.
- The involvement of higher education institutions and of students as competent, active and constructive partners in the establishment and shaping of the European higher education area.
- The importance of enhancing the attractiveness of the European higher education for the students of Europe and of the rest of the world. To make the European diplomas more easily readable and comparable, it is important to develop a common framework of qualifications as well as coherent quality assurance and accreditation/certifications mechanisms and to increase information efforts.

Washington Accord agreement was set out in October 1997 and consented to by engineering accrediting organizations from Australia, Canada, Ireland, New Zealand, United Kingdom, United States, South Africa, and Hong Kong. This agreement sets criteria, policies and procedures for accrediting engineering academic programs.

The signatories agreed that they accept accreditation decisions by each other and will publish statements to that effect. They recognize the "substantial equivalence" of each other's programs in satisfying the academic requirements for the practice of engineering. They also agreed that they will carry out information exchange and mutual monitoring, observe each other's accreditation visits, and work to encourage best practices.

There is no formal engineering accreditation agency in the higher education system in Turkey similar to those practiced in countries like U.S.A. or U.K. However, since the curricula of the engineering departments were initially designed and still are very similar to the curricula of leading universities of the U.S.A. with similar educational philosophies, it is possible to request an external evaluation from ABET (Accreditation Board for Engineering and Technology) to evaluate and accredit the engineering programs as "substantially equivalent" to comparable accredited programs in the U.S.A.

2.3.1. Accreditation Board for Engineering and Technology (ABET) and Engineering Criteria 2000 (EAC 2000)

The Accreditation Board for Engineering and Technology is a federation of 28 professional engineering societies. ABET has been in the business of quality assurance in engineering education for over 60 years. Originally organized as the Engineers Council for Professional Development, ABET is responsible for the accreditation of engineering, engineering technology and engineering related programs offered by postsecondary educational institutions.

Accreditation Board for Engineering and Technology is recognized by the Council for Higher Education Accreditation as the only organization responsible for the accreditation of engineering-related programs at colleges and universities in the United States. ABET establishes procedures for mutual recognition of ABET-accredited programs and corresponding programs in other countries and in assisting agencies in other countries with development of their own accreditation process.

Engineering Criteria 2000 of ABET (or ABET 2000 Criteria) is composed of eight criteria that bring a student-focused approach to improvement of quality in engineering

education. The document maintains the traditional core of engineering, mathematics, and science requirements, but also places importance on a set of skills that includes teamwork as well as global, economic, social, and environmental awareness. At the core of Engineering Criteria 2000 is an outcomes assessment component that requires each engineering program seeking accreditation or reaccreditation to establish its own internal assessment process, which in turn, will be assessed by ABET. The outcomes assessment component calls for: detailed, published educational objectives that are consistent with the institution's mission and Engineering Criteria 2000; a curriculum and process that ensures the achievement of these objectives; and a system of ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program. This component provides flexibility for major innovations in curriculum design and delivery methods, while assuring quality engineering education. For programs whose faculty and administration envision no immediate programmatic innovations, the outcomes assessment portion of Engineering Criteria 2000 is a useful self-test to determine if the programs' traditional goals are being met on a consistent basis.

In the past, ABET's accreditation criteria focused almost entirely on resources. When reviewing programs, evaluators looked at any number of things, including faculty members' qualifications, curriculum details, and the adequacy of laboratory facilities. Engineering Criteria 2000, however, takes a broader approach, focusing on both resources and processes. This new focus grew out of ABET's awareness of the need to provide programs with more flexibility and to encourage innovation in meeting the needs of constituents. To ensure that the needs of these groups are being met, each faculty member needs to get input from each constituents when setting and evaluating educational objectives. Higher education institutions serve several constituents. The primary constituents of a higher education institution are:

- Students,
- Faculty,
- Employers,
- Alumni and
- Society as a whole.

Various assessment tools can be used for assessing student learning. The more tools used to assess a specific program outcome or course learning objective, the greater the likelihood that the assessment will be both valid (what is actually being assessed is what is supposedly being assessed) and reliable (the conclusion would be the same if the assessment were conducted by other assessors or again by the same assessor). Some possible assessment tools are categorized in Table 2.1. according to its level (course, program or both) and its source type (direct or indirect indicators of learning).

Table 2.1. Assessment tools

Assessment Tools	Level	Type
Written tests or test items clearly linked to learning objectives	Course	Direct
Written project reports		
Oral presentations (live or on videotape)		
Research proposals, student-formulated problems		
Abstracts, executive summaries, papers		
Assignments, reports, and tests in the capstone design course	Program/Course	Direct
Standardized tests (e.g., GMAT, GRE)		
Student portfolios		
Curriculum and Syllabus Analysis		
Employer, Alumni and Exit surveys and interviews	Program	Indirect
Student surveys, individual and focus group interviews	Program/Course	Indirect
Peer evaluations, self-evaluations		

The educational objectives and learning outcomes systems constitute the process half of the Engineering Criteria 2000 assessment equation. The resource requirements form the other half. ABET bases its decision to accredit a program partly on its confidence that the program will continue to have adequate resources available for the next six years. Resources can be loosely defined as any input necessary for an educational program to achieve its stated objectives and the program outcomes required by Engineering Criteria 2000. Such inputs include the students, professional standards, faculty, facilities, and institutional support services.

2.3.1.1 ABET Accreditation and Engineering Criteria 2000. The ABET accreditation process is a voluntary system of accreditation that

- assures that graduates of an accredited program are prepared adequately to enter and continue the practice of engineering,
- stimulates the improvement of engineering education,
- encourages new and innovative approaches to engineering education and
- Identifies these programs to the public.

It is the responsibility of the institution seeking accreditation of an engineering program to demonstrate that the program meets the following criteria (ABET, 2000).

Criterion 1. Students: The quality and performance of the students and graduates is an important consideration in the evaluation of an engineering program. The institution must evaluate, advise, and monitor students to determine its success in meeting program objectives.

Criterion 2. Program Educational Objectives: Each engineering program for which an institution seeks accreditation or reaccreditation must have in place

(a) detailed published educational objectives that are consistent with the mission of the institution and these criteria

(b) a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated

(c) a curriculum and process that ensures the achievement of these objectives

(d) a system of ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program.

Criterion 3. Program Outcomes and Assessment: Engineering programs must demonstrate that their graduates have

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs

(d) an ability to function on multi-disciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development and improvement of the program. The assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the program, including those listed above, are being measured. Evidence that may be used includes, but is not limited to the following: student portfolios, including design projects; nationally-normed subject content examinations; alumni surveys that document professional accomplishments and career development activities; employer surveys; and placement data of graduates.

The institution must have and enforce policies for the acceptance of transfer students and for the validation of credit courses taken elsewhere. The institution must also have and enforce procedures to assure that all students meet all program requirements.

Criterion 4. Professional Component: The Professional Component requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The engineering faculty must assure that the program curriculum devotes adequate attention and time to each component, consistent with the objectives of the program and institution. Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints that include most of the following considerations: economic; environmental; sustainability; manufacturability; ethical; health and safety; social; and political. The professional component must include

(a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline,

(b) one and one-half years of engineering topics, to include engineering sciences and engineering design appropriate to the student's field of study,

(c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

Criterion 5. Faculty: The faculty is the heart of any educational program. The faculty must be of sufficient number; and must have the competencies to cover all of the curricular areas of the program. There must be sufficient faculty to accommodate adequate levels of student-faculty interaction, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners, as well as employers of students.

The faculty must have sufficient qualifications and must ensure the proper guidance of the program and its evaluation and development. The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and registration as Professional Engineers.

Criterion 6. Facilities: Classrooms, laboratories, and associated equipment must be adequate to accomplish the program objectives and provide an atmosphere conducive to learning. Appropriate facilities must be available to foster faculty-student interaction and to create a climate that encourages professional development and professional activities. Programs must provide opportunities for students to learn the use of modern engineering tools. Computing and information infrastructures must be in place to support the scholarly activities of the students and faculty and the educational objectives of the institution.

Criterion 7. Institutional Support and Financial Resources: Institutional support, financial resources, and constructive leadership must be adequate to assure the quality and continuity of the engineering program. Resources must be sufficient to attract, retain, and provide for the continued professional development of a well-qualified faculty. Resources also must be sufficient to acquire, mai"ntain, and operate facilities and equipment appropriate for the engineering program. In addition, support personnel and institutional services must be adequate to meet program needs.

Criterion 8. Program Criteria: Each program must satisfy applicable Program Criteria. Program Criteria provide the specificity needed for interpretation of the basic level criteria as applicable to a given discipline. Requirements stipulated in the Program Criteria are limited to the areas of curricular topics and faculty qualifications. If a program, by virtue of its title, becomes subject to two or more sets of Program Criteria, then that program must satisfy each set of Program Criteria; however, overlapping requirements need to be satisfied only once.

At the core of Engineering Criteria 2000 is an outcomes assessment component that requires each engineering program seeking accreditation or re-accreditation to establish its own internal assessment process, which in turn, will be assessed by ABET.

Assessment is an ongoing process aimed at understanding and improving student learning. It involves making constituencies' expectations explicit and public; setting appropriate criteria and high standards for learning quality; systematically gathering, analyzing, and interpreting evidence to determine how well performance matches those expectations and standards; and using the resulting information to document, explain, and improve performance. When it is embedded effectively within larger institutional systems, assessment can help to focus collective attention and create a shared academic culture dedicated to assuring and improving the quality of higher education.

There are many valid assessment methods including, but not limited to, student portfolios, (inter)nationally-normed subject-content examinations, alumni surveys that document professional accomplishments and career development activities, employer surveys, and placement data of graduates. It's up to each engineering program to select the assessment methods that it deems most appropriate to the outcome being assessed. However one assessment method alone is generally insufficient to measure a desired outcome.

2.3.1.2. The Two Loops of EAC 2000. The ABET EAC 2000 Criteria require continuous assessment and improvement as illustrated below in the two loops.

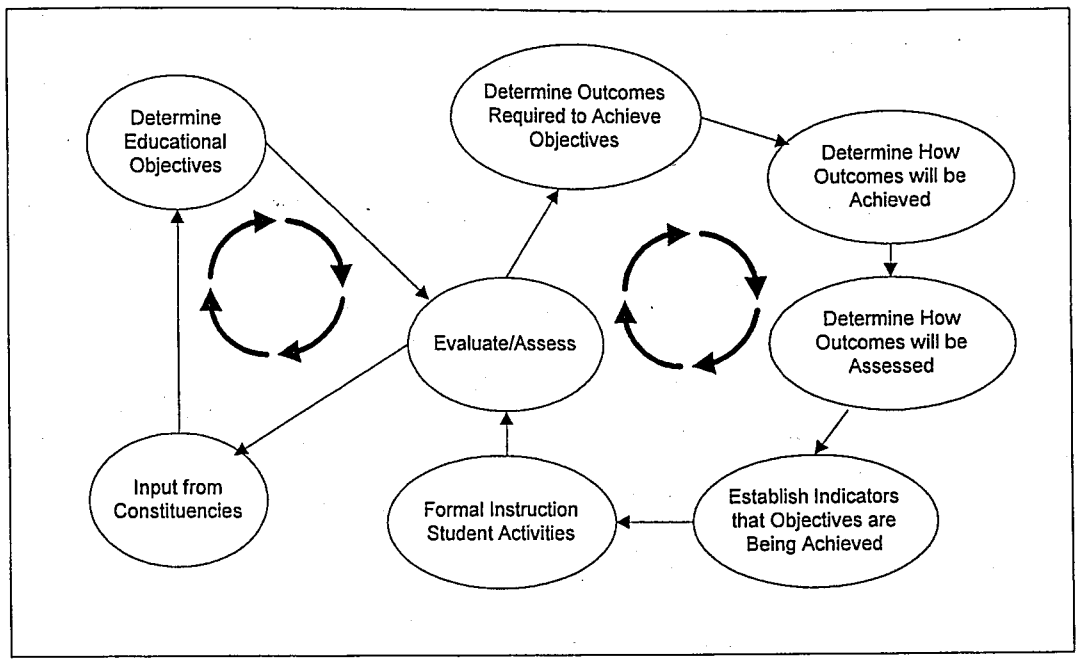

Figure 2.5. Two loops of EAC 2000, ABET (2000)

As seen in the two loops above, the program educational objectives (PEO's) are determined based on the published mission of the institution and according to the program outcomes. Program outcomes are statements that describe what students are expected to know and are able to do by the time of graduation. According to criterion 3(a-k), which is the most important and potentially most difficult to meet, engineering programs must demonstrate that their graduates have a set of eleven attributes of an engineer.

Next step after the determination of PEO's is the determining how those PEO's will be achieved. It involves the activities like curriculum design, course design, and design and improvement of support activities that leads to the achievement of the program outcomes. After this step, outcomes assessment methods are determined. It includes, but is not limited to senior exit interviews, alumni surveys, employer surveys, course evaluations, student portfolios, course portfolios, GRE and/or GMAT exams and course grades. After the instruction process, the student performance and achievement of the program outcomes is assessed based on the predetermined assessment methods. Measuring the extent of expected success in achieving the objectives consists of assessing the actual student outcomes and comparing the results with the program outcomes. At this step, achievement

of the PEO's is also evaluated and feedback about the achievement of program outcomes and PEO's is given to the constituents.

Analysis of different cases reflects different approaches to determining the program educational objectives and program outcomes. Various examples show that;

- PEO's and program outcomes are flexible statements which should be related and defined clearly.
- PEO's are broad statements which reflect the qualifications that programs aim graduates to have relevant to the profession and sectors that graduates will be employed in.
- PEO's should be aligned with the mission of the program and based on the needs and expectations of the stakeholders.
- Program outcomes are more specific and detailed statements which reflect how the PEO's will be achieved. They include program-specific qualifications of the prospective graduates.
- Program outcomes can vary in number from one program to another.
- It is not a good practice to write down the exact outcomes given in criterion 3(a-k), but they should be more detailed and explicated.

2.4. Comparison of EAC 2000, Balanced Scorecard and EFQM Excellence Model

EAC 2000, Balanced Scorecard and EFQM Excellence Model have certain simiarities and differences compared to each other. The main difference of these three models comes from their origin. EAC 2000 is specifically designed for engineering schools while the other two models are generic models that can be applied to various organizations.

The Balanced Scorecard and EFQM model share several important characteristics that make them appear quite similar. Both rely intensively on measurements to promote a dialogue about performance improvement; both strive to act as catalysts for change; and both depend on continuous feedback and learning. Also, they both require that management be deeply committed to improving organizational performance. The two

types of systems, however, approach performance enhancement from different perspectives; they have different origins and seek to deliver different specific benefits.

Preparation for ABET accreditation gives a recipe for total quality management approach in engineering schools by its non-prescriptive criteria about resources, course contents, curriculum and processes and minimum set of student outcomes since ABET aims to standardize the engineering education. However, ABET Criteria (EAC 2000) do not offer a quality framework for the whole institution. It focuses more on the education side of the engineering schools while quality issues relevant to knowledge creation function of engineering schools are not clearly emphasized.

The basic characteristics of EAC 2000 are as follows:

- It is not a management system, but a mechanism for evaluating and improving the engineering education.
- It was developed specifically for engineering education.
- It assures that engineering graduates have certain attributes expected by the constituencies.
- It focuses on improvement by processes.
- It keeps account of the resources for improving the processes and continuity of the program. ABET Engineering Criteria 2000 seeks to change the focus from external, end-item inspection to development and implementation of internal assessment and evaluation processes to assure that program quality is sustained and enhanced. Under EAC 2000, each program must set its goals, have an assessment process in place involving the program's constituents (stakeholders), document the results of assessment based on outcomes, and show evidence that the results are applied to continuously develop and improve the program.

The main difference of EFQM Business Excellence Model and EAC 2000 lies in the origin of these two methods. EFQM Business Excellence Model was developed for increasing the competition among European companies and it includes 9 main criteria, and 32 subcriteria. The EFQM Excellence Model can be used for a number of activities. Examples include self-assessment, benchmarking and as a basis for applying for the

European Quality Award. EFQM Model can be applied in various sectors including higher education institutions while EAC 2000 was designed specifically for accrediting engineering schools. ABET accreditation process involves the performance evaluation of engineering schools and detecting the existence of well defined processes in place for monitoring and improving the performance of engineering schools. Student-focus and outcomes assessment is of greater importance in EAC 2000 while it sustains its emphasis on the resources used for engineering education.

Balanced Scorecard, unlike these two frameworks, is a strategy-focused management system which evaluates an organization in four perspectives. This organization may belong to private, public or not-for-profit sectors. Balanced Scorecard of an organization is derived from the vision of that organization and corporate strategies to achieve that vision. Corporate strategies lead to the development of strategies of each unit in that organization thus, Balanced Scorecard of each unit can be built.

Table 2.2. Relation of EFQM Excellence Model with BSC and EAC 2000

EFQM Excellence Model	Balanced Scorecard		Related Criteria in EAC 2000
	Perspectives	Processes	
Leadership		Clarifying and Translating the Vision and Strategy, Planning and Target Setting	7
Policy and strategy			
People	Learning and Growth		5
Partnerships and resources	Learning and Growth		6, 7
Processes	Internal Processes		1, 2, 3, 4, 7
People results	Learning and Growth, Internal Processes	Communicating and Linking	3
Customer results	Customers	Strategic Feedback and Learning	3
Society Results	Customers		3
Performance Results	Financial, Internal Processes, Learning and Growth		3

Table 2.2. shows the relationship of criteria of EFQM Excellence Model with the perspectives and processes for implementing EAC 2000.

Balanced Scorecard does not prescribe certain criteria for self-assessment or benchmarking as a checklist, however, it describes contents of its four perspectives so that an organization can develop its own performance measures based on the cause-and-effect relationships between the strategies of that organization. In other words, Balanced Scorecard measures the achievement of strategies of an organization. Since Balanced Scorecard of an organization may not be similar to that of another, tracking the performance in time is more typical application than benchmarking with other organizations.

Kaplan *et al.* (2001) identify five major ways EFQM Business Excellence Model can benefit from a Balanced Scorecard program:

- The BSC provides explicit causal linkages through strategy maps and objectives. The EFQM model attempts to portray high-level causality among its categories. However, merely drawing arrows between categories falls far short of the cause-and-effect linkages of a detailed strategy map based on a properly constructed BSC. EFQM model verifies that a strategy process exists and is well followed. But the linkages inherent in these approaches are implicit. To build a BSC strategy map, the organization's strategy must be explicit. The hypotheses underlying the strategy become explicit and testable as data accumulate over time and across similar organizational units.
- The BSC establishes targets for breakthrough – not merely existing best practice – performance. EFQM model evaluates internal process performance against benchmarked best practices and, as a result, focus on continuous improvement. In contrast, target setting with the Balanced Scorecard starts with aspirations for radical performance breakthroughs in financial and customer outcome measures.
- The BSC often identifies entirely new critical processes for achieving strategic objectives. Quality models strive to improve existing organizational processes. But applying the BSC principles, particularly when implementing a new strategy, often reveals entirely new processes at which an organization must excel. Once new, strategically vital processes have been identified, quality programs can then be employed to improve their performance.

- The BSC sets strategic priorities for process enhancements. Even without the strategic need to introduce new processes into the organization, companies still need to assess priorities. Some processes are more essential to strategic success than others. The EFQM model provides a critical and comprehensive assessment of all processes by comparing them to industry best practice. Resources get committed to processes that have been identified as falling short of best practice. This allocation process, however, occurs independently of strategic priority-setting. The BSC, in contrast, identifies which processes must perform at or beyond current best practice levels, as well as those processes that are less crucial to strategic success.
- The BSC integrates budgeting, resource allocation, target-setting, reporting, and feedback on performance into ongoing management processes. EFQM model evaluates and scores leadership and strategy-setting as if they were independent processes. With the BSC, leadership and several management processes are inextricably linked together.

Table 2.3. gives the typical applications and benefits emphasized by each model.

Table 2.3. Emphasis and the model choice

EMPHASIS	THE MODEL CHOICE
To perform regular evaluations of all business processes for identifying strengths and weaknesses	EFQM Excellence Model
To initiate and drive a continuous process improvement program	
To enable external benchmarking of processes	
To develop a "checklist" indicating "good practice" used for business planning and evaluation	
To improve understanding of cause and effect aimed at informed and improved management decisions and actions	Balanced Scorecard
To align operational activities with strategic priorities, based on vision/mission statement	
To prioritize strategic initiatives	
To facilitate two-way communication of strategy and strategic issues	
To focus more on future strategic issues than on historic financial issues	
Specific concentration to educational objectives and processes of an engineering school	EAC 2000
Deployment of the needs and expectations of constituents in curriculum and course design processes	
Develop a model for measuring student outcomes	

Unlike EFQM Excellence model, the BSC does not weight or measure whether each of the critical management principles is done well. The measure of performance is whether the strategy was implemented effectively, and whether the organization achieved breakthrough performance in its strategic outcomes.

2.5. Other Issues in Quality of Engineering Education and Accreditation

According to the Green Report (ASEE, 1994), the engineering education must not only teach the fundamentals of engineering theory, experimentation and practice, but be relevant, attractive and connected. It should be relevant to the careers of students, preparing them for a broad range of careers, as well as for lifelong learning both formal programs and hands-on experience. It should be attractive so that the excitement and intellectual content of engineering will attract highly talented students with a wider variety of backgrounds and career interests. It should be connected to the needs and issues of the broader community through integrated activities with other parts of the educational system, industry and government.

The Joint Task Force on Engineering Education Assessment (1996) draws attention the importance of assessment of engineering education. Their report identifies the principles of good practice for assessing student learning. They are as follows.

