

Determinants of Effective Capacity at Tertiary Institutions in Kenya.

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Abstract- The study aimed at identifying the determinants of effective capacity in tertiary education institutions in Kenya and to establish the relative importance of the determinants. The study was a descriptive survey where data was collected using questionnaires with both closed and open ended questions. A total of 60 respondents from 30 tertiary education institutions in Kenya were interviewed and the response rate was 78%.

Findings of the research indicated that there are many determinants of effective capacity in tertiary education institutions in Kenya. The most important were established as operational, facilities and human factors. Other determinants, in order from most to least important were process, external, policy, service, supply chain and other factors.

Index Terms- capacity management, effective capacity, operation management, service management tertiary institutions

I. INTRODUCTION

The services sector is gaining more and more relevance in the international economy; and as a result, research is being attracted in to the management of this field. There are numerous enterprises that currently develop their functions in the services sector. In spite of their particular characteristics of heterogeneity, perishability, intangibility and simultaneity, Hope and Muhlemann (1997) state that services also present similar problems to those of manufacturing. This leads to consideration of the possibility of extrapolating techniques traditionally employed in the manufacturing sector to solve problems of activities belonging to the service sector (Fry et al, 1994).

Capacity decisions are concerned with the ability of an operation to meet customer demand and to respond to changes in that demand over time. As such, they lie at the heart of operations management; since one of the main objectives of operations management is to satisfy customer demand. Not having sufficient capacity to meet customer demand means dissatisfied customers and lost sales opportunities. Having more capacity than required, implies under-utilized resources, which normally means higher costs than necessary and particularly higher unit costs (Dilworth, 1992).

Effective capacity refers to the volume that a workstation or process can produce in a given period under normal operating conditions. It is also defined as the actual maximum load or demand a device or system can carry or meet. Effective capacity can be influenced by the age and condition of the machine, the skills, training, and flexibility of the workforce, and the availability of raw materials Both these capacity decisions are

short term decisions and relate more to the team and individual resource level rather than to the branch or network which are associated with longer term increases or decreases in capacity such as building a new facility or purchasing additional equipment and recruiting substantially more personnel resource (Barnes, 2008).

Effective Capacity and its Determinants

The concept of capacity requires careful consideration, as it can involve decisions about the size and location of each of an organization's facilities, and the size, type and mix of equipment and the working practices (e.g. working hours and staffing levels) at a single facility. Once made, decisions about facilities and equipment can not be changed easily or cheaply and certainly not in the short term. However, there can often be more flexibility in deciding how to manage those facilities. Additionally, decisions about capacity inevitably affect an organization's ability to serve particular markets from any given location (Barnes, 2008).

Most operations don't normally work at their full capacity, as this tends to put a strain on both resources and people. Instead, they work at a lower level that they can sustain more comfortably over time. Based on this, there are two measures of capacity. The first is a designed capacity, which is the theoretical limit that can be achieved under ideal conditions with no disruptions or problems of any kind. The second is a more realistic effective capacity which is the maximum output that can be sustained over the long term under normal conditions. This allows for set-up times, breakdowns, stoppages, maintenance and so on. Thus, capacity is often not a fixed, absolute value, but it is an agreed quantity that can vary according to circumstances. Effectiveness measures how well an organization sets and achieves its goals (Slack, 2001).

The designed capacity might give a more stable upper limit but the effective capacity is more variable and depends on prevailing conditions. Such conditions are caused by changes in determinants of effective capacity, which are facilities, products and services, human factors, processes, supply chains, operational, policy and external factors. Facilities factors refer to layout, design, location and environment of the facility. Process factors refer to quantity and quality capabilities of the production system. Human factors refer to job content, job design, training and experience, motivation, compensation, learning rates, absenteeism and labour turnover and knowledge. Operational factors include scheduling, materials management, quality assurance and equipment breakdowns. Products or service factors are design and product/service mix. Policy factors refer to management policies of the firm concerning production. Supply

chain factors refer to the capacities of each player in the chain, both upstream and downstream. External factors are product standards, unions, safety regulations, pollution control and environment standards, stability of society and government (vanLooy, 1998)

Due to the high volatility of demand in services, capacity management is a must for every service delivery system if it is to offer high quality output. The education sector falls in the service industry. One of the characteristics of education service is that there is long time contact between the students and the lecturers, leading to loyalty. Capacity has to be well managed for that loyalty to be maintained (Fitzmmons et al, (1994).

