

## Capacity Management for Continuous Improvement in Distance Education

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### **Abstract**

The most significant trend in education in recent times is the rapid growth of distance education. Many traditional universities are investing in the technologies available and the required infrastructure. Distance education is being used extensively as the vehicle for reaching students isolated by distance, geographical barriers or life circumstances. However, in delivering distance education these universities and colleges are constrained by limited resources, including the amount of funds available for spending. Many state-funded institutions, monitored closely by their various governments, are demanding greater accountability and also the delivery of quality education. These institutions have suffered financial setbacks due to financial difficulties at the state level; and this situation is compounded by a resistance by students to tuition increases. These tertiary institutions, especially in small island states, are forced to operate with these constraints while satisfying demands for increased access, conserving resources, controlling costs, and finding alternative sources of revenue, at the same time trying to maintain optimal capacity levels. This paper discusses capacity management and continuous improvement as a means of satisfying the above conditions within a distance education framework. It advances the idea that before there is any consideration of greater investments to increase existing capacity, the educational institutions first confront the situation as a management problem by using the techniques of the Theory of Constraints (TOC) and Total Quality Management (TQM).

### **Introduction**

Many modern tertiary educational institutions are now faced with the challenge of a consistently growing demand for places in various academic programmes. Increasingly, the challenges for access to these programmes are from potential students with geographically distant and culturally diverse backgrounds. Many educational institutions have responded to the

demand for increased access by adopting distance education as a mode of delivery and they have created virtual universities. An appropriate definition of distance education (DE), as proposed by Delling (1966, 186), is that:

Distance Education is a planned and systematic activity which comprises a choice, didactic preparation and presentation of teaching materials as well as the supervision and support

of student learning and which is achieved by bridging the physical distance between student and teacher by means of at least one appropriate technical medium.

Delling sees distance education as a multidimensional system of learning and communication processes, with the aid of an artificial signal carrier (Keegan, 1996, 57). Saba (1999) postulates that, "a systems approach is necessary to describe distance education and define a set of prescriptive principles and rules for its effective use, as well as a set of criteria to determine its effectiveness."

The systems approach to defining and analysing the organization and its processes is now widely accepted. Modern organization theory has moved away from a highly structured, closed-system approach towards the open-system approach. Scott and Mitchell (1972, 55) state that:

The distinctive qualities of modern organisation theory are its conceptual-analytical base, its reliance on empirical research data, and, above all, its synthesising, integrating nature. These qualities are framed in a philosophy which accepts the premise that the only meaningful way to study organisation is as a system.

Distance education institutions and the processes in distance education, in a similar way, may be conceptualized and analysed from a systems perspective.

Delling's definition also highlights communication processes and such communication has to take place by the use of one or a number of technological media: print, telephone, teleconference, audio, video, broadcasting, computer. The systems concept therefore incorporates these methods of communication.

One of the major virtues of distance education is that it can absorb the constraint on enrolment that is created by the physical limits of the campus facility. Enrolment is increased because the physical capacity of the campus or the geographical constraint of distance away from it no longer restricts access. In effect, additional capacity is created through distance education and its use of the technological media.

Although, theoretically, additional capacity is created through distance education, sometimes bottlenecks occur in the processes, which then diminish the gains achieved through distance education. It is important, therefore, that the management of distance education views distance education as a system with many related processes and that they manage these processes.

### **Education Processes**

A process is the transformation of a set of inputs into outputs that satisfy customer needs and expectation. The inputs can be such things as actions, methods and operations and the outputs are in the form of products, information, services, etc., and are transferred to someone – the customer (Oakland, 1994, 14).

The education process, then, provides inputs in the education of students who emerge out of the education system as graduates, the final product. As such, every task in education, whether it is distance education or otherwise, must be viewed as a process. To produce an output that meets the requirements of the students or any customer in the process, it is necessary to define, monitor and control the inputs in the process, which in turn may be supplied as an output from an earlier process. For example, print materials may be the output from the printing department, but they are

inputs to the actual student learning activities.  
*Examples of processes in a university include:*

1. Admission - the process of student's matriculation
2. Teaching - the process of didactic inculcation of knowledge and skills
3. Curriculum development - the process of subject content definition
4. Print materials preparation - the process of educational literature expansion
5. Print materials distribution - the process of teaching material delivery
6. Computer and information services - the communication and information flow
7. Student support services - the process of student accommodation and acculturation

In reviewing such processes from a distance education perspective one has to determine, among other things, the demographic composition of the distance students, their specific needs, their biases to learning and the currently existing economic proclivities of these students/customers.

