Some Issues in System Dynamics Model Building to Support Quality Monitoring in Higher Education

Michael Kennedy

Information Management and Modelling Group

School of Computing, Information Systems and Management

South Bank University

Borough Road, LONDON SE1 OAA

Tel: (+44) 171 815 7416 Fax: (+44) 815 7499

e-mail: kennedms@sbu.ac.uk

Key words: *Higher Education, Quality Issues, Quality Model Dynamic Simulation*

ABSTRACT

This paper examines issues in monitoring, assessing and managing quality in Higher Education (HE). It discusses factors that should be incorporated in a system dynamics (SD) model, designed to assist in policy analysis regarding quality issues.

Quality has been an issue for many organisations attempting to improve organisational performance. In the UK HE sector, various peer review structures have been established to attempt to assess the quality of both research output and teaching. Most institutions have created internal monitoring and review procedures. Many issues remain controversial however: how can we define "quality"? how can we measure it?; are output measures sufficient or should we compute "value added"?; what are the relationships between research and teaching quality?; what is the impact of changing resource levels?; what is the impact of various management styles?

The paper assesses the potential usefulness of SD in exploring quality issues and linked resource problems. A conceptual model of “Higher Education Quality Management Factors” is produced. The potential value of SD for quality management is in accommodating non-linear and iterative views, hard and soft issues, strategic objectives, and changes in educational processes.

As reported in a companion paper, (Kennedy, 1998), to examine the practicalities of the concepts explored in this paper, a pilot study has been completed. A. Mania, conducted the pilot study under the supervision of the Author, with assistance from D. Williams. The model should help management to investigate the impact of specific policies before implementing them. This paper shows the potential role of SD in coping with the ever-reducing resources available, and increasing quality standards demanded in the UK.

It is emphasised that this review is reported as the first stage of a long-term project. The author would welcome comments from these with an interest in the field, particularly those interested in some form of continuing dialogue or collaboration. A fuller version of this paper, with an extended discussion of relevant aspects of TQM and performance indicators, is available from the Author.

INTRODUCTION

Quality delivery in higher education is a major concern for both higher institutions and government departments, particularly as resources available continue to deplete. Quality issues relate to all aspects of an institution’s planning, students' performance, staff performance, administration and finance.

The conceptual model of 'Quality Management Process' in higher education settings developed, is based on key issues identified by researchers in the field of quality standards in higher education. The SD model developed if calibrated and optimised, can serve as an effective quality monitoring and planning system for managers or heads of higher education departments.

The need for effective quality monitoring in Higher Education [HE] may be seen by HE’s contribution to the UK national economy, the issues and the challenges facing HE noted in the Dearing Report (1997).

- The higher education sector has a turnover of £11 billion.
- Higher education employs more than 250,000 people
- The UK has 1.3 million undergraduates.

- The number of first degree graduates rose by 5% in 1995/96 to 252,200; there were also 59,600 other undergraduate qualifications awarded.
- 105,500 postgraduate qualifications were awarded in 1995/96 - up 17% on 1994/95. The university sector spends £12.58 billion annually on goods and services produced in the UK.
- By 2003 the number of UK students starting full-time first-degree courses will have increased by an estimated 25%.
- Today one in three school-leavers go on to higher education compared to one in seven in 1985. In 1962 less than one in ten school-leavers went on to higher education.
- Institution expenditure on buildings and estates represents 12% of total expenditure across higher education, the second biggest single component of their costs. The total estate has been valued at £30 billion.
- Universities and colleges face a funding shortfall of £350 million in 1998-99 and £565 million in 1999-2000, rising to at least £2 billion a year in 20 years time. A 6.5% cut in spending per student over the next two years - as planned under present public spending targets - is likely to damage the quality of higher education; the Dearing Report estimates that such a cut would mean funding for teaching each student had been halved in the last 25 years and recommends a smaller reduction of only 2% over the next two years.
- In the last six years, the amount of money invested for each student has fallen in real terms by 28%.
- Uses of technology will increase dramatically throughout the sector, demanding significant investment and initially increasing the pressure on both staff and systems. Institutions, which adopt an integrated approach to their technology infrastructure, will benefit from savings in cost and time and from increased efficiency compared to those universities, which fail to implement a coherent systems strategy.