Ochieng' (2006) in his study on capacity management strategies concluded that, although capacity management is faced by many challenges, good capacity management strategies are vital to the improvement of service delivery systems. Svetlana and Marc (2005), in their study on decision support system for managing capacity utilization in universities concluded that there is a need for academic workload management.

The above two studies highlighted the need for proper capacity management. To be able to manage capacity properly, the determinants of effective capacity in the specific industry need to be clearly understood. Once understood, the operations managers will then be able to manage each determining factor in the right way, thus leading to overall proper capacity management. It is in view of these observations that the need for carrying out research on determinants of effective capacity in tertiary educational institutions was established. The focus of this study was on Tertiary Educational Institutions in Kenya. The study sought to answer the question:

II. RESEARCH ELABORATIONS

Hayes et al (2005) defines capacity as the level of activity or output that can be achieved (by an operation, facility or organization) in a given period of time under normal working conditions. In a service setting, this might be the number of customers that can be handled between noon and 1pm. In manufacturing, this might be the number of books a printing firm can produce in a day. Capacity is a relative term; in an operations management context, it may be defined as the amount of resource inputs available relative to output requirements over a particular period of time (Klassen et al, 2002).

According to Armistead and Clark (1994), capacity management is the process of planning, analyzing, sizing and optimizing capacity to satisfy demand in a timely manner and at a reasonable cost. They also see capacity management as a process with a broad scope that brings together business, service, and resource capacity needs to ensure optimal use of the resources to achieve the required levels of performance. In this regard, the manner in which capacity is managed is influenced by objectives which determine what must be achieved by an operating system structure, which influences what is feasible. Capacity management, therefore, is the most critical and strategic decision area of operations incorporating decisions on how to balance demand and the capacity of the service delivery system to satisfy the demand. A service firm's success or failure in the process of balancing quality of service and resource management, expressed in terms of resource productivity,

depends on its skill in managing capacity to match demand (Armistead 1991).

Service capacity is related in many similar issues to manufacturing capacity, but there are several important differences. Jacobs et al., (2008) states that service capacity is more time- and location- dependent, it is subject to more volatile demand fluctuations and utilization directly impacts service quality. Services cannot be stored for later use, thus the capacity must be available to produce a service when it is needed. The service capacity must also be located near the customer. The capacity to deliver the service must be first distributed to the customer (either physically or through some communications medium); then the service can be produced (Donald, 2006).

The volatility of demand on a service delivery system is much higher than that on a manufacturing production system for three reasons. First since services cannot be stored, inventory cannot smooth the demand as in manufacturing. Secondly, customers interact directly with the production system and these customers often have different needs, will have different levels of experience with the process, and may require different numbers of transactions. This contributes to greater variability in the minimum capacity needed. The third reason for the greater volatility in service demand is that it is directly affected by consumer behaviour. For example, demand for rooms at a hotel is higher during weekends than on weekdays (Jacobs, 2008).

Capacity can be refined into two useful definitions of capacity: Design capacity and effective capacity. Design capacity is the maximum rate of output achieved under ideal conditions. Effective capacity is usually less than design capacity owing to realities of changing product mix, the need for periodic maintenance of equipment, lunch breaks, coffee breaks, problems in scheduling and balancing operations, and other similar circumstances (Angus, 1995).

In general, inadequate planning is a major limiting determinant to effective planning and sees the need to balance a firm's operating capacity as one way of solving this problem (Armistead, 1991). Many organizations operate below maximum processing capacity, either because of an insufficient demand to completely fill the capacity, or as a deliberate policy to respond to every new order. Often, organizations have some parts of their operations below capacity while others are at their capacity ceiling. It is the parts at capacity ceiling which are the capacity constraints and are causing bottle necks for the whole operation. These parts would have to be improved to ease bottlenecks that constrain the whole operation (Armistead 1991).

For efficient and satisfactory service delivery to the customer, operational factors such as appropriate scheduling and acceptable level of stock will be maintained to avoid late deliveries, while ensuring satisfactory after service support, inspections and quality control procedures. It is equally important to consider the acceptance level of performance in the face of external forces which include the need to comply with regulatory standards that demand heavy paper work. In summary therefore, the main determinants of effective capacity are facilities, product and service, process, human, policy, operational, supply chain and external factors (Thacker, 2009).