- Successful assessment flows from the institution's mission and educational purposes.
- Successful assessment emerges from a conceptual framework.
- Assessment is most effective when it reflects an understanding of learning as multidimensional, integrated, and revealed in performance over time.
- Assessment works best when the programs it seeks to improve have clear, explicitly-stated purposes.
- Assessment requires attention to outcomes but also and equally to the experiences that lead to these outcomes.
- Assessment works when it is ongoing, not episodic.
- Successful assessment is cost-effective.
- Successful assessment has institution-wide support.

Skvarenina (2000) draws attention to the shift of the focus of accreditation from resource-based to outcome-based assessment. Skvarenina mentions that program outcomes criterion 3(a-k) are analogous to specifications that a product is expected to have. These outcomes constitute the minimum set of specifications that should be met, however, there is no single way to achieve those outcomes. Each engineering program seeking accreditation should demonstrate that their curricula and processes meet their program's outcomes which encompass the outcomes mentioned in ABET criterion 3(a-k).

Sacre *et al.* (2000) mention that an operational definition of student learning outcomes is needed to properly evaluate engineering programs. They operationalize the program outcomes in ABET criterion 3(a-k) by defining them more extensively and clearly so that the survey respondents can better understand the program outcomes by the help of the detailed definitions of the outcomes.

McGourty (2000) draws attention to the difficulties in collection of data from many stakeholders of engineering education. McGourty defines "multisource assessment" as a formal process that provides critical information from several sources, such as peers, self, and instructors, on student competencies and specific behaviours and skills, affording the student a better understanding of personal strengths and areas in need of development. McGourty also proposes a computer-based survey tool that is used for gathering data from several sources and he explains its contribution to ABET accreditation process.

Peppen and Rujigh (2000) define two types of consistency required by engineering education. External consistency is defined as the agreement of stakeholder opinions, concerning the academic and societal relevance of the educational program. This criterion for quality indicates not only how stakeholders appreciate the program as a whole, but also if they agree upon the academic level and value to society of program objectives, exit qualifications, course materials, teaching methods and the learning environment. External consistency leads to educational program that is open to and concerned with changes in academics and society. External consistency is reached when all stakeholders agree on the program's quality from their point of view. Internal consistency, on the other hand, implies congruence of curriculum design, course design, teaching activities, and program organization. Internal consistency leads to a well-integrated program in which classes build

on skills and knowledge acquired in preceding classes; teaching and testing methods are appropriate for learning objectives; facilities for teaching and learning are sufficient; and the class schedule allows time for self-study, interaction with instruction, and exam preparation.

Boaden and Cilliers (2001) investigate the ways in which the performance of academic research can be measured. In particular, they consider research as a service and product and they propose performance measures from both service quality and product quality dimensions.

Willis and Taylor (1999) looks at the quality issue from the perspective of one of the most important stakeholders of the university – the business firms that hire the school's graduates. First, the role of TQM in higher education is discussed. This is followed by an assessment of the skills that businesses desire in new employees and the ability of universities to fulfill those needs, and sample survey data obtained from business organizations are presented. A ranking of required skills is presented and the implications for colleges and universities are discussed.

3. ENHANCED PERFORMANCE MEASUREMENT MODEL FOR ENGINEERING DEPARTMENTS

In chapter 2, EFQM Excellence Model, Balanced Scorecard Management System and EAC 2000 have been compared with each other and; similarities and differences of each model over the others have been identified.

As a result of these discussions, a new quality management model has been formed. In this chapter, the proposed quality model for engineering schools is presented and its coimplementation with Balanced Scorecard performance measurement system is discussed.

3.1. The Proposed Model for Engineering Schools

Various accreditation models for higher education that have an institutional scope are lacking specific focus on a certain field of study like engineering disciplines. On the contrary, Furthermore, specific accreditation models such as ABET 2000 do not have an institutional scope. They are program-based. Thus, a model designed specifically for engineering education and having an institutional scope is needed. Such a model can also be used as a basis for benchmarking.

EFQM Excellence Model is a general purpose model that can be implemented in a range of organizations since it has a generic structure and criteria. Unlike the EAC 2000, EFQM model has an institutional scope; therefore, it covers all processes and aspects of an organization including resources, policy and strategy and leadership.

By restructuring the EFQM Excellence Model for higher education institutions and integrating it with EAC 2000, a special purpose model for engineering schools has been developed.

The proposed model is composed of 5 components that expose an institutional approach to engineering schools and it sets criteria for evaluating the core and support

processes performed in an engineering school as well as resources, and integrity of the engineering schools that makes these processes realizable.

To provide a better understanding of vision, strategic objectives and relations between them, the proposed model is supported by BSC. By using the strategy maps, Balanced Scorecard creates a structured media for communication.

The key benefits of BSC approach in conjunction with the proposed model are:

- Clarity and effective communication of strategy;
- Linkage of strategy to processes;
- Clear accountabilities of human resources, for objectives and resources;
- A balanced picture of the organization for all levels of organization.

By implementing the BSC in an engineering school, academic and administrative staff become aware of and clearly accountable for what they should achieve with respect to the vision of the institution.

Performance of academic and administrative staff can be measured by using their personal scorecards and a well-defined rewarding system may be formed and rewards can be given according to their contribution to the achievement of vision.

EAC 2000 is integrated with the proposed model for its specific focus on the educational objectives and processes of an engineering school with its non-prescriptive criteria. These criteria are about how an engineering school sets its objectives with respect to its educational processes and how it should evaluate its performance in education.

In the proposed model, EAC 2000 approach can be used for deploying the needs and expectations of constituents about the attributes of the graduates of an engineering school. These attributes are the characteristics that each engineering graduate should have or be able to perform by the time they graduate. Therefore, success of an engineering school's educational processes can be determined by measuring its graduates' level of achievements in having those attributes.

The proposed model is presented in diagrammatic form in Figure 3.1. The arrows in the model emphasize the strong relationships between the model components.

The model is driven by the mission and vision of the academic departments. It focuses on the core processes of the integrated system structured and the major resources as input. The system integrity surrounds the input resources and the processes. The results are displayed as an output component.

Before presenting the five components of the model, the integrity issue concerning the whole system is first emphasized.

The institution must subscribe to, exemplify, and advocate high ethical standards in the management of its affairs and in all of its dealings with students, faculty, staff, external agencies and organizations, and the general public.

The institution must be committed to the free pursuit and dissemination of knowledge and its educational policies and procedures must be applicable and equitably applied to all its students.

The institution must manage its administrative operations with honesty and integrity. The institution must have established and publicized clear policies ensuring institutional integrity. Included among them are appropriate policies and procedures for the fair resolution of grievances brought by faculty, staff, or students.

The institution must also have non-discriminatory policies and practices in recruitment, admissions, employment, evaluation, and advancement. It must foster an atmosphere within the institutional community that respects and supports people of diverse characteristics and backgrounds.

The effectiveness of its ethical policies and procedures must be periodically assessed and the existence of mechanisms for the effective implementation of its principles must be demonstrated.

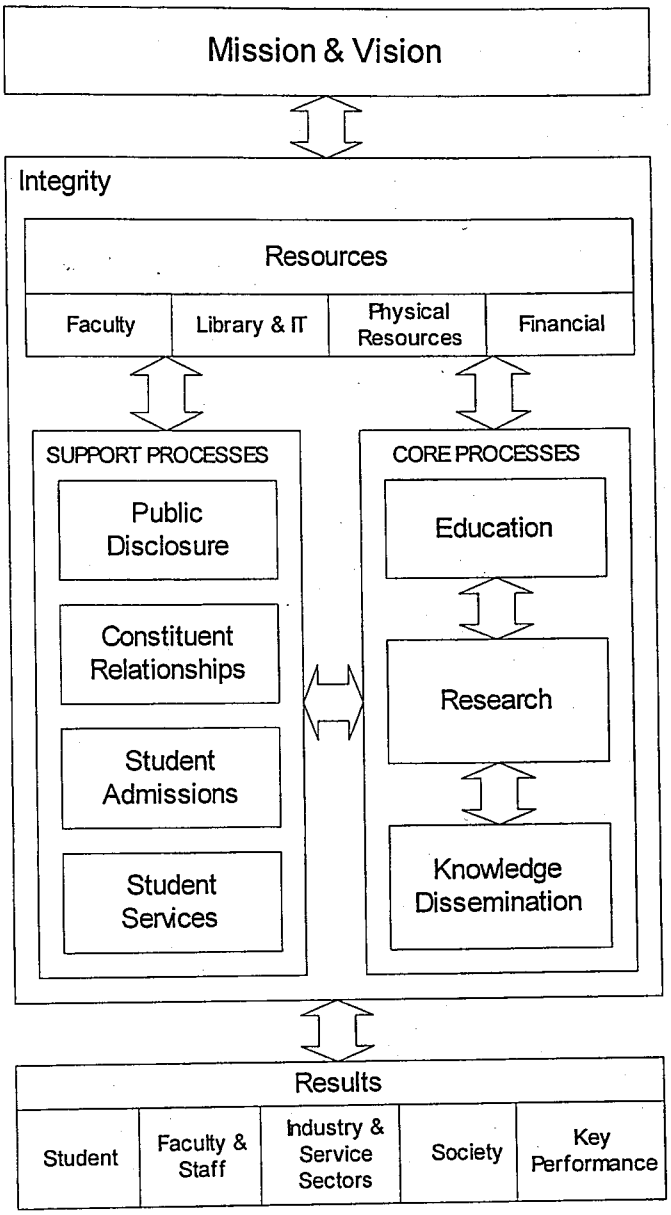

Figure 3.1. The proposed model for engineering schools

The 5 components of the proposed model are defined as follows.

3.1.1. Mission and Vision

The institution must have a published mission and vision appropriate which defines its distinctive character, addresses the needs of society and identifies the students it seeks to serve, and reflects both the institution's traditions and its projection and targets for the future.

The institution's vision must be concrete and realistic and, within the context of its resources, it must define its educational objectives as well as other dimensions, including research, and public service.

The mission and vision statements must be fully comprehended and accepted widely understood by its faculty, and administration. They must provide direction to the curricula and other activities. Specific objectives, reflective of the institution's overall mission and vision, must be developed for the institution's individual units.

The institution must perform short- and long-term planning and evaluation to accomplish and improve the achievement of its mission and vision giving primary focus to the realization of its educational objectives. Planning and evaluation must be broad-based, systematic, interrelated, and appropriate to the institution's circumstances and its needs. They must involve the participation of individuals and groups responsible for the achievement of institutional purposes and realistic analyses of internal and external opportunities and constraints. The institution must also determine the effectiveness of its planning and evaluation activities on an ongoing basis.

3.1.2. Resources

An engineering department has four major resources, which must be continuously developed, managed, controlled, maintained and renewed.

3.1.2.1. Faculty. Faculty qualifications and performance must be sufficient to accomplish the institution's mission and vision. The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, and participation in professional societies. The institution must provide substantial and equitable opportunities to its faculty for continued professional development throughout their careers.

Number of faculty members must be sufficient to carry out duties in addition to instruction, which may include such functions as student advising and academic planning,

and to participate appropriately in policy-making, course and curricular development, and institutional governance.

The institution must employ an open and orderly process for recruiting its faculty. Faculty must participate in, or perform the search process for new members of the academic staff. The institution must observe pertinent legal requirements related to equal employment opportunity and compatible with its mission and vision, and address its own goals for the achievement of diversity of race, gender, and ethnicity.

Each prospective faculty member must be provided with a written contract that states explicitly the nature and term of the initial appointment and, when applicable, institutional considerations that might preclude or limit future appointments.

Faculty must be provided reasonable contractual security for appropriate periods consistent with the institution's ability to fulfill its mission. Salaries and benefits must be at levels which ensure its continued ability to attract and maintain an appropriately qualified instructional staff of a quality consistent with the institution's mission and vision.

Faculty assignments and workloads must also be consistent with the institution's mission and vision allowing them adequate time to provide effective instruction, advise and evaluate students, continue professional growth, and participate in scholarship, research, and service compatible with the mission and vision of the institution. Faculty workloads must be reappraised periodically and adjusted as institutional conditions change.

In a faculty handbook or in other written documents that are current and readily available, the institution must clearly define the responsibilities of faculty and the criteria for their recruitment, appointment, evaluation, and promotion. The institution must employ effective procedures for the regular evaluation of faculty appointments, performance, and retention.

3.1.2.2. Library and Information Technologies. The institution must make available the library and information technologies necessary for the academic and research program and the intellectual and cultural development of students, faculty, and staff.

Library services include the book and journal collections, media centers, electronic services, language laboratories and any other repositories of information or technological systems required for the support of institutional offerings.

Information technologies include the Internet, computer centers, computer software, educational laboratories and special purpose research laboratories. Library and information technologies, systems, and services must be sufficient in quality, level, diversity, quantity, and currency to support and enrich the institution's academic offerings. The institution must provide facilities adequate to house the collections and equipment so as to foster an atmosphere conducive to inquiry, study, and learning among students, faculty, and staff.

Number of professionally qualified staff must be adequate to administrate the institution's library, information technologies, and services. The institution must also provide appropriate orientation and training for use of these resources, as well as instruction in basic information literacy.

The institution must provide sufficient and consistent financial support for the effective maintenance and improvement of the institution's library, information technologies, and services.

3.1.2.3. Physical Resources. The institution must have sufficient and appropriate physical resources, including laboratories, network infrastructure, materials, equipment, and buildings and grounds. They must be designed, maintained, and managed at both on- and off-campus sites to serve institutional needs as defined by its mission and vision. Classrooms and laboratories, real or virtual, and other facilities must be appropriately equipped and adequate in capacity. Proper management, maintenance, and operation of all physical facilities and virtual environments, must be performed by adequate and competent staffing.

The institution must plan its physical resources linked to academic and student services and financial planning. It must determine the adequacy of existing physical resources and identifies and plans the specified resolution of deferred maintenance needs.

Space planning must occur on a regular basis as part of physical resource evaluation and planning, and is consistent with the mission and vision of the institution.

Facilities must be constructed and maintained in accordance with legal requirements to ensure access, safety, security, and a healthful environment with consideration for environmental and ecological concerns.

3.1.2.4. Financial Resources. The institution must control its financial resources and allocates them in a way which reflects its mission and vision. The institution must be financially stable. The institution's financial resources must be sufficient to sustain the achievement of its educational objectives and to further institutional improvement now and in the foreseeable future. All or substantially all of the institution's revenue must be devoted to the support of its educational objectives and programs. The institution must have the ability to respond to financial emergencies and unforeseen circumstances.

The institution must ensure the integrity of its finances through attentive financial management and organization, a well-organized budget process, appropriate control mechanisms, and timely financial reporting, providing a basis for sound financial decision-making. The institution's financial records must clearly relate to its educational activities. The financial resources and transactions of independent institutions must be audited periodically by an external auditor in accordance with the generally accepted auditing standards for universities.

3.1.3. Support Processes

Support processes include public disclosure, constituent relationships, student admissions and student services. They are important for the success of the core processes in achieving the mission and vision of the institution.

3.1.3.1 Public Disclosure. Public disclosure includes the publicity processes through which the institution promotes the services it provides to its constituents. In presenting itself to students and other members of the interested public, the institution must provide information that is complete, accurate, and clear.

The institution must have a current catalogue in which it describes itself consistent with its mission statement and sets forth the obligations and responsibilities of both students and the institution. Publications, print or electronic, must contain the institution's mission, objectives, and expected educational outcomes; requirements and procedures and policies related to admissions and the transfer of credit; student fees, charges and refund policies; rules and regulations for student conduct; other items related to attending or withdrawing from the institution; academic programs, courses currently offered, and other available educational opportunities; and academic policies and procedures and the requirements for degrees or other forms of academic recognition. They must also include a list of current faculty, indicating departmental or program affiliation, distinguishing between those who have full- and part-time status, showing degrees held and the institutions granting them.

The institution must publish and make readily available a description of the size and characteristics of the student body, the campus setting, those institutional learning and physical resources from which a student can reasonably be expected to benefit, and the range of co-curricular and non-academic opportunities available to students.

The institution must have readily available valid documentation for any statements and promises regarding such matters as program excellence, learning outcomes, success in placement, and achievements of graduates and faculty.

Through a systematic process of periodic review, the institution must ensure that its publications are accurate and current.

3.1.3.2. Constituent Relationships. To ensure that the needs of the constituents are correctly identified and satisfactorily being met, engineering schools need to get input from each constituent when setting and evaluating objectives of the institution for education, knowledge creation and dissemination activities.

The institution must have a formal process performed periodically on an ongoing basis for surveying the various constituencies to identify their needs and expectations from

each program and institution as a whole. The analytical methods that are used to gather data should measure the relative importance of different needs within a given constituent.

Constituents often have competing and incompatible needs. For this reason, the institution must devise a process for resolving potential conflicts and setting reasonable educational objectives.

3.1.3.3. Student Admissions. The institution must have an orderly and ethical program of admission which complies with the requirements of legislation concerning equality of educational opportunity. Its admission and retention policies and procedures must be clear, consistent with its mission and vision, and available to all students and prospective students through appropriate publications.

Standards for admission must ensure that student qualifications and expectations are compatible with institutional objectives. Individuals admitted must demonstrate through their intellectual and personal qualifications a reasonable potential for success in the programs to which they are admitted. If the institution accepts undergraduate transfer credit from other institutions, it must have policies and procedures which provide adequate safeguards to ensure that credit accepted reflects appropriate levels of academic quality and is applicable to the student's program.

3.1.3.4. Student Services. The institution must provide an environment which fosters the intellectual and personal development of its students consistent with its mission and vision and mode of educational delivery. It must be sensitive to the non-academic needs of its students and recognize that their educational experience consists of an academic component and interrelated developmental opportunities provided through a co-curricular program of student services. These services must be guided by a philosophy, disseminated and reviewed on a regular basis, which is conducive to the development of a shared learning community and which prepares students to become responsible members of society. The institution must also support opportunities for student leadership and participation in campus organizations and governance.

In accordance with its mission and vision, the institution must provide equal opportunity for diversity. It must ensure that appropriate services, facilities, and technology are readily accessible to students in all programs in the institution, including members of physically disabled and distance learning populations.

The institution must provide appropriate and effective orientation, career development and placement counseling and, as appropriate, relevant health education and access to professional health care, including psychological health care.

The institution must have in place an effective system of academic advising which meets student needs for information and advice and is compatible with its educational objectives. Faculty and other personnel responsible for academic advising must be adequately informed and prepared to discharge their advising functions.

The institution systematically must identify the characteristics and learning needs of its student population and then makes provision for responding to them. It must assist students to resolve educational and technological problems and, where appropriate, personal and physical problems.

Through a program of regular and systematic evaluation, the institution must determine whether the co-curricular goals and needs of the students are being met. Information obtained through this evaluation must be used to revise these goals and improve their achievement.

3.1.4. Core Processes

Core processes involve the functions of an engineering department that are defined and publicized in the mission statement of the institution. It involves education of individuals through undergraduate and graduate degrees, research and knowledge dissemination processes.

3.1.4.1. Education. It involves two sub-processes: program outcomes deployment and instruction.

Program Outcomes Deployment: It is the design process of the related engineering program. The curriculum has to be restructured to comply with the educational objectives and to meet the desired outcome indicators. Each engineering program offered by the institution must have:

- Detailed published educational objectives that are consistent with the mission of the institution and specific enough to differentiate the program from others,
- Program outcomes that describe what graduates will be expected to know and be able to do after completing a curriculum. The unique program outcomes associated with the program objectives should encompass the attributes mentioned in section 2.3.1.1. criterion 3(a-k),
- A curriculum and courses that ensures the achievement of these program outcomes by devoting adequate attention and time to each component, consistent with the objectives of the program and institution. The curriculum must include a combination of college level mathematics and basic sciences, engineering topics and a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives. The relative weights of these components are described in more detail in 2.3.1.1. criterion 4.

Instruction: It is the actual delivery process related to the courses offered. Instructional techniques and delivery systems must be compatible with and serve to further the mission and vision of the institution as well as the objectives of individual courses. Methods of instruction must be appropriate to the students' capabilities and learning needs. Academic research by students must be encouraged and appropriately assessed. Students must be taught by a variety of faculty in order to ensure experience in different methods of instruction and exposure to different viewpoints.

The institution must strive to enhance the quality of teaching. Experimentation with methods to improve instruction must be encouraged. The effectiveness of instruction must be periodically and systematically assessed using adequate and reliable procedures; and the results must be used to improve instruction.

Courses and programs offered for credit off-campus, through technologically mediated instruction, or through continuing education, evening or week-end divisions must be consistent with the educational objectives of the institution. Such activities must be integral parts of the institution and maintain the same academic standards as courses and programs offered on campus. They must receive sufficient support for instructional and other needs. The institution must maintain direct and sole responsibility for the academic quality of all aspects of all programs and assures adequate resources to maintain quality. In programs and/or courses that use special delivery systems (such as computers, newspapers, television, video or audiotape) appropriate opportunities must be provided for students to question and discuss course content with faculty.

3.1.4.2. Research. Research involves the creation, revision, or application of knowledge as undertaken by faculty and students. The institution must provide evidences that academic research (individually and cooperatively) is performed for achieving the mission and vision of the institution. Physical and administrative resources together with academic services must be adequate to support the institution's research commitment. Faculty workloads must reflect the institution's research commitment. Policies and procedures related to research, including ethical considerations, must be established and clearly communicated throughout the institution.

Research activities and outputs must be linked to the educational processes and knowledge dissemination activities. The research outputs must be presented to students and public through the renewal of the curricula and disseminated knowledge.

3.1.4.3. Knowledge Dissemination. Knowledge dissemination includes the ongoing application, utilization, and dissemination of existing knowledge through continuing education activities, seminars, conferences, voluntary services for public organizations and industry consulting services. The institution must provide evidences that knowledge dissemination activities receive encouragement and support and faculty and students are accorded the academic freedom to pursue these activities.

