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Abstract: Presents an analysis of productivity including definition/analysis, socio-economic implications, strategic implications, challenges and improvement techniques.

Productivity

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PRODUCTIVITY

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DEFINITION OF PRODUCTIVITY

Today, even though productivity is highly discussed, the concept is not really understood [15], [16], [17]. This is mainly due to the complexity of issues surrounding and affecting productivity [15].

A general definition of productivity is: "the relationship between the output generated by a production or service system and the input provided to create this output" [15]. In other words, it is a measure of the efficiency with which products are produced [18]. Thus, productivity is defined as the efficient use of resources; labor, capital, land, materials, energy and information in the production of various goods and services. On the other, since time is a universal measurement, productivity can also be defined as the relationship between results and the time it takes to accomplish them [16].

Regardless of the economic, political and manufacturing systems, the general definition of productivity remains the same [17]. Although, there is no one definition that everybody agrees on, the focus should be on the answer of do we get more output by using the same or less input than before [14]?

Generally speaking, productivity could be considered as a comprehensive measure of how organizations satisfy the following criteria:

Objectives: The degree to which they are achieved.

Efficiency: How effectively resources are used to generate useful output.

Effectiveness: What is achieved compared with what is possible.

Comparability: How productivity performance is recorded over time.

Though there are many different definitions of productivity, the most common approach to designing a productivity model is to identify the right output and input components in accordance with the long, middle and short-term development goals of the enterprise, business sector or country [16].

THE IMPORTANCE OF PRODUCTIVITY

Productivity increases as output grows faster than the inputs that are used. This increase is important at all levels may they be national, industrial, company wide, or personal.

At the national level, productivity is a major element of economic growth and progress. The growth of productivity also provides a proportionate offset to increases in wage rates and other input prices, thereby reducing the rate of inflation of output prices. Moreover, since the growth of total productivity means reduction in requirements for labor, capital, and natural resource inputs per unit of output, it contributes to greater leisure time, to increased consumption, and to conservation [19]. Increased national productivity not only means optimal use of resources, but also helps to create a better balance between economic, social and political structures in the society [16].

Productivity growth at the industry level, leads to relative decline in costs and prices. In both domestic and international markets, this increases the competitiveness of the firms of the progressive industries, which consequently tend to grow faster than average [17].

At the company level productivity is fundamental to profitability and survival. Companies in the higher level than the average tend to have higher profit margins. Moreover, if productivity is growing faster than that of competitors, the margins will rise. Conversely, below average levels and rates of productivity will ultimately lead to adverse situations for the organization [19].

Increasing productivity in all of one's activities is an important aspect of self-fulfillment. To the individual, as a member of firm or the organization, it serves as a key to advancement since it helps increase the productivity of the organization [17].

PRODUCTIVITY ANALYSIS

Productivity analysis is a very important tool for decision making which helps to determine priorities at all economic levels. It also helps to identify factors affecting income and investment distribution within different economic sectors[16]. Productivity measurement and evaluation can tell us when we are ineffective, inefficient, and when there is a potential quality problem [17]. Productivity measurement results guide where to look for opportunities to improve and also shows how well improvement efforts are proceeding. However, the success of productivity measurement and analysis depends on a clear understanding of its importance by concerned parties (enterprise management, workers, employer, trade union organizations, and government institutions). Thus, productivity measurement approaches differ depending on these parties [18].

The different approaches to productivity measurement in different sectors can be summarized as follows:

- In capital intensive sectors and operations an increase in productivity often reduces work-hour requirements and may be generated by additional fixed capital and not by labor. Here productivity can be measured in terms of productivity of capital only.
- In labor intensive sectors and operations an increase in labor productivity does not decrease the fixed capital requirements, but indicates an increase in the productivity of capital. For such situations it is sufficient to measure the productivity of direct labor alone [16].

At the national and sectorial levels, productivity indications help us to evaluate economic performance and the quality of social and economic policies. These policies influence such diverse matters as the level of technological development, the maturity of management and the labor force, planning, incomes, wages and price policies and taxation. Productivity indices are also used by local and central authorities to detect problem areas and to evaluate the impact of national development programs. They provide valuable, objective information for directing public resources [18], [19].