Importantly, every distance education institution must define its processes and ensure the integration of these processes. In these organizations there are many participants in the various processes, including: academics, subject matter experts, editors, instructional designers, graphic designers, tutors, exam invigilators, who generally work in administratively distinct units of the organization. Therefore, according to Woudstra and Powell (1989), "in distance teaching institutions, intra- and inter-departmental linkages are critical to efficient and effective education."

Since the organization is viewed from a systems perspective, management must always be

mindful of the functional interconnectedness of the various processes. The improvements in one process must be accompanied by improvements in related processes and it must also be monitored carefully to avoid the loss of benefits from improvements gained elsewhere. For example, the print quality of materials for students may have been improved, but if there are bottlenecks in the distribution process, this enhanced print material may reach students after the required time for its use, thereby diminishing the benefits from the improved quality. This further amplifies the usefulness of the systems approach because, according to McMullen (1998, 26), "it [the systems concept] helps to show that things that appear to be different and separate are actually one and interrelated."

The starting point in defining and shaping the processes in education is an understanding of the customer's needs and wants (*the customer - product - process cycle*). Since the inputs and outputs change with the scope of the process, process definition becomes important, and process improvement becomes critical. To begin with, in DE there are at least two "customers": (1) the students, and (2) those who will use the services of those students. In creating the processes of education, it is a fundamental requirement that there be clear articulation and understanding of the needs of those who will use the services of those students who graduate from the various programmes. Adequate insight into customer needs leads to product/service definition, which in turn leads to a full description of process parameters and definition of processes (Creech, 1995, 193).

Once the processes are defined and set in motion, the execution becomes the next major issue. This involves moving from the *customer*

- *product - process* cycle to the *process - product - customer* cycle. In the first of the two cycles, the customer is used as the guide in the product and process and in the second cycle, the customer is the ultimate judge of the product. "Quality is what the customer says it is" (Stanleigh, 1992).

## **Capacity and Possible Capacity Measures**

Capacity is defined and measured in terms of the facility being used to provide the product or service (Maguire and Heath, 1997, 26). The term capacity, in this sense, implies an upper limit or a constraint on facility utilization. In deciding on the best measure of capacity, institutions may choose from a range of options, all of them representing varying levels of capacity. These options include theoretical capacity, practical capacity, normal capacity and budgeted capacity.

- Theoretical capacity assumes that all personnel and equipment will operate at peak efficiency. It is the maximum sustainable rate of output of that facility over its estimated useful life. It is theoretical in the sense that it does not allow for stoppages or interruptions. There is no speculation about future technologies; neither is consideration given to the appropriateness of the existing facility. For example, teleconferencing, videoconferencing and other modes of delivery should be operational 24 hours a day, and every day.
- Practical capacity factors in lost time due to non-working days, such as shutdowns for holidays, Sundays and any unavoidable operating interruptions. Practical capacity also includes idle capacity imposed by industrial conventions and other things, such as union agreements, which can

control the working hours and staffing levels. In instances where idle capacity is beyond management's control, such as may be imposed by legislative agreements, the idle capacity does not represent waste. In operating at the practical capacity, management may choose to operate at a capacity level below theoretical capacity. However, care must be taken not to set the activity at a level that hides inefficiencies.

- *Normal capacity* allows for human and equipment inefficiencies and idle time.
- *Budgeted capacity* estimates the student demand for courses for the current year.

The management of distance education institutions must select the appropriate capacity option for capacity management in their organization. Practical capacity represents the output level that managers could reasonably expect. For distance teaching universities offering tutorial support, practical capacity would take into consideration a practical constraint such as the number of qualified instructors/tutors the university can afford to hire.

Capacity management is a concept concerned with the optimal use of existing facilities and incorporates decisions about expansion, contraction, replacement, or the use of alternative technologies (Maguire and Heath, 1997). Given that distance education programmes increase the intake of students, such increased enrolment can create pressure on the existing capacity's absorptive capability. But management may not have to resort to spending more money and increasing the level of investment to provide for any perceived shortage of capacity as a result of this expansion. An alternative approach would be to embark on a programme of capacity management for

continuous improvement. The aim would be to use the existing resources and infrastructure while achieving the desired expansion without impairing the quality of the education.

