

Some Issues in Building System Dynamics Models for improving the Resource Management Process in Higher Education

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Abstract

This paper examines issues in the Resource Management process in Higher Education Institutions. It discusses factors that should be incorporated in a system dynamics (SD) model designed to assist in policy analysis regarding Resource Management issues. It builds on a previous paper regarding Quality Management and various pilot studies described at previous conferences by the authors and others.

Resource Management is an important issue for Higher Education Institutions. In the UK, various structures have been established or proposed to attempt to measure the resources deployed and the impact on quality. Many issues remain controversial however: who are the stakeholders and what should be their relative importance?; what should be the relationships between resources devoted to research and teaching?; what is the impact of changing resource levels on academic and support staff, accommodation, equipment, learning resources and information technology?; what is the impact of various management styles?; how can we define "quality"?

The paper assesses the potential usefulness of SD in exploring resource issues. A conceptual model of the 'Resource Management Process' in higher education settings is presented.

1. Introduction

The UK higher education sector has a turnover of over £11 billion and employs more than 250,000 people. Today, one in three school-leavers go on to higher education compared to one in seven in 1985 and one in ten in 1962. By the year 2003, the number of UK students starting full-time first-degree courses will have increased by an estimated 25% compared to today's figures. Participation rates still vary dramatically between different social groups however.

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 an estimated funding shortfall of £350 million in the current session and £565 million in 1999-2000, rising to at least £2 billion a year in 20 years time. In the last six years, the amount of money invested for each student has fallen in real terms by 28%.

It is expected that uses of technology will increase dramatically throughout the sector,

demanding significant investment and initially increasing the pressure on both staff and systems (Dearing, 1997). 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.

Resource Management in Higher Education has been highly controversial in the UK. Since the 1980s there has been a political process involving the government, and the Universities. Cave et al. (1997) state that, "Government determined to bring to bear on higher education the principles it was seeking to install across the public sector: strong central direction; accountability for the economic, efficient and effective use of public money; the measurement of performance against outcome criteria and the substitution of the concepts and methods of management for those of administration or professionalism."

This political process led to the Jarratt Report (1985), which recommended that universities must work to clear objectives and achieve value for money. Jarratt also made far-reaching recommendations about the governance and management of universities. Cave et al. (1997) state that, "Universities had long been regarded as diarchies in which the power of the collegium, as represented by Senate and the academic autonomy of individual teachers, worked in tandem with the hierarchy embodied in the vice-chancellor, deans and heads of departmentsJarratt now proposed institutions' Vice Chancellors would, in turn, become chief executives, overseeing the corporate management of the university."

This debate between the "managerialists", favouring strong central direction and the "collegiumists", who see the university as a community of scholars continues. Some of the criticism of the Dearing Report (1997) centres on the contention that the committee implicitly adopted the "managerialists" mindset (see, for example, Blake, Smith & Standish (1998) in "The Universities we need – Higher Education after Dearing")

Issues of Resource Management in Higher Education Institutions cannot be separated from issues of quality and standards. 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.

2. Resource Management Issues in Higher Education

2.1 Identifying the Stakeholders & Customers

Whereas the stakeholders of many commercial organisations can be easily identified, a university's stakeholders fall into four distinct groups, according to Clare (1995). Firstly, the students of the institution are stakeholders (as well as its product). They look to the institution to provide a service in the form of a course of study leading to a recognised qualification and a general educational benefit. Recent informal interviews carried out at South Bank, indicate that the applicant of the late 1990s is far more discerning about their course of study and the host institution than their predecessors. Part of the reason is the awareness of graduate unemployment which leads students to seek courses that will minimise the risk of unemployment. The severe pressure on student finance (including the recently introduced student fees), leading to the necessity to take out loans or be subsidised by parents also tends to focus the mind towards looking for value for money.

The second category of stakeholders are the employers of graduates and diplomates. Their needs for well qualified, well educated and adaptable employees in the shape of new graduates have to be satisfied. Success in this area reaps other benefits such as investment by employers in research, development, consultancy and short courses with the institution. Here, a careful balance needs to be struck. The natural instinct for the "old" universities was to build courses around the latest theoretical research; indeed this has been the standard approach for many years and can be seen to have been successful in providing the UK with first rate scholars. The direct needs of industry have often been seen as being satisfied with direct training courses that are not the province of the universities. "New" universities (ex-Polytechnics), on the other hand, have always sought to try to satisfy some of the needs of industry directly as part of the degree and diploma courses they offer. Over the years, they have managed to develop a balance between up-to-date material that will enable the graduate to become immediately useful to an employer, and material designed to provide a firm under-pinning, to enable the student to be able to adapt to future changes in the industry or in technology.