Productivity indices are also useful in inter-country and inter-firm comparisons designed to detect factors accounting for economic growth. That is why productivity measurement should be among the first priorities for any productivity improvement both at the national and enterprise level.

In enterprises, productivity is measured to help analyze effectiveness and efficiency. Its measurement can stimulate operational improvement: the very announcement, installation and operation of a measurement system can improve labor productivity, with no other organizational change or investment[19]. Productivity indices also help to establish realistic targets and check-points for diagnostic activities during an organization development process, pointing to bottle-necks and barriers to performance [16].

SOCIO-ECONOMIC IMPLICATIONS

As America enters the "Age of Productivity," there is a sense of urgency in increasing and maintaining a high level of growth in the economy. Corporations are striving to

make up for a period of economic stagnation during the late 70's and 80's, and again strive for leadership in the changing world economy. Restructuring of corporations and the drive for increased productivity has placed pressure on the American worker, who is faced with adapting to the new structure as well as learning the new technology [1]. Since the beginning of the Industrial Age, the worker has learned to adapt to a constantly changing economy, as new technologies make their way to the production line. Factors affecting productivity include material and labor costs. Implementation of new technologies enables a company to increase productivity, often with the same or fewer workers. GTE Corp's operation in the Tampa-Sarasota region of Florida is an example of the trend. The region's population and telephone system have grown approximately 7 percent per year, yet GTE has not increased its service staff. DuPont Co. has slashed it's middle and upper management ranks since 1991, plummeting employee morale. Subsequent reorganizations and restructuring finally resulted in improved earnings of 65 percent in 1994 [1].

Wages Remain Flat

As corporate productivity has grown significantly, workers' wages have not kept up. Even after adjustment for inflation, wages have remained stagnant in the 1990's [1], [10]. Recent trends have demonstrated that improved competitiveness and productivity do not necessarily translate into higher incomes. Companies are finding that there is a global pool of workers emigrating to the US who are willing to work for lower wages than their American counterparts. In the past, this trend affected factory workers, but now engineers and software programmers are also susceptible to foreign competition [10].

Plant Work Forces Reduced

In order to remain competitive with their foreign rivals, American companies have wrung concessions from their labor union, reduced white collar staff by lay-offs, invested in new automated equipment, and relocated some of their manufacturing facilities to areas with lower labor costs. The changes have had an affect on the labor market. Long-time employees who had developed a sense of job security suddenly found themselves looking for jobs at substantially lower wages. In order to reduce production costs, some of the companies looked elsewhere for new manufacturing

facilities. For example Briggs & Stratton Corp. found that wages for the available work force in Kentucky and Missouri were half of those in their home state of Wisconsin. The move will affect 2,000 of their 5,500 total workers [10].

Rise of Outsourced Labor

At its Oakland, California facility, American Airlines found that it can reduce the amount it pays it's ticket agents by more than half by using a contractor instead of it's own employees [10]. IBM also reduced its permanent staff and used contract programmers, reducing the average wage from $43 an hour to $28. This trend has created an industry in contractors providing lower cost services to many large corporations, replacing technical, clerical and administrative personnel. A host of professions that thrived in the '80s is now losing ground in their compensation. According to a national survey by Robert Half, "nearly 80% of the 142 job categories it surveys in accounting, information systems, and commercial banking received below-inflation raises" in 1994 [10].

Reduced Wages Equals Less Consumption

With the American worker making less money, consumers have pared their spending habits. "Growth in consumer spending is half the rate of the 1980's". "Since consumers comprise two-thirds of gross national product, per capita Gross Domestic Product growth is running substantially below historical trends" [10].

A More Efficient Work Force

A reduction of what some have considered to be "artificially high" wages have allowed many corporations to shift resources to capital spending. Investment in the use of new technology in production processes has created a work force with higher technical capabilities and the ability to work competitively. While the adjustment for the worker is difficult, the improved productivity helps place the US on the way to leadership in the global economy.

