

Productivity Improvement in Manufacturing Sector

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ABSTRACT

The term productivity can be used to examine efficiency and effectiveness of any activity conducted in an economy, manufacturing, business, government, or by individuals. For example, learning activities or studying methods used by students that include reading and/or writing the content of a topic and revising the topic by saying out aloud or rewriting, can be examined in terms of productivity. Efficiency, effectiveness and productivity can also be evaluated for businesses in service and production sector. Productivity however, is broadly evaluated mostly through service volume, delivery processes, and customer-perceived quality in services offered. In the context of the real world, productivity is mostly examined and evaluated with reference to businesses or an economy. This work discussed meaning of productivity and improvement of productivity in the manufacturing or production sector. It also highlighted terms used in relation to productivity such as efficiency and effectiveness.

(Keywords: productivity, improvement, efficiency, effectiveness, and production)

INTRODUCTION

Productivity is an overall measure of the ability to produce a good or service. More specifically, productivity is the measure of how specified resources are managed to accomplish timely objectives as stated in terms of quantity and quality [1]. Productivity may also be defined as an index that measures output (goods and services) relative to the input (labor, materials, energy, etc., used to produce the output) [2]. Productivity is created in the real process; productivity gains are distributed in the income distribution process; and these two processes constitute the production process.

Productivity has become a household word as almost everyone talks about it. Yet, the term 'productivity' means different things to different persons [3]. As a phenomenon, it ranges from efficiency to effectiveness; to rates of turnover and absenteeism; to output measures; to measure of client or consumer satisfaction; to intangibles such as disruption in workflow; and to further intangibles such as morale, loyalty, and job satisfaction. To put it bluntly, the definition of productivity is complex and this is because it is both a technical and managerial concept.

Productivity is a matter of concern to government bodies, trade unions, and other social institutions not minding the disagreements over its conceptualization by different groups and individuals [3]. Hence, discussing productivity at all levels is common because of the direct relationship between productivity and the standard of living of a people. It is perceived that the more different are the goals of the different individuals, institutions and bodies that have a stake in productivity as a problem, the more different their definitions of productivity will be. In addition, the production in a firm or country affect the productivity, the overall EU cost of poultry meat production from Figure 1 is higher than in any other region of the world according to Hannula (2002) [4]. This may affect the productivity of the EU.

To date, at least three perspectives have dominated the field of productivity namely economics, industrial engineering, and administration. These perspectives have complicated a search for any precise definition of the concept 'productivity'. One additional problem to the conceptualization of the term 'productivity' is the fact that productivity is not only to be defined and managed; it is also to be measured [6].

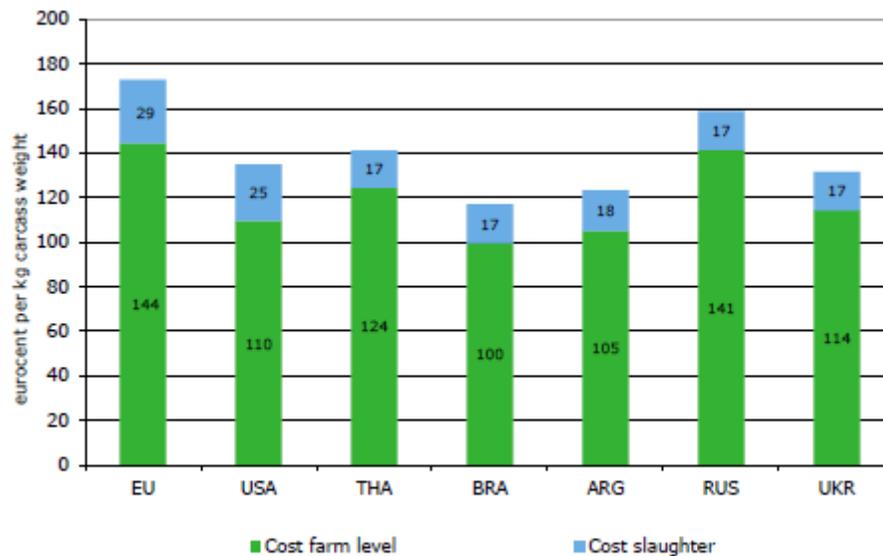


Figure 1: Broilers - Cost of Production and Slaughter in 2011 [5] (eurocent/kilo) (Source: van Horne and Bondt, 2014), Competitiveness of the EU Poultry Sector (LEI).