The third group of stakeholders are the Government (via the funding councils), local Government and Government agencies (the Research Councils, Training and Enterprise Councils etc.). For the foreseeable future, these bodies will be the major providers of funds to a university. Consequently, they should be regarded as stakeholders with needs to be satisfied. The main way in which this is currently achieved is by the institutions recruiting to target, graduating quality students, completing the funded research and so on.

The final group of stakeholders for the services of a higher education institute is the wider community. Each institution has obligations (although it may not have realised them) in the areas of:

- (i) access to the facilities of the institution for the local community
- (ii) contribution to the wider academic community
- (iii) providing services to the international community via the enrolment of overseas students, collaborative research, consultancy and other projects
- (iv) the welfare of society in general.

2.2 Resourcing Streams

The resourcing of operations of UK universities comes from a variety of sources, but these can be broken down into three main categories: the main grant, research funding, and other income.

2.2.1 Main Grant

The bulk of the funding for the "new" universities and a considerable proportion of the funding for "traditional" universities arrives in the form of an annual grant from the Government, administered by the appropriate "Higher Education Funding Council". The grant covers notional funding for teaching activities, for research, and in some cases, for special initiatives, such as widening access. In addition to the main grant, the Funding Councils occasionally provide limited funds for capital projects such as buildings or technical equipment.

The part of the grant for teaching costs is based on the numbers of students enrolled on the courses offered by the university. There are four "price groups", designed to reflect the different costs of teaching technical as opposed to non-technical subjects. The grant is set on target recruitment numbers which, if they are not met, can lead to some of the teaching grant being withheld. Along with the actual teaching grant, each student recruited generates a fee to be paid by the student or a sponsor. Although the fee is the responsibility of the student as opposed to the central government, its generation is tied closely to recruitment and can therefore be considered alongside the teaching funding.

The research element of the grant is based on the results of the periodic Research Assessment Exercise (RAE), where a programme of peer review results on a grade being assigned to the different areas of research in the university. If the grade is above a certain base level, the department attracts funding based on the grade and the number of active researchers within the department.

Despite the grant being calculated in a transparent way and to strict formulae, there is no requirement for the university to allocate the grant in the same (or indeed similar) proportions; the university has freedom to allocate the grant as it sees fit.

2.2.2 Research Grants

These grants can be central government funds (for example from the UK Research Councils), European initiatives (such as the EU 5th framework) or direct research grants from industry. In all cases, they will be based on specific proposals for a fully costed research project or programme. A major debate in higher education circles around research grants concerns the charging of overhead costs. The degree to which overheads can be recouped depends on the funding source, and in many cases these are thought to be inadequate. Many research projects use accommodation, equipment, technical and administrative support which should be covered by appropriate overhead charges. In the absence of such charges, these supporting activities are funded by the main grant.

2.2.3 Other Income

This is the term used for income from such activities as Consultancy, short and full-cost courses, the hire of university facilities, and the activities of any trading arm that the university may operate. In many cases, the problem of overheads mentioned above is less severe because the university is able to charge reasonable overheads to what

are, in the main, commercial customers. There is an expectation that while the majority of the funds will go to the unit that generated the income, a reasonable proportion will be retained by the centre to supplement the main grant income.

3. Survey of Current Higher Education Approaches to Resource Planning.

3.1 Problems with Current Methods

The main problems identified as being associated with the current methods Ashworth and Harvey (1994) and Walkin (1992) are:

- 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 issues together and this is foreseen as a major problem.

3.2 Input /output models

The Problems with most input /output models, such as those reproduced from Cave et al. (1997) below, is that they adopt a static, linear view. They thus ignore both dynamic interaction between the input /output factors and the nature of the 'transformation' taking place (in fig 1.1 in the 'Higher education sector'). They are thus of little use when considering process improvement.