Off-campus, continuing education, distance education, international, evening and week-end programs must be clearly integrated and incorporated into the policy formation and management system of the institution.

3.1.5. Results

Each program must have an assessment process in place for measuring the core functions of the institution with documented results. The assessment process must demonstrate that the student outcomes important to the mission of the institution and the achievement of objectives of each program are being measured. Evidence that may be used includes, but is not limited to the following:

- Student portfolios, including design projects;
- Nationally-normed subject content examinations;
- Alumni surveys that document professional accomplishments and career development activities;
- Employer surveys; and
- Placement data of graduates.

These student results must be used for further development and improvement of the educational programs. The results of knowledge creation and dissemination activities must also be periodically measured and the results must be used for further improvement.

Faculty results with respect to their perception and performance must be measured. Perception measures are related to opinions of faculty members about the university and they are obtained from satisfaction surveys, focus groups, interviews and systematic performance evaluations. They include motivation and satisfaction level of faculty. Performance indicators are internal measures for determining, estimating and improving the performance of academic and administrative staff and estimating their perceptions.

Besides the internal stakeholders such as faculty, staff, and students, the institution must also measure the results with respect to its external constituents and society on an ongoing basis. These measures should be assessed to see the current status and possible

trends and also to set the targets for improvements to be realized. These measures are related to perceptions of constituents about the university. They are similarly obtained from satisfaction surveys, focus groups, interviews, complaints and evaluations. They are related to general image of the institution and quality of education, research and knowledge dissemination activities and their outputs.

Society results are what the institution is achieving in relation to local, national and international society as appropriate. These results are related to perceptions of society about the university and they are obtained from surveys, reports, public meetings, various associations and government. They are related to public services performed by the institution, sensitivity about the local, national or global problems and effort for providing solutions for them and contribution to the local and national economies.

Key performance results of the institution must be measured on an ongoing basis. Key performance results are what the university is achieving in relation to its planned performance. Key performance results cover the financial and non-financial measures that are directly driven from the planned outcomes of the university. Financial measures may include the budget, revenues (research grants, endowments), and expenditures. Non-financial results may include the level of success in achieving its vision (e.g. new program development, better rankings, shorter residence time of students, increased faculty productivity, improved research outputs and stronger industry relations).

3.2. Program Outcomes Deployment Process

Deployment of the needs and expectations of various constituents is very crucial for the overall success of education component in the proposed model. It includes the processes illustrated in Figure 3.2.

Program outcomes are based on various constituents' needs and expectations. Program objectives are formulated in agreement with the program outcomes and mission statement of the institution. Design and review phase both at the program level as the overall curriculum and the course level specifies the assessment processes including the sufficient tools to measure the achievement of program objectives.

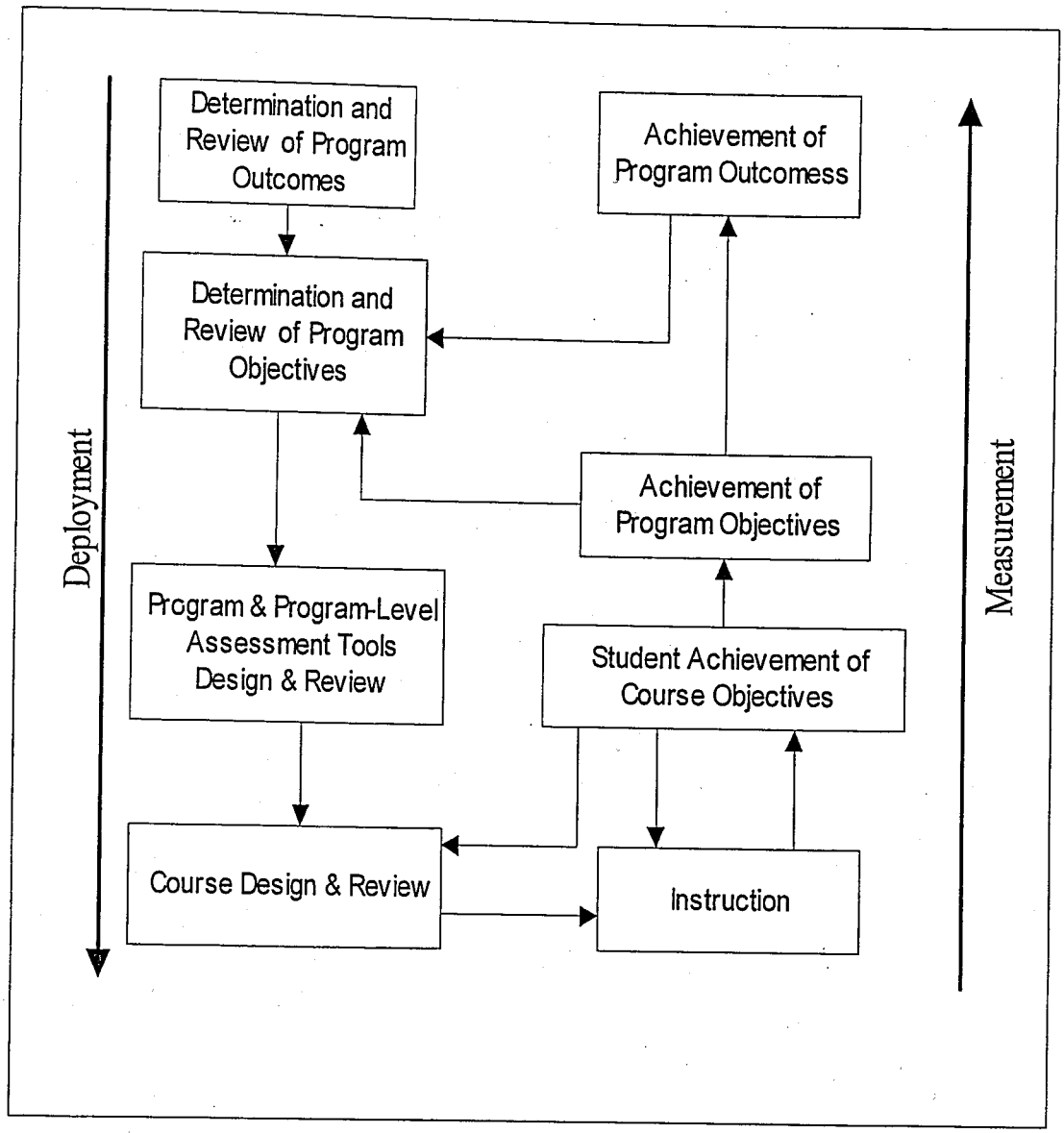

Figure 3.2. Program outcomes deployment process

Quality Function Deployment (QFD) (Juran and Godfrey, 1999) may be as a vehicle to translate constituents' needs and expectations into program objectives, course design, and delivery and assessment methods as seen in Figure 3.3. QFD is a systems approach structured on a visual model referred as house of quality. It is frequently utilized as a planning and communication tool.

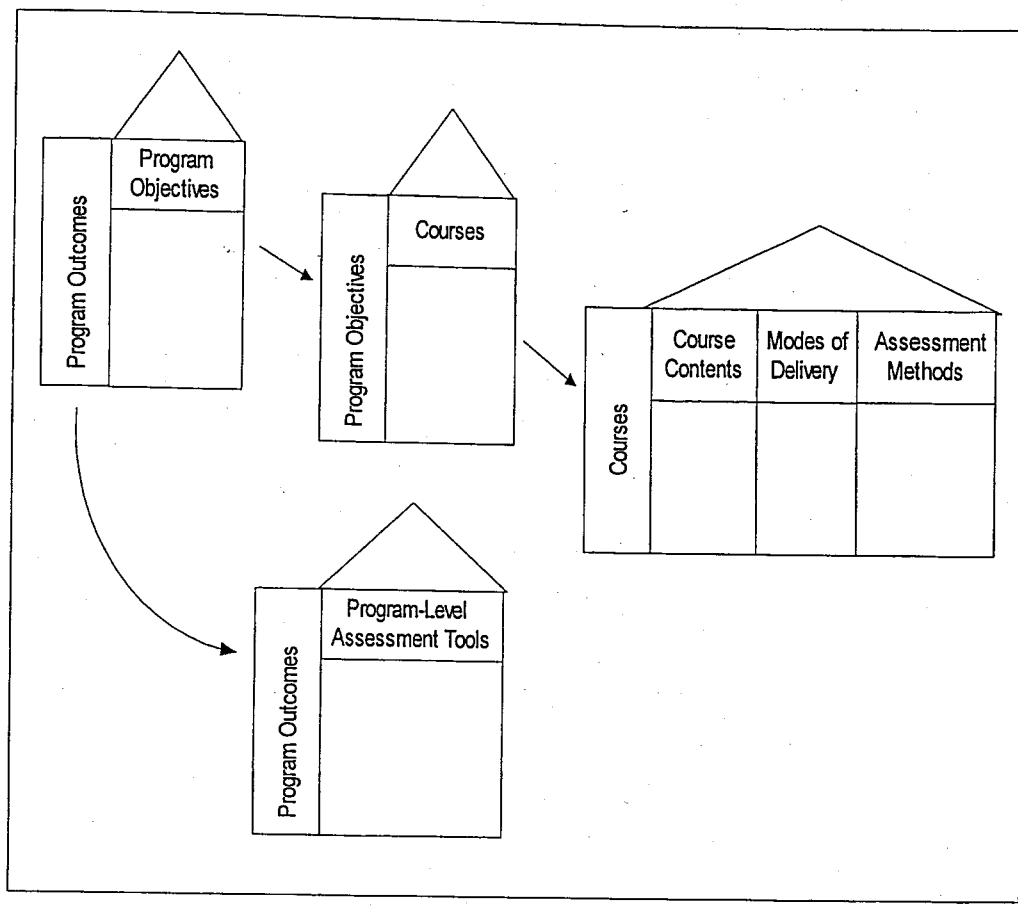

Figure 3.3. QFD approach to program outcomes deployment

The first house of quality is concerned with translating the program outcomes, which express the needs and expectations of the constituents, into program objectives. Constituents' needs and expectations reflect the detailed attributes that graduates should have by the time of graduation. From EAC 2000 perspective, these attributes should also cover the outcomes given in 3(a-k). In this phase, affinity diagrams and analytic hierarchy process may be used to organize and prioritize the constituents' needs and expectations.

Since the relations of program outcomes with program objectives and courses are determined by faculty members individually; there must be a common understanding among faculty members about the program outcomes given in 3(a-k). Table 3.1. gives a detailed description of these program outcomes.

Table 3.1. Detailed definitions of criterion 3(a-k)

3(a-k)	Definition
a) an ability to apply knowledge of mathematics, science, and engineering	encompasses the basic mathematical, scientific, and engineering fundamental knowledge needed by engineering graduates. The emphasis is on: 1) formulation and solution of mathematical models describing the behavior and performance of physical, chemical, and biological systems and processes and, 2) use of basic scientific and engineering principles (e.g., conservation laws, rate and consecutive equations, thermodynamics, materials science) to analyze the performance of processes and systems.
b) an ability to design and conduct experiments, as well as to analyze and interpret data	comprises four straightforward elements: 1) designing experiments, 2) conducting experiments, 3) analyzing data and 4) interpreting data. Statistically designed experiments, laboratory based experiments and field experiments are considered. Each element can be further broken down into descriptive attributes that encompass the larger element. For example, designing experiments includes setting up experiments, determining the proper models to use, considering the variables and constraints, using laboratory protocols and considering ethical issues that arise
c) an ability to design a system, component, or process to meet desired needs	comprises four elements: 1) design a system (or component or process) to (insert one or more goals or functions) and report the results (insert specifications regarding the required scope and structure of the report). Variants of this objective could be included in traditional lecture courses (including the freshman engineering course) as well as the capstone design course. 2) use engineering laboratory data to design or scale up a system (or component or process). 3) build a prototype of a design and demonstrate that it meets performance specifications. 4) list and discuss several possible reasons for deviations between predicted and measured results for an experiment or design, choose the most likely reason and justify the choice, and formulate a method to validate the explanation.
d) an ability to function on multi-disciplinary teams	is divided into four behavioral dimensions found to be prevalent in successful student work teams. These four dimensions are collaboration, communication, conflict management, and self-management. The specific attributes are designed to measure the occurrence of behaviors in the context of working groups..

Table 3.1. Detailed definitions of criterion 3(a-k) (continued)

3(a-k)	Definition
e) an ability to identify, formulate, and solve engineering problems	is based on the problem solving process that has been well documented in engineering texts. The elements of the process include: problem or opportunity identification, problem statement and system definition, problem formulation and abstraction, information and data collection, model translation, validation experimental design, solution development or experimentation, interpretation of results, implementation and documentation.
f) an understanding of professional and ethical responsibility	comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. The ability to recognize potential ethical dilemmas is emphasized, as is the relationships between cost and schedule pressures and increased risk.
g) an ability to communicate effectively	consists of three elements: 1) an ability to write clear and concise technical reports 2) an ability to make an oral presentation of a design project or a proposal, 3) an ability to prepare presentation quality visual aids, e.g., PowerPoint presentations.
h) the broad education necessary to understand the impact of engineering solutions in a global and societal context	is based on how the engineering student interprets solutions in both a societal (more micro context), and global (more macro context). The societal context might be a particular community, state or even country. The global context might cover more than one community, nation, country, etc. Example impacts might include, but are not limited to, political, economical, religious, environmental, communication, and aesthetic impacts.
i) a recognition of the need for, and an ability to engage in life-long learning	includes 1) having an exposure to the changing demands and the necessity to adapt in today's workplace 2) an ability to find relevant sources of information about a specified topic in the library and on the World Wide Web (or perform a full literature search)
j) a knowledge of contemporary issues	focuses on "knowledge" and is interpreted to mean the student's obtaining in-depth knowledge of at least one contemporary issue. Three types of examples are given - socio-economic, political and environmental. Specifically excluded are contemporary, technical engineering issues since these are included in outcome "k" as well as in "a".
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	encompasses a wide range of tools and skills needed by engineering graduates including computer software, simulation packages, diagnostic equipment, and use of technical library resources and literature search tools.

The second house of quality shows the areas of curriculum where students are equipped with the target attributes defined as program outcomes. By assigning learning

objectives to each course, faculty members can ensure that every course in a curriculum contributes to the required program outcomes and that the curriculum as a whole satisfies the program's overall educational objectives.

A course is specified as three components: course contents, modes of delivery and assessment methods. In the third phase, each course introduces specific course contents delivered in some certain modes of delivery such as lectures, problem sessions, and laboratory sessions. This house of quality also involves course-level assessment methods like midterm examination, project reports and presentations, quizzes and homework assignments. For the students' grades to be meaningful, faculty must integrate assessment of student achievements of course contents into the regular grading process. For instance, students who fail to meet the minimum requirements of a course should not get passing grades. In this way, a passing grade can serve as the indicator that a student has achieved the required course learning objectives defined by course contents.

The fourth house of quality in the lower part of Figure 3.3., determines the appropriate program-level (or macro) assessment tools for measuring any engineering program's success in meeting the program outcomes which are based on the constituents' needs and expectations. These assessment tools include, but is not limited to, student portfolios, including design projects; standardized examinations; alumni surveys that document professional accomplishments and career development activities; employer surveys that reflect employers' evaluation of graduates' skills and knowledge.

After building a concrete grading policy linked to contents of the course learning objectives, students must be informed about the course learning objectives, method of evaluation and grading policy by course syllabi. Therefore, students' involvement in their education process is maintained since they are the cooperators in their education process.

As an example, deployment process has been applied to "IE 423 - Quality Engineering" course offered in Boğaziçi University School of Engineering (BUSoE), Industrial Engineering Department. The course is structured on four main topics. These are: overview of quality concepts, statistical process control, off-line quality control and acceptance sampling. These four topics included ten sub-topics as seen in the Figure 3.4.

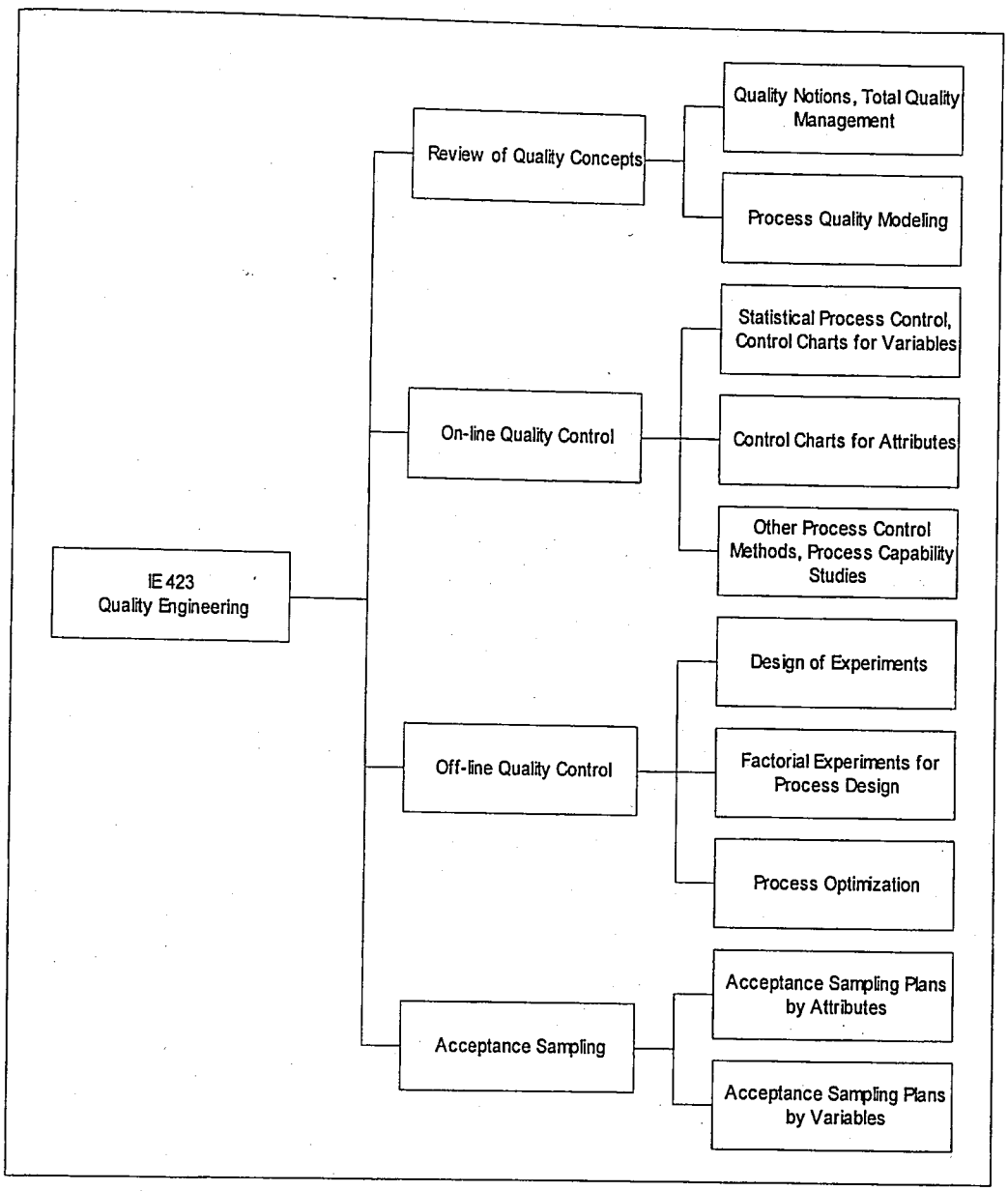

Figure 3.4. IE 423 course contents

It was assumed that IE program in this example has twelve program outcomes which included the eleven outcomes in criterion 3(a-k) and an additional outcome which was determined as "leadership ability to contribute towards the achievement of the mission and vision of future institution for long term success and implement these through appropriate actions". To determine the relation of program outcomes with the contents of the course, modes of delivery and assessment methods, the following relationship matrix has been formed.

Table 3.2. Program outcomes vs. course contents

		Course Contents										Modes of Delivery				Assessment Methods				
		1	2	3	4	5	6	7	8	9	10	Lectures	Problem Session	Software Laboratory Session	Seminars	Midterm Examination 1	Midterm Examination 2	Final Examination	Project Report and Presentation	Quizzes
Program Outcomes	a	1	4	4	4	4	4	4	4	4	4	4	4	1	1	2	3	3	4	4
	b	1	5	5	5	5	5	5	5	5	5	5	5	4	1	4	5	5	5	5
	c	3	1	1	1	1	1	1	3	1	1	1	1	1	3	2	1	1	4	2
	d	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1
	e	1	5	5	5	5	5	5	5	5	5	5	5	4	1	4	5	5	5	5
	f	2	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1
	g	1	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	1	4	1
	h	3	1	1	1	1	1	1	1	1	1	2	1	1	5	1	1	1	1	1
	i	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1
	j	2	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1
	k	1	1	3	3	3	3	3	3	3	3	1	3	5	1	1	1	1	3	1
	l	2	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	4	1

The numbers in the above table show the degree of the relation of program outcomes with course contents, modes of delivery and assessment methods. In the above table, 5 represents "very strong relationship" while 4, 3, 2 and 1 stand for "strong relationship", "medium relationship", "weak relationship" and "very weak relationship" respectively.

The relationship matrix above can be used to determine the overall contribution of this course to the achievement of program outcomes intuitively as seen in Table 3.3.

Table 3.3. IE 423 vs. program outcomes

	IE 423
a	4
b	5
c	2
d	3
e	4
f	2
g	3
h	2
i	1
j	2
k	3
l	3

The similar approaches to all courses in the curriculum reveals the relative weight of each program outcome or percentage of using each assessment method in an engineering program. The relative weights of each program outcome must be consistent with the constituents' actual needs and expectations of the program.