Its measurement poses no fewer problems than its definition. Perhaps, Krugman (1990) [7] intended to assert that defining or measuring productivity is a herculean task when he asserted that “productivity isn’t everything, but in the long run it is almost everything”.

Definition of Productivity

The least controversial definition of productivity is that it is a quantitative relationship between output and input [8]. This definition enjoys general acceptability because of two related considerations. One, the definition suggests what productivity is thought of to be in the context of an enterprise, an industry or an economy as a whole. Two, regardless of the type of production, economic or political system, this definition of productivity remains the same as long as the basic concept is the relationship between the quantity and quality of goods and services produced and the quantity of resources used to produce them [9].

Eatwell and Newman (1991) defined productivity as a ratio of some measure of output to some index of input use [10]. Put differently, productivity is nothing more than the arithmetic ratio between

the amount produced and the amount of any resources used in the course of production. Figure 2 shows wheat production in different country, some French or Polish farms show lower costs per tonne of wheat than some US farms. These costs of production greatly affect productivity.

This conception of productivity goes to imply that it can indeed be perceived as the output per unit input or the efficiency with which resources are utilized [12]. By way of analogy, Amadi (1991) explained that an example of productivity ratio is kilometers driven per gallon of petrol where petrol is the input and kilometers covered constitute the output [13]. However, input measure of petrol is not used to determine the efficiency of the car’s performance. Other related factors such as speed, traffic flow, the engine’s efficiency and the fuel’s efficiency are equally involved in the computation of the input index. The output measure of kilometers driven therefore becomes a gauge of the magnitude or effectiveness of the results achieved. Expressed simply:

Productivity = total output/total input which is identical to total results achieved/total resources consumed or effectiveness/efficiency [1].

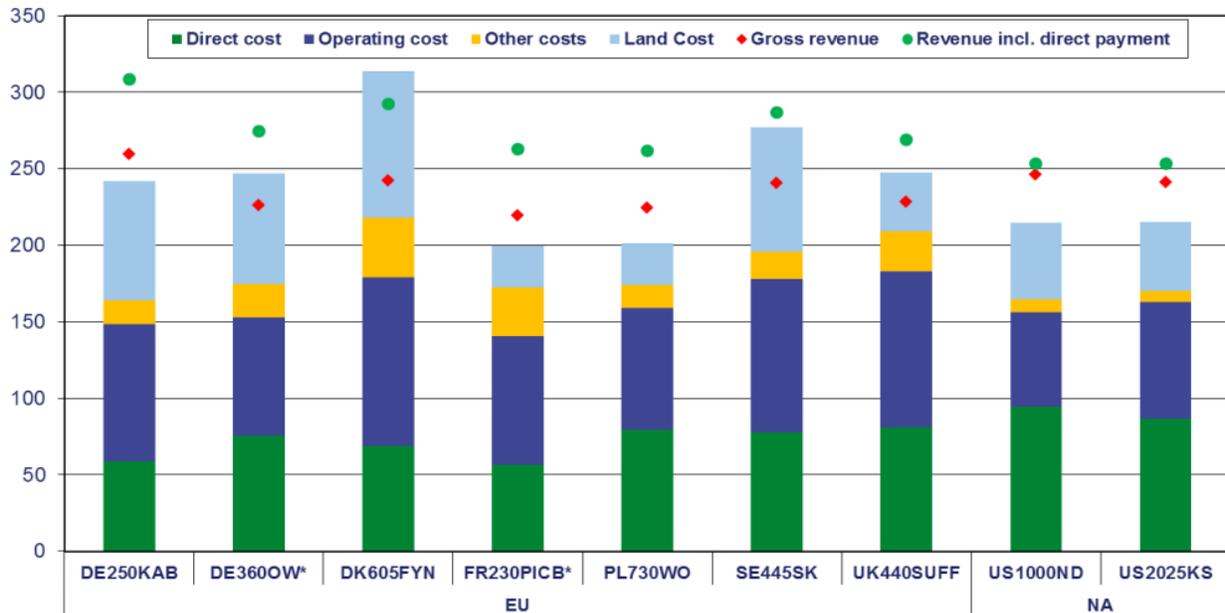


Figure 2: Wheat - Total Cost of Production [11].