### **Continuous Improvement and Capacity Management**

“Continuous improvement (CI) is the relentless pursuit of improvement in the delivery of value to customers” (Maguire and Heath, 1997, 27). Continuous process improvement of quality (CI) is concerned with organizational transformation. By refocusing organizational attention on the quality aspects of its product or service, many of the ingrained “business as usual” norms start to collapse and the transformation is set in motion. The key concepts of continuous improvements are:

1. Planning the process and its inputs
2. Providing the inputs
3. Operating the processes
4. Evaluating the outputs
5. Examining the performance of the processes
6. Modifying the processes and their inputs (Oakland, 1994, 431)

From this list, it is evident that defining and implementing the process is an important element of continuous improvement. Once a process has been defined, established and proved capable of meeting the requirements, the next thing to do is to continuously improve that process. However, improving a process requires first acknowledging that there is room for improvement. Further, it must be a vision shared by all in the organization: that processes can be improved and, in turn, similar improvements will be realized in design, output and cost.

Improving the process may include eliminating steps that do not add value and generally cause unnecessary complexity. In this regard, CI drives out scrap, discarded work; removing the need to discard and start over work already done; and CI also drives out rework, which means eliminating the necessity to fix mistakes made earlier in the process. However, to eliminate scrap and rework, which are major goals of total quality management (TQM), CI requires the adoption of a philosophy of zero errors and zero defects and changing the institutional culture to ‘do it right the first time’. The desire to enhance quality must of necessity inspire the drive toward continuous improvement. CI in the quality of services in distance education can often be obtained without major capital investment, if the organization marshals its resources prudently, thoroughly understands the processes involved and the linkages of these various processes. As these improvements are made, changes are in effect being made by the organization or organizational transformation is taking place.

### **Process Improvement – Tools and Techniques**

The moment management embraces the concept of continuous improvement, it is in fact embarking on the principles of TQM, since the foundation upon which TQM is built is that of “continuous improvement in quality, productivity, and effectiveness” (Hanks, 1993).

In attempting to improve processes in the CI drive within the framework of TQM, there are certain tools and techniques that can be adopted. But one need first bear in mind that “in the never ending quest for improvement in the ways processes are operated, numbers and information will form the basis for understanding, decisions and actions; and a thorough data gathering, recording and

presentation system is essential”, which constitutes the basic elements of a quality system (Oakland, 1994, 215).

While the Japanese quality guru Ishikawa identifies seven basic tools that should be used to interpret and derive the maximum use of the data, Oakland (1994, 215) proposes the following extended version:

- Process flowcharting - what is done?
- Check sheets/tally charts - how often is it done?
- Histograms - what do overall variations look like?
- Scatter diagrams - what are the relationships among factors?
- Stratification - how are the data made up?
- Pareto analysis - what are the big problems?
- Cause and effect analysis and brainstorming - what causes the problems?
- Force-field analysis - what will obstruct or help the change or solution?
- Emphasis curve - what are the most important factors?
- Control charts - which variations to control and how?

These tools and techniques where used to manipulate existing data can produce a positive response in the way of continuous capacity improvement. Dilton-Hill and Glad (1994) point out that “capacity may change dramatically over time as a result of the following: continuous improvement, process reengineering, outsourcing . . .”. They also point out that successful continuous improvement programmes always lead to surplus capacity, because they attack quality problems (e.g.,

rework and scrap) and the excess time taken to complete a task. In essence, a programme of CI often uncovers excess capacity that was hidden by inefficiencies or some other factors, and thereby creates additional capacity.

CI also displaces the traditional standard-setting approach, which tends to build in hidden inefficiencies. With traditional standard setting there is an acceptable level of waste or spoilage and there is no institutional motivation to eliminate this, since it is considered normal. For example, an accepted level of student failure represents an acceptable level of spoilage or waste. When these students repeat courses this is considered rework. But the precise aim of CI is to eliminate rework. Consequently, reducing such defects created by traditional standards becomes a goal in the CI process; defects in a general sense meaning any measurable quantity that is in need of improvement (Kaplan, 1990). In this regard, data collection on student success rates and overall performances in distance education programmes become a basis for reviewing improvements over time.