The design, location, layout and environment of the facility where production of goods or delivery of services is done are important components of a business's overall operations, both in

terms of maximizing the effectiveness of the production process and meeting the needs of employees (Jacobs, 2008). Layout decisions entail determining the placement of departments, work groups within the departments, workstations, machines and stock-holding points within a production facility. The objective is to arrange these elements in a way that ensures a smooth workflow (in a factory) or a particular work pattern (in a service organization) and also ease flow of information (Sherali et al, 2003).

A process is a set of logically related tasks or activities performed to achieve a defined business outcome (Hope, 1997). Product designers and manufacturing engineers are particularly interested in process capability and develop process capability studies to help them predict how well a process will meet the required specifications or tolerances and to specify the amount of control necessary as well as the equipment requirements. Process capability is a measure of the uniformity of a process, or in other words, a measure of the ability of the combination of inputs and resources- employees and other people, machines, methods and materials- to consistently produce a product or service within design specifications or tolerances. Inconsistency results in too much scrap rework and lost time; which leads to wasted material and labour time, and thus less capacity (in quality and quantity) (Namahias, 2001).

Flexible processes also account for more effective capacity management. Flexible processes are epitomized by flexible manufacturing systems on one hand and simple, easily set up equipment on the other. Both of these technological approaches permit rapid low-cost switching from one product line to another, enabling economies of scope (Ignacio, 2006).

Human capital is the contribution of people (their skills and knowledge) in the production of goods and services (Scarborough, 2003). Human capital contributes to the success of the firm in attaining its objectives and thus has to be properly managed. Human factors that affect capacity are job content, job design, training and experience, motivation, compensation, learning rates, absenteeism and labour turnover, and knowledge. Job content refers to all the data about an existing job, which activities are performed and what skills are required (Foot, 2008). Job design is the process of identifying tasks that each employee is responsible for completing. It affects job satisfaction and productivity. Jobs may be simplified, so that they involve few tasks, or they may be expanded, so that they involve many tasks (Lussier, 2009).

Employees have to be taught how to perform a new job. Training is the process of teaching employees the necessary skills to perform a job. Development is ongoing education to improve skills for present and future conceptual, and decision-making skills in managerial and professional employees. Training and development constitute a good investment because they benefit individuals, and their organizations, and the economy as a whole. An employee who has done a job for some time has more experience in it and is most likely going to perform better. With time, he masters the processes and reduces the number of mistakes in the production or service delivery

process. This increases his output, thus increasing the capacity of the organization. This also leads to motivation of the employee (Bagley, 2007).

The operations function is the ‘doing’ part of the organization and thus no organization can hope to be successful unless its operations are well managed. The activities of the operations function are central to achieving efficiency and effectiveness. Operations such as scheduling, materials management, quality assurance, maintenance policies and equipment breakdowns largely affect the effective capacity of the firm as it processes inputs into outputs (Dilworth, 2002).

One of the most critical factors in a committed and collaborative relationship between supply chain partners is trust. If trust is present, it can improve the chances of a successful supply chain relationship; if not, transaction costs can rise through poor performance. Effective communication throughout the supply chain helps a company improve the efficiency of its supply and logistics operations. Networked communications enable all members of the chain to share essential market and operational information, improving productivity and reducing time-to-market. Regular marketing communication also builds teamwork by keeping all parties informed on developments that impact their operations. By bringing together all parties through communication, a company can build an extended enterprise that operates as a single, coordinated unit (Hines, 2004).

A descriptive research design of a survey type was used to ascertain the determinants of effective capacity. Survey method of a cross sectional type is often used to study the general behaviour, attitudes, values and characteristics of a population through the collection of quantifiable information from the sample (Mugenda and Mugenda, 2003). Survey research is therefore a type of descriptive research.

A simple random sample of 30 institutions was used. Two employees were selected from each institution, resulting in a sample of 60 respondents. These included the people in charge of operations for each institution. These individuals were selected because they are directly responsible for planning in their institutions. Primary data was used for the study. The data was collected using a structured questionnaire consisting of open- and closed – ended questions. The questionnaires were administered using the drop and pick later method. The respondents of this study were the officers in charge of operations in the selected institutions. The closed ended questions were analyzed quantitatively based on weighted means and standard deviations and presented in tables and charts.