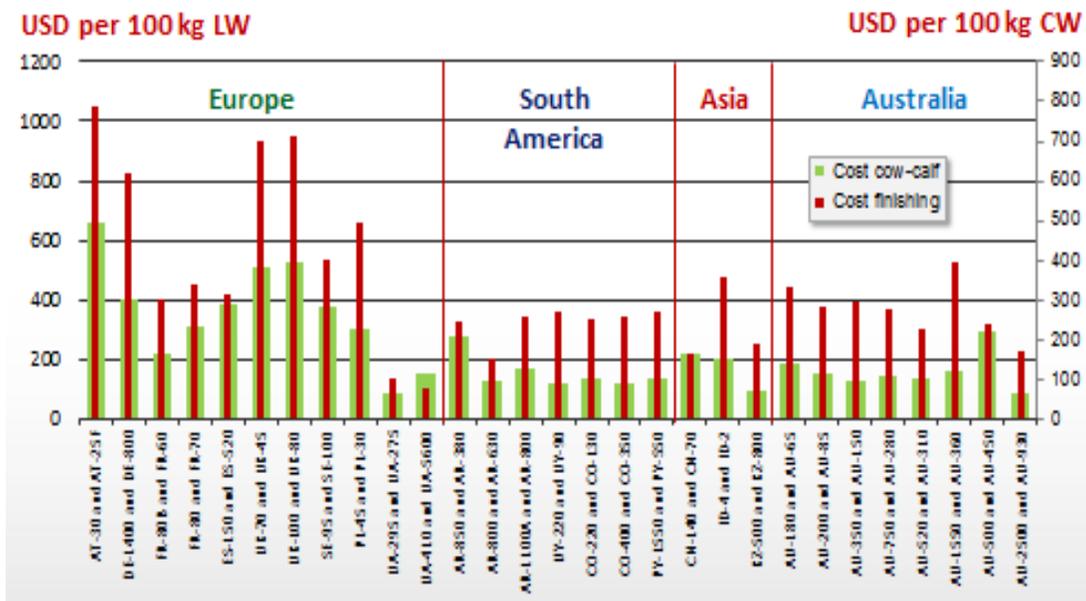


Figure 3: Beef - Total Cost of Complete Cycle Farms 2015 (Source: Agri Benchmark) [13].

In effect, productivity becomes the attainment of the highest level of performance with the lowest possible expenditure of resources. It represents the ratio of the quality and quantity of products to the resources utilized. Figure 3 shows the cost of meat production in some countries of the world which affect productivity.

For beef, production in Ukraine or South America is characterized by lower costs than in any of the EU reference farms followed (while some EU farms have similar cost levels as some Australian ones) [13].

It is evident in the literature on productivity that almost all the definitions of productivity centre on 'outputs' and 'inputs'. Unfortunately, definition of either output or input or both may sometimes pose more difficulty to the understanding of what productivity is. For output, it is in the form of goods, if visible, and services, if invisible. Inputs, on the other hand, are less easily defined. Since production (creation of goods and services) is a team effort thereby making the demand for inputs to be interdependent, various elements (inputs) are involved in the production of output. This makes the definition of input more complex than that of output.

To ease this problem of defining inputs, it is common a practice to classify inputs into labor (human resources), capital (physical and financial assets), and material. Again, in an attempt to circumvent the difficulty of defining inputs, productivity is sometimes defined as goods and services produced by an individual in a given time. In this sense, time becomes the denominator of output with the assumption that capital, energy, and other factors are regarded as aids, which make individuals more productive.

Olaoye (1985) observed that productivity as a concept can assume two dimensions: namely total factor productivity (TFP) and partial productivity [15]. The former relates to productivity that is defined as the relationship between output produced and an index of composite inputs; meaning the sum of all the inputs of basic resources notably labor, capital goods and natural resources.