The strength of the SD is its ability to handle some of the soft quality issues. Although the development of the first model was straightforward, one major difficulty was incorporating academic and research staff perceptions about quality.

ASPECTS OF QUALITY IN HIGHER EDUCATION

Ovretveit (1992) defines three general dimensions of quality:

Client quality: what customers (students) and clients (employers) want from the service;

Professional quality: whether the service meets needs as defined by professional providers and whether it carries out techniques and procedures which are believed to be necessary to meet clients needs;

Management quality: the most efficient and productive use of resources within limits and directives set by higher authorities.

O'Neil (1994) suggests that quality may be judged by three means:

Academic standards of courses (fitness for purpose) - what the institution demands of the students, and the extent it meets the staff needs;

Teaching quality - staff training and development, appraisal systems, evaluation of the results of teaching, reports from external examiners and patterns of employment of graduates and feedback from students themselves;

Student achievements - performance indicators to be used include numbers and class of degrees obtained, non-completion rates, acquisition of specialist knowledge and communication skills, enterprise, and value-added comparisons, for example, entry qualifications compared with achievements.

Diana Green (1994) stresses that since the mid-1980s, public interest in and concern about quality and standards has been intensified by the increasing attention given by successive British governments to reforming higher education. The reasons for this growing concern are:

- Rapid expansion of student numbers against a backlog in public expenditure.
- The general quest for better public services.
- Increasing competition within the educational 'market' for resources and students.
- The tension between efficiency and quality.
- Managing institutions of higher education is a complex task in maintaining their effectiveness. Institutional managers have a crucial role to play in relation to quality in the following ways:

- Finding ways of using the institution's resources to better effect and generate more resources.
- Being accountable to the wider society, through use of effective means of assuring academic standards.
- Developing improved systems of strategic planning and institutional management.

A quality management system

A total commitment to product quality and performance will help ensure that an institution will play an important role as a leading education and training provider. Future growth of an institution will depend to some extent on achieving quality throughout the entire institution. As such there will be a commitment to the continual improvement of the service provided. To achieve this objective competent staff needs to be employed and the support of existing staff obtained. Walkin(1992) identifies the following issues that need to be addressed in achieving a quality management system:

The need for competent staff: Responsibility for ensuring that deadlines are met and that outcomes are efficiently achieved, which are consistent with challenging cost, quality and customer need, rests with course directors. Accountability for enhancing overall service in terms of performance and profitability of staff employed within a given course or department will rest with program directors or Heads of departments respectively.

Management responsibility: The management will need to produce a manual that clearly details quality systems and appoint a management representative to oversee quality functions. The quality management system must include documented methods of applying, recording and auditing quality assurance and improvement programs.

Quality policy: This should relate to the institution's mission statement and embrace quality aspects of its strategy and operational plans. The policy must set achievable targets and aim to make the most effective use of the human and material resources available to foster a climate of continual quality improvement. For example, a staff development and training policy would ensure that new employees are inducted into a quality-oriented approach to their work and all other employees are trained to work competently, with total commitment to the achievement of quality criteria.

Quality Manuals: This will serve as a policy document but must be sufficiently detailed to be used to audit the systems in use. It will be backed up with codes of practice that define processes, procedures, activities and specifications by which the institution will satisfy its policy and mission.

Quality planning: Planning involves

- analysing service requirements;
- developing performance criteria and action plans to enable standards to be achieved;
- documenting systems and control procedures and defining responsibilities;
- resourcing and delivering the service;
- monitoring, auditing and reviewing the effectiveness of implementation and operating a quality;
- Improvement program where non-compliance is revealed by audit.