3.3. Integration of Balanced Scorecard with the Proposed Model

Although Balanced Scorecard (BSC) is usually implemented in private sectors, the performance of higher education institutions can also be measured and communicated by Balanced Scorecard performance measurement and strategic management system. This can be performed by determining the cause-and-effect relationships between the strategic objectives of a higher education institution derived from its vision and categorizing them under four perspectives of the Balanced Scorecard.

Next, the strategic objectives are broken down for developing the strategic objectives of each academic and administrative unit in that institution. Indicators for measuring the achievement of corporate strategies are also determined and current performance levels are measured. Finally, targets for these measures are set and they are communicated to each academic and administrative unit.

BSC can be used as a well-structured strategic tool for performing the following activities in higher education institutions context:

- To prioritise strategic initiatives,
- Communication of vision and strategic objectives to all units in higher education institutions by departmental scorecards, personal scorecards and cause-and-effect relationships,
- Upward communication of personal and departmental performance measures by using personal and departmental scorecards.

These three functions are performed in four perspectives of the BSC. Each of these perspectives have four components:

- Objectives
- Measures
- Targets
- Initiatives

The objectives in each perspective are derived by dividing the vision of the institution into measurable goals. Then, measures that indicate the achievement of these objectives are determined and targets are set for these measures. Last step is to determine the initiatives to reach these targets.

This approach may be improved by adding one more component to existing four. It is the "identification of the related processes to each strategic objective. Identification of the related process brings a "process-focus" to BSC perspectives and it creates a better understanding of how outcome measures and performance drivers are derived for measuring the achievement of strategic objectives.

A hypothetical engineering school, for example, employs 100 faculty members and it has 2000 students. Thus, the current student-faculty ratio is 2000/100 which is equal to 20. The university desires to improve this ratio to 16. Therefore, the strategic objective, related process, outcome measure, performance driver, target and initiative for this illustration can be stated as follows:

- Objective: "Improve the student-faculty interaction in and out of class."
- Outcome Measure: Student-faculty ratio
- Current level: 20
- Target: 16
- Related Process: Faculty recruitment
- Performance Driver: Time and money spent for faculty recruitment activities
- Initiative: Contact with colleagues in other universities to recruit 25 new faculty members

Outcome measures are, then, periodically checked and achievement of the objective in the example is measured. If the results are not satisfactory, faculty recruitment process is analyzed and improved in order to reach to target.

Top-down and bottom-up communication of strategic objectives and performance results in higher education institutions occur at four layers. These layers are university, engineering school, academic departments and individual faculty members.

University and engineering school levels are administrative layers in which none of the core processes (teaching, research and projects) are performed. At these layers, vision and strategic objectives of university and engineering school are determined and communicated to the academic departments.

For example, BUSoE Scorecard can include performance measures which are aggregated from the performance measures of six academic departments (Chemical Engineering, Civil Engineering, Computer Engineering, Electrical and Electronics Engineering, Industrial Engineering and Mechanical Engineering, Departments).

There will be two-way communication between academic departments and BUSoE. The vision and strategic objectives flow down to the academic departments and performance results of each department are communicated to the BUSoE and BU administration by the Balanced Scorecards of the academic departments.

The academic departments determine their own vision and strategic objectives aligned with the vision and strategic objectives of engineering schools, set by the dean and the executive committee of an engineering school.

The strategic objectives of each department are communicated to the faculty members in that department, and the performance results of faculty are collected at the department level and department performance results are found.

This whole process described above can be seen in Figure 3.5.

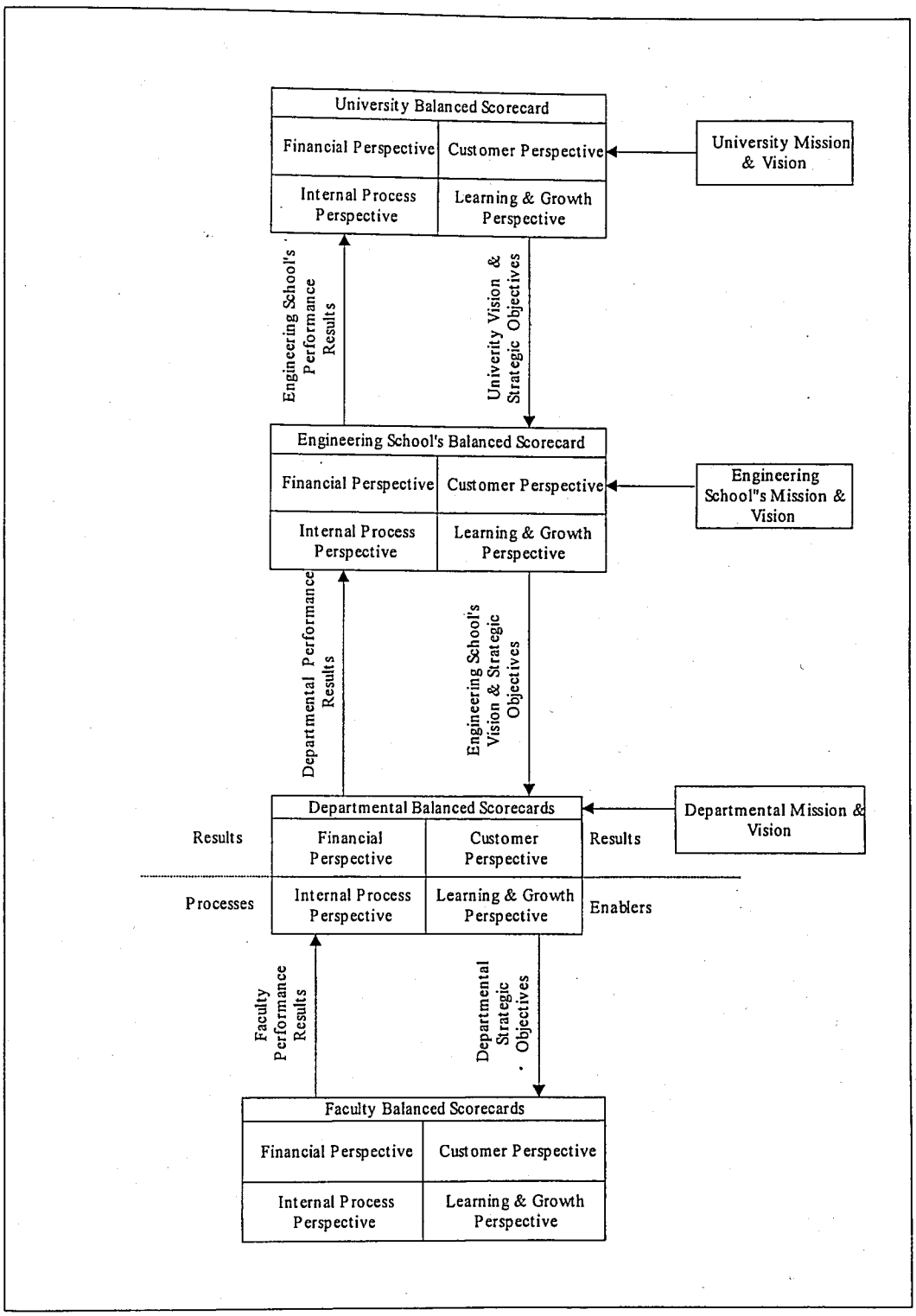

Figure 3.5. Communication with BSC in higher education institutions

Communication of strategic objectives and performance results take place under four perspectives of BSC. The four perspectives of BSC in higher education context are given in Figure 3.6.

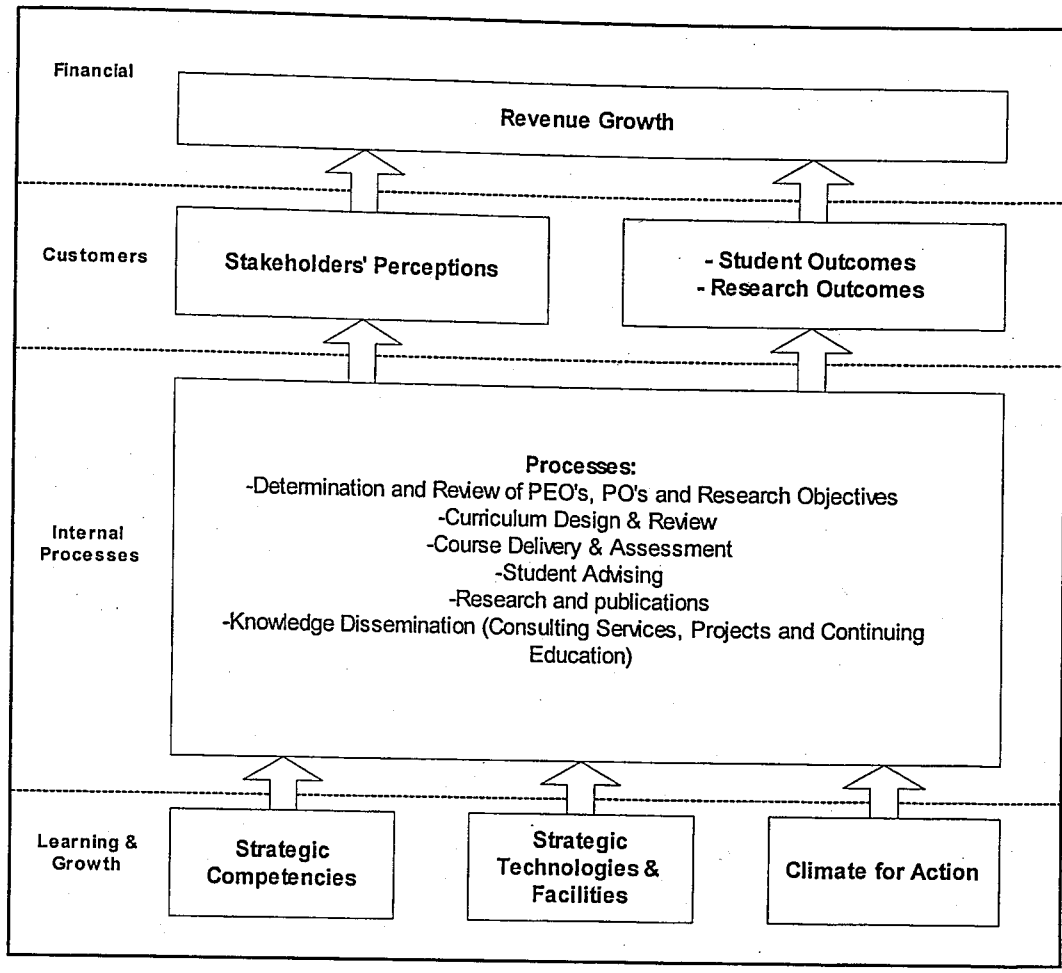

Figure 3.6. Four perspectives of BSC for higher education institutions

3.3.1. Learning and Growth Perspective

Learning and growth perspective includes the strategic competencies, technologies and facilities and climate for action. Strategic competencies in a higher education institution include strategic skills and knowledge required by the workforce to support the strategy. In the engineering education context, strategic skills and knowledge are required not only for faculty and non-academic personnel, but also for students since they carry their own skills and knowledge, which they gained through their prior education, into higher education institutions. Thus, students are co-operators of their education process. The strategic competencies of higher education institutions includes the knowledge and skills of

- Academic staff

- Students
- Technical and non-academic personnel

Faculty development through research, industry projects and other scholar activities extends the overall knowledge base in the academic departments and increase the diversity and depth of curricular areas in engineering curricula. These results in innovation and improvement in curricula and instruction methods are summarized in Figure 3.7. and Figure 3.8.

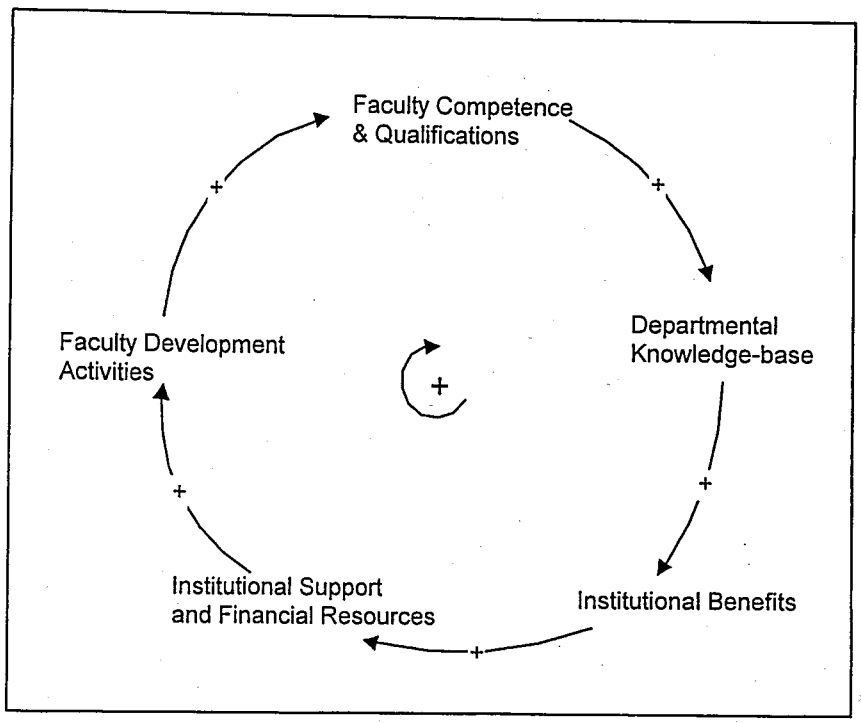

Figure 3.7. Reinforcing loop of faculty development

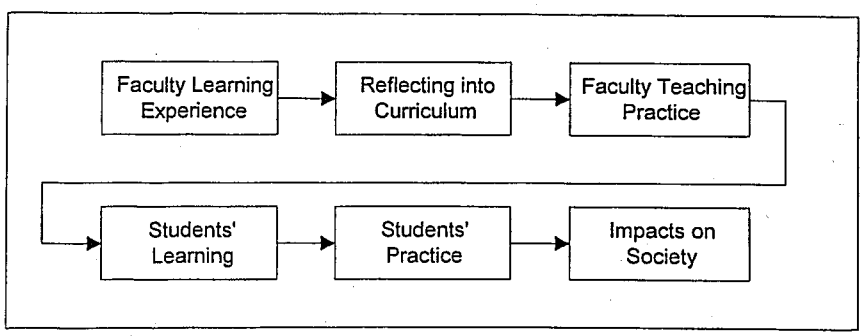

Figure 3.8. Impact of faculty development

Faculty recruitment is very important for a program in two ways. First of all, faculty recruitment increases the number of faculty members, thus decreases the work load of each faculty member. Second, faculty recruitment may bring heterogeneity into curricular areas by employing people with backgrounds different than those of the existing faculty members. In both ways, the growth of the program is maintained by increasing the strategic competencies of the academic departments as seen in Figure 3.9.

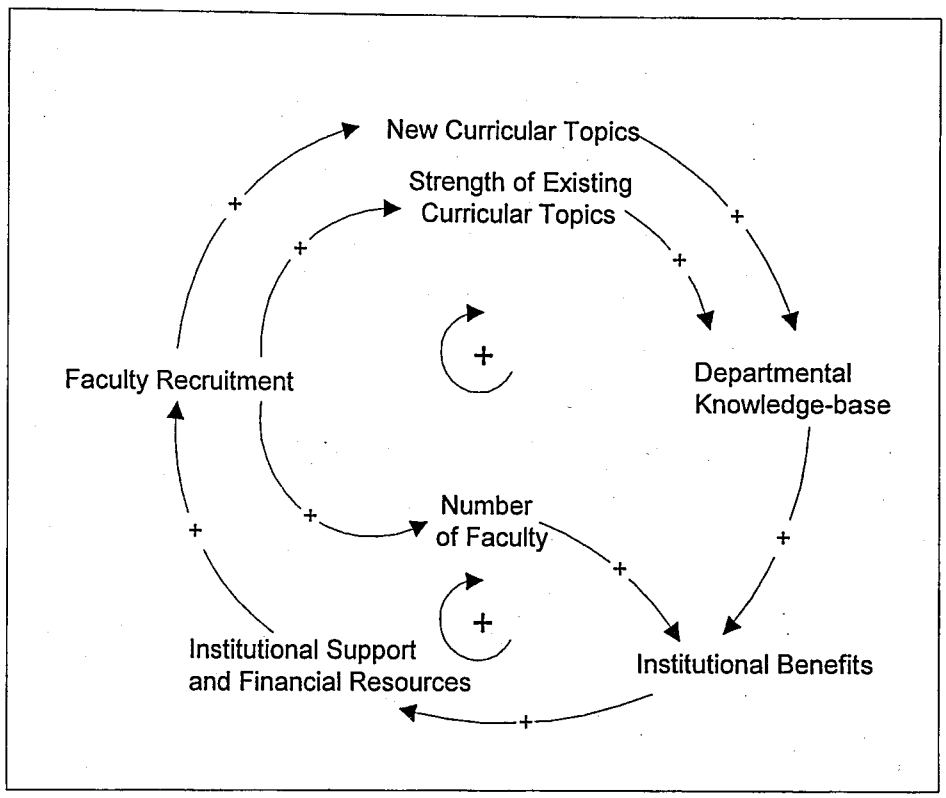

Figure 3.9. Reinforcing loop of faculty recruitment

There must be a sufficient number of t"eaching/research assistants to support the teaching and research activities of the faculty. Teaching/research assistant measures are as follows.

- Number of teaching/research assistant per faculty
- Diversity of academic backgrounds of teaching/research assistants

Recruitment of qualified graduate students, especially for Ph.D. degree, is very important for research function of engineering schools since they are employed as

research/teaching assistants and involved in research and projects with faculty. Therefore recruitment of top students in the country is important for knowledge creation.

Undergraduate student quality is very important for all teaching process since students are the co-operators in their education. They can also be thought as the raw materials supplied by the high schools. Since raw material quality is important for any process, new student quality is thus important for the teaching process. Resources spent for high quality students become more efficient and brings in high returns. High quality students can be more successful in representing an engineering school nationally an internationally by their post-graduate achievements.

Strategic technologies and facilities include the information systems, software, computer facilities, educational and research laboratories, libraries, classrooms, offices and other facilities and physical infrastructure required to support teaching, research and administrative processes of engineering schools.

Climate for action involves the cultural shifts needed to motivate, empower, and align the workforce behind the strategy. In academic environment, it involves faculty and administrative staff satisfaction and motivation.

3.3.2. Internal Process Perspective

Internal processes are the processes that the organization must excel to achieve its mission. There are three core processes that are performed by the higher education institutions. These processes are:

- Education
- Knowledge Creation
- Knowledge Dissemination
- Student Advising

Education is the process of preparing individuals for their professional or academic career. Advising and career mentoring are support processes that also affect the post-graduation achievements of the students in higher education institutions.

Knowledge creation is performed through research and communicated to industry through continuing education, consulting activities, seminars and conferences.

3.3.3. Customer Perspective

Customer perspective involves the post-graduation achievements of the graduates, their satisfaction with their education and satisfaction levels of other constituent with the quality of education and professional performance of the graduates.

The performance indicators in the customer perspective can be grouped in three main categories:

- Graduate characteristics and satisfaction level of constituencies
- Stakeholder satisfaction level research/project output quality
- Public service recipients' satisfaction level

3.3.4. Financial Perspective

Success for government and not-for-profit organizations should be measured by how effectively and efficiently they meet the needs for customers and constituencies. Tangible objectives must be defined for customers and constituencies.

Financial considerations can play an enabling or constraining role, but will rarely be the primary objective. Therefore the customer, internal processes and growth side of these objectives gain more importance.

For engineering schools, financial goal may be to increase the revenues of the engineering school where the revenues include research grants, endowments, and income from graduate programs for professionals.

Based on the four perspectives of the BSC, a detailed generic strategy map and a list of the departmental performance measures are arranged in the Balanced Scorecard's four perspectives have been formed as seen in Figure 3.10. and Table 3.4. – Table 3.7.

These performance measures are driven from cause-and-effect relationship given by the generic strategy map in Figure 3.10 Each arrow in the strategy map represents a hypothesis which should be tested.

The strategy map and list of performance measures are adaptive and iterative tools that will evolve as data accumulate over time and as hypotheses become testable. Testing of the hypotheses may reduce the number of strategic objectives, their causal relations and number of performance measures over time.

Next step is to determine the strategic objectives which have higher priority than the others. These objectives are determined by a performance analysis using the historical data from processes and specifically gathered subjective data from the stakeholders.

After these activities, the number of strategic objectives and corresponding performance measures in Balanced Scorecard of the academic departments is reduced; and targets are set for those measures of strategic objectives in the Balanced Scorecard and initiatives required to reach those targets are determined.