In the past, improvements in production efficiency have led to gradual increases in the workers' wages. Former Federal Reserve Board Governor Wayne D. Angell states "In

the long run, labor productivity will rise, and eventually will put upward pressure on wages" [10].

The Social Cost

With lower wages, more pressure is placed on the traditional family. The last 20 years have seen a decline in the single-income family (except in the cases of single parent families, which are on the rise). The burden on, and resulting shift in traditional roles may be one of the many root causes of societal problems. Lower pay often requires a worker to seek additional work, or both partners entering the work force to maintain a family's standard of living.

The short term unemployment created by corporate downsizing sometimes leads to alcoholism, divorce and other negative impacts on worker and family members. The economic burden on state welfare and other assistance agencies creates a higher tax burden, further reducing the workers' disposable income.

STRATEGIC IMPLICATIONS

Global and domestic competitiveness is on the increase today, making the companies re-organize themselves around new technologies in order to improve their productivity.

New Technology Implementation

A company, to be competitive, has to invest smart in appropriate new technologies[5]. But this is not enough, stopping at this stage can be disastrous to the future of the company. A new technology implementation goes hand in hand with the company's re-structuring to create new ways to do things. To make workers more efficient and more involved, the company has to break down the old functional structure, delegate sufficient authority and re-deploy the workers in multi disciplinary teams [3]. The company has to re-engineer, redesign the work and rethink everything it does before proceeding [2]. Because a new technology requires much experimentation and learning, the company has to create the structures to educate workers and managers who have to master unfamiliar skills in order to use the frontier technology [1], [2]. This requires time and money but additional innovations make it easier. Such as software written for

Microsoft Corp.'s Windows, is more efficient to use as compared to DOS applications [3].

Many companies do not reorganize themselves along with the implementation of a new technology or they keep the old ways of doing things. This limits the new technologies' power. Others do not spend enough time to educate management and workers, thereby making the new technology difficult and arduous to use.

Only after going through these laborious stages, can a company take full advantage of the new technology [5].

New Technology Impacts

New technologies enable both manufacturing and service companies to improve their productivity(see fig 1). GE-ED&Co., by implementing total automation manufacturing systems via CIM, met outstanding payoffs and reduced lighting panelboard plants from six to one, customer delivery cycle from two weeks to three days, total costs were down by 30%, while direct labor reduced by 55%. Inventory was reduced from forty five days to nine days while eliminating requisition engineering.

Caterpillar, by investing in information technology, improved customers' satisfaction owing to electronic ordering and customized products [2].

New technologies enable companies to improve the quality of services or goods while reducing total cycle time and cost. Companies are able to provide higher quality products or services at a lower price leading to improved customer satisfaction. Such an improvement makes companies more competitive and enables them to increase their market share. With sales increasing and lower costs and expenses, its stockholders' equity and earnings increase, in turn making it possible for them to invest in new technology [3].

"Catch 22": Productivity Leads to Productivity.

At the national level, productivity growth has many effects that implicate a productivity growth; this is a "catch 22" in a good sense of the word.

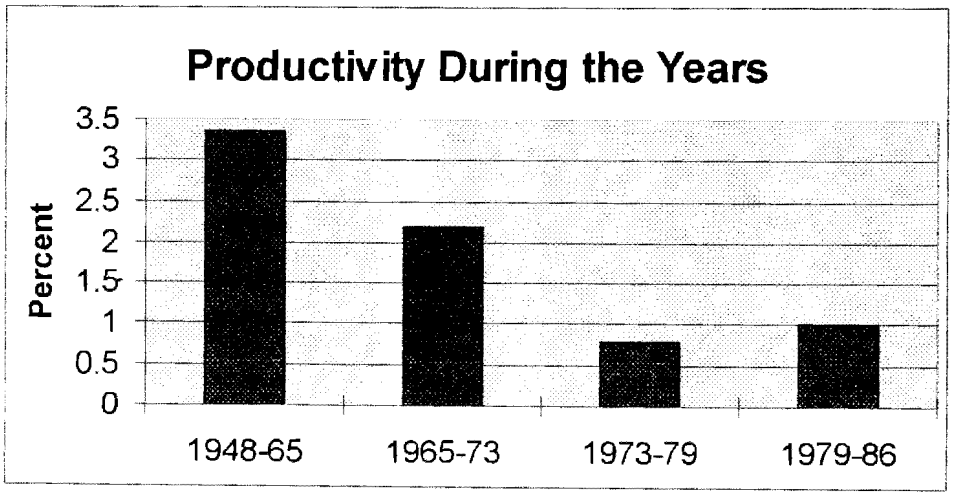
Skeptics think that this productivity expansion will not be followed by an income increase because wages are still flat [6]. This is a short term vision. Up to now, premium wages have been paid for skilled labor while non-skilled labor has not benefited.