An effective planning system is required to identify the key elements within all aspects of the institution. Such a system relies on the aims and objectives set up by the management of the institution . According to Barlas (1996) "*Administrators of contemporary universities face the challenge of maintaining the quality of the fundamental functions of a university, namely teaching, research, academic and professional service, while trying to serve the students, under the pressure of limited resources in terms of faculty, facilities and income* .

The effectiveness of management system depends highly on the manager's conceptual ability to view the whole institution and understand the interrelationship between different aspects of its activities. Managers must have the ability to work with, understand, and motivate people, both as individuals and as groups. Some methods employed in the management of institutions in planning may include:

- Delegation of planning activities to individual departments who set their aims and objectives;
- Increase staff involvement in decision-making to improve performance aimed at improving communication and co-ordination between employees and between the departments leading to increased employee motivation;
- Use of quality circles . This involves several small groups(circles), each made up of volunteers from a department who meet regularly to identify, analyse and recommend solutions to work-related problems.

Some of the components of dynamic administrative leadership that need to be considered in establishing an effective university administration are:

- competent management of information,
- control and effective use of the budget and
- administrator's power of initiative, which allows the establishment of task forces, study committees, evaluation studies and planning efforts.

Many institutions of higher education execute their quality control, assurance procedures and maintenance of standards through their academic boards or their equivalents. Ashworth and Harvey (1994) suggest that the procedures have the following aims:

- the holistic development of their students including their better preparation for employment
- the maintenance and enhancement of the quality of education experienced by their students
- the assurance that new programs of study are developed to the appropriate standards and quality
- that subject development is taking place whereby program inputs are at the appropriate level and content to reflect current developments
- to encourage staff to be involved in review, monitoring, evaluation and validation as apart of there own personal development.

The setting of standards is usually determined by the academic boards that are also responsible for assessing whether they are actually being achieved. The control of quality is done on a continuous basis to examine whether or not the specified standards and aims are being maintained and improved.

The next section will examine specific quality issues in the management of Higher Education faculties and departments.

TOTAL QUALITY MANAGEMENT (TQM)

Current Problems

The main fundamental problem in achieving quality in higher education institutions is in deriving effective methods of measuring the qualitative aspects of activities. It is relatively easy to develop quantitative measures in areas such as student performance, resources, income and funding but it is difficult to quantify issues such as motivation and perceptions.

The traditional tools used currently to capture aspects of quality using Total Quality Management techniques have not been very successful and thus the need for a new approach.

Applications of TQM in Education

Many TQM applications in educational settings have been concerned with empowering the customer and creating an awareness of customer-supplier responsibilities. Though there is no data available which indicate exactly how many institutions in Britain have adopted a quality policy with a total management approach, it is the authors opinion that there is considerable interest, but also some cynicism in respect of TQM.

According to Morgan(1994) customer focus of TQM in education is seen to provide data to disclose exactly what the quality issues are and to answer such questions as:

- To what extent are teachers able to accept some of the central concepts of TQM?
- Do teachers recognise they have customers in the TQM sense?
- Is the whole idea of 'customer-supplier chains' in schools acceptable?
- Do students have views of their institutional world, management practices, or improvements they would like to see in their school?
- Could students make a greater contribution to the design of school policies and practices?
- Do students have views about whether they learn more with some teachers, and which can contribute to teaching effectiveness generally?
- Do teachers and students endorse the explicit setting of performance standards?

Samuel(1991) suggested that the best way to introduce the concept of TQM in institutions be first to senior staff and, progressively, to all teaching and non-teaching staff so that it penetrates the institution.

Problems of TQM

Distinct barriers to TQM that are common to all types of institutions and within all management levels have been identified. TQM initiative is usually not introduced and implemented effectively and even after being introduced it fades over time. The 8 barriers that plague institutions most often are, (Slack et al, 1995 and Oakland, 1993):

- lack of management commitment,
- inability to change institutional culture,
- improper planning,
- lack of continuous training and education,
- incompatible institutional structure and isolated individuals and departments,
- paying inadequate attention to internal and external customers,
- inadequate use of empowerment and teamwork, and
- ineffective measurement techniques and lack of access to data and results.
- a fear that the widespread adoptions of TQM will reduce the number of jobs available or the opportunities for promotion.
- The reluctance to accept full accountability for action.