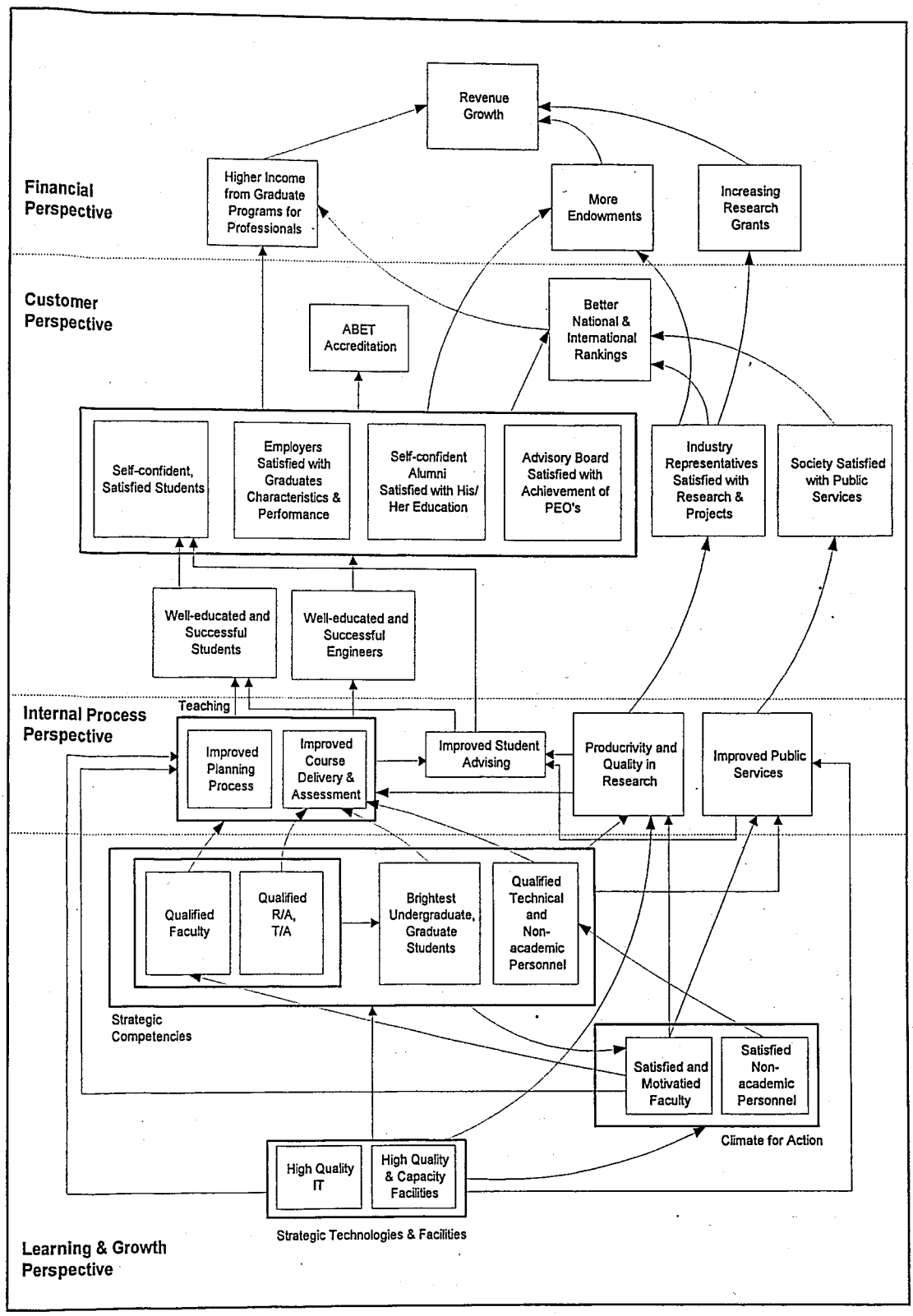

Figure 3.10. Generic strategy map for academic departments

Table 3.4. Learning and growth performance measures

Objective		Measure
Build sufficient and high quality faculty inventory by faculty development and recruitment	Faculty Inventory	Student-faculty ratio
		Credit hrs. per faculty
		Rank distribution of the faculty
		Academic age of faculty (in years)
		Residence time of faculty in engineering school (in years)
		Diversity of academic background of the faculty
		Industrial or professional experience (in years)
		Memberships to professional and scientific societies
	Faculty Development	Seminars and conferences attended by faculty
		Money spent per faculty for attending to conferences and seminars (travel money, seminar fees, etc.)
	Faculty Recruitment	Number of faculty members recruited
		Diversity of academic backgrounds of faculty members recruited
		Time and money spent for faculty and recruitment
Build sufficient and high quality teaching/research assistant staff by teaching/research assistant development and recruitment	Teaching/Research Assistant Inventory	Number of teaching/research assistant per faculty
		Diversity of academic backgrounds of teaching/research assistants
	Teaching/Research Assistant Development	Degrees completed
		Presentations at conferences and seminars
		Seminars, conferences attended
		Teaching/research assistants involved in research and projects
		Time distribution of teaching/research assistants for a) Teaching b) Research c) Own degree studies
		Money spent per teaching/research assistant for attending to conferences and seminars (travel money, seminar fees)
	Teaching/Research Assistant Recruitment	Number of teaching/research assistant recruited
		Diversity of academic backgrounds of teaching/research assistants recruited
		Time and money spent for teaching/research assistant recruitment
Recruit best graduate students		Number of graduate students a) M.S b) Ph.D.
		Number of students accepted for graduate studies / Number of applications a) M.S b) Ph.D.
		Quality of academic backgrounds of graduate students recruited: a) Profiles of universities awarding the B.S. degrees b) Undergraduate GPA scores of entering graduate students c) GRE scores d) TOEFL scores e) LES scores
		Time and money spent for attracting graduate students
Develop the existing graduate students		Number of graduate students involved in research and projects with faculty
		Cost per graduate student

Table 3.4. Learning and growth performance measures (continued)

Objective	Measure
Recruit best undergraduate students	Number of undergraduate students
	SPE score statistics of entering freshman
	English Proficiency and/or TOEFL scores of entering freshman
	Percentage of entering freshman whose first choice was that department
	Ranks of the new students in SPE
	Promotion and advertising expenses for attracting high school graduates
	Time spent for promotion activities (in man-hours)
Recruit best transfer students	Number and percentage of transfer students
	English Proficiency and/or TOEFL scores of the entering transfer students
	GPA scores of entering transfer students
Recruit and develop best technical and non-academic personnel	Number of technical and non-academic personnel recruited
	Time and money spent for recruitment development of technical non-academic personnel
Improve the IT and physical infrastructure	Total expenditures for maintenance and improvement of a) information technologies b) educational and research laboratories c) library d) physical infrastructure e) instructional technologies
	Total usable area
	Number of computers per student
	Internet speed and availability
	Number and total area of a) classrooms b) computer laboratories c) educational and research laboratories d) offices
	Number of each type of instructional tools and devices (data projectors, overhead projectors)
	Total number of books available in the library
	Number of books and periodicals related to program and related disciplines available in the library
	Number of electronic databases available in the library
Motivated and satisfied faculty and non-academic personnel	Average academic and non-academic staff income level
	Rewards (monetary and non-monetary) given to faculty for a) teaching b) research c) industry consulting d) institutional service
	Rewards (monetary and non-monetary) given to non-academic staff
	Percentage of academic and non-academic staff suggestions realized by administration
	Academic and non-academic staff satisfaction level

Table 3.5. Internal process performance measures

Objective		Measure
Improve all teaching processes to meet the accreditation requirements and satisfy the needs and expectations of constituents	Program design	Number of programs (undergraduate and graduate) offered
		Number of courses offered per semester in a) Undergraduate programs b) Graduate programs
		Total number of credits
		Number of credits of a) mathematics and basic science courses b) engineering courses c) general education courses d) engineering courses containing design
		Number and duration of summer training
		Offering frequency of required courses
		Relative weights of program outcomes
		Frequency of a) meetings with advisory board for PEO's b) employer surveys c) alumni surveys d) student surveys about their achievement of PO's
		Number of faculty hours spent for curriculum design
		Number of revisions in curriculum a) Undergraduate programs b) Graduate programs
	Course delivery and graduation	Residence times in a) Undergraduate degree b) M.S. degree c) Ph.D. degree
		GPA statistics
		Percentage of teaching a) in class b) in laboratories c) by site-visits d) other
		Percentage of time per faculty for b) undergraduate teaching c) graduate teaching
		Class size (as number of students) statistics
		Percentage of time spent for office hours
Improve research processes and research outputs		Number of research and projects (ongoing and completed)
		Total number and frequency of scholarly products (annually) a) Books b) Papers c) Presentations at conferences and seminars
		Percentage of faculty, research assistants who are a) involved in research b) engaged with industry and other institutions for research
		Scope of research performed in the department
		Number of thesis (ongoing and completed)
		Durations of research and projects
		Cost per publication

Table 3.5. Internal process performance measures (continued)

Objective	Measure
Improve research processes and research outputs	Research expenditure per faculty
	Percentage of time per faculty for a) research and projects b) industry consulting activities
Improve student advising process	Average percentage of faculty time for advising
Improve the public services of engineering school	Number of public service activities attended or organized by the department
	Total faculty time spent for public service
	Total financial expenditures for attending or organizing public services

Table 3.6. Customer perspective performance measures

Objective	Measure
Improve student achievements	Time-to-employment after graduation
	Starting salaries of graduates
	Profiles, and quality of recruiters of graduates
	Percentage of graduates who has a position related to completed program
	GRE, GMAT scores of new graduates
Improve the satisfaction level of all constituents with graduates' skills and knowledge	Students' (undergraduate and graduate) self-evaluation of achievement of program outcomes
	Alumni's self-evaluation of achievement of program outcomes and career plans
	Employers' satisfaction level with graduates
	Student's (undergraduate and graduate) satisfaction level with the quality and quantity of resources, services provided and academic environment
	Alumni satisfaction level with the quality and quantity of resources, services provided and academic environment
	Advisory board satisfaction with the achievement of PEO's
	Graduates who prefer further education
Improve overall reputation of department	National and international ranking of department
Improve the relations with industry for research, projects and consulting, and improve their satisfaction level	Number of companies and other external organizations collaborated for research or projects
	Range of industries accessing research outputs
	National and international awards received per faculty for a) Research b) Consulting services
	Impact factors of publications by type (books, papers, proceedings, etc.)
	Immediacy indices of publications by type (books, papers, proceedings, etc.)
	Cited half-lives of publications by type (books, papers, proceedings, etc.)
	Project sponsor or industry's satisfaction with Research/project outputs and consulting services
Improve public service outputs and society satisfaction level with public services	Public service recipients' satisfaction level.

Table 3.7. Financial performance measures

Objective	Measure
Increase the revenues of the department	Total budget of the department
	Proportion of funding from new areas
	Research grants by sources
	Income from graduate programs for professionals
	Endowments

"Academic age of the faculty" proposed in Table 3.4. is the time passed up to the current year since completion of the Ph.D. degree. It reflects the maturity level of the faculty. Percentage of young faculty members is a crucial indicator to have a sustainable competitive advantage.

Research competence are measured with three indicators in Table 3.6, named as impact factor, immediacy index and cited half-life which are created by Institute of Scientific Information (ISI). Impact factor is calculated by dividing the number of current citations a publication receives in the two previous years by the number of publications in the same years. Immediacy index is calculated by dividing the citations a publication receives in the current year by the number of publications in that year. The cited half-life is the number of years that the number of current citations takes to decline to 50 per cent of its initial value. It is a measure of how long articles in a journal continue to be cited after publication.

3.4. Chapter Summary

In this chapter, a quality model for engineering schools has been developed. The proposed model, which has an institutional scope, was built by restructuring EFQM Excellence Model for engineering schools and integrating with Balanced Scorecard management system as a strategic deployment and performance measurement tool.

The reason for integrating BSC in the model is its concrete structure for communicating the vision and strategic objectives of engineering schools by the help of strategy maps and its explication of accountabilities of people by departmental scorecards and personal scorecards. The cause-and-effect relationships can be very beneficial for people to understand their role in the achievement of strategic objectives and vision and

personal scorecards can be a structured method for measuring individual performances of the academic and administrative staff.

EAC 2000 is employed at operational level instead of strategic processes in the engineering schools because of its specific focus on engineering education issues. In the proposed model, EAC 2000 is used for the deployment of constituents' needs and expectations into course learning objectives.

4. PERFORMANCE ANALYSIS IN BOĞAZİÇİ UNIVERSITY SCHOOL OF ENGINEERING

After developing a quality model with BSC performance measurement system, next step is to determine the strategic objectives which have higher priority than the others. These objectives are determined by a performance analysis using the historical data from processes and specifically gathered subjective data from the constituents. This will identify the critical strategic objectives for the achievement of vision. Thus, a subset of generic strategic objectives and corresponding performance measures in Table 3.4. – Table 3.7. are tracked over time and the Balanced Scorecards of academic departments are reduced to contain a few performance measures. After this step, targets are set for those measures with higher priorities and initiatives required to reach those targets are determined.

In this chapter, the results of two surveys designed specifically to measure the performance of BUSoE based on perceptions of BUSoE 2001 graduates and faculty members are analyzed. These surveys are involved in the "results" component of the proposed model described in Chapter 3, and these results are to be used for improvement of the components of the model.

Another results component analyzed in this chapter is about the BUSoE graduates in the industry which is based on the data about graduates of years 1972 to 2001. These results are crucial for identifying the sectors which BUSoE's educational processes are serving and determining the program objectives based on the needs and expectations of these sectors from BUSoE graduates.

Also analyzed in this chapter is the determination of the faculty profile in BUSoE since faculty is the major resource of a higher education institution and which is very difficult to recruit and retain. The measures of faculty diversity in BUSoE constitute an example for the "resources" component in the proposed model.

4.1. Academic Staff Measures

BUSoE currently employs 47 professors, 28 associate professors, 12 assistant professors and 8 instructors in full-time status. In part-time status, BUSoE employs 7 professors, 1 associate professor, 4 assistant professors and 7 instructors. The total number of faculty in part-time status is 19 and the number of full-time faculty is 95. Thus, the total number of academic staff is 114 by January, 2002. The distribution of the full-time faculty by rank is as shown in Figure 4.1. 50 per cent of the academic staff is composed of professors and 8 per cent is instructors.

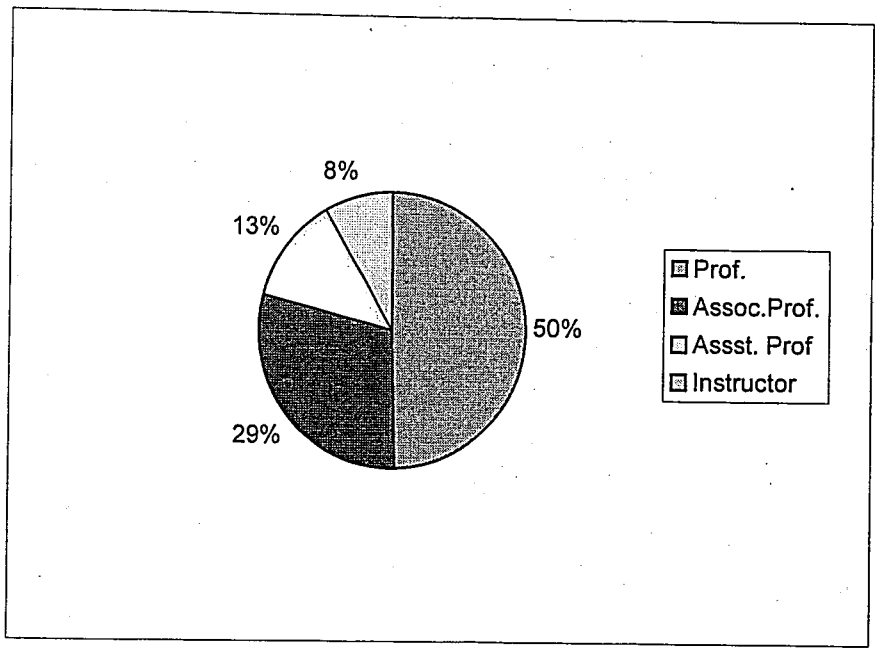

Figure 4.1. Rank distribution of full-time faculty by January 2002

4.1.1. Academic Age of Full-time Faculty

Academic age is the time passed up to the current year since completion of the Ph.D. degree. Figure 4.2. shows the academic staff categorized in nine ranges of academic age. According to this figure, full-time faculty at academic age of 10-14 years has the highest density. Then, faculty with academic age of 15-19 years, 5-9 years, 20-24 years follow. Number of full-time faculty with academic age of 1-4 years is only three.

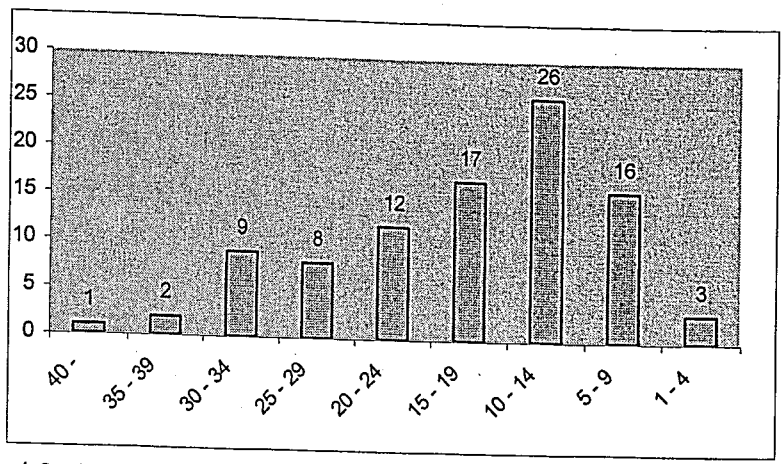

Figure 4.2. Academic age distribution of full-time faculty by January 2002

4.1.2. Residence Time of Full-time Faculty in BUSoE

Table 4.1. shows the statistics about the residence time of full-time faculty in BUSoE. According to this table, mean residence time is approximately 14 years. This measure shows the loyalty of academic staff and it may be an indicator of the satisfaction level of full-time faculty despite the low salary levels.

Table 4.1. Residence time of full-time faculty in BUSoE

Statistics	Years
Mean	13,97
Median	12
Standard Deviation	9,55
Maximum	46
Minimum	1

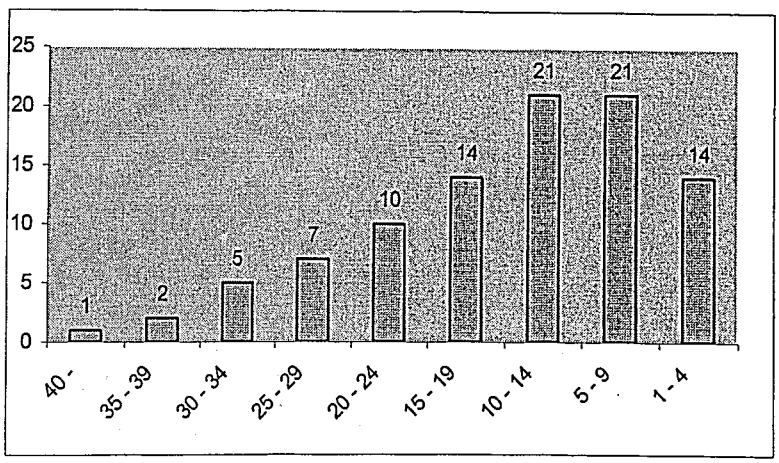

Figure 4.3. Residence time of full-time faculty in BUSoE (January 2002)

Figure 4.3. shows the residence time of full-time faculty. By January 2002, the employment duration of 10-14 years and 5-9 years have the highest density and then 1-4 years and an 15-19 years follow. There is one faculty working for 46 years in BUSoE, which is an extreme case, as seen in the Figure 4.3. More statistics about faculty are available in Appendix B.

4.2. BUSoE Graduates in Industry

One of the most important measures in the proposed model is the profile of the sectors that BUSoE graduates are employed. This measure is in the results component since it is related to the quality of the education that the students receive at BUSoE.

In order to measure the success of the BUSoE graduates in industry, employment data of the graduates of 1972 to 2001 have been collected. Data of 1675 graduates have been used in this study which included the name of the graduates, year of the graduation, name of the companies they are currently employed, and their position. For the period 1972 to 2001, 7238 students have graduated from BUSoE. Therefore, a sampling rate of 23.14 has been obtained. The graduates have been categorized according to the sectors they are employed. The sectors recruiting the most of BUSoE graduates are reflected in Figure 4.4.

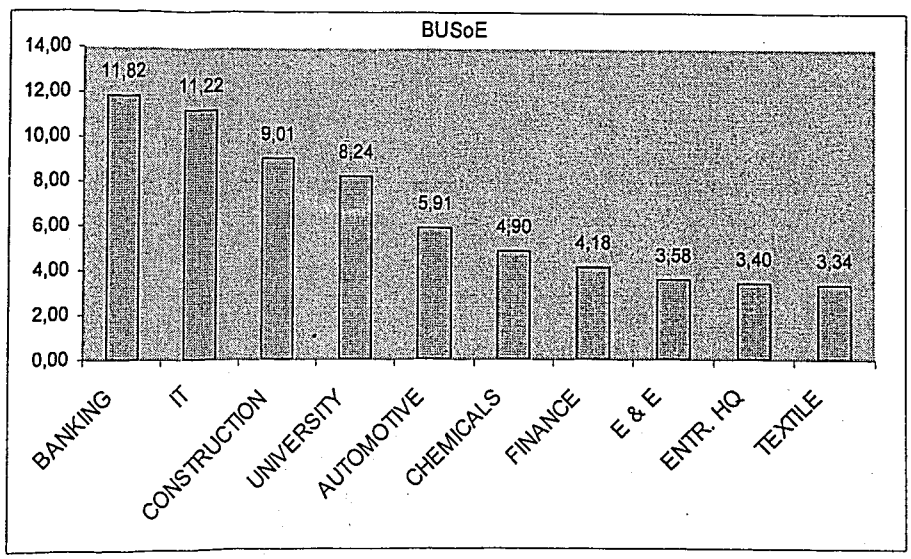

Figure 4.4. BUSoE graduates by sectors

Table 4.2. Spectrum of fields

Sector	ChE	CE	CmpE	EE	IE	ME	TOTAL
AEROSPACE						1	1
AUTOMOTIVE	4	4	4	6	17	65	100
BANKING	17	49	31	31	37	34	199
CHEMICALS	40	10	5	2	10	15	82
CONSTRUCTION	10	82	12	6	16	25	151
CONSULTING	12	4	11	2	6	10	45
CONSUMER GOODS	6	7		3	14	13	43
ELECTRICS & ELECTRONICS	6	5	4	13	19	13	60
EDUCATION			1	2	4	1	8
ENERGY	1	1		1	1	3	7
ENGINEERING DESIGN	7	15	5	3	11	14	55
FINANCE	6	11	5	13	22	14	71
FOOD & BEVERAGES	10	6	2	2	7	7	34
FOOD & RETAILING		1		1			2
FOREIGN TRADE	4	2	4	4	16	5	35
GLASSWARE		1	4	7	2		14
HEALTH				2			2
ENTERPRISE HEADQUARTERS	9	7	8	3	19	11	57
HOUSEHOLD APPLIANCES	4	2	6	10	12	12	46
INSURANCE	2	8	4		5	5	24
IT	7	14	48	44	39	38	190
JEWELLERY		1					1
LABORATORY				1			1
LABORATORY SUPPLIES						1	1
MACHINERY & EQUIPMENT	2	2	2	6	5	16	33
MEDIA	3	1			1	2	7
MEDICAL SUPPLIES	6			2	3	4	15
MEDICINE	21	1		5	8	2	37
METAL AND METAL PRODUCTS	3	5	1		9	3	21
MINING			1			1	2
PACKAGE	1	1		1	1	1	5
PAPER AND PAPER PRODUCTS	1		1	1	2	2	7
PETROLEUM	5	4			3	11	23
PLASTICS	3	1			7	7	18
PRINTING & PUBLISHING		1	3	3	4	3	14
TELECOMMUNICATION	4	2	4	25	6	4	45
TEXTILE, GARMENT & LEATHER	12	10	1	2	11	20	56
TOBACCO PRODUCTS			1		3	2	6
TOURISM	2	2	1	3	7	4	19
TRANSPORTATION		3	1	1		1	6
UNIVERSITY	34	28	18	28	17	13	138
WOODEN PRODUCTS & FURNITURE				2		1	3
TOTAL	242	291	188	235	344	384	1675

According to Figure 4.4., first five sectors employing the BUSoE graduates are ranked as follows:

- Banking
- Information Technologies
- Construction and Construction Supplies
- University
- Automotive

The graduates were further categorized according to their departments as seen in Table 4.2. and Appendix C and the following results were obtained.