Companies now spend more and more time and money in workers training and education and any additional innovations make the new technology easier to use. Thus workers will be more educated and be able to compete in the new economy(see fig 2) [1].

In the long term, wages will follow the productivity growth. This along with better quality and more affordable goods and services will increase the living standards, and boost the consumption. Because that technology will be more affordable, it will be implemented in companies ,making workers more effective in their jobs, leading companies to provide better products and services to this new consumer society [9].

CHALLENGES TO PRODUCTIVITY

Quality and productivity are two terms that come up more and more whenever there is reference made to the challenges faced by US companies in the global arena. Generally, whenever productivity is mentioned, it refers to that nations' labor productivity. Labor productivity is defined as the *'total output of goods and services during a year divided by the total hours worked by the nation's entire work force during that year'* [8], [11].



Source: Productivity Why It's The No. 1 Underachiever, Business Week, April 20, 1987

As the graph above shows, the US economy showed a slump in productivity until the late seventies and now is seeing a period of growth again. Still the US has to cover remarkable ground to come inline with the productivity shown by some other nations. The increase in overall productivity has been mostly in the manufacturing sectors [6],

[9]. Service related industries have shown a much slower growth in productivity. This is because service industries are generally more labor intensive and account for a larger piece of US employment and hence their larger effect on the productivity of the nation [8].

To be competitive in the global market, productivity is not the only issue. It is important that the quality of goods and services provided is of exceptional value to the customer [9]. Labor productivity no longer provides a total picture, with automation, computers and the use of robots in the industry, labor can be more easily substituted by capital [12].

IMPROVEMENT TECHNIQUES

All business organizations, may they be in the service sector or the manufacturing sectors are under pressure to increase productivity these days [8]. Both these types of organizations can be extremely labor intensive at times, leading to higher cost for increased productivity. Productivity improvement techniques can be divided into the following categories:

a. Skill Improvements

Productivity can be increased by working harder or more skillfully. Working skillfully and more intelligently is always a better option. This can usually be done by better employee training and selection procedures for the various skill levels.

b. Standardization of Production

By increasing the amount of standardization and utilizing more automation in the process, productivity can be increased. In the service sector, this would be akin to the use of an assembly line. Though the approach seems to be less personal, it has been applied in the medical industry (HMO's) resulting in higher productivity and lower costs for the same resources available [6].

c. Improved Design and Reduced Service

By designing products that require less labor to manufacture or assemble, the total output of the organization is increased. In the service industry if the need for that service in a repetitive basis is reduced, the total productivity is increased.

d. Substitution

By switching the burden of service to the customer, the firm is instantly able to increase its productivity. For example, the post office with its lower rates for pre sorted mail has been able to increase its productivity and better able to serve other customers by shortening the time waiting in line at the counters [9].

e. Reducing Downtime

The reduction of downtime in a manufacturing environment positively affects the productivity of the organization. As the utilization of the available machine time increases, the productivity also increases.

f. Utilization of Information Technology

Increased utilization of computers in everyday work, both for service as well as manufacturing organizations has resulted in increased productivity. As long as the various functions within the organization are able to restructure themselves around the technological advancement (reorganization of work), there is increase in productivity [11], [13].

On the path to increased productivity, the perception of quality by the consumer/customer should never be forgotten. Standardizing quality sometimes leads to increased customer satisfaction, but too much of it could lead to a 'generic' product without the personal touch.

CRITICAL ISSUES

Resistance to Change:

Implementing technology to increase productivity requires change. It is human natures to resist change. This resistance slows the acceptance of new technology. As a result it takes even longer to show gains in productivity from new technology.

Another consequence of this resistance to change is the parallel operation of both the old manual system and the new one. "Computerization decreased efficiency because until the new systems reach critical mass and, more important, won the full confidence of managers, they operated side by side with the old. manual way of doing things"[7].

"Imposing the technology over top of traditional work systems rarely works. The only way that real productivity gains can be achieved is by re-engineering work systems that is thoroughly re-examining the work methods to find new, more effective ways to perform tasks through the use of technology." [5]. "First you have to clear away the existing structure, a tightly organized whole in which everything is so intricately adapted to everything else that demolition is tough" [2].

Time Lag:

When new information technology is introduced, there is a time lag before productivity gains is realized [1]. The work force must be retrained and it takes time for workers to become familiar with the new technology. Until workers become familiar with the technology, productivity gains can not be realized.

There is a period of transition to shift the work force from a mass manufacturing skill set into the skills needed to be successful in an information based economy. Just as craft workers were replaced during the industrial revolution by machines, the workers that have been replaced by re-engineering will have to be retrained. "As more workers gain skills, the premium paid to operators of high-tech gear will fall, but overall wage will rise." "The march of the micro processor will also increase economic mobility as workers upgrade their skills and move up the earnings ladder." [1].

Accessibility:

When computers were first introduced, the only people who could operate them were well educated and had extensive training in computer programming and operations. "Technology may actually close the gap between the technoworkers and the less skilled. New graphical programs, such as software written for Microsoft Corp.'s Windows, are making computers more accessible to millions of workers." [3].

Litchfield states:

> " The other, more comforting reason that the technology revolution is finally here to stay is the overall friendliness of the new generations hardware and software. Whereas the "information solutions" of a few years ago had tremendous sales appeal, they were often opaque, cantankerous to use, cost too much and did too little. The problem lay in

> a simple law of nature: people will invest only so much time and effort in learning a new way to do things. Technology has finally gone to the grass roots computers are now easy and intuitive enough to use that everyone should be using them [4].

Because of this accessibility the workers of tomorrow, being exposed to computers even as young as toddlers, will accept computers as an everyday part of life. This generation of youth is even better prepared to meet the challenges of the 21st century and the information age.

Under Measurement:

The gains in productivity have been under measured by the government agencies that track the economy. "The advantages to consumers from automated teller machines, affordable fax machines, and increased choices of mutual funds do not show up in the figures. Moreover, by understating the extensive use of software, telecom gear, and other high-tech investment, the official statistics underestimate GDP and by inference, productivity". The purchase of new software is not considered an investment by government statisticians as a result any gains in productivity go unreported [1].

Deregulation:

After being protected by government regulation for many years, many service industries have been forced to be more productive following the deregulation of telecommunications, financial services, banking and transportation, and cable TV. In order to fend off new competitors, these service industries have had to enact rapid restructuring using information technology to automate operations [7].

Cumulative Effect:

There is a cumulative effect from the use of information technology. As design firms, software companies, and hardware manufactures utilize information technologies to produce their goods and services, these goods and services are improved. The users of these goods and services are able to increase their productivity as a result of these improvements. This leads to a continuous process were the increased productivity of one entity is passed on to the next consumer and so on.

PRODUCTIVITY: The Future

The third quarter results of productivity released by the Labor Department show that productivity in the manufacturing sector reached the 6.3% mark. This is the largest gain in the last two years.

Since output and hours worked at a factory level make up only a fifth of the total business sector, this would imply that productivity in the service sector fell sharply. Economist Joseph Liro of CIBC Wood Gundy Securities Corp., brings up the difficulty of measurement of productivity in service sectors and attributes either that, or the inability of other sectors to match productions productivity for such low overall performance. On the other hand analysts also predicted this slow down citing the inplacement of cost controls and computer systems that have been around for awhile now and have already provided their boost to productivity levels [20].

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APPENDIX

Fig 1: New technology Impacts
Fig 2: Productivity Leads to Productivity

Fig1 : New Technology Impacts.

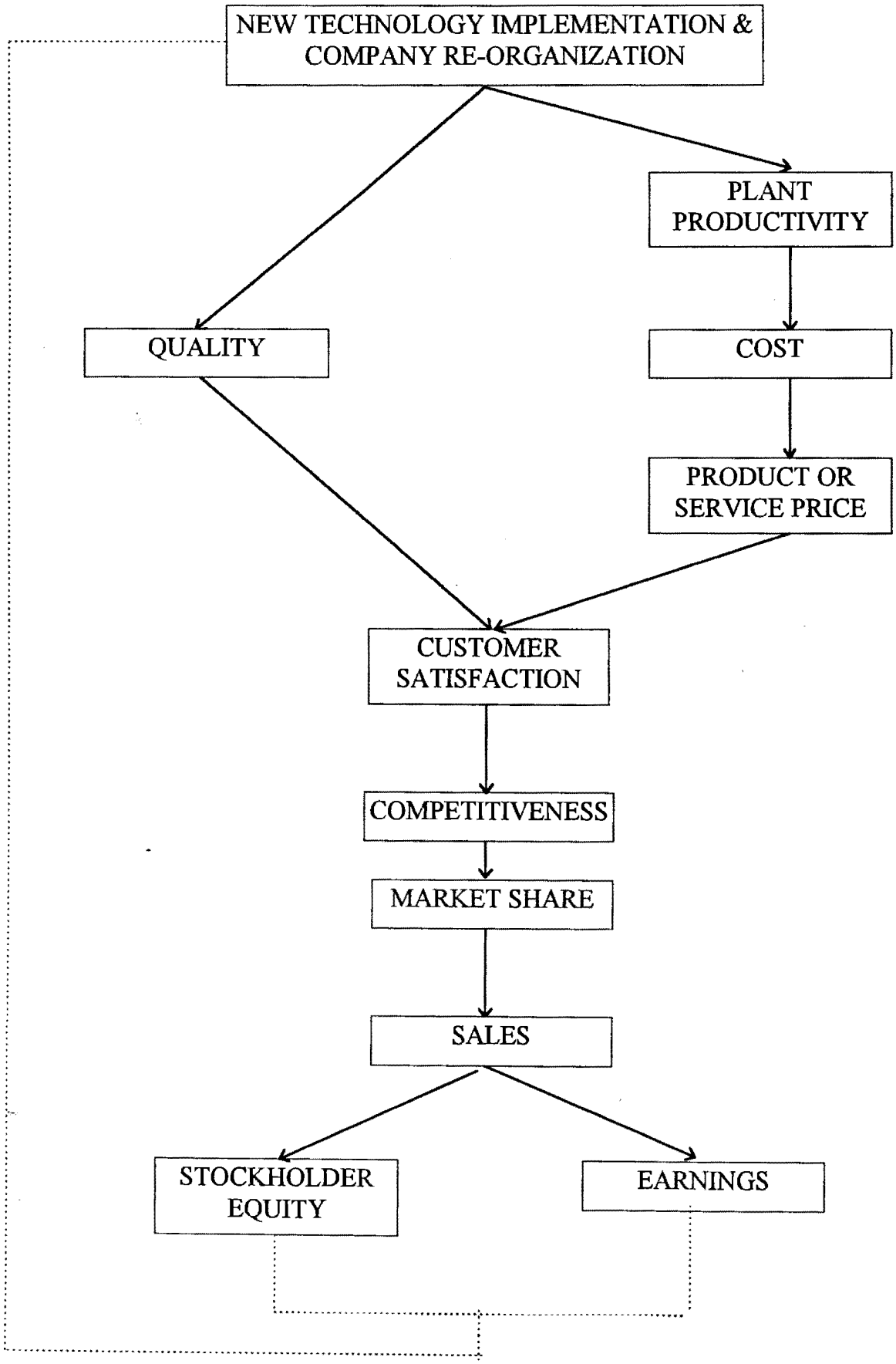

Fig2 : Catch 22: Productivity Leads To Productivity.