As a result of all these problems, the TQM concept has frequently not been successfully implemented in higher education institutions.

THE PLACE OF 'PERFORMANCE INDICATORS' IN AIDING MANAGERIAL DECISION MAKING IN HIGHER EDUCATION

Introduction to Performance Indicators

Performance indicators are statistics, ratios and other quantitative information, which indicate the way in which a program of study or a college is operating. The performance indicators used should relate to the mission statement of the college and, over a period of time, may confirm, or otherwise, whether the college is making progress in meeting the objectives set out in the mission statement

Performance indicators should be used not as an end in themselves to draw definitive conclusions, but to trigger areas of concern and provide a catalyst for further investigation. If performance indicators are not used to facilitate decision making and day-to-day management, they are likely to fall into disrepute and be disregarded.

The main desirable features of performance indicators in supporting the quality management process are:

- relevant to the mission statement of the institution
- assist in the monitoring and evaluation of the institution’s activities
- provide data by which to make judgements on resource allocations
- assist in forward planning and decision making
- acceptance and motivation of staff.

Conclusions Regarding Performance Indicators

In the author's view, performance measures have been evolved for HE that provide some indication of strengths and weaknesses and provide a further basis for investigation, discussion and action

The collation of a range of indicators on a regular basis is still not standard practice, many being only collated in response to outside pressure (especially from the Funding Council), so they do not form the valuable aid to routine decision making that they could do.

The reasons for this may lie in a suspicion of the appropriateness of such 'managerial' practice by some staff combined with the inability of many information systems to generate them automatically, (especially those measures which require data collected from more than one source or functional area).

The indicators in current use were formulated in an attempt to answer perceived managerial issues given the information available or obtainable. In the author's opinion, many are excessively concerned with resource utilisation without reference to the quantity and quality of the output so obtained. When a greater understanding of the current, basic, measures is achieved, more complex, but more meaningful, measures should be explored, for instance, the ' Value added ' to student attainment measured against the resource inputs utilised to achieve it.

The author anticipates that on a financial performance level, reports will be produced of departmental/faculty Income and Expenditure aggregating the various sorts of income and expenditure (after allowance for central overheads). This will be equivalent to a divisional profit and loss account for a commercial organisation and will permit the utilisation of suitably modified commercial financial ratios.

Problems with Current Methods

The main problems associated with the current problems are:

(Ashworth and Harvey(1994) and Walkin(1992)

- Accuracy: Here the main emphasis is the extent to which people should believe in the figures obtained from computations of quantitative issues.
- Costs: The methods outlined above are costly and thus many organisations are not able to have continuous implementation policies carried out.
- The methods are not able to measure both qualitative and quantitative issue together and this is foreseen as a major problem.

THE RATIONALE FOR A SYSTEM DYNAMICS APPROACH

Some preliminary attempts to use System Dynamics to explore and understand High Education planning effectiveness (Barlas, 1996) and Higher Education Funding (Kennedy, 1997) have been made, but this paper suggests that a much more comprehensive application may be possible.

As seen in the previous section, there is a need for an alternative method, which would eliminate the problems mentioned. There is a need for a method that has the following attributes:

- Accuracy: This is in terms of the analysis of data so that it is not misleading.
- A method that gives a realistic approach to problem solving in terms of how easy it is to use and understand.
- Simplicity: The method needs to be simple and not using complex methodologies in problem solving.

There are various methods that can be adopted to solve this problem such as Neural Networks, Statistical techniques, Machine Leaving algorithms and System Dynamics. The first three methods mentioned tend to be very tedious and laborious, as they will require constant updates, which cannot be triggered easily.