Eatwell and Newman (1991) [10] captioned total factor productivity as 'multi-factor productivity'. For the latter, output is related to any factor input implying that there will be as many definitions of productivity as inputs involved in the production process whereby each definition fits a given input. For example, when output is associated to per man-hour or per unit of labor, this definition of productivity is a partial one and it relates to labor productivity.

Partial factor productivity is equally known as average product. Symbolically, if Y stands for output, and F_i for any individual factor, we have $APF = Y/F_i$ where APF is the average product. It only measures how the output per unit has changed over time, ignoring the contributions from other factors to the detriment of production process reality.

NECA2 (1991) observes that it is more common in productivity studies to see emphasis placed on labor productivity [16]. By coincidence, at the national level, labor productivity translates to what is known as human productivity. It is the type 3 of productivity that affects directly the purchasing power of the population since: National productivity = Gross National product.

Working Population

Theoretically, it goes without saying that there is a link between per capita income of an economy and such economy's marginal labor productivity. One justification for the special emphasis on labor productivity is perhaps because labor is a universal key resource. The term labor productivity implies the ratio of physical amount of output achieved in a given period to the corresponding amount of labor expended. By implication, productivity here means the physical volume of output attained per worker or per man-hour. However, apprehension exists on the definition of labor that is suggestive of the fact that labor productivity is an expression of the intrinsic efficiency of labor alone. Indeed, productivity is more of the end result of a complex social process involving science, research, analysis, training, technology, management, production plant, trade union, and labor among other inter-related influences.

Practically, the interdependence nature of the demands for factors implies that it is impossible to say precisely and clearly how much output has been created by any one of the different inputs taken by itself. The phenomenon is like attempting to answer the question: which is more essential in producing a baby, a mother or a father?

Some common misunderstandings exist about productivity. First, productivity is not only labor efficiency or labor productivity even though; labor productivity statistics are essentially useful policy-making data. Productivity is much more than just labor productivity and needs to take into account other inputs involved in the production process.

Secondly, productivity is not the same as increase in output or performance. Sumanth (1984) described this misconception as the confusion between productivity and production [17]. Output may be increasing without an increase in productivity if, for example, input

costs have risen disproportionately. One useful way to combat this misconception is to be conscious of the trend of input costs particularly by relating output increases to price increases and inflation. This approach is often the result of being process oriented at the expense of paying attention to final results. Bureaucratic settings are more prone to this misconception of productivity.

In an attempt to draw the line between productivity and output increase, the term 'productivity growth' is sometimes introduced whereby it denotes the rate of growth of the level of productivity. For example, if output per worker is 1,000 units in 1998, and it grows to 1,250 units in 1999, then it is said that productivity growth was 25% per year on the assumption that prices and input costs are constant.

The third misconception about productivity is the confusion between productivity and profitability. Profitability is a function of the extent of price recovery, even when productivity has gone down. Again, high productivity may not always go with high profit if goods and services produced efficiently and effectively are not in demand.

Confusing productivity with efficiency or effectiveness can equally cloud the meaning of productivity. Efficiency means producing high-quality goods in the shortest possible time. It is important to ask if goods produced efficiently are actually needed. Also, effectiveness refers more to the production of results. In the private sector for instance, effectiveness could mean making profit and preserving future market share. According to Scott (1983), efficiency and effectiveness are actually measures of performance just as productivity is equally a measure of performance [19].

Another misconception is a mistake of believing that cost cutting always improves productivity. Whenever this is done indiscriminately, it can even bring about productivity decline in the long run. It is equally not to be believed that productivity can only be applied to production. In reality, productivity is relevant to any kind of organization or system including services, particularly information. For example, improved information technology alone can give new dimensions to productivity concepts and measurement. Recent advancement in information technology seems to be suggesting that labor productivity may actually be subordinate

to the productivity of capital and other scarce resources such as energy or raw materials.

The concept of productivity is also being linked with quality of output; input and, the interacting process between the two. An important element is the quality of the work force, its management and its working conditions as it has come to be noticed that rising productivity and improved quality of working life go hand in hand.