III. RESULTS AND DISCUSSION

Facilities Location, Design and Layout

The location, design and layout of the facility affect the effective capacity of the institution. The study sought to establish the extent to which the various elements of facilities design, location and layout were important to the institutions. The findings of the study were as presented in table 4-3-1.

factor	Descriptive statistics	
	Mean	Std deviation

space utilization	1.40	0.57
Government legislation	1.57	0.76
proximity to customers	1.57	0.79
safety factors	1.68	0.72
ease of communication & support	1.77	0.82
ventilation & lighting	1.79	1.44
fast service delivery	2.13	1.03
minimizing total costs	2.34	1.09
Facility attractiveness	2.51	1.05
Overall mean	1.86	

The results in show that space utilization, government legislation, proximity to customers, ease of communication and support and safety factors; ease of communication and support and ventilation and lighting were considered to be very important determinants of effective capacity (Mean=1). Fast service delivery, minimizing total costs and facility attractiveness were considered important determinants (Mean=2). This shows that facilities are considered very important as determinants of effective capacity in tertiary education institutions. They affirm Jacobs' (2008) proposition that; the design, location, layout and environment of the facility where production of goods or

delivery of services is done are important components of a business's overall operations, both in terms of maximizing the effectiveness of the production process and meeting the needs of employees.

Service Factors

The output rate of a service determines its effective capacity, according to Rhyme (1998). This is depends on the service mix, uniformity and design. The study sought to establish the extent to which the various elements of service were important to the institutions.

Factor	Descriptive statistics	
	mean	standard deviation
Service Mix	2.64	0.94
uniformity of service	2.85	1.03
service design	3.04	1.44
Overall mean	2.29	

From the results in table it was found that service mix and uniformity of service were considered important determinants (Mean=2). Service design was considered a neutral determinant with a mean of 3.04. The relatively low overall mean (2.29) is an indication that these institutions fairly consider service factors as a determinant of effective capacity. This is because they customize their services so much to cope with the growing demand. It hence concurs with Rhyme's (1998) observation that customized services lead to less capacity.

Process Factors

The tasks or activities in a process of offering a service determine the outcome of the service offered (Hope, 1997). These activities therefore determine the capacity of the institution. The study sought to establish the extent to which the various elements of process were important to the institutions.

Factor	Descriptive statistics	
	Mean	Std deviation
process capability	1.51	0.54
process flexibility	1.85	0.82
process simplicity	2.79	1.43

Overall mean	2.05	
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From the responses in table it was found that process capability and process flexibility were considered to be very important determinants of effective capacity (Mean=1). Process simplicity was considered a neutral determinant with a mean of 2.79. This infers that process factors are important in effective capacity. This is in line with Namahias' (2001) proposition that process capability and flexibility contribute to more capacity.

Human Factors

Human capital is essential to the operation of any business. According to Scarborough (2003) human capital contributes to the success of the firm in attaining its objectives and greatly affects its effective capacity. The study sought to establish the extent to which the various human factors were important to the institutions.

Factor	Descriptive Statistics	
	Mean	Std deviation
Labour turnover	1.68	0.83
Job content	1.79	0.62
Motivation	1.80	1.66
Absenteeism	1.83	0.68
Training and experience	1.85	1.17
Job design	1.96	0.87
Compensation	2.17	1.04
Learning rates	2.60	1.16
Overall mean	1.96	

From the responses in table, it was found to a very great extent that tertiary education institutions consider labour turnover, job content, motivation, absenteeism, training and experience job design as factors determining their human capital (Mean=1). Compensation and learning rates were considered important determinants (Mean=2). The results show high rating of human factors as determinants of effective capacity in tertiary education institutions. This affirms Foot's (2008) observation that; Knowledge is the firm's sole capability and is important to

sustained capability to compete. She further concluded that organizational performance depends significantly on how the organization manages knowledge.

Policy Factors

Management policies regarding the operations of the business affect its capacity (Barnes, 2008). The study sought to establish the extent to which the various policy factors were important to the institutions.