CI is the means to an end and not the end itself: if the goal is to increase the intake of students by creating additional capacity while maintaining a high quality of education and maintaining or even reducing current cost levels, then CI is the means to the institutional goal. This goal may be expressed as the maximization of capacity with the existing infrastructure without increasing costs. This move away from increasing capacity and throughput through increased spending or at the expense of quality facilitates the idea that within the CI mode, management of institutions can increase throughput without excessive additional costs or at the expense of quality. It proposes through TQM that if an educational institution wants to increase its intake of

students using distance education as the expansion mode, the infrastructure of the distance education system need not necessarily be expanded to increase institutional capacity. Once the processes are determined by which distance education will be delivered, then, continuous improvement of those processes can satisfy the objective of increased intake of students without impairing quality or incurring additional costs.

### **The Theory of Constraints (TOC)**

In adopting a CI approach to processes, a review of all the processes and the nature of their interconnectedness must be undertaken. In that review the basic assumption that should be adopted is that there must be at least one process that is a constraint on the entire system. If it were not so, its output would be unlimited. This constraint may impede the capacity of the organization to perform at its optimal and the organization may therefore not operate at its defined capacity level as a result of this limitation. This may then prove to be a hindrance to the goal of the institution; it may also impact adversely on the cost of providing a service or it may even result in a reduction in revenue intake.

The TQM continuous improvement to process approach should be focused on the system constraint where improvements can have the greatest effect, because improvements in areas where there is no constraint may not actually lead to overall improvements in the system. Sometimes in a distance education setting there is an imbalance between the output capacity of the infrastructure and the actual student demand and this leads to either a surplus or a shortage of capacity. If there is a shortage, there must be a constraining resource in the system. CI has to be executed with reference to this

constraint. The theory of constraints (TOC) is a mechanism that can be used to identify that constraint and thereby provide an approach to eliminate the capacity shortages.

TOC is a management science mechanism developed by Eli Goldratt, who was concerned with managing production constraints in manufacturing enterprises. The techniques, just like other management techniques adopted from manufacturing enterprises, can be easily applied to constraints in any distance education institution. Justification for such adoption can be ascribed to Woudstra and Powell (1989), who have compared course development and client service in distance education institutions with the way in which a product moves through a manufacturing organization from supplier to user. Easterby-Smith (1987) has also lent support to such adoptions by suggesting ways in which corporate thinking may translate into a university setting.

TOC is a disciplined approach to verbalizing the intuition of persons in any organization. It allows the organization the opportunity to master the processes used to create breakthrough solutions using the cause-and-effect mode of thinking, and also to create other improvements that are well tailored to the unique challenges and opportunities of the organization.

TOC has as its core assumption that every real system must have at least one constraint. This constraint limits the system from getting more of what it strives for. McMullen (1998, 32) expresses the view that regardless of the goal, a constraint can be defined as anything that blocks the system from accomplishing its goals. Similarly, Noreen, Smith and Mackey (1995, 27) see a constraint in a system as anything that limits the system from achieving its objective.

If the existence of constraints is taken as a given, then the problem is to figure out how to optimize within the limitations it imposes. A continuous improvement approach is needed in breaking down the barriers created by the constraint and it also aids in the optimisation process. Indeed, Noreen, Smith, and Mackey (1995) express the thought that “the TOC approach to continuous improvement is a perfect complement to total quality management (TQM) - focussing TQM efforts with laser-like precision on the point in the system where they are likely to be most effective.” In other words, the institution should break the constraints rather than accept them and this can be achieved through the TQM continuous improvement approach.

Goldratt, the recognized authority on the subject, gives five steps for managing constraints that are very powerful tools for pursuing continuous improvement:

1. Identify the system’s constraint(s);
2. Decide how to exploit the system’s constraint(s);
3. Subordinate everything else to the above decision;
4. Elevate the system’s constraint(s);
5. If in the previous steps a constraint has been broken, go back to step 1 (Noreen, Smith and Mackey, 1995, 42-47).

Having posited these five steps, Goldratt specifically warns organizations not to allow inertia to cause a system constraint. He points out that many systems are limited mainly by policy constraints which, though logical when instituted, subsequently become outmoded and useless. Distance education institutions are no different in this regard. For example, in instances

where campus-based universities adopt distance education, many of the policies suited to campus-based education are not useful in the distance education environment and can actually create constraints.