In a nutshell, productivity is concerned with efficiency and effectiveness simultaneously. Lawlor (1985) sums up productivity as comprehensive measures of how efficient and effective an organization or economy satisfies five aims: objectives, efficiency, effectiveness, comparability and progressive trends [20]. No matter how it is perceived, productivity implies that there is an incremental gain in what is produced as compared with the expenditure on measures utilized

Productivity Improvement

Productivity improvement is one of the core strategies towards manufacturing excellence and it also is necessary to achieve good financial and operational performance [21]. It enhances customer satisfaction and reduce time and cost to develop, produce and deliver products and service. Productivity has a positive and significant relationship to performance measurement for process utilization, process output, product costs, and work-in-process inventory levels and on-time delivery. Improvement can be in the form of elimination, correction (repair) of ineffective processing, simplifying the process, optimizing the system, reducing variation, maximizing throughput, reducing cost, improving quality or responsiveness and reducing set-up time.

Capacity Management

Capacity management is responsible for all aspects of operations' capacity. It is generally responsible for matching the long-term capacity of a process to the demand for its products. It does this through capacity planning, which describes more specific methods for achieving this match.

Capacity management is the management of the limits of an organization's resources, such as its labor force, manufacturing and office space, technology and equipment, raw-materials, and inventory [22]. Capacity management also deals with the capacity of an organization's processes

— for example, new product development or marketing — as well as with capacity constraints that arise when various resources are combined.

The capacity of a business measures how much a company can achieve, produce or sell within a given period of time. For example, a call center can handle 7,000 calls per week, a café can brew 800 cups of coffee per day, a production line is able to complete 250 trucks per month, a service center can attend to 40 customers per hour, a restaurant has a seating capacity of 100 diners, etc. Since capacity can change due to seasonal demand, industry changes, unexpected economic events, maintenance and repair programs, etc., companies need to incorporate a system that always ensures the ability to meet expectations. This type of management process is referred to as capacity management.

Companies that integrate capacity management seek to ensure that adequate capacity is always available to meet current and future needs of a business and its consumers in a cost-effective manner. Capacity management requires a thorough understanding of how business demand influences demand for services, and how service demand influences demand on components.

Resources that may need to be adjusted depending on demand include on-hand inventory, labor capacity, service quality, office space, etc. Implementing capacity management may include structuring overtime shifts, outsourcing business operations, purchasing more equipment, leasing or selling buildings, etc. A company with a poor management system which sees customer demand, even if sudden, not fulfilled runs the risk of losing revenue, market share and consumers.

Inadequate or improper capacity management can affect a company's financial performance and impede its business prospects. For example, a company that has introduced an innovative new product and mounted an aggressive marketing campaign to promote it must have enough manufacturing capacity to meet the expected surge in demand. If manufacturing capacity is insufficient, the product may be sold out before it is replenished in retail outlets, which could lead to a shortfall in sales and cause disappointed customers to look for alternatives at competing businesses. Since capacity constraints in any process or resource can be a major bottleneck for a company, capacity management is of critical importance.

In order to manage capacity, a company must factor in the proportion of capacity that is actually being used over a time period. For example, consider a company's physical location operating at its maximum capacity of 500 employees across three floors of the building. If the company downsizes, reducing the number of employees to 300, it will be operating at a capacity of $300/500 = 60\%$ utilization. 40% of its office space is left unused, which means that the firm is spending more on production or unit costs even if its output has decreased due to the reduced labor force. To save costs, the company might decide to allocate its labor resources to only two floors and end its lease of the office space on the third floor. If it does this, the company will reduce costs for building rent, insurance, utilities and any other costs associated with the additional floor.

While businesses usually aim to produce as close to full capacity as possible to minimize production costs and to ensure its capital is not tied to underutilized resources, there are some issues with operating at high levels of capacity. The company may not have the time needed to implement proper quality control on its products or services, machinery and equipment might break down due to frequent use, and employees may suffer from stress and low employee morale if they are required to work overtime for a prolonged period.

Mean Time Between Failure (MTBF)

MTBF is the sum of the operational periods divided by the number of observed failures. If the "Down time" refers to the start of "downtime" and "up time" refers to the start of "uptime".

MTBF refers to the average amount of time that a device or product functions before failing. This unit of measurement includes only operational time between failures and does not include repair times, assuming the item is repaired and begins functioning again [23]. MTBF figures are often used to project how likely a single unit is to fail within a certain period of time.