According to Table 4.2. and Appendix C, 23.53 per cent of the CmpE graduates are employed in IT sector which is the most related sector with their education. Banking is the second sector that employs most of the CmpE graduates and third sector is university.

EE graduates are also employed at sectors relevant to their field of education. They are mostly employed at IT, banking, telecommunication and university.

28.18 per cent of the CE graduates are employed in construction sector. Banking, university and engineering sectors follow construction sector by 16.84 per cent, 9.62 per cent, and 5.15 per cent respectively. CE is the department which has the highest percentage of graduates employed in engineering design sector.

The first three sectors employing ME graduates are automotive, IT, and banking. Automotive sector is dominant over the other sectors by a significant difference in employment percentages.

16.53 per cent of the ChE graduates are employed in chemical industry which is the most related sector with their field of education. University and medicine are second and third sectors employing ChE graduates.

IE graduates are employed in highly diversified sectors since IE is an interdisciplinary field. Most of the IE graduates are employed at IT, banking, enterprise headquarters, automotive and, electrics and electronics sectors.

4.3. Faculty Satisfaction Survey

In December 2001, a faculty satisfaction survey has been carried in the SoE. Number of respondents by departments was given in Table 4.3.

Table 4.3. Respondents by departments

Department	Number of Respondents
ME	14
EE	14
IE	11
CmpE	11
ChE	11
CE	9
Total	70

Faculty satisfaction is included in the "results" component of the proposed model. Results will be analyzed at BUSoE level. However, it is also possible to analyze the responses at the departmental level. Then, the results obtained for each of six academic departments will be placed in the Balanced Scorecard of each department.

The survey tool, as seen in Appendix D, consisted of five parts:

- Resources and services
- Academic environment
- Use of time
- Overall satisfaction
- Personal information

For the first two parts, faculty members were asked to assess the items includes in these parts by five-point Likert scale, and they were also asked to express the importance of those items. Importance of items in resources and services were expressed in five-point Likert scale. Importance of factors affecting the academic environment were measured by ranking the most important ten items among the given 29 items where the item in the first order was the most important factor and the item in the tenth order was the least important

factor. While analyzing this part, the order of the items were converted to points where the item in the first order received ten points and the item in the tenth order received one point. In the third part, faculty members were asked to divide their time among the activities they currently perform. Also they were asked to show their ideal use of time. There was an overall satisfaction question for which faculty members were expected to answer by considering all of their experience in BUSoE. The average of the responses for this question was 3.51 out of five. This value represents the average overall satisfaction level of faculty members in six academic departments of BUSoE.

Table 4.4. Assessment of resources and services

	Assessment scale: 5 = "excellent", 1 = "poor"	SoE	ME	EE	IE	CmpE	ChE	CE
1	Cultural activities	4,00	3,92	3,90	4,10	3,82	4,10	4,22
2	Bookstore services and products	3,81	3,71	3,79	4,00	4,00	3,73	3,67
3	Library's hours of operation	3,63	3,57	3,08	3,56	4,20	3,60	3,78
4	Library's electronic services	3,60	3,43	3,79	3,82	3,50	3,45	3,75
5	Computer laboratories	3,49	3,77	3,92	3,09	3,09	3,11	3,86
6	Campus health services (BU Infirmary)	3,47	3,50	3,36	3,89	3,30	3,11	3,71
7	Sports facilities	3,44	3,00	3,67	3,33	3,50	3,38	3,60
8	Personal safety on the BU campus	3,30	3,69	3,14	3,90	3,10	2,40	3,75
9	Offices	3,26	3,54	2,86	4,18	3,00	2,73	3,33
10	Print services	3,23	3,00	3,22	3,63	3,57	3,20	2,50
11	Instructional technologies (data projector, overhead etc.)	3,22	4,00	2,31	3,91	2,18	3,45	3,67
12	Research laboratories	3,20	2,33	3,31	3,60	2,70	3,91	3,22
13	Educational laboratories	3,19	3,00	3,08	3,43	3,00	3,44	3,44
14	Library's periodicals collection	3,09	2,93	3,15	3,45	3,00	2,82	3,11
15	Transportation in between campus	3,09	3,44	2,89	3,43	3,13	2,78	2,67
16	Library's book collection	3,03	2,93	3,21	2,91	2,90	3,00	3,33
17	Classrooms	3,03	3,57	2,54	3,73	2,18	2,91	3,33
18	Administrative personnel	2,98	3,00	2,46	3,13	2,80	3,10	3,44
19	Internet service quality (availability and speed)	2,86	3,00	2,29	2,91	2,82	3,27	3,00
20	Campus maintenance and repair services	2,79	2,92	2,31	3,18	2,64	2,73	2,88
21	Buildings (heating, appearance, condition, and etc.)	2,71	3,14	2,07	3,09	2,55	2,45	2,89
22	Campus food services (dining hall, canteen)	2,70	3,42	1,93	3,60	2,60	1,78	3,50
23	Building supervisor and janitors	2,63	2,85	2,43	3,33	2,00	2,27	3,25
24	Parking space	2,44	2,50	2,57	2,67	2,56	2,09	2,22
25	Faculty housing services	2,14	2,33	1,71	3,20	1,67	1,80	2,20

According to the analysis of results relevant to assessment of resources and services of BUSoE, Table 4.4. was obtained by sorting the items in descending order according to the results in SoE column since the results are analyzed for BUSoE as a whole. According to this table, cultural activities, bookstore services and products, library's hours of operation and electronic services, and computer laboratories were the items that faculty

members were most satisfied with. The least satisfactory (having an average below 3.0) items were faculty housing services, parking space, building supervisor and janitors, buildings, campus maintenance services, Internet service quality, and administrative personnel.

As mentioned before, the importance of each item in resources and services section was also asked. As a result of the analysis, Table 4.5. was obtained by sorting the items according to their importance in the BUSoE level.

Table 4.5. Importance levels of resources and services

	LEVEL OF IMPORTANCE	SoE	ME	EE	IE	CmpE	ChE	CE
1	Library's periodicals collection	4,63	4,86	4,50	4,36	5,00	5,00	3,89
2	Internet service quality (availability and speed)	4,60	4,64	4,64	4,64	4,82	4,78	3,89
3	Computer Laboratories	4,58	4,64	4,71	4,55	4,55	4,75	4,25
4	Research laboratories	4,56	4,64	4,64	4,30	4,91	5,00	3,78
5	Library's electronic services	4,48	4,64	4,50	4,36	4,64	4,56	3,88
6	Educational laboratories	4,31	4,29	4,79	4,00	4,36	4,50	3,78
7	Library's book collection	4,31	4,29	4,50	4,36	4,73	4,11	3,56
8	Faculty housing services	4,26	4,54	4,09	4,38	4,00	4,29	4,14
9	Administrative personnel	4,19	4,38	4,09	4,38	4,09	4,38	3,89
10	Classrooms	4,15	4,14	4,23	4,00	4,36	4,33	3,67
11	Campus health services (BU Infirmary)	4,08	4,21	4,25	3,40	4,27	4,56	3,67
12	Personal safety on the BU campus	4,08	4,57	4,08	3,18	4,18	4,44	3,78
13	Offices	4,05	4,23	4,23	3,64	4,27	4,11	3,67
14	Instructional technologies (data projector, overhead)	4,00	4,21	4,00	3,45	4,18	4,44	3,56
15	Buildings (heating, appearance, condition, and etc.)	3,98	4,00	4,08	3,82	4,36	3,89	3,67
16	Hours of Operation	3,91	4,08	4,14	3,40	4,09	3,89	3,67
17	Building supervisor and janitors	3,90	4,17	3,77	3,67	3,73	4,56	3,38
18	Campus maintenance and repair services	3,87	4,15	3,64	3,55	4,00	4,38	3,50
19	Bookstore services and products	3,84	3,93	3,92	3,10	4,27	4,22	3,33
20	Cultural activities	3,76	3,92	3,58	3,90	3,73	3,78	3,44
21	Campus food services (dining hall, canteen)	3,63	3,86	4,15	2,80	3,82	3,78	2,86
22	Parking space	3,44	4,14	3,77	2,82	2,82	3,67	3,00
23	Sports Facilities	3,34	3,67	3,55	3,38	3,18	3,00	2,86
24	Print services	3,18	3,14	2,92	2,89	3,64	2,86	3,56
25	Transportation in between campus	3,14	3,31	3,50	2,44	3,70	2,67	2,88

As seen in this table, the most important items (which has 4.00 points or above) by descending level of importance are as follows:

- Library's periodicals collection
- Internet service quality (availability and speed)

- Computer Laboratories
- Research laboratories
- Library's electronic services
- Educational laboratories
- Library's book collection
- Faculty housing services
- Administrative personnel
- Classrooms
- Campus health services (BU Infirmary)
- Personal safety on the BU campus
- Offices
- Instructional technologies (data projector, overhead etc.)

In the second part of the survey, respondents were asked to express their opinions about the academic environment in the BUSoE in five-point Likert scale, where 1 represents "poor" and 5 represents "excellent". The results were summarized in Table 4.6.

Table 4.6. Assessment of academic environment

	ACADEMIC ENVIRONMENT	SoE	ME	EE	IE	CmpE	ChE	CE
1	Undergraduate student quality	4,52	4,64	4,64	4,82	4,45	4,36	4,00
2	Your relations with the administration at department level	4,40	4,08	4,79	4,70	4,18	4,73	3,78
3	Academic freedom in BUSoE	4,34	4,50	4,14	4,60	4,18	4,55	4,11
4	Quality of your department's curriculum at undergraduate program level	4,22	4,43	4,14	4,64	3,91	4,18	3,89
5	Your relations with the administrative personnel at department level	4,12	3,93	4,21	4,64	3,64	4,45	3,78
6	Competence of faculty in your department	4,06	3,86	4,00	4,55	3,91	4,09	4,00
7	Your relations with the administrative personnel at SoE level	4,03	4,14	4,07	4,36	3,55	4,09	3,89
8	The reputation of BUSoE nationally	4,03	4,21	4,07	4,20	3,64	4,18	3,89
9	Effectiveness of information flow at department level	3,88	3,79	4,23	3,90	4,00	3,64	3,56
10	Diversity of fields of interest in your department	3,86	3,79	3,93	4,00	3,91	3,82	3,67
11	Your relations with the faculty	3,85	3,93	4,00	3,73	3,73	3,80	3,89
12	Your relations with the administration at SoE level	3,81	3,86	4,21	4,30	2,73	4,00	3,67
13	Quality of your department's curriculum at M.S. program level	3,78	3,64	3,93	3,82	3,82	4,00	3,33

Table 4.6. Assessment of academic environment (continued)

	ACADEMIC ENVIRONMENT	SoE	ME	EE	IE	CmpE	ChE	CE
14	Your department's interest in recent progresses in engineering and science	3,78	3,50	3,93	3,91	3,73	4,09	3,56
15	Students' respect to faculty	3,74	3,57	3,86	3,91	3,82	3,55	3,78
16	Research support: BU Research fund	3,74	3,43	3,36	4,30	3,36	4,27	3,89
17	Institutional autonomy of BUSoE	3,68	4,29	3,42	3,89	3,09	3,44	3,89
18	Your relations with the administration at university level	3,58	3,64	3,86	3,73	2,64	3,91	3,67
19	Your relations with the administrative personnel at university level	3,57	3,57	3,50	3,55	3,18	3,80	3,89
20	Quality of your department's curriculum at doctoral level	3,55	3,14	3,64	3,27	3,82	3,91	3,44
21	The reputation of BUSoE internationally	3,50	3,43	3,50	4,00	2,64	3,73	3,78
22	Respect and interest of faculty to their job	3,49	3,50	3,14	3,73	3,27	4,00	3,33
23	Quality of research in your department	3,49	2,93	3,43	3,73	3,55	4,00	3,33
24	Graduate student quality	3,40	2,93	2,92	3,18	4,00	4,09	3,56
25	Research assistant support in your department	3,38	3,14	3,21	4,00	3,45	3,09	3,44
26	Effectiveness of information flow at SoE level	3,34	3,57	3,23	3,60	2,64	3,36	3,67
27	Secretarial services in your department	3,26	2,79	3,21	3,82	3,09	3,73	2,89
28	The clarity of objectives and plans in your department in short run (1-2 years)	3,21	3,86	3,15	3,45	3,18	2,55	2,67
29	Effectiveness of information flow at university level	3,13	3,43	2,92	3,30	2,36	3,18	3,67
30	Rewards and recognition for research and scholarly activity	3,12	3,08	2,86	3,55	3,09	3,45	2,38
31	Class sizes (as number of students)	3,10	3,43	3,43	3,00	2,82	2,27	3,43
32	The clarity of objectives and plans in your department in medium run (3-5 years)	2,99	3,79	2,92	3,00	2,91	2,36	2,44
33	The use of time for research and projects	2,88	2,93	2,31	3,18	3,09	3,00	2,78
34	Collaboration among your colleagues for projects and research	2,78	2,50	2,86	2,73	2,64	3,18	2,78
35	Research support: State Planning Organization	2,71	2,69	2,46	2,90	2,56	3,57	2,13
36	Research support: TUBITAK	2,64	2,00	3,00	2,80	2,90	2,00	3,11
37	Technical personnel support in your department	2,48	1,64	2,50	2,64	2,36	3,09	2,78
38	Industrial relations of your department	2,32	1,93	2,43	2,82	2,27	1,36	3,63
39	Rewards and recognition for teaching	2,32	2,46	2,15	2,45	2,27	1,91	2,63
40	Rewards and recognition for institutional service	2,03	1,92	1,92	2,00	2,09	2,00	2,25
41	Research support: International support	1,87	1,23	2,08	2,20	1,80	2,00	2,00
42	Research support: Industry support	1,83	1,38	2,08	2,10	1,90	1,14	2,38

Table 4.6. reveals that undergraduate student quality, relations with the administration at department level, academic freedom in BUSoE, quality of department's curriculum at undergraduate program level, relations with the administrative personnel at department level, competence of faculty in the department, relations with the administrative personnel at BUSoE level, and the reputation of BUSoE nationally are the items that faculty members evaluate as close to excellent.

According to Table 4.6., industry and international support for research, rewards and recognition for institutional service and teaching, technical personnel support in the department, TUBITAK and State Planning Organization support for research, collaboration among colleagues for projects and research, the use of time for research and projects, and the clarity of objectives and plans in your department in medium run (3-5 years) are the items that faculty members evaluate as "poor".

Table 4.7. Importance ranking of factors affecting academic environment

	Order of Importance (1st Order = 10 Points, 10th Order = 1 Point)	**SoE**	**ME**	**EE**	**IE**	**CmpE**	**ChE**	**CE**
1	Graduate student quality	397	72	79	79	71	56	50
2	Undergraduate student quality	375	56	77	82	68	48	53
3	Research support	338	98	58	29	63	65	25
4	Quality of research in your department	276	59	42	43	63	33	36
5	Quality of your department's curriculum	170	28	53	45	44	32	24
6	Rewards and recognition for research and scholarly activity	156	51	37	4	19	36	9
7	The use of time for research and projects	147	27	38	11	29	20	22
8	Industrial relations of your department	145	53	19	10	29	16	18
9	Collaboration among your colleagues for projects and research	122	25	40	11	29	9	8
10	Research assistant support in your department	120	24	35	18	22	14	7
11	Respect and interest of faculty to their job	112	31	24	20	15	0	22
12	Academic freedom in BUSoE	110	30	22	16	22	13	7
13	Competence of faculty in your department	104	21	10	22	11	24	16
14	The clarity of objectives and plans in your department	94	27	5	22	0	18	22
15	Your relations with the faculty	85	14	24	15	12	14	6
16	Your department's interest in recent progresses in engineering and science	82	21	20	9	9	18	5
17	Rewards and recognition for teaching	77	16	20	3	10	21	7
18	Class sizes (as number of students)	69	5	21	13	19	11	0
19	Technical personnel support in your department	66	21	27	0	12	4	2
20	The reputation of BUSoE internationally	57	19	13	21	4	27	14
21	The reputation of BUSoE nationally	54	19	20	12	3	16	15
22	Your relations with the administration	50	10	22	11	2	5	0
23	Effectiveness of information flow	48	10	7	0	16	10	5
24	Institutional autonomy of BUSoE	42	17	11	5	9	0	0
25	Rewards and recognition for institutional service	36	7	6	4	7	6	6
26	Students' respect to faculty	30	4	20	0	0	0	6
27	Diversity of fields of interest in your department	29	3	0	12	8	6	0
28	Your relations with the administrative personnel	21	1	10	10	0	0	0
29	Secretarial services in your department	16	1	3	4	8	0	0

In the second part of the questionnaire, faculty members were asked to select and order the most important ten items. As seen in Table 4.7., the most important factors that

affect the academic environment are graduate and undergraduate student quality, research support, quality of research in the department, quality of department's curriculum, rewards and recognition for research and scholarly activity, the use of time for research and projects, industrial relations of the department, collaboration among faculty members for projects and research, and research assistant support in the department.

In third part of the questionnaire, faculty members were asked how they allocated their time among the activities they perform and how they would like to divide in the ideal case. Table 4.8. shows the results of this question.

Table 4.8. Use of time of faculty in SoE

Use of Time (per cent)	Current	Ideal	Difference
Research and scholarly products	23,55	39,91	-16,36
Teaching	39,45	28,41	11,04
Administrative work (committees etc.)	15,30	8,41	6,89
Student advising	8,66	7,18	1,47
Industrial counselling	3,57	9,42	-5,85
Public service	3,12	4,17	-1,05
Other	6,36	2,51	3,85

According to Table 4.8., faculty members spend 16.36 per cent less time on research and scholarly products than ideally they would like to. On the contrary, they spend 11.04 per cent more time on teaching than they would like to spend. Faculty members would also like to spend less time for administrative work and student advising. They would like to spend more time on industrial counselling than the current situation. These results reveal that faculty is not satisfied with their current use of time.

4.4. Self-Evaluation of 2001 Graduates

This survey was conducted in spring 2001 to understand how engineering graduates evaluate themselves about achieving the outcomes that are mappable to program outcomes given in ABET criterion 3. 35 Mechanical Engineering, 53 Chemical Engineering and 33 Electrical and Electronics Engineering Department graduates participated to this survey and the results ranked in descending order are given in Table 4.9. These results are found by the analysis of responses of three departments together. Five-point Likert scale was

used in this survey where 1 means "totally disagree" and 5 means "totally agree". The Self-evaluation survey questionnaire is available in Appendix E.

Table 4.9. Students' self-evaluation by the time of graduation

	Average	Standard Deviation
I am able to reinforce and support ideas from team members.	4,34	0,81
I am constantly aware of team process and dynamics for good team performance.	4,31	0,88
I am confident in my abilities to be aware of the issues I will likely face in my career and to make ethical decisions and to behave responsibly in all aspects of my occupation.	4,30	0,87
I am confident in my abilities to apply my knowledge of mathematics to solve engineering problems.	4,28	0,67
I am able to plan work and set goals.	4,28	0,79
I am able to negotiate agreements and handle conflict.	4,26	0,80
I am able to communicate effectively with persons from other disciplines.	4,26	0,82
I am confident in my abilities to function on multi-disciplinary teams.	4,25	0,82
I am able to stay on task toward a timely completion of goals.	4,24	0,81
I am able to work for and accept consensus or compromise.	4,21	0,75
I am able to encourage open discussion of ideas.	4,20	0,82
I am confident of my ability to identify, formulate, and solve engineering problems.	4,20	0,79
I am able to use the tools of creative problem solving (such as brainstorming, withholding judgment, force-fitting of unconventional ideas, etc.) to produce a roster of creative solutions to a problem.	4,15	0,83
I am confident in my abilities to apply my knowledge of engineering to solve engineering problems.	4,11	0,80
I am able to define and apply a systematic approach to tasks.	4,11	0,81
I am confident in my understanding of the impact of engineering solutions in a global and societal context.	4,05	0,80
I am confident in my abilities to apply my knowledge of science to solve engineering problems.	4,03	0,73
I am able to define an engineering problem in succinct terms which express its essential elements and needed context.	4,02	0,77
I am able to "sell" my ideas or design solutions by effective written reports.	4,02	0,96
I have begun a plan for remaining current in my field.	3,94	1,10
I am able to use organized methods of comparing alternative solutions to problems to evaluate and evolve progressively better solutions before final selection	3,90	0,87
I am able to "sell" my ideas or design solutions by effective technical presentations	3,74	0,94
I am confident in my abilities to design and conduct experiments which are statistically valid and to interpret the data.	3,72	1,02

Table 4.9. shows that graduates evaluate themselves as successful in achieving these outcomes. The outcomes that they evaluate themselves less successful are:

- Designing and conducting experiments which are statistically valid and to interpret the data,
- Selling their ideas or design solutions by effective technical presentations,
- Using organized methods of comparing alternative solutions to problems to evaluating, and evolving progressively better solutions before final selection,
- Remaining current in their fields.