System Dynamics may be adopted, as it is a holistic and systematic approach to problem solving. It adopts a ‘top down’ analysis of the problem. The aggregate position was examined by the Dearing Committee (1997) and was commented on by SAP (1997) among others.

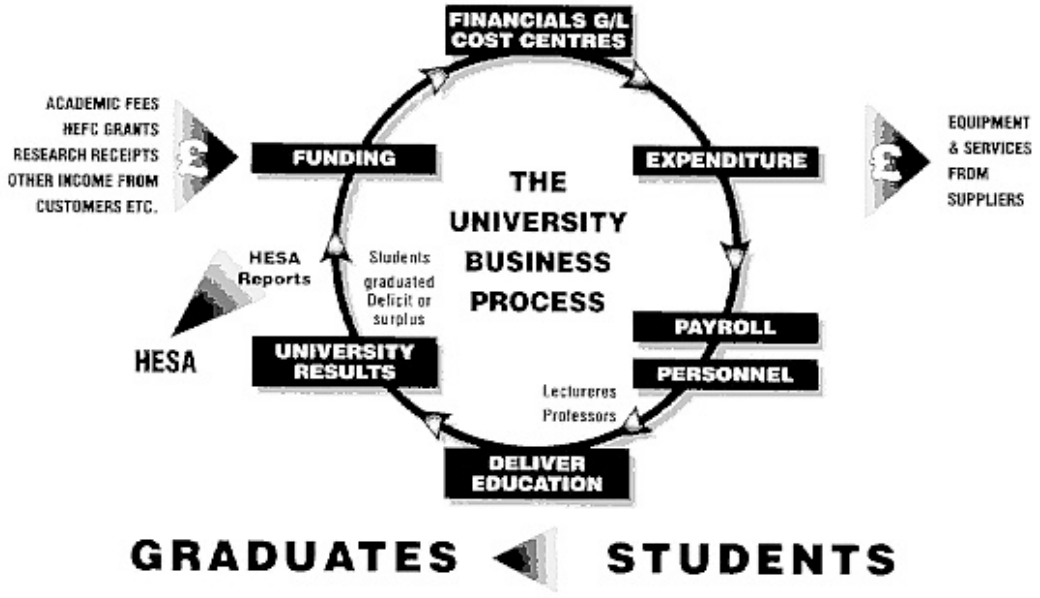

Figure 2: Higher Education Dynamics as per Dearing Report [source http://www.sap.com/uk/]

As reported in a companion paper, (Kennedy, 1998), to examine the practicalities of the concepts explored in this paper a pilot study has been completed. In that pilot study the *Higher Education Quality Management factors* presented below is used.