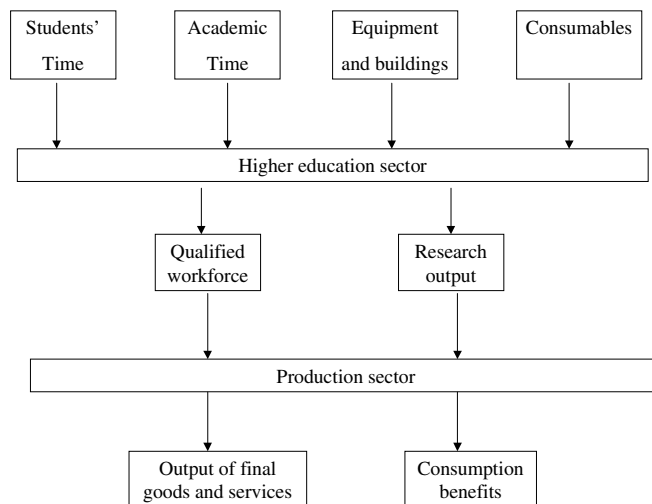


Figure 1 Inputs and outputs in higher education
Source; (adapted from) Cave et al. (1997)

A somewhat more sophisticated approach is adopted by models which incorporate the by the aggregate higher education dynamic position but many still ignore both the nature of the dynamic interactions between the input /output factors and the nature of the 'transformation' taking place. The example reproduced below was produced by SAP (1997) while commenting on the Dearing Report (1997).

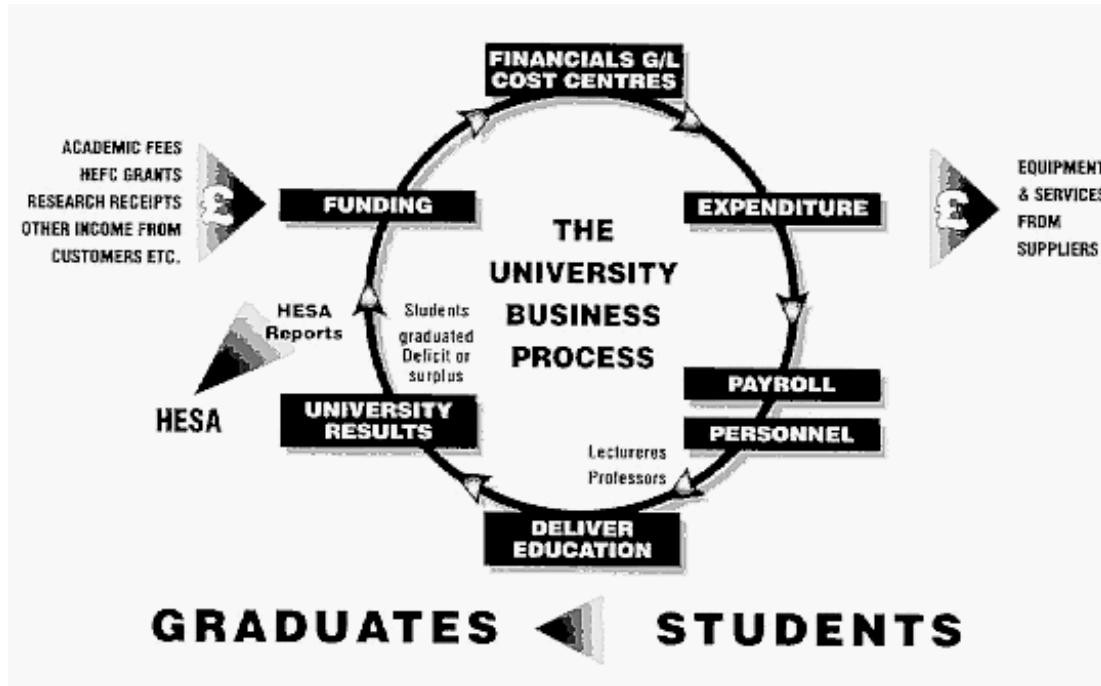


Figure 2: Higher Education Dynamics as per Dearing Report (1997)
 [source <http://www.sap.com/uk/>]