These results show that designing and conducting experiments and analysis of experiment results, technical communication skills, problem solving skills and life long learning should be emphasized more in the curriculum.

4.5. Conclusions

The current academic staff is quite experienced in teaching. At the average, they have 16.56 years of academic age. However, there are only three faculty members which have 1-3 years of academic age. Therefore, if younger faculty members are not recruited in the near future, average academic age of faculty will increase, productivity of the faculty may decrease.

Another problem is in the research and project productivity. Faculty satisfaction survey reveals that faculty is motivated and enthusiastic for performing research and projects. However, their current use of time is not suitable for performing these functions. They spend too much time on teaching, institutional service and advising but very little time on industry counseling and research. Academic staff is also dissatisfied with international research support, and research support from State Planning Organization and industry. They are also dissatisfied by the relations with industry, research assistant support and graduate student quality. Faculty is also not satisfied with collaboration for research and project. They are satisfied with library's electronic services, but they are somehow satisfied with research laboratories and dissatisfied with Internet service quality. Putting all these together, it can be concluded that although faculty is motivated and qualified to perform more projects and research, because of the low quality and lack of resources they can not increase their research productivity. Following initiatives may be taken to solve these problems:

- Increasing the number of faculty so that better use of time for faculty is maintained.
- Building strong ties with industry and other external organizations for raising funds for research and projects and for increasing counseling services for industry.
- Recruiting more research assistants.
- Developing and recruiting well-qualified graduate students.
- Improve the Internet service quality and research laboratories.

Self-evaluation survey of 2001 graduates show that students feel that they achieved the intended program outcomes. However, graduates evaluates themselves weak in

- Designing and conducting experiments which are statistically valid and to interpret the data,
- Selling their ideas or design solutions by effective technical presentations,
- Using organized methods of comparing alternative solutions to problems to evaluating, and evolving progressively better solutions before final selection,
- Remaining current in their fields.

Therefore, curriculum, resources and other educational processes should be directed towards the achievement of these outcomes.

Analyses of the data about the companies that employ BuSoE graduates showed that banking, IT, construction, university and automotive are the top five sectors that employ BUSoE graduates. CE, ChE CmpE, EE and ME graduates work in sectors that are more related with their field of education while IE graduates are employed in more diversified sectors.

The two most important stakeholders are employers and alumni. An alumni survey tool has been designed as seen in the Appendix F. Applying this survey tool and employer survey may reveal very valuable information for the improvement of educational programs in BUSoE. Especially, employers' satisfaction with graduates' achievement of program outcomes is the most important measure to assess the educational processes. These data and more should be collected continuously and systematically in time, and data collection system should be standardized and institutionalized. Since collection and analysis of these

data require great time and effort, data collection should be automated as much as possible by the use of computers and information technologies. This provides easy collection and analysis of data and elimination of paperwork. However, response rate can be lower than paper response rate. In order to overcome this drawback, stakeholders should be encouraged, motivated or firmly forced to express their opinions about the service they receive.

5. CONCLUSION

The main purpose of this study is to design a quality model for assessing and improving the quality of the engineering schools. The proposed model in this study is based on the EFQM Excellence Model, Balanced Scorecard framework and Engineering Accreditation Criteria 2000.

According to ABET 2000 Criteria, engineering programs seeking accreditation must have processes in place to determine program educational objectives based on constituencies' needs and expectations and they must have well-defined processes for assessing the student outcomes. The engineering schools must also show evidences that these processes are continuously improved. ABET 2000 reflects a total quality management approach with its emphasis on continuous improvement, stakeholder-focused approach and outcomes-based approach.

The similarities and differences of these three models have been analyzed and their distinguishing points have been identified. In the proposed model, EFQM Excellence Model is restructured for performing regular self-assessment of the engineering schools' processes and benchmarking with other engineering schools (external evaluations) by defining 5 criteria as a basis. ABET 2000 has been integrated with the model for managing and controlling the educational processes. Therefore, engineering schools seeking accreditation can implement the proposed model for institutionalization of ABET 2000 criteria in their educational processes and other processes affecting educational quality.

In the proposed model, Balanced Scorecard is used as an in-house strategic tool for linking departmental performance results and personal performance results of each academic unit and faculty to the vision and strategic objectives of engineering schools. This function of BSC has been considered in four layers: university, engineering school, academic departments and faculty layers. In this study, academic departments were determined to be the units where the core processes (education, research and public service) are performed. University and engineering school are administrative units, which own the leadership role and define a common vision, and set strategic objectives for

academic departments. The vision and strategic objectives of the institution are communicated to all layers by the academic unit and personal scorecards and strategy map which reveal the cause-and effect relationships between the strategic objectives. These tools provide clear accountabilities to departments and individuals in the system and awareness about impact of every process on the achievement of the vision.

After building a generic model for engineering schools and developing a list of performance measures under four perspectives of BSC, next step was to prioritize the generic strategic objectives in the context of Boğaziçi University School of Engineering (BUSoE). Two surveys were performed in BUSoE. These were faculty satisfaction survey and 2001 graduates' self-evaluation survey. Subjective data obtained from the faculty and students revealed that faculty recruitment process is the most critical process to both teaching and research functions. Faculty retention also gains importance in this respect. Rising foundation universities, that offer better income for faculty members, make it more difficult for BUSoE to compete against them for retaining the existing faculty.

The other critical process affecting the research function of BUSoE was determined to be the fund raising process which depends on building strong ties with industry and other external funding organizations. Faculty members were not dissatisfied with Boğaziçi University Research Fund, but they were dissatisfied with the research support of industry, State Planning Organization and TUBITAK.

Faculty satisfaction survey has also revealed that faculty members are dissatisfied by rewards and recognition in BUSoE. Therefore recognition and rewarding for the outstanding performance in teaching and research must be institutionalized and used as a tool for motivating the faculty members.

This study revealed that collection, analysis and synthesis of data are very important in building an organisation that is managed by facts. Continuous and systematic feedback from all core processes and critical support processes should be maintained. Implementation of such a quality model also requires total participation of the academic and administrative staff. Communication of strategic objectives by and performance results are critical for total participation. By communicating through the strategy maps and

scorecards; faculty and administrative staff will be aware of their roles in the achievement of the strategic objectives and performance results of individuals will be gathered in a more systematic manner.

The following topics can be given for future study:

- Conceptual design and implementation of an automated data collection and analysis system for performance measurement based on the proposed model in this study.
- Benchmarking BUSoE with national and international competitors by taking the proposed model as a basis.
- Testing the hypotheses given in the generic strategy map in Figure 3.10. by using a system dynamics model upon the collection of data, over time, for the proposed performance measures.

APPENDIX A: GLOSSARY OF KEY TERMS

The definitions of the key terms used in this thesis are given as follows:

- Accreditation: a formal, published statement regarding the quality of an institution or a program, following a cyclical evaluation based on agreed standards. Accrediting agencies can be categorized according to the territory they serve and their scope. According to the territory they serve, accreditation agencies may be regional, national and international and they can be institutional or program-specific according to their scope.
- Assessment: a diagnostic form of quality review and evaluation of teaching, learning, and programs based on a detailed examination of curricula, structure, and effectiveness of the institution, its internal review, and quality control mechanisms.
- Constituents: the group of people affected by or interested in the program. There are two categories of constituents, primary and secondary. The primary constituents are the groups most directly impacted by the programs and include students, faculty, alumni, and industry. The secondary constituents are interested in the program but are not as directly impacted by the program's performance.
- Course learning objectives: statements of observable student actions that serve as evidence of the knowledge, skills, and attitudes acquired in a course.
- Course outcomes: knowledge, skills, and attitudes that the students who complete a course should acquire. Some of the outcomes in each required course should map onto (or be identical with) one or more program outcomes.
- Criteria: standards for accreditation or certification of an institution or program. These involve expectations about quality, effectiveness, financial viability, compliance with national rules and regulations, outcomes, and sustainability.
- Curriculum: the series of courses in which students are introduced to and master the skills and attitudes (i.e., the program outcomes) needed for an engineer. The courses are organized on the assumption that students increasingly master the desired skills and attitudes as they pass through a series of courses.

- Peer Review: external review and evaluation of the quality and effectiveness of an institution's academic programs, staffing, and structure, carried out by a team of external evaluators who are specialists in the fields reviewed and knowledgeable about higher education in general. Reviews may be based on standards set by the accrediting organizations or on quality standards set more broadly.
- Performance Indicators: representations (usually numeric) of the state of, or outcome from, an educational organization, its programs, or processes. In higher education context, it may include admission and graduate data, research records, employment of graduates, cost per student, student/staff ratios, staff workloads, student relevance, class size, laboratory and other equipment, libraries, information technology, and other learning resources.
- Program: consists of everything (faculty, courses, classrooms, other resources and processes) needed to convert a student into a graduate who is ready to start working as an engineer or to continue on in graduate school.
- Program Objective: a high level or general statement of what is desired by graduation.
- Program Outcome: knowledge, skills, and attitudes that the students acquire by the time of graduation.
- Quality Assessment: a diagnostic review and evaluation of teaching, learning, and outcomes based on a detailed examination of curricula, structure, and effectiveness of the institution or program. It is designed to determine if the institution or program meets generally accepted standards of excellence
- Quality Assurance: planned and systematic review process of an institution or program to determine that acceptable standards of education, scholarship, and infrastructure are being maintained and enhanced.

APPENDIX B: ACADEMIC STAFF STATISTICS

Statistics related to the faculty members are given in Table B.1. and Table B.2.

Table B.1. Number of faculty members by years

	Full Time					Part-time					Total				
Year	Prof.	Assoc. Prof.	Asst. Prof.	Instr.	Total	Prof.	Assoc. Prof.	Asst. Prof.	Instr.	Total	Prof.	Assoc. Prof.	Asst. Prof.	Instr.	Total
89-90	14	26	18	4	62	19	3	-	6	28	33	29	18	10	90
90-91	28	21	15	2	66	18	4	-	10	32	46	25	15	12	98
91-92	28	19	20	6	73	13	5	-	2	20	41	24	20	8	93
92-93	28	20	20	7	75	15	3	-	6	24	43	23	20	13	99
93-94	36	19	27	5	87	14	2	-	5	21	50	21	27	10	108
94-95	36	23	22	3	84	16	2	-	7	25	52	25	22	10	109
95-96	37	26	23	2	88	16	3	1	8	28	53	29	24	10	116
96-97	37	25	23	4	89	9	3	2	2	16	46	28	25	6	105
97-98	38	32	11	9	90	13	4		7	24	51	36	11	16	114
98-99	42	31	14	7	94	10	3	2	12	27	52	34	16	19	121
99-00	44	29	15	5	93	6	2	2	11	21	50	31	17	16	114
00-01	44	27	12	3	86	8	2	6	13	29	52	29	18	16	115
January'02	47	28	12	8	95	7	1	4	7	19	54	29	16	15	114

Table B.2. Faculty members by the universities that they received their Ph.D. degrees

	University	Count		University	Count
1.	BU	17	25.	Purdue	1
2.	ITU	10	26.	Rochester	1
3.	Northwestern U.	4	27.	Stanford	1
4.	Syracuse University	4	28.	Sussex U.	1
5.	U. of California, Berkeley	4	29.	U. of Pittsburg	1
6.	Georgia Institute of Tech.	3	30.	U. of Akron	1
7.	Rensselaer Polytech.	3	31.	U. of California,Irvine	1
8.	Columbia U.	2	32.	U. of Florida	1
9.	New York Polytech.	2	33.	U. of Pittsburgh	1
10.	New York U.	2	34.	U. of South Florida	1
11.	Oklahoma State	2	35.	U. of Southern California	1
12.	U. of Delaware	2	36.	U.of Texas at Austin	1
13.	U. of Virginia	2	37.	McMaster University, Canada	1
14.	U.of California, Los Angeles	2	38.	Queen's U. Canada	1
15.	Yale	2	39.	U. of Toronto, Canada	1
16.	Carnegie Mellon	1	40.	U.of Ottawa, Canada	1
17.	Case Western Reserve	1	41.	U. Of Manchester, UK	2
18.	Duke University	1	42.	Imperial College, U. of London, UK	1
19.	George Washington	1	43.	U. of Birmingham, UK	1

Table B.2. (continued)

	University	Count		University	Count
20.	Lehigh	1	44.	Univ. Paris VII, France	1
21.	Louisiana State University	1	45.	Ecole Polytech. Fed. De Lausanne, Switzerland	1
22.	MIT	1	46.	U. of Vienna, Austria	1
23.	Oregon State	1	47.	U. Of Sarajevo, Bosnia	1
24.	Princeton	1			

APPENDIX C: BUSoE GRADUATES IN INDUSTRY

The following illustrations reflect the distribution of BUSoE graduates for the period 1972-2001 among different business sectors.

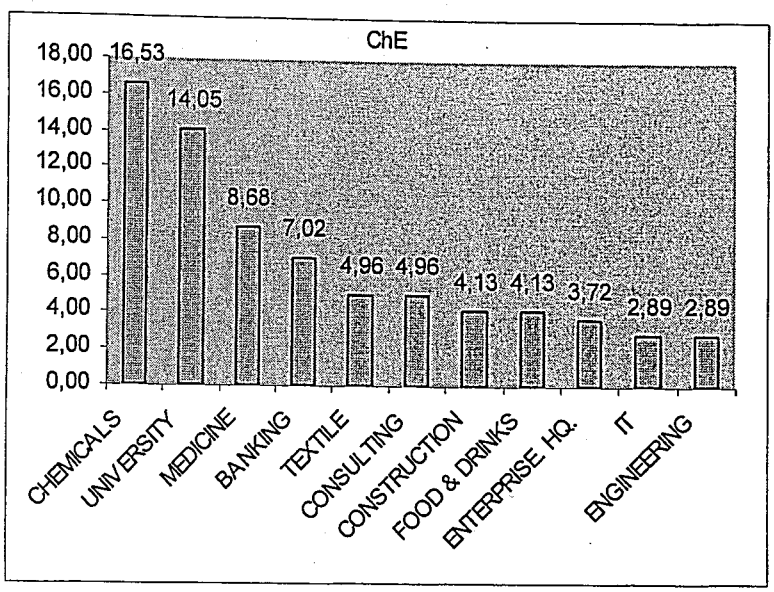

Figure C.1. ChE students by sectors

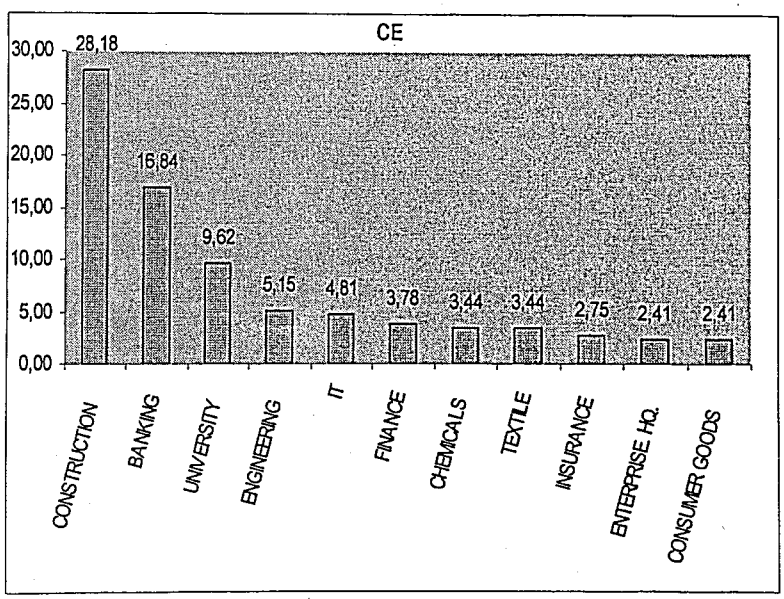

Figure C.2. CE students by sectors

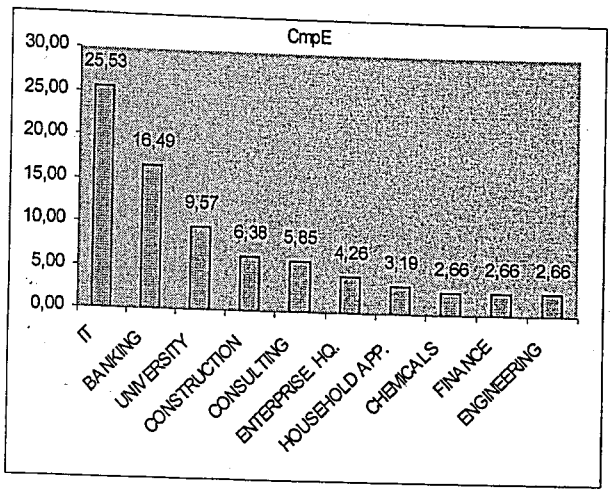

Figure C.3. CmpE students by sectors

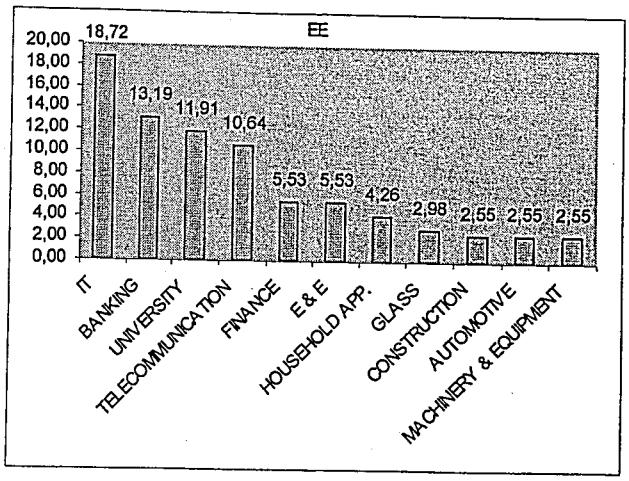

Figure C.4. EE students by sectors

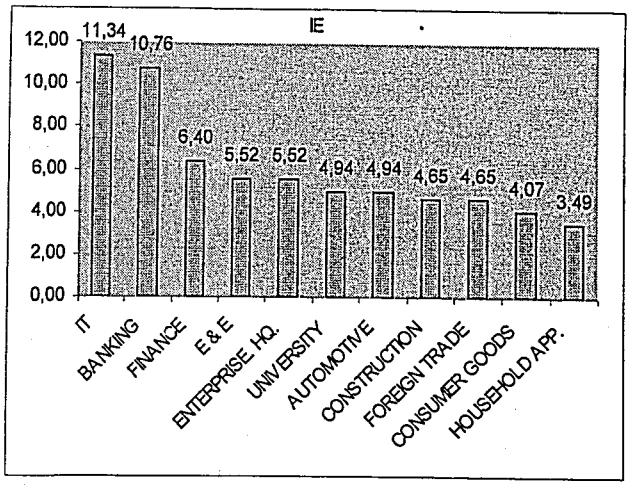

Figure C.5. IE students by sectors

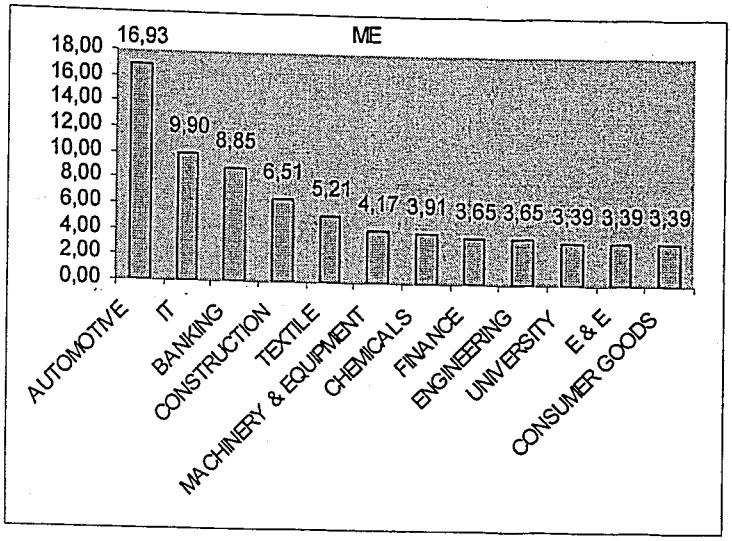

Figure C.6. ME students by sectors

Table C.1. Spectrum of fields by percentages

Sector	ChE	CE	CmpE	EE	IE	ME
AEROSPACE	0,00	0,00	0,00	0,00	0,00	0,26
AUTOMOTIVE	1,65	1,37	2,13	2,55	4,94	16,93
BANKING	7,02	16,84	16,49	13,19	10,76	8,85
CHEMICALS	16,53	3,44	2,66	0,85	2,91	3,91
CONSTRUCTION	4,13	28,18	6,38	2,55	4,65	6,51
CONSULTING	4,96	1,37	5,85	0,85	1,74	2,60
CONSUMER GOODS	2,48	2,41	0,00	1,28	4,07	3,39
E & E	2,48	1,72	2,13	5,53	5,52	3,39
EDUCATION	0,00	0,00	0,53	0,85	1,16	0,26
ENERGY	0,41	0,34	0,00	0,43	0,29	0,78
ENGINEERING DESIGN	2,89	5,15	2,66	1,28	3,20	3,65
FINANCE	2,48	3,78	2,66	5,53	6,40	3,65
FOOD & BEVERAGES	4,13	2,06	1,06	0,85	2,03	1,82
FOOD & RETAILING	0,00	0,34	0,00	0,43	0,00	0,00
FOREIGN TRADE	1,65	0,69	2,13	1,70	4,65	1,30
GLASSWARE	0,00	0,34	2,13	2,98	0,58	0,00
HEALTH	0,00	0,00	0,00	0,85	0,00	0,00
ENTERPRISE HEADQUARTERS	3,72	2,41	4,26	1,28	5,52	2,86
HOUSEHOLD APPLIANCES	1,65	0,69	3,19	4,26	3,49	3,13
INSURANCE	0,83	2,75	2,13	0,00	1,45	1,30
IT	2,89	4,81	25,53	18,72	11,34	9,90
JEWELLERY	0,00	0,34	0,00	0,00	0,00	0,00
LABORATORY	0,00	0,00	0,00	0,43	0,00	0,00
LABORATORY SUPPLIES	0,00	0,00	0,00	0,00	0,00	0,26
MACHINERY & EQUIPMENT	0,83	0,69	1,06	2,55	1,45	4,17
MEDIA	1,24	0,34	0,00	0,00	0,29	0,52
MEDICAL SUPPLIES	2,48	0,00	0,00	0,85	0,87	1,04
MEDICINE	8,68	0,34	0,00	2,13	2,33	0,52