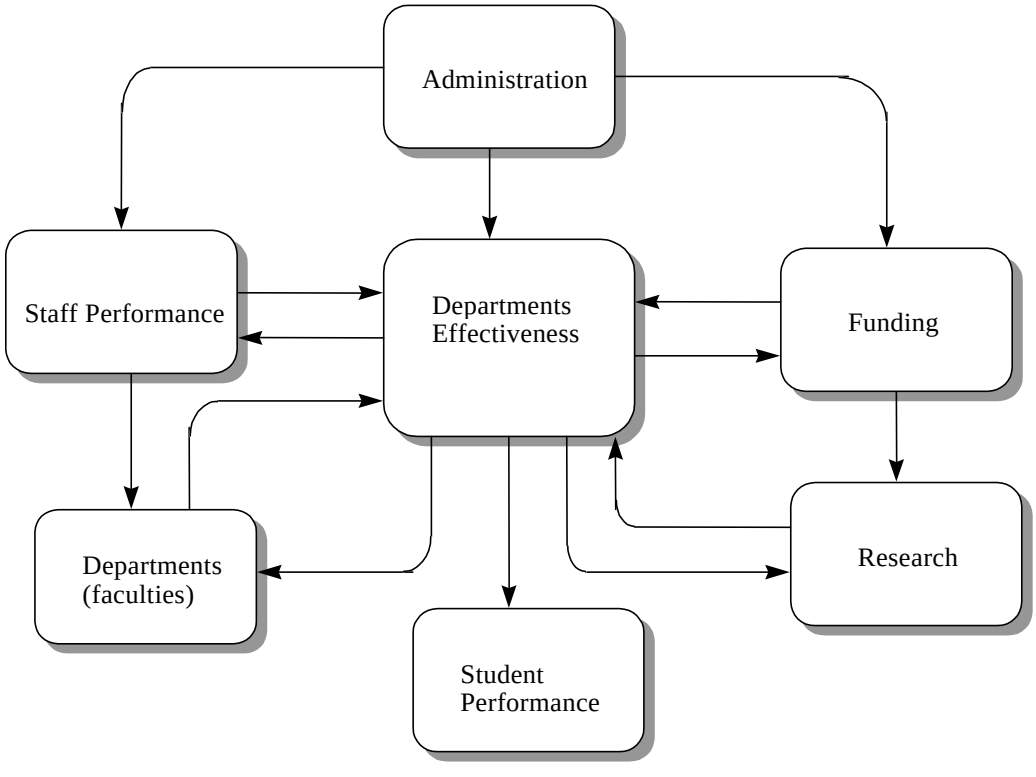

Figure 2: Higher Education Quality Management factors

Requirements for such a system need to be identified and analysed effectively, particularly as requirements change over time, as management changes its decision styles, and teaching staff need new operational data and information.

Student performance and Staff morale are also not linear. These change over time as new management practices are introduced by course directors and unit leaders, and their own input quality and student basis change. In addition to looking at overall historical experience with student enrolment, funding and staff development, it is important to consider more recent trends in performance.

The problem of Quality Management has become an important concern in recent years. (O'Neil, 1994). Total Quality techniques have been used to try to improve Quality Management in Higher Education.

System Dynamics techniques can be used to identify feedback loops in the current management system and assist in evaluating proposed improvements in them.

REFERENCES

Ashworth A., Harvey R., (1994), Assessing Further and Higher Education, Jessica Kingsley publishers, London.

Barlas Y., Vadet G D., Decision Support for Strategic University Management: A Dynamic Interactive Game, www:http://ireiris.cc.boun.edu.tr/faculty/barlas/ybhome

Dearing R., (1997), National Committee of Inquiry into Higher Education. (Dearing Report), HMSO *or http*://www.leeds.ac.uk/educol/ncihe/ *see also http*://d3e.open.ac.uk/Dearing/ *and* http://www.sap.com/uk/

Dearing Report. (1997) *see above*

Green.D., (1994), What is Quality in Higher Education, St. Edmundsbury press.

Jarratt Report, 1985, Report of the steering committee for the efficiency studies in Universities. London, Committee of vice- chancellors and Principals.

Kennedy M., (1997), Transforming Spreadsheets into System Dynamics Models; Proceedings of 15th System Dynamics Conference, Istanbul, Turkey.

Kennedy M., (1998), A pilot System Dynamics model to Capture and Monitor Quality Issues in Higher Education Institutions: Experiences Gained. Proceedings of 16th System Dynamics conference, Quebec City, Canada.

Morgan C., Murgatroyd S., (1994), TQM in the Public Sector, Biddles Ltd.

O'Neil M., Nightingale P., (1994), Achieving Quality Learning in Higher Education, Biddles Ltd.

Oakland J.S., (1993), Total Quality Management: The route to improving performance, Clays.

Ovretveit, J. (1992) Health Service Quality; an Introduction to Quality Methods for Health Service, Blackwell

Richmond B., 1994, System Dynamics/ System Thinking: Let's Just Get On With It, Location: http://www.hps-inc.com

SAP (1997) http://www/sap.com/uk/

Slack N, Chambers S, Harland C, Harrision A, Johnston R (1995). Operations Management, Pitman.

Walkin L., (1992), Putting Quality into Practice, Stanley Thornes Ltd.

Zahedi F., 1995, Quality Information Systems, Boyd & Fraser publishing company.