3.3 Spreadsheets

Problems in the utilisation of spreadsheets were examined in Kennedy (1997), which described our experiences in replicating spreadsheet models of investment appraisal and higher education into a SD environment. Though spreadsheets are selected for the vast majority of business modelling purposes (Clarke and Tobias, 1995), some disadvantages of spreadsheets have become apparent. They have often become unwieldy and inaccurate, but more fundamentally, they only incorporate the 'hard' aspects of the environment. Clarke and Tobias (1995), reported that a significant proportion of their survey respondents claimed that spreadsheets were overly complex, difficult to use and inflexible. Other disadvantages included lack of robustness, lack of data security and integrity. For a modelling tool to be of analytical and predictive use, it should reflect both the internal and external factors that affect the way business' operate or the ability to trace the structure and underlying assumption in the mode. This is one of the fundamental conceptual weakness of a spreadsheet compared to a SD environment.

3.4 Performance Indicators

3.4.1 Influence of Quality/Performance Measures and Indicators on funding

Performance indicators [PIs] are statistics, ratios and other quantitative information, which indicate the way in which a program of study or a college is operating. The PIs 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. They 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 PIs are not used to facilitate decision making and day-to-day management, they are likely to fall into disrepute and be disregarded.

PIs have been highly controversial in the UK. Cave et al. (1997) state that, "The explicit introduction of PIs into higher education in the UK was the product of a highly political process involving the government, the Committee of Vice-Chancellors and Principals (CVCP) and the then University Grants Committee (UGC). As such it exemplified a significant dynamic in the evolution of higher education policy in the 1980s."

The main desirable features of PIs 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.

Although there is not, as yet, an overt connection between PIs and funding, there are thought to be some influences.

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.

For the categories listed under other income discussed above, the system of performance or quality measure is the same as with any commercial activity. A contract is formed for a piece of work which has explicit and/or implicit quality definitions. The work is undertaken and the performance of the team can be assessed in terms of adherence to budget and timescale and the "product" assessed for its quality. The reputation of the team and the consequent ability to win further contracts rests largely on those measures.

A similar situation occurs with the research grants. Whatever the source of the funding, the project proposal would have been comprehensive in terms of the costs, deliverables and the deadlines. There are also provisions for interim reviews of the work and the budgets, and this is a particular feature of EU research grants. Consistent failure to deliver on any of these fronts would have an adverse effect on future funding applications no matter how eminent the research leader.

Feedback on these two areas is related in the way in which it influences other income generation, research grants and the Research Assessment exercise. One of the factors considered in the last RAE was the extent to which the research group generated external funding in the form of research grants or contracts with industry. The degree of importance attached to this aspect varied between subject areas but in some (such as some engineering disciplines) it carried considerable weight. As mentioned above, the RAE ratings certainly determine the amount of the research component in the main grant. However, the rating signals an important quality message about the

research work of that group. Many referees to research grant applications will be aware of the rating and will be influenced by it. In addition, the rating is likely to be known to major companies that may be approached to fund research, development or consultancy. Consequently, the level of activity can be influenced by the RAE rating which itself is influenced by the funds generated.

The effect of external performance and quality measures on the teaching grants is less direct. Each year notional targets are set for the recruitment of students within the price groups. Although target numbers can be varied by the institution between the price groups, differential pricing means that the virement is not on a one-to-one basis i.e. a shortfall of one engineering student, requires almost two additional business studies students to compensate. Once the recruitment round is complete, the current student population forms the basis of the following year's targets. In addition to the grant effects, each student not recruited means a loss of the fee that the student (or their sponsor) would have paid. Consequently, recruitment to target is a crucial factor in the financial well-being of the institution.

Students pay a significant proportion of their teaching costs and are responsible for all of their support expenses. This means that their choice of institution is likely to be more considered than when higher education in the UK was subject to the award of grants to cover tuition and living expenses. Any information can inform that choice and the recent publication of the teaching quality scores for university departments, their research ratings and other data that can be presented in the form of "league tables". Although at present, the teaching grant is not adjusted with reference to any of these PIs, the funding councils reserve the right to do so. However, students who are aware of these indicators could be influenced in their choice of which institution to attend; and these decisions will affect the overall recruitment and therefore the funding.