Table C.1. Spectrum of fields by percentages (continued)

Sector	ChE	CE	CmpE	EE	IE	ME
METAL AND METAL PRODUCTS	1,24	1,72	0,53	0,00	2,62	0,78
MINING	0,00	0,00	0,53	0,00	0,00	0,26
PACKAGE	0,41	0,34	0,00	0,43	0,29	0,26
PAPER AND PAPER PRODUCTS	0,41	0,00	0,53	0,43	0,58	0,52
PETROLEUM	2,07	1,37	0,00	0,00	0,87	2,86
PLASTICS	1,24	0,34	0,00	0,00	2,03	1,82
PRINTING & PUBLISHING	0,00	0,34	1,60	1,28	1,16	0,78
TELECOMMUNICATION	1,65	0,69	2,13	10,64	1,74	1,04
TEXTILE, GARMENT & LEATHER	4,96	3,44	0,53	0,85	3,20	5,21
TOBACCO PRODUCTS	0,00	0,00	0,53	0,00	0,87	0,52
TOURISM	0,83	0,69	0,53	1,28	2,03	1,04
TRANSPORTATION	0,00	1,03	0,53	0,43	0,00	0,26
UNIVERSITY	14,05	9,62	9,57	11,91	4,94	3,39
WOODEN PRODUCTS & FURNITURE	0,00	0,00	0,00	0,85	0,00	0,26
TOTAL	100,00	100,00	100,00	100,00	100,00	100,00

APPENDIX D: FACULTY SATISFACTION SURVEY QUESTIONNAIRE

Boğaziçi University School of Engineering (BUSoE) Faculty Satisfaction Survey

The purpose of this questionnaire is to measure the faculty satisfaction level at the Boğaziçi University School of Engineering (BUSoE). As you answer these questions, think about your experiences at BUSoE over the past years. Since the information gathered by this survey will be used for improving the programs and services provided by BUSoE, we request and expect you to be sensitive and attentive in answering the questions.

A. RESOURCES AND SERVICES

Based on all your experience at BUSoE, how would you evaluate each of the following? Please circle the most appropriate number. Also indicate the importance you give to following items using the following scale.
(ASSESSMENT SCALE: 5 = "excellent", 1 = "poor", 0 = "don't know/didn't use)
(IMPORTANCE SCALE: 5 = most significant, 1 = least significant)

Technological Infrastructure for Teaching and Research	Assessment						Importance				
Internet service quality (availability and speed)	1	2	3	4	5	0	1	2	3	4	5
Educational laboratories	1	2	3	4	5	0	1	2	3	4	5
Computer Laboratories	1	2	3	4	5	0	1	2	3	4	5
Research laboratories	1	2	3	4	5	0	1	2	3	4	5
Instructional technologies(data projector, overhead etc.)	1	2	3	4	5	0	1	2	3	4	5
TECHNOLOGICAL INFRASTRUCTURE (overall)	**1**	**2**	**3**	**4**	**5**	**0**	**1**	**2**	**3**	**4**	**5**

Library	Assessment						Importance				
Book collection	1	2	3	4	5	0	1	2	3	4	5
Periodicals collection	1	2	3	4	5	0	1	2	3	4	5
Electronic services	1	2	3	4	5	0	1	2	3	4	5
Hours of Operation	1	2	3	4	5	0	1	2	3	4	5
LIBRARY (overall)	1	2	3	4	5	0	1	2	3	4	5

Campus and Support Services	Assessment						Importance				
Buildings (heating, appearance, condition, and etc.)	1	2	3	4	5	0	1	2	3	4	5
Offices	1	2	3	4	5	0	1	2	3	4	5
Classrooms	1	2	3	4	5	0	1	2	3	4	5
Print services	1	2	3	4	5	0	1	2	3	4	5
Bookstore services & products	1	2	3	4	5	0	1	2	3	4	5

Campus food services (dining hall, canteen)	1	2	3	4	5	0	1	2	3	4	5
Campus health services (BU Infirmary)	1	2	3	4	5	0	1	2	3	4	5
Parking space	1	2	3	4	5	0	1	2	3	4	5
Personal safety on the BU campus	1	2	3	4	5	0	1	2	3	4	5
Transportation in between campus	1	2	3	4	5	0	1	2	3	4	5
Sports Facilities	1	2	3	4	5	0	1	2	3	4	5
Cultural activities	1	2	3	4	5	0	1	2	3	4	5
Campus maintenance and repair services	1	2	3	4	5	0	1	2	3	4	5
Faculty housing services	1	2	3	4	5	0	1	2	3	4	5
Administrative personnel	1	2	3	4	5	0	1	2	3	4	5
Building supervisor and janitors	1	2	3	4	5	0	1	2	3	4	5
CAMPUS AND SUPPORT SERVICES (Overall)	**1**	**2**	**3**	**4**	**5**	**0**	**1**	**2**	**3**	**4**	**5**

B. ACADEMIC ENVIRONMENT

Please assess BUSoE in terms of the following attributes by circling the most appropriate number.
(ASSESSMENT SCALE: 5 = "excellent", 1 = "poor")

1	Undergraduate student quality	1	2	3	4	5
2	Graduate student quality	1	2	3	4	5
3	Class sizes (as number of students)	1	2	3	4	5
4	Students' respect to faculty	1	2	3	4	5
5	Competence of faculty in your department	1	2	3	4	5
6	Collaboration among your colleagues for projects and researches	1	2	3	4	5
7	Respect and interest of faculty to their job	1	2	3	4	5
8	Your relations with the faculty	1	2	3	4	5
9	Your relations with the administration at					
	a) Department level	1	2	3	4	5
	b) SoE level	1	2	3	4	5
	c) University level	1	2	3	4	5
10	Your relations with the administrative personnel at					
	a) Department level	1	2	3	4	5
	b) SoE level	1	2	3	4	5
	c) University level	1	2	3	4	5
11	Quality of your department's curriculum at					
	a) Undergraduate program level	1	2	3	4	5
	b) M.S. program level	1	2	3	4	5
	c) Doctoral level	1	2	3	4	5
12	Diversity of fields of interest in your department	1	2	3	4	5
13	Your department's interest in recent progresses in engineering and science	1	2	3	4	5
14	Research assistant support in your department	1	2	3	4	5
15	Technical personnel support in your department	1	2	3	4	5
16	Secretarial services in your department	1	2	3	4	5
17	The use of time for research and projects	1	2	3	4	5
18	Research support:					
	BU Research fund	1	2	3	4	5

	State Planning Organization	1	2	3	4	5
	TÜBİTAK	1	2	3	4	5
	Industry support	1	2	3	4	5
	Foreign support	1	2	3	4	5
19	Quality of research in your department	1	2	3	4	5
20	Industrial relations of your department	1	2	3	4	5
21	Rewards and recognition for teaching	1	2	3	4	5
22	Rewards and recognition for research and scholarly activity	1	2	3	4	5
23	Rewards and recognition for institutional service	1	2	3	4	5
24	The clarity of objectives and plans in your department					
	a) Short run (1-2 years)	1	2	3	4	5
	b) Medium run (3-5 years)	1	2	3	4	5
25	Academic freedom in BUSoE	1	2	3	4	5
26	Institutional autonomy of BUSoE	1	2	3	4	5
27	Effectiveness of information flow					
	a) Department level	1	2	3	4	5
	b) SoE level	1	2	3	4	5
	c) University level	1	2	3	4	5
28	The reputation of BUSoE nationally	1	2	3	4	5
29	The reputation of BUSoE internationally	1	2	3	4	5
ACADEMIC ENVIRONMENT (overall)		**1**	**2**	**3**	**4**	**5**

Please select the most important 10 items in your opinion from the list given in section B. List those 10 items according to their relative importance by writing the order number in section B according to the following scale.

(1 = "most important, 10 = "least important")

1.____ 2.____ 3.____ 4.____ 5.____ 6.____ 7.____ 8.____ 9.____ 10.____

C. USE OF TIME:

How do you currently divide your time among the following activities? How would you ideally like to distribute your time? (Distribute 100 percentage points in each column)

	Current	Ideal
Research and scholarly products	_____	_____
Teaching	_____	_____
Administrative work (committees etc.)	_____	_____
Student advising	_____	_____
Industrial counselling	_____	_____
Public service	_____	_____
Other	_____	_____
	100	100

OVERALL SATISFACTION:

Please consider all your experiences to date at BUSoE and your answers in sections A, B and C. How satisfied are you with the Boğaziçi University School of Engineering?

(SCALE: 1= "very dissatisfied", 2 = "satisfied", 3 = "neither satisfied nor dissatisfied", 4 = "dissatisfied", 5 = "very satisfied")

_____

PERSONAL INFORMATION:

Your gender?

☐ Male ☐ Female

Your department?

☐ CE ☐ ChE ☐ CmpE ☐ EE ☐ IE ☐ ME

Your academic rank?

☐ Professor ☐ Associate Professor ☐ Assistant Professor ☐ Instructor/Lecturer

Current status?

☐ Full-time faculty ☐ Part-time faculty

What percentage of your total income is your BU-earned salaries?

☐ 81-100 ☐ 61-80 ☐ 41-60 ☐ 21-40 ☐ 1-20

In what year have you joined BUSoE? _____

Additional comments and opinions

_____

_____

_____

_____

_____

_____

Thank you for your valuable contribution.

APPENDIX E: 2001 GRADUATES' SELF-EVALUATION SURVEY QUESTIONNAIRE

BOĞAZİÇİ UNIVERSITY
DEPARTMENT OF ENGINEERING

CLASS OF 2001 SURVEY

Please respond to each of the following statements by writing a number (at left) from 1 to 5 corresponding to your degree of agreement with the statement using the scale below.

1	2	3	4	5
totally disagree	disagree	neither agree nor disagree	agree	totally agree

Based on my overall experience gained in my engineering education:

-- 1. I am confident in my abilities to apply my knowledge of **mathematics** to solve engineering problems.

-- 2. I am confident in my abilities to apply my knowledge of **science** to solve engineering problems.

-- 3. I am confident in my abilities to apply my knowledge of **engineering** to solve engineering problems.

-- 4. I am confident in my abilities to **design and conduct experiments** which are statistically valid and to interpret the data.

-- 5. I am confident in my abilities to function on multi-disciplinary teams.

-- 6. I am constantly aware of team process and dynamics for good team performance.

-- 7. I am able to reinforce and support ideas from team members.

-- 8. I am able to negotiate agreements and handle conflict.

-- 9. I am able to encourage open discussion of ideas.

--10. I am able to work for and accept consensus or compromise.

--11. I am able to plan work and set goals.

--12. I am able to stay on task toward a timely completion of goals.

--13. I am able to define and apply a systematic approach to tasks.

--14. I am able to communicate effectively with persons from other disciplines.

--15. I am confident of my ability to identify, formulate, and solve engineering problems.

--16. I am able to define an engineering problem in succinct terms which express its essential elements and needed context.

--17. I am able to use the tools of **creative problem solving** (such as brainstorming, withholding judgment, force-fitting of unconventional ideas, etc.) to produce a roster of creative solutions to a problem.

--18. I am able to use organized methods of comparing alternative solutions to problems to evaluate and evolve progressively better solutions before final selection.

--19. I am able to "sell" my ideas or design solutions by effective technical presentations.

--20. I am able to "sell" my ideas or design solutions by effective written reports.

--21. I am confident in my abilities to be aware of the issues I will likely face in my career and to make **ethical decisions** and to behave responsibly in all aspects of my occupation.

--22. I am confident in my understanding of the impact of engineering solutions in a global and societal context.

--23. I have begun a plan for remaining current in my field.

APPENDIX F: ALUMNI SATISFACTION SURVEY

Boğaziçi University School of Engineering (BUSoE) Alumni Satisfaction Survey

This questionnaire has been designed to measure the satisfaction of Boğaziçi University School of Engineering graduates with their experience BUSoE.

A. GENERAL INFORMATION

1. Your department in BUSoE? ☐ CE ☐ ChE ☐ CmpE ☐ EE ☐ IE ☐ ME

2. Year of graduation _____

3. Your GPA? ☐ 3.5 – 4.0 ☐ 3.0 – 3.49 ☐ 2.5 – 2.99 ☐ 2.0 – 2.49

4. Your gender? ☐Male ☐Female

If you do not want to mention your name and company, please move to question 7.

5. Name and Surname: _____

6. Company: _____

B. FIRST JOB EXPERIENCE

7. When did you find your first job after graduation?

☐ I was already working before graduation and I continued at the same company
☐ Immediately after graduation
☐ 1 – 3 months after graduation
☐ 4 – 6 months after graduation
☐ 7 – 12 months after graduation
☐ longer than one year after graduation
☐ I am still unemployed

8. Have you ever been refused for your job application after having an interview? ☐Yes ☐No

9. If your answer is "yes" in question 8, which of the following, in your opinion, were the most important reasons? (choose 3 reasons at most)

☐ Insufficiency of your success in your education in BUSoE (your GPA)
☐ Lack of specific knowledge about the position you have applied
☐ Position you have applied was not related with your field of education
☐ Your performance at the job interview was not satisfactory
☐ Your high salary expectation
☐ Other, please specify_____

C. EMPLOYMENT INFORMATION

10. Are you currently employed? ☐Yes ☐No **(Please move to Part D)**

11. How many jobs did your change after graduation? _____

12. Please specify the sector of the company you are working for.

Industry:

☐Wood Industry
☐Marine Industry
☐Paper
☐Machine Industry
☐Defense Industry
☐Cement/Earthen/Glass Industry
☐Food Industry
☐Chemical/Medicine/Petrol Industry
☐Metal Industry (Iron/Steel/Casting)
☐Textile/Leather/Shoe/Garment Industry
☐Electrics and Electronics Industry
☐Construction Industry
☐Mining Industry
☐Automotive Industry

Finance:

☐Banking ☐Stock Exchange ☐Leasing-Factoring ☐Investment

Other:

☐IT (Software/Hardware)
☐Entertainment--art
☐Heating-Cooling
☐Retailing
☐Health
☐Agriculture/Stockbreeding
☐Commerce
☐Other:_____
☐Household appliances
☐Energy
☐Public Service
☐Media
☐Insurance
☐Transportation/Travel
☐Tourism-Hotel Management
☐Education
☐Public Relations
☐Auditing
☐Restaurant
☐Promotion/Advertising
☐Telecommunication
☐Management Consultancy

13. How long have you been working at your current job?

☐ Less than 12 months
☐ 13 - 24 months
☐ 25 - 36 months
☐ 37 - 48 months
☐ 49 - 60 months
☐ More than 61 months

14. Your average monthly income in year 2001?

☐ Less than 750 Millions TL
☐ 751 Millions – 1000 Millions TL
☐ 1001 Millions – 1250 Millions TL
☐ 1251 Millions – 1500 Millions TL
☐ 1501 Millions – 2000 Millions TL
☐ 2001 Millions – 3000 Millions TL
☐ 3000 Millions TL or more

15. Which of the following is the closest to your current position?.

☐Research & Development
☐Support ServicesImport
☐Industrial Relations
☐Auditing/Accounting
☐Quality Systems
☐Operation
☐Advertising
☐Strategic Planning
☐Product Design
☐Other:_____
☐Maintenance – Reparation
☐Export
☐Finance/Budgeting
☐Administration
☐Cost accounting
☐Marketing
☐Purchasing
☐Production
☐Product Management
☐IT
☐Education
☐Public Relations
☐Human Resources Management
☐Materials Management
☐Project Management
☐Warehousing/Handling
☐Production Planning
☐Investment Planning

16. Your current job status?

☐High-level manager
☐Middle-level manager (department manager)
☐Executive assistant/consultant/coordinator

☐Team leader/chief/specialist
☐Engineer/Researcher
☐Other, please specify_____

17. How long have you been in your current position?

- ☐ Less than 6 months
- ☐ 7 - 12 months
- ☐ 13 - 24 months
- ☐ 25 - 36 months
- ☐ 37 - 48 months
- ☐ More than 48 months

D. GRADUATE EDUCATION

If you did not complete or if you are not continuing a graduate degree, please move to section E.

18. Please enter the graduate degree programs by name of the university and program and year of graduation (if completed).

	University	Program	Year of Graduation
M.S./M.A.			
Ph.D			

19. Please specify the certificate programs you have completed after graduation by institution and program name, duration and year of completion.

Program Name	Institution	Duration	Year

E. SATISFACTION LEVEL

20. Please specify your level of satisfaction with BUSoE with respect to the following items.
(Scale: 1 = "very dissatisfied", 2 = "dissatisfied", 3 = "normal", 4 = "satisfied", 5 = "very satisfied")

	Assessment				
Quality of the curriculum in your department with respect to					
a) up-to-datedness	1	2	3	4	5
b) diversity	1	2	3	4	5
c) depth	1	2	3	4	5
Competency of faculty in your department	1	2	3	4	5
Preparation of your education for your profession	1	2	3	4	5
Preparation of your education for graduate degrees	1	2	3	4	5
Interest of your academic advisor	1	2	3	4	5

Quality of the library	1	2	3	4	5
Quality of the computer laboratories	1	2	3	4	5
Quality of the educational laboratories	1	2	3	4	5
Quality of the facilities (buildings, sports facilities, classrooms)	1	2	3	4	5
Support services (health, food, registration, bookstore etc.)	1	2	3	4	5
Social life in the campus	1	2	3	4	5
Job opportunities in the campus	1	2	3	4	5

21. How much has your education in BUSoE contributed to the following knowledge, traits and abilities. **(ASSESSMENT SCALE: 1="very little contribution", 5="very much contribution")**

		Assessment				
1	Oral communication	1	2	3	4	5
2	Written communication	1	2	3	4	5
3	Ability to apply knowledge of mathematics, science, and engineering	1	2	3	4	5
4	Ability to design and conduct experiments, as well as to analyze and interpret data	1	2	3	4	5
5	Ability to design a system, component, or process to meet desired needs	1	2	3	4	5
6	Ability to function on multi-disciplinary teams	1	2	3	4	5
7	Ability to identify, formulate, and solve engineering problems	1	2	3	4	5
8	Understanding of professional and ethical responsibility	1	2	3	4	5
9	Broad education necessary to understand the impact of engineering solutions in a global and societal context	1	2	3	4	5
10	A recognition of the need for, and an ability to engage in life-long learning	1	2	3	4	5
11	Knowledge of contemporary issues	1	2	3	4	5
12	Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	1	2	3	4	5
13	Developing original products/ideas	1	2	3	4	5
14	Adaptation to changing situations	1	2	3	4	5
15	Systems approach	1	2	3	4	5
16	Critical thinking	1	2	3	4	5
17	Ability to complete a job from beginning to end	1	2	3	4	5
18	Ability to gather knowledge from various resources and use that knowledge	1	2	3	4	5
19	Impact of your English proficiency on your professional career	1	2	3	4	5
20	Impact of your second language (if exists) on your professional career	1	2	3	4	5

22. Please rank the most important 10 items given in the previous question according to their relative importance for your current job.
(1 = "most important", 10 = "least important")

1.____ 2.____ 3.____ 4.____ 5.____ 6.____ 7.____ 8.____ 9.____ 10.____

23. If you had a chance, would you again like to complete

a) your undergraduate degree in the same department? ☐Yes ☐No
b) your graduate degree in the same department? ☐Yes ☐No

If your answer is "no" in the previous question, please specify the reasons:

_____
_____
_____
_____

24. Considering all your experiences in BUSoE and your answers to previous questions, please specify your overall satisfaction level with BUSoE.
(Scale: 1 = "very dissatisfied", 2 = "dissatisfied", 3 = "normal", 4 = "satisfied", 5 = "very satisfied")

_____

Your additional opinions and comments:

_____
_____
_____
_____
_____
_____

Thank you for your valuable contribution.

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