	Descriptive statistics	
	Mean	standard deviation
no. of working hours per week	1.80	0.84
performance measurement system	2.44	1.07
other capacity cushions	3.09	1.35
excess labour	3.17	1.45
Overall mean	2.63	

From the responses in table, number of working hours per week was considered to be a very important determinant of effective capacity (with a mean of 1.8). Performance measurement system was considered to be an important determinant of effective capacity (with a mean of 2.44). Excess labour and other capacity cushions were considered neutral determinants (Mean=3). The overall mean of 2.63 indicates that policy issues are important to the effective capacity of the institutions. Indeed the mean of 1.8 in number of working hours per week affirms Barnes' (2008) proposition that capacity is

particularly affected by management policies with regard to the number of hours worked each week.

Operational Factors

The activities of the operations function are central to achieving efficiency and effectiveness of its capacity, as observed by Hill (2005). The study sought to establish the extent to which the various operational factors were important to the institutions.

Factor	Descriptive Statistics	
	Mean	Std deviation
scheduling/timetable	1.36	0.69
managing equipment breakdowns	1.96	0.77
materials management	2.06	1.00
quality assurance	2.19	1.01
Overall mean	1.89	

From the results in table it was found that scheduling/timetable and managing equipment breakdowns were considered to be very important determinants of effective capacity (Mean=1). Materials management was considered an important determinant (Mean=2.06). Quality assurance was considered a neutral determinant (Mean=3.81). The very high overall mean of 1.89 shows that this function is very important to the effective capacity of tertiary education institutions. It is in agreement with Dilworth's (2002) observation that; the operations function is the 'doing' part of the organization and thus no organization can hope to be successful unless its

operations are well managed. He also argued that the activities of the operations function are central to achieving efficiency and effectiveness.

Supply Chain Factors

Rahman (1998) in his study on the Theory of Constraints concluded that each of the players in the supply chain has its own capacity limits, and thus affects the effective capacity of the entire system. The study sought to establish the extent to which the various supply chain factors were important to the institutions.

Factor	Descriptive Statistics	
	Mean	Std deviation
matching of supply to demand	2.60	1.12
effective communication	2.62	1.55
trust among partners	2.83	1.29
supply chain visibility	3.34	1.33
performance metrics	3.45	1.39
Overall mean	2.97	

From the results in table, important determinants of effective capacity related to supply chains were found to be matching of supply to demand, effective communication and trust among partners (Mean=2). Supply chain visibility and performance metrics were considered neutral determinants (Mean=3). The results indicate that supply chain factors are considered as determinants of effective capacity in tertiary education institutions. This is in line with Rahman's (1998) proposition

that; a firm's ability to use its own capacity is often directly dependent on capacity up and down the supply chain.

External Factors

Any business operates in an environment where there are definitely forces beyond its control, as indicated by Donald, (2006). The study sought to establish the extent to which the various external factors were important to the institutions.

Factor	Descriptive Statistics	
	Mean	Std deviation
market service standards	1.57	0.71
safety regulations	2.11	0.90
stability of society & government	2.60	1.18
pollution control & environment standards	2.72	0.96

trade/workers unions	3.66	1.56
Overall mean	2.53	

From the results in table, it was found that market service standards was considered to be a very important determinant of effective capacity (with a mean of 1.57). Safety regulations, stability of society and government and pollution control and environment standards were considered important determinants (Mean=2). Trade/workers unions were considered to be a neutral determinant (with a mean of 3). These results show that external factors are important determinants of effective capacity. The high mean of 1.57 for market service standards affirm Klassen's

(2002) statement that; the market sets the product/service standards, and the firm has to comply with that standard so as to remain competitive in the market.

Other Factors

There are other factors which affect capacity, but do not directly fit in any of the above named groups. The study sought to establish the extent to which other factors were important to the institutions.

Factor	Descriptive statistics	
	Mean	Std deviation
total quality management	2.70	1.48
IT based information system	2.85	1.47
part time employees	3.02	1.52
business process reengineering	3.26	1.61
organizational learning	3.40	1.27
outsourcing	3.57	1.35
Overall mean	3.13	

From the results in table, it was found that total quality management and IT based information systems were considered an important determinants (with a mean of 2). Part-time employees, business process reengineering, organizational learning, and outsourcing and were considered to be neutral determinants (Mean=3). The results show that there is a relatively low extent to which these factors are considered as determinants of effective capacity. However, total quality management and IT based information system stands out in this group with a mean of 2. This affirms how needful it is for education institutions to offer good quality services, with IT as an enabler as proposed by Barnes (2008).

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