As well as the general concerns over league tables there is debate over the validity of the formulation of individual indicators. The government's of formulation 'employability' is currently being hotly contested by vice- chancellors and education secretary David Blunkett (THES, 1999). Some of the other factors that are used in the preparation of league tables are more controversial and have, in many cases, been ill-thought through. Examples include the staff-student ratio (SSR) and the number of first class honours degrees awarded. A low SSR could be considered a positive aspect (more face to face contact between students and staff) or negative (inefficient use of resources). A university awarding a high number of "firsts" may be a highly effective teaching institution or may be thought to have lower than average standards. Perhaps the most controversial element concerns the entry qualifications and the retention of the students. Institutions with a mission to widen access to higher education necessarily take on students with non-standard entry qualifications. The majority of these students are successful but they are a "high risk" group in that a number will not be able to cope with a full programme. Such institutions are penalised in league tables on both counts because in the absence of genuine measures of added value in education, their success in adherence to their mission cannot be properly reflected.

4. Current (SD) Contributions to Higher Education

Some preliminary attempts to use System Dynamics to explore and understand High Education planning effectiveness (Barlas and Diker, 1996) and Higher Education

Funding (Kennedy, 1997) have been made, but this paper suggests that a much more comprehensive application may be possible. In the closely related field of quality, Kennedy (1998a, 1998b), has examined some issues and described a prototype model. In the author's opinion, is now an appropriate time to critique the work done to date.

The main objective of Barlas and Diker's (1996) research is to construct an interactive dynamic simulation model, on which a range of problems concerning the academic aspects of a university management system can be analysed and certain policies for overcoming these problems can be tested. More specifically, the model focuses on long-term, strategic university problems that are dynamic and persistent in nature, such as growing student-faculty ratios, poor teaching quality, low research productivity. The model generates numerous performance measures about the three fundamental activities of a university, namely, teaching, research and professional projects.

Carol Frances and co-workers (1994) have reported on several interventions by using system dynamics to improve planning and budgeting for higher education both to inform public policy /State Management [Results from Arizona] and to inform university wide policy [Results from Houston, Texas]. She has also reflected on wider issues in 'Shaping Higher Education's Future'.

Peter Galbraith, (1998a, 1998b) has investigated the impact of managerial policy on HE institutional performance, with particular emphasis on time delays between policy change and the results being evident and has posed the question "Are Universities Learning Organisations?"

5. Future Contributions of System Dynamics to HE Resource Management

The potential combination of SD to IS/IT HE management appears to lie in four areas:

Firstly, at the most basic level, in some cases it may be possible to replicate existing models developed originally using other modelling styles or techniques. In this domain this is normally spreadsheets. The author has described various replications of this sort (Kennedy, 1997a; Kennedy, 1997b). This process may be of value in convincing managers that they are not losing desirable aspects of their current systems, in better handling any dynamic behaviour incorporated in the previous model, in building confidence in SD models and in giving some secondary benefits such as better documentation, but it will not generally realise the full potential of SD. In some cases, it may allow for the incorporation of other factors (e.g. intangible benefits) that were not incorporated before, or any dynamic behaviour known of but not previously incorporated, in an enhanced model. It could also form the basis for a more radical reconstruction incorporating tried and tested elements of the previous [non SD] model.

Secondly, it is possible to produce SD models of some of the issues mentioned in this paper. Some prototype examples (Figures 3 & 4) follow as a basis for discussion. The requirements for such a model need to be identified and analysed effectively, particularly as requirements change over time, as management changes its decision styles, and staff need new operational data and information. Delays between action and result are of particular importance.

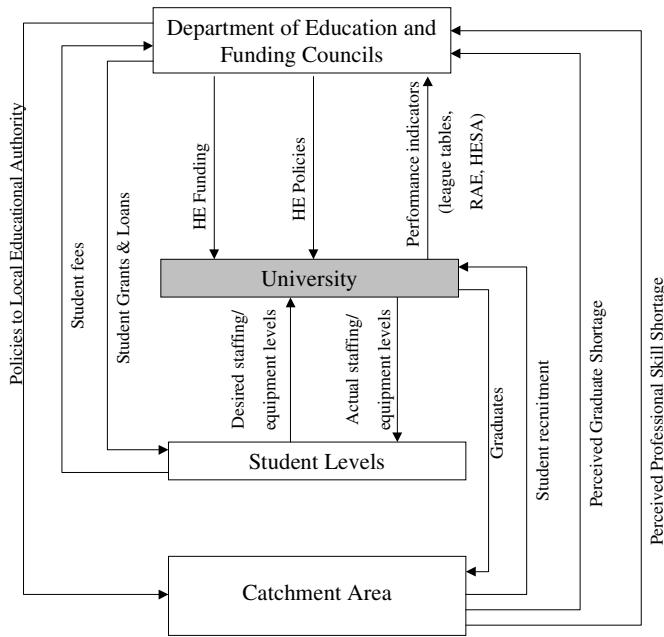


Figure 3: Block Diagram of Major Feedback Structures in HE Management at an Institutional level