Tobin (1995) suggests that there are some areas within the administration of distance education that are in need of further examination, including the organizational change that is required, the effectiveness of organizational structures established for distance education, as well as the nature and extent of inter-organizational cooperation, and professional development for the changing roles of faculty. Moore (1994) supports the need for continued examination of management issues in distance education. He too suggests that: “the major problems are associated with organizational change, change in faculty roles, and change in administrative structures”. Equally, Murgatroyd and Woudstra (1989, 15) observe that: “Of all the areas of study in the field of distance education, the field of management appears most neglected.” What may be inferred is that the management and administration of distance education may be operating with a set of outdated policies and procedures which effectively create management problems, such as the inability to cope with the changing demands being experienced by the organization. These outdated policies and procedures become constraints in the system. When a constraint is a policy, it should be replaced with a better policy. Therefore, steps 2 and 3 in Goldratt’s process of ongoing improvement should be excluded.

Where the constraint is the result of policy, an institution adopting distance education will therefore have to review its original policies on processes such as admissions, staff hiring, delivery modes, student assessments, etc. These

policies may be in conflict with the goal that the institution is trying to achieve through distance education and may well act as a policy constraint. In this regard, *The Thinking Process*, a set of analytical tools, is devised in the pursuit of solutions.

***The Thinking Process***

The Thinking Process is a set of analytical logic-based tools developed by the Avraham Y. Goldratt Institute (AGI). The process promises to help people diagnose problems, find solutions, and draw up successful implementation plans. The Thinking Process can be used to tackle policy constraints. It begins with the premise that to improve, people need to be able to answer three questions: “*What to change?*”; “*What to change to?*”; and “*How to change?*” The Thinking Process has formal analytical tools that are intended to help people answer these three questions (Noreen, Smith and Mackey, 1995, 48). The roles played by the tools are summarized below:

Once the core problem has been identified using the Current Reality Tree, the next question is *what to change to?* The persistence of a core problem often indicates that there is some conflict that blocks the resolution. Goldratt rejects any compromise solution in such a situation. His view is to identify the assumption that leads to the belief that a clean solution is not possible. The technique used to identify the assumption underlying the apparent conflict and to break the deadlock is called an “Evaporating Cloud”.

Once a solution is identified, a Future Reality Tree is used to check whether successful implementation of the injection will eliminate the symptoms or result in any negative consequences.

In answering *how to change?* all imaginable obstacles to implementing the injection are laid out in the Prerequisite Tree. The final tool is the Transition Tree and it identifies the specific actions that should be taken to overcome the obstacles identified in the Prerequisite Tree.

<p><b>What to change?</b> ◇ <b>Current Reality Tree</b></p>	<p><b>What to change to?</b> ◇ <b>Evaporating Clouds</b> <b>Future Reality Tree</b></p>	<p><b>How to change?</b> ◇ <b>Prerequisite Tree</b> <b>Transition Tree</b></p>
<p>Source: Noreen et al. <i>The Theory of Constraint</i></p>		

The Current Reality Tree is used to diagnose causes or core problems. Based on a pattern of observed symptoms or “Undesirable Effects” (UDEs) a common cause is deduced. The Current Reality Tree moves persons away from intuition to a formal cause-and-effect map constructed with the objective of identifying a few core problems that can explain all (or virtually all) of the observed Undesirable Effects. It answers the question: *what to change?*

The use of the TOC logic tree processes and the five-step TOC focusing process virtually forces management to home in on solutions with great impact results. The main results in distance education will be the enhancement of quality through the process of continuous improvement and the creation of additional capacity without significant additional capital investments.

## Conclusion

This paper proposes that the capacity of a distance education institution is sometimes limited by the constraints imposed by the structure of the system and the associated policies. It contends that it is possible through a process of continuous improvement to increase capacity without any attendant increase in cost or the sacrifice of quality. What is needed, it concludes, is the adoption of the total quality management (TQM) approach and the theory of constraint (TOC) focus in the search for solutions to the problem of capacity management in distance education. The paper also highlights that these two approaches are compatible with the process of continuous improvement. It further points out, albeit in a rudimentary way, that the theory of constraint (TOC) approach to continuous improvement complements total quality management (TQM) and assists in precision focusing of the TQM effort for continuous improvement.

For distance education institutions, continuous improvements using these approaches can result in significant cost savings through increased capacity. Increased capacity results in the intake of additional students, which can reduce the cost per student for the enterprise. While pursuing increased capacity, through continuous improvements, quality is enhanced.

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