One important aspect of MTBF is that those looking at these kinds of statistics should know whether the measurement applies to one unit that functions until failure, or a large number of different units run for a short time, where the MTBF represents the likelihood of failure during

this shorter testing phase. By itself, MTBF does not always indicate how long the test process is for a given unit. For example, if a thousand devices are run for several hours each and 1 percent of them malfunction, this will yield different results than if one unit is tested until it eventually fails.

Mean Time To Repair (MTTR)

MTTR is a basic measure of the maintainability of repairable items. It represents the average time required to repair a failed component or device. Expressed mathematically, it is the total corrective maintenance time divided by the total number of corrective maintenance actions during a given period of time. MTTR is a basic measure of the maintainability of repairable items [24]. It represents the average time required to repair a failed component or device.

Expressed mathematically, it is the total corrective maintenance time for failures divided by the total number of corrective maintenance actions for failures during a given period of time. It generally does not include lead time for parts not readily available or other Administrative or Logistic Downtime (ALDT).

In a fault-tolerant design, MTTR is usually considered to also include the time the fault is latent (the time from when the failure occurs until it is detected). If a latent fault goes undetected until an independent failure occurs, the system may not be able to recover.

MTTR is often part of a maintenance contract, where a system whose MTTR is 24 hours is generally more valuable than for one of 7 days if mean time between failures is equal, because its Operational Availability is higher.

However, in the context of a maintenance contract, it would be important to distinguish whether MTTR is meant to be a measure of the mean time between the point at which the failure is first discovered until the point at which the equipment returns to operation (usually termed "mean time to recovery"), or only a measure of the elapsed time between the point where repairs actually begin until the point at which the equipment returns to operation (usually termed "mean time to repair"). For example, a system with a service contract guaranteeing a mean time to "repair" of 24 hours, but with additional part

lead times, administrative delays, and technician transportation delays adding up to a mean of 6 days, would not be any more attractive than another system with a service contract guaranteeing a mean time to "recovery" of 7 days.

Cause and Effect Analysis

Common use of Ishikawa diagram is product design and quality defect prevention, to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation. Causes are usually grouped into major categories to identify these sources of variation.

Quality and Productivity Improvement

Today highly competitive world, quality plays a vital role as it leads to improvement in productivity. Productivity, quality, and cost of operation relatively depended to each other. The relation of productivity, quality and cost are shown in Figure 4. By improving the productivity, the quality also must be improved and hence lower the reject rates or defects.

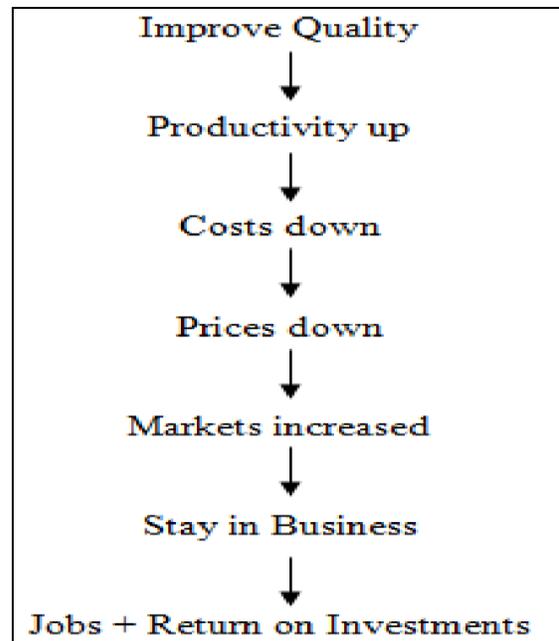


Figure 4: Relation Between Productivity, Quality and Cost. Source: Mohamed (2005).

CONCLUSION

Productivity enhancement as a process to achieves higher levels of output while consuming same or lesser amounts of input resources. The researchers believe that if the same output level is reached in shorter time, it indicates improved productivity. Productivity is also defined as the ratio of what is produced to what is required to produce it. Productivity measures the relationship between outputs such as goods and services produced, and input that includes that labor, capital, material and other resources. Besides that, how manager or supervisor can manage that issues. The factor of productivity is important in quality product. Sometimes the basic approach in productivity comes from management team. The other thing is how to apply technology and reduce staff.

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