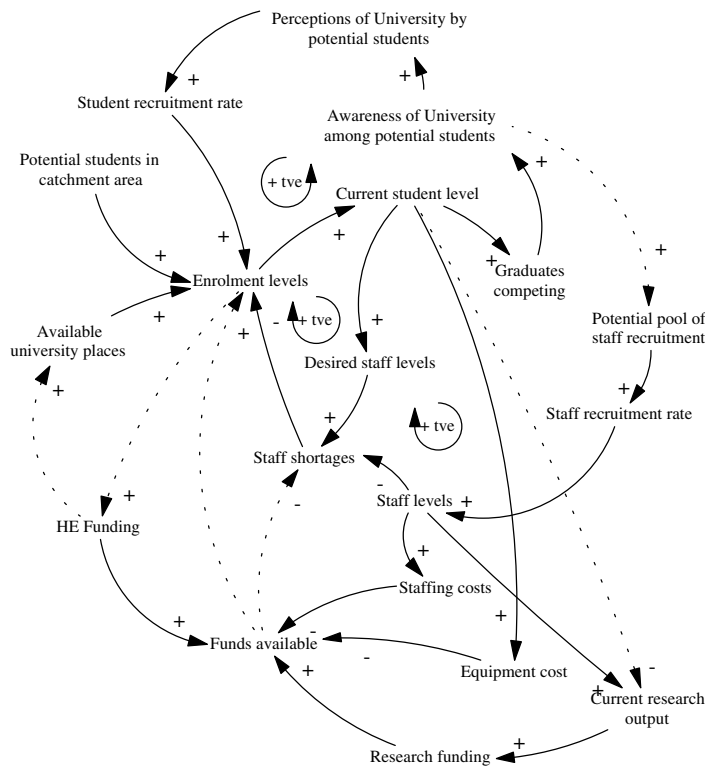


Figure 4: High Level Dynamic Hypothesis of HE Management

Thirdly, we may develop models of a business showing HE management processes before and after a proposed process change. The anticipated value of the benefits derived, (in terms of greater revenues, resources saved or perceived improvements in

quality or reputation), can be compared to the estimated costs. This would be of considerable value in “Transformation” type projects.

6. Conclusion

Based on the discussion above we would propose three research themes:

6.1 Higher Education Planning: Where Next?

The objective would be to examine the theoretical justification for HE planning approaches and tools. It would contain a review of current higher education approaches to planning including input/output models, regression models, spreadsheets and compare the potential of SD. It would also highlight the meta-theoretical assumptions underpinning these planning approaches

6.2 A Critical Review of System Dynamics Models that Investigate Higher Education Issues

The objective would be to identify relevant SD structures for incorporation in future work, to examine the appropriateness of different styles of SD modelling in this area, so guiding the selection of an appropriate research approach. It would describe the key findings of previous authors (including Barlas, Frances, Galbraith, Radzicki, Saeed) research and outline their underpinning research approach.

6.3 Highlighting Important Higher Education Management Issues

The objective would firstly be to identify “The Givens” in Higher Education e.g. in the UK the Research Assessment Exercise [RAE]. It would then examine the various conjectures on the way that “The Givens” influence the structure of higher education systems and policy formulation. The work could be done at four Hierarchical Levels:

- International/National
- Regional/ Cluster
- Institutional/ University
- Departmental

7 Summary

The potential value of SD for HE management is in incorporating non-linear and iterative views, hard and soft issues, strategic objectives, and changes in educational processes. A SD model of the resource allocation process 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 of higher education institutions in many parts of the world.

It is emphasised that this review is reported as the early stage of a long-term project. The authors would welcome comments from these with an interest in the field, particularly those interested in some form of continuing dialogue or collaboration.

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