AN ABSTRACT OF THE THESIS OF

Osama K. Al-Agha for the degree of Master of Science in Industrial Engineering presented on June 9, 1988

Title: The Development of Productivity Interfirm Comparison Procedures for the Cement Industry of Saudi Arabia

Abstract approved: Redacted for Privacy

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Productivity Interfirm Comparison (PIC) is a simple method used to improve productivity at the firm level, where a number of firms operate in the same product line so that performance information on the firms can be compiled and compared. This results in identifying potential areas for improvement or exploitation. The comparison may unearth performance inefficiencies that, over time, may have insidiously come to be regarded as acceptable when quite the contrary is true. Three Saudi cement firms participated in this research whose purpose was to determine the usefulness and applicability of PIC for firms in Saudi Arabia. Data were collected from the participating firms and converted to ratios which were represented graphically and discussed in detail. In spite of the differences between Saudi Arabia and the United States, it

was found that PIC is useful to firms in Saudi Arabia and many benefits could be gained from its use. This includes use at the national level in applying PIC in all industries. Experience in its use could be gained by affiliating or contracting with productivity improvement and measurement centers and organizations. PIC procedures can also be conducted internationally.

The Development of Productivity Interfirm Comparison Procedures for the Cement Industry of Saudi Arabia

by

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A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

Completed June 9, 1988

Commencement June 1989

APPROVED:

Redacted for Privacy

Associate professor of Industrial Engineering
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Date thesis is presented June 9, 1988

Typed by Harvey McCloud for Osama K. Al-Agha

ACKNOWLEDGEMENTS

Praise be to God, the cherisher and sustainer of the worlds, most gracious, most merciful, master of the day of judgment, who blessed me by extending my life to complete my masters in the United States, gain a lot of knowledge, and be able to finish this research which I hope benefits my country, Saudi Arabia.

- Sincere appreciation and thanks go to several people who have made my stay at Oregon State University both an enjoyable and rewarding experience. First of all of these are my parents, who gave me a lot of support, cooperation, and patience (My Lord! Bestow on them Thy mercy, even as they cherished me in childhood). Second is for my wife, who struggled with me and made it easier for me in living away from home.
- My sincere thanks go to my advisor, Dr. Robert Safford, for his guidance, encouragement, and teaching he gave me, which benefitted me greatly. I also thank all of my committee members, Dr. Robert Safford, Dr. Sabah Ranadawa, Dr. David Gobeli, Dr. Erik Larson, and Dr. John Sessions, for their comments and remarks.
- My thanks go to all doctors at O.S.U., from both the Industrial Engineering Department and the

Business School, who taught me and added to my experience. They are: Dr. Barry Shane, Dr. Dave Dickmann, Dr. David Gobeli, Dr. Eldon Olsen, Dr. Erik Larson, Dr. Jack Drexler, Dr. Ken Funk, Dr. Martin Henner, and Dr. Steven Lawton.

- I also would like to express my thanks and appreciation to Dr. Gerald Earth at the Oregon Productivity Center for his time that he gave me to explain and discuss the process of PIC and its applications in the Pacific Northwest region of the U.S.A.
- I also would like to express my thanks to all brothers in Salman Al-Farsi Islamic Center with whom I enjoyed staying.
- Finally, I thank my government for supporting and providing services that gave me the opportunity to finish my masters studies.

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CHAPTER I

INTRODUCTION

Saudi Arabia is one of the countries in the Middle East that takes the lead in developing itself in every field. It is progressing in every field and pushing very hard in the industrial field by encouraging people to invest in production facilities.

One of the oldest industries in Saudi Arabia is cement manufacturing. There are eight cement factories (owned by eight companies) that are located in different parts of the country. Their annual production capacity totals fifteen million tons. The capital invested in these factories totals eight thousand billion reyals (around 2.1 trillion dollars), owned by more than a quarter million investors (shareholders).

Each of the eight factories produces cement and sells it within the region it exists in, or even exports the product to neighboring countries. However, there are no means by which a factory can determine how well it performs in terms of production, sales, etc., compared to other factories.

Productivity interfirm comparison (PIC) is a simple method whereby members of a group of companies engaged in

a common enterprise and operating in similar areas and settings compile information on the effectiveness and efficiency of their operations. This information is stated in terms of ratios. The information is forwarded to a third party and then each company receives feedback on how well it is performing compared with other firms that have reported similar information. This technique could be an effective tool for productivity promotion. Comparative analysis of the performance of firms operating in similar areas can be useful in revealing important sources of productivity variations and dormant productivity potentials.

Interfirm comparisons (IFC) were known in the mid-1950s when Herbert Ingham and Leslie Taylor Harrington were conducting research at the British Institute of Management on the general subjects of performance assessment and comparisons. In 1959 the United Kingdom's Centre for Interfirm Comparison was founded. In 1966 the Australian Department of Trade began running comparisons that today amount to 3500 firms in 95 industries. The United Kingdom's Centre for Interfirm Comparison and Canada's Commerce Department Interfirm Comparison program have run comparisons between over 1000 firms in over 50 different industries. In fact, the CIFC has carried out interfirm comparison in over 100 industries, trades, services and professions in the U.K., many of these on a regular annual

basis covering several years. Also, the Centre provides international services. These include:

- The preparation and conduct of international IFCs in a number of industries. These have mainly involved European companies but in several cases the comparisons have been enlarged to include companies in the USA, South America, Australia and South Africa.
- The setting up of ratio systems for evaluating financial performance and productivity within multinational companies with branches all over the world. Some of the problems and techniques used are similar to those relating to international IFCs.
- Training programs for overseas companies; over the past few years the Centre has trained people from a number of overseas countries whose government or other agencies wish to develop IFC techniques. Programs have been designed specifically for each person allowing special emphasis to be placed on those industries or subjects that are of particular interest. Countries for which such training programs have been designed include the USA, Egypt, India, Democratic Republic of Yemen and Sri Lanka. Several of these programs have been financed by international development agencies e.g. UNIDO. As well as training individuals from overseas, the Centre has provided advice and know-how to organizations in several other

countries, including Australia, Canada, France and Japan (51: 12,13).

The Asian Productivity Organization (APO) organizes conferences, workshops, symposiums and study meetings to increase the awareness of the potentials and methods of application of the interfirm comparisons among Asian countries. Participants in such meetings express experiences of the APO and current situations of the countries participating through papers, presentations, and case studies.

The United States Bureau of Labor Statistics and the American Productivity Center conduct interfirm comparisons for various industries. Other productivity centers also conduct such comparisons. One of these is the Oregon Productivity Center, which began running the productivity interfirm comparisons, now called PICs, in 1980.

In this research we will address the applicability of PIC technique to the Saudi Arabian cement industry.

We will first give the reader some information about the cement industry and the process of production. Second, the literature review of certain models of productivity measurement and improvement will be addressed, then we will talk about the PIC for the participating companies. Results and discussions of the measures used will follow, and after that we will address some differences between

Saudi Arabia and the United States. Finally, we will conclude this research by answering the question, Is PIC useful to Saudi Arabian industry?

CHAPTER II

THE CEMENT INDUSTRY

Cement is one of the building materials that is essential for the development of any country. Even the consumption of cement is considered a measure of economic and social development (see Table II.1).

Cement is important for Saudi Arabia to build dams and water reservoirs to have sources of water; to build roads, bridges and tunnels to have a road network connecting different parts of the country; to build industrial cities; to build ports; to build houses and shelters; and, more generally, to establish a modernized and civilized country with big cities replacing small, old-fashioned villages.

The raw materials required to manufacture cement exist in many parts of the country. This fact has helped the Saudi Arabian government to plan for good geographic distribution of the eight cement plants which exist in the country (see Fig. II.1).

The Process of Manufacturing Cement

Crushing Limestone

When limestone is brought to the factory from the locations where it is found, it is in the form of big rocks. These rocks first pass through a primary crusher where they are converted to smaller pieces of limestone.

Table II.1. Cement consumption in Saudi Arabia.

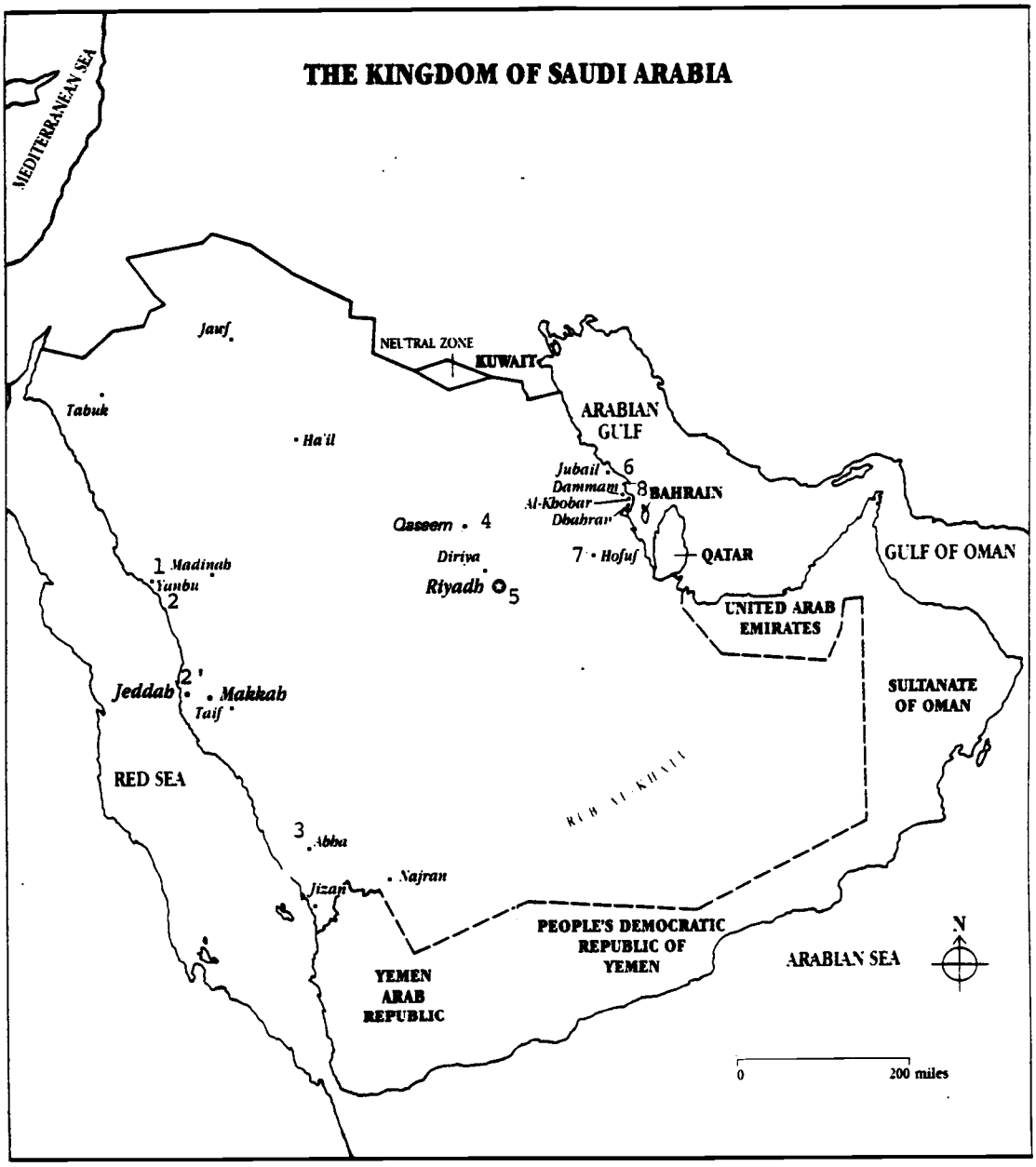
Year	Sales from domestic production (000 tons)	Imported cement (000 tons)	Total consumption (000 tons)	Change rate
1970	667	464	1131	-
1975	1126	1126	2952	+161%*
1980	2911	10002	12913	+337%*
1981	4781	9501	14282	+10.5%
1982	7153	10605	17758	+24%
1983	8126	15120	23246	+31%
1984	7686	13700	21380	-8%**
1985	9597	7435	17032	-20%
1986	9494	2006	11500	-32.5%

Source: Publication of the Southern Province Cement Co., 1986.

* The first two change rate percentages are for five year periods; the following are for one year periods.

** The negative values of the change rates for latter periods indicate the effect of the Iran-Iraq war on the economy as a whole for the Gulf area, and particularly here for the decrease in consumption of cement. A second factor is the competition between domestic producers and importers of cement (note that domestic sales increase and imported sales decrease). Another factor is the completion of most important projects in Saudi Arabia. The trend of consumption depends mainly on these three factors. It is expected to increase if the war stops.

Figure II.1 (the Map)



1 Yaunbu Cement Company
2 Rabique cement plant belongs to 2'
2' The Arabic Cement Company Ltd. was at Jeddah.
3 Southern Province Cement Company at Abha
4 Qaseem Cement Company
5 Saudi Yamama Cement Company at Riyadh
6 Al Saudi-Al Kuwait Cement Company (Dammam)
7 The Eastern Saudi Cement Company (Hofuf)
8 Al Saudi - Al Bahrain Cement Company (Dammam)

These pieces then go to a secondary crusher where they become still smaller (25 mm). The limestone is then stored in a homogeneous shape after passing through a sampling station where samples are taken to ensure quality and homogeneity.

Crushing Raw Materials

The raw materials used in producing cement are iron ore, sandstone, bauxite, sweet lime, and limestone. Each of these raw materials is stored in a separate bin. According to known ratios, a proportional quantity of each of the materials is sent to an additive crusher where it is crushed to a certain level of fineness.

Mixing and Homogeneity

Before sending the raw material to the ovens, the particles should be homogeneous. This is achieved by crushing the raw materials to a higher degree of fineness and then using air to separate particles to obtain a homogeneous mixture. This mixture is then stored in a blending and storage silo.

Heating

The heating system consists of an oven of four stages and a kiln. The mixture is pumped to a channel between the first and second stage in the preheating tower, and there the heating exchange takes place between the entering mixture and the oven exhausted gases. Then in every stage

the mixture is separated from the gases and the process is repeated. After that, the mixture enters a long, rotary kiln and the material is heated up to 1400-1600°C to convert it to the precement form called "clinker." The clinker is then cooled by air to 100°C and is stored.

Cement

The clinker is then transferred to a mill where it is mixed with crushed gypsum with a certain ratio (3-4%). The cement formed is stored in silos from where the packing and palletizing can take place before shipping (48: 9) (see Fig. II.2).

The Cement Market in Saudi Arabia

Investment in cement companies has been profitable in Saudi Arabia. Cement manufacturing is one of five major sectors of the market that are monitored to provide a measure of the status of the economy. The other four are services, electricity companies, agricultural companies, and industrial companies.

Saudi Arabia is a consuming and developing country which depends heavily on imported goods. Cement is one of the building materials that Saudi Arabia imports. The cement is imported from several countries, including Japan, Korea, Spain, Greece, Poland, Romania and Bulglaria, as well as others. Several large companies and establishments

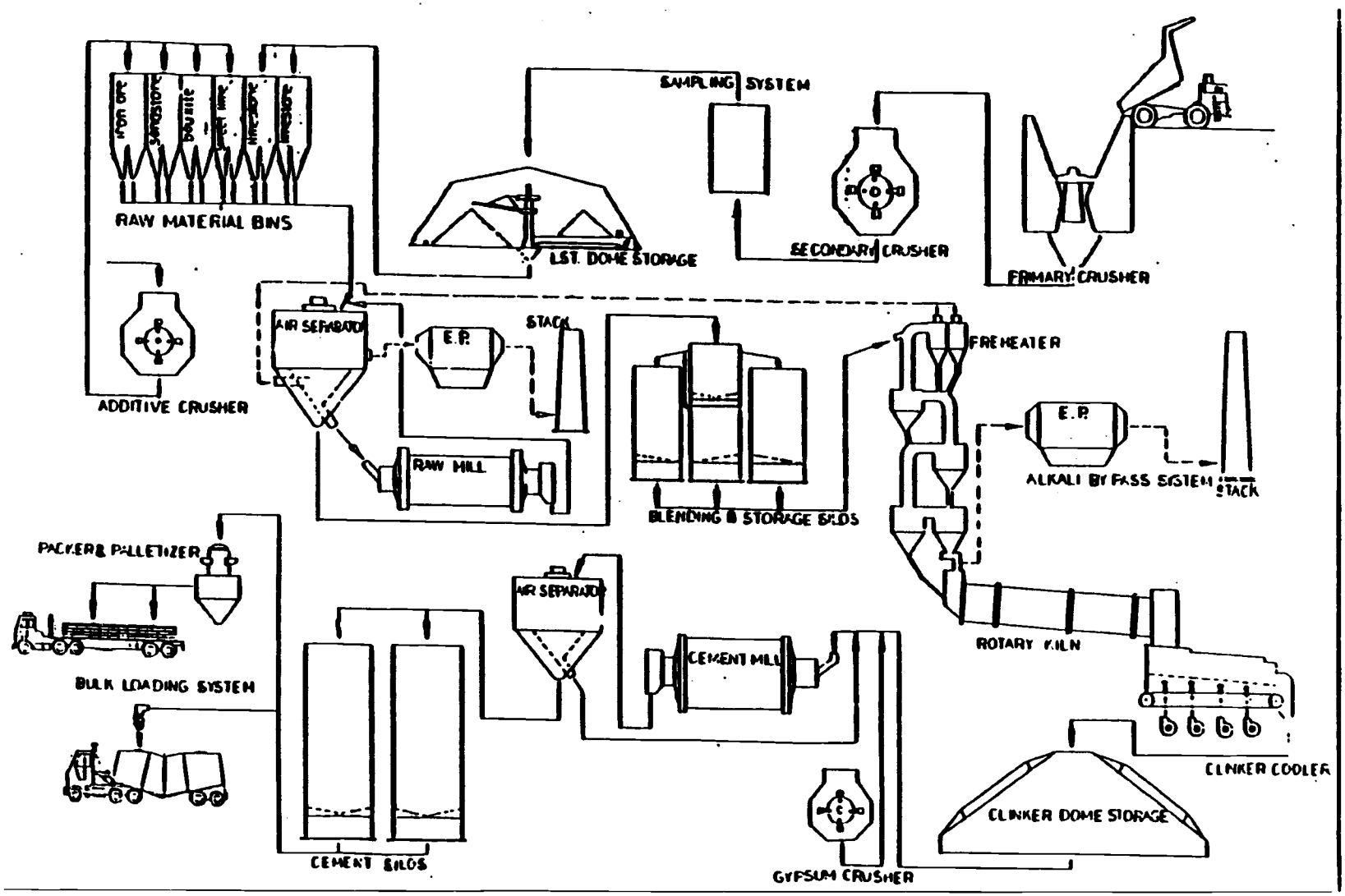


Figure II.2. The process flow chart for cement manufacturing.

deal with the business of importing cement and these are in competition with the domestic firms.

A battle between the domestic cement producers, represented by the eight cement firms, and the importers has been going on and has affected prices, production quantities, consumer attitude, and the economy. The domestic producers claim that the country is self-sufficient in cement and they can satisfy the needs of the market. The importers claim that they are protecting the consumers from monopoly by domestic producers and therefore that they are protecting the people from paying high prices.

However, as was mentioned earlier in reference to Table II.1, the total consumption rate of cement in Saudi Arabia is decreasing due to three factors: the Iran-Iraq war, the end of most of the developing projects, and the competition between the domestic producers and importers. As a result, the trend of sales of domestic cement is leveling off while the trend of importing sales is decreasing. The domestic producers are now considered capable of producing more than the needs of the market, and this has brought the government lately, in 1988, to impose a 20% customs dues on the imported cement. This will give the domestic firms a competitive edge over the importers and will make it necessary for the them to increase production (53).

CHAPTER III

REVIEW OF LITERATURE: PRODUCTIVITY MEASUREMENT AND IMPROVEMENT

Introduction

Management theorist Peter Drucker notes that "productivity is the first test of management's competence" (6: 111). Through the analysis of measurements of productivity it is possible to determine the degree to which the major resources of land, labor and capital are utilized. There are a variety of models and theories which delineate methods of productivity measurement, parameters of productivity comparisons, and processes of productivity improvement.

The purpose of this literature review is to present and analyze the major components of those models. Specifically, productivity measurement and improvement will be considered on the level of interfirm comparison, the level of the individual firm (e.g through the objective matrix), the level of groups within the firm (e.g., quality circles, team units), and the level of the individual within the firm. Before proceeding with a discussion of these various models, however, it is first necessary to define productivity.

Definition of Productivity

The U.S. Bureau of Labor Statistics defines productivity as the value of goods manufactured divided by the amount of labor input (40: 55). This can also be expressed as the ratio between total manufacturing output and a single factor of input -- labor. It is important to note that the BLS figure is therefore not a measure of total productivity, but rather one of partial productivity. Mark (1986) notes that there are two major reasons behind the BLS focus on labor productivity as the predominant measure of productivity. First of all, among the major resources, labor is probably the most easily measurable. Secondly, labor has the advantage of being involved in all aspects of the production process (27: 3).

Yet despite the technical advantages of using labor as the main measure of productivity, there are a number of theoretical and practical difficulties in attempting to equate labor productivity with total firm productivity. First of all, since labor is involved in all aspects of production, measures of labor productivity (as expressed in changes in output per hour) are unable to measure the specific contribution of labor or any other factor of production. This system ignores the differential contributions of factors such as capital investment, economies of scale, organization of production, changes in technology, and managerial skills. Moreover, the approach can be

criticized for its focus on direct labor cost, a factor which represents a relatively small percentage of total production output. Skinner (1986), for example, notes that direct labor costs exceed 10% of sales in only a few industries (40: 56).

The alternative is to take a multifactor approach to measuring productivity. Chew (1988) maintains the importance of focusing on "labor content, not labor cost" (3: 110). Chew's definition of productivity is expressed as a ratio between the units of output (goods produced, goods sold) and the units of input (capital, labor, and materials). Edosomwan (1987) presents two alternatives to partial measures of productivity (i.e. labor productivity): "total productivity," represented as the ratio of total output to all input factors; and "total factor productivity," represented as the ratio of total output to the sum of associated labor and capital (factor) input (8: 64).

The rationale behind the development of a multifactor measure of productivity directly relates to the limitations of a single factor model of productivity measurement. Chew notes:

> "The trouble with single-factor productivity measures (whether output per labor hour, output per machine, or output per ton of material) is that it is easy to increase the productivity of one factor by replacing it with another..." (3: 114).

A single-minded focus on labor productivity may create particular problems. Drucker cites the example of the

paper industry which has increased labor productivity through heavy investment in high-tech, high-speed processing machines. But because of the substitution of capital for labor, the industry overall is actually less productive and only marginally profitable, despite impressive increases in labor productivity (6: 112). Chew cites an example of an individual firm, a New York bank, which invested heavily in computer systems to improve labor productivity. While the increases in labor productivity in most departments were encouraging, productivity declined sharply in the one department most burdened by the computer system -- data processing and overhead was up sharply for the company overall (3: 111).

It is thus apparent that in order to assess changes in a firm's overall productivity, it is necessary to consider all the components of productivity, not just labor productivity. A focus on labor productivity may be particularly inappropriate for firms which are highly capital-intensive and/or highly automated, since labor cots are only a very small component of total costs (34: 13).

While multifactor measures of productivity represent the optimal approach to productivity measurement, such processes also have inherent difficulties and drawbacks. It is especially difficult for one index to encompass all productivity inputs. Moreover, even if one were to develop a single index which theoretically did encompass all

inputs, it would still be limited in its usefulness because it would be difficult to ascertain the individual sources of the aggregate productivity trends. Because of this limitation, it often makes sense to use a variety of measures, such as a sum of single-factor input measures.

Another problem in the multifactor approach involves the difficulty of defining and quantifying all the various inputs: Mark (1986) notes that the BLS has encountered a wide variety of difficulties in quantifying the inputs of capital and intermediate inputs such as materials, fuels, and business services. He concludes that:

> "Multifactor productivity measurement presents challenging problems of shaping sometimes imperfect data into empirical measures that take advantage of recent theoretical advances... it is important to, recognize that they [multifactor measures] do not have the same degree of precision that the labor productivity measures have. In estimating them, many more assumptions have to be made, particularly with regard to measuring capital input" (27: 11).

The inherent limitations in the multifactor model of productivity measurement thus dictate the necessity of approaching both the identification of productivity change (measurement) and the possible sources or methods of productivity improvement from a variety of vantage points.

Interfirm Comparison

Interfirm comparisons of productivity as means to identify potential areas for improvement or exploitation are in a sense analogous to country-wide or industry-wide

comparisons compiled by a variety of government agencies. The U.S. Bureau of Labor Statistics tracks changes in manufacturing labor productivity and labor costs in the United States and other industrial nations. BLS data from 1960 to 1985 have generally portrayed the U.S. as less productive than most other industrialized nations (32: 12). Such data has led to a scramble among U.S. manufacturers to adopt manufacturing and production techniques from other countries (especially Japan) in an effort to boost productivity.

The Bureau of Labor Statistics also tracks productivity in the U.S. on an inter-industry basis. Until recently, such productivity was tracked purely on a single-factor, labor productivity basis. Beginning in 1987, however, the BLS introduced its new multifactor productivity measure, known by the acronym KLEMS. The KLEMS multifactor measure which is "output per unit of combined capital, labor, energy, materials, and business service inputs" (13: 18). The KLEMS measure makes it possible to ascertain localized production growth within various industries as well as assessing the impact of intermediate inputs such as raw materials and business services.

While inter-country and inter-industry productivity comparisons help to point to the importance of multifactor inputs in productivity trends, it is the interfirm comparison which can aid the individual company in pinpointing

areas for productivity improvement or exploitation. Data from the Canadian Interfirm Comparison Programme (which covered 55 sectors and more than 1,500 individual firms) indicates that interfirm comparisons provide companies with a wide range of important information, including the company's relative productivity, its relative profitability, its tendency towards over- or under-capitalization, its utilization of assets, and the adequacy of its human resource base (2: 82).

The comparative measures utilized in interfirm comparisons can be based on financial data, physical output and input data, or some combination of the two (22: 65). Typically, the comparative measures are constructed as a configuration of operating or financial ratios, particularly the rate of return on operating assets, profit margin on sales, and the asset turnover rate (2: 87).

The U.S. BLS conducted interfirm comparisons for various industries utilizing comparisons based on value added per production-worker hour (BLS reports on interfirm comparisons based on this measure stopped in 1976). The various measures used in the comparisons included value added per employee; value added per production-worker hour; value added per production worker; production-worker wage per production-worker hour; value of shipments per employee; value of shipments per production worker; and value of shipments per production-worker hour (22: 67).

Government-sponsored interfirm comparisons are underway in a number of industrialized countries. The specific purpose and approach of these comparison programs varies from country to country. Some programs make comparisons primarily on the basis of financial ratios, while others focus more exclusively on physical productivity comparisons. Programs also differ as to whether they collect information for the total plant only, or whether they also account for individual processes, departments, and operations. Differences in methods of data collection (e.g., mail, telephone survey, on site visits) also vary from program to program. A commonality evinced among most national programs is the anonymity granted to the individual volunteer firm (a code number generally identifies the firm to its management).

As previously noted, most interfirm comparisons focus on financial ratios as units of comparison. The Canadian program is typical of those which focus on financial ratios. Table III.1 summarizes the comparison units used for the Consumer Products Sector in the Canadian program and provides an example of measures commonly used in interfirm comparisons.

The American Productivity Center is currently conducting interfirm comparisons which are designed to "provide respondents with a feedback of comparisons of a variety of physical productivity ratios, relating inputs of

Table III.1. Measures of comparison, Canadian program.

Return on Assets	
Operating Profit/Operating Assets	%
Profit Margin, Turnover of Assets & Gross Profits	
Operating Profit/Sales	%
Sales/Operating Assets	%
Gross Profit/Sales	times
Production Costs (/Sales Value of Production)	
Product Costs	%
Materials and Components	%
Total Production Labor Cost	%
Manufacturing Overhead	%
Operating Expenses (/Sales)	
Total Operating Expenses	%
Selling & Promotion	%
Administration	%
Asset Utilization Ratios (Per $1,000/sales)	
Total Operating Assets	$
Current Assets	$
Fixed Assets	$
Current Asset Utilization (Per $1,000/sales)	
Raw Material Inventory	$
Work-in-Process Inventory	$
Finished Goods Inventory	$
Total Inventory	$
Accounts Receivable	$
Other Current Assets	$
Fixed Asset Utilization (Per $1,000/sales)	
Land and Buildings	$
Machinery and Equipment	$
Road Vehicles	$
Furniture and Fixtures	$
Productivity Ratios	
Sales Per Production Employee	$
Value Added/Production Employee Hours	$
Value Added/Production Floor Area	$
Sales Increase (Decrease) Over Prev. Year	%
Production Labor Costs/Prod. Employee Hours	$
Machinery & Equipment/Production Employee	$

Note: each row of ratios is calculated to show the median and extremes of that particular unit.

Source: Productivity Measurement and Analysis (Tokyo: APO, 1983), p. 86.

energy, labor, capital, and materials to factory output by product, process, or department, in addition to the factory total" (22: 74). It is hoped that this physical/financial combination unit of measure comparison will provide a more meaningful identification of a firm's productivity standing than the more traditional, purely financial means of comparison.

Kendrick (1984) notes that exclusive reliance on financial ratios obscures differences in plant standings which result from physical differences. Included in these differences are variations in plant size, diversification of output, age and condition of machinery, processes applied, average product or product line, and percentage of designed plant capacity utilized (22: 68).

The American Productivity Center's interfirm comparison program differs from financial ratio-oriented plans such as the Canadian program on a number of measures. In particular, productivity ratios are considered in terms of the ratio of waste to the good or product and the labor cost to the cost of machine use. In addition, the APC program also takes into account output per machine-hour and labor-hour material input within specific products, processes, or departments (22: 73-74). Regardless of these differences, the APC model is still highly dependent upon financial ratio measures. Miller (1987) notes that the APC model is based on a system which links productivity changes

to the firm's profitability and is built on the assumption that "a firm's profitability change is a direct functional result of the change in its productivity performance and the change in its price recovery" (30: 1501).

The preceding discussion has encompassed the rationale behind and specific configuration of the major models of interfirm comparison as they are now in use within various countries. These major programs are generally government-sponsored and rely on the voluntary cooperation of a large number of firms within various industries. The absence of specific product or specific departmental comparisons within such plans as well as the broad scope of industry (including firms varying widely in size, capitalization levels, age, etc.) may necessarily limit the direct applicability of information gleaned from the comparisons to the individual firm.

As such, a smaller-scale interfirm comparison encompassing firms within the same industry and comparing plants which are similar in size, diversification of output, product line, age and condition of machinery, and capacity utilization generally provide more directly applicable information on productivity change to the individual firm. An example of such a program recently applied will serve to illustrate the usefulness of this smaller-scale form of interfirm comparison.

Hayes and Clark (1986) conducted a longitudinal, cross-sectional interfirm comparison of twelve factories in three companies over a 61-month period. The results of the comparison confirmed the importance of a multifactor approach to productivity. Specifically, the researchers noted the detrimental effect of management's preoccupation with labor productivity (in this case, labor productivity was defined as factory labor as opposed to managerial labor) despite the fact that direct labor accounted for less than 15% of total costs and management's inattention to the effects of the materials consumption or productivity despite the importance of that factor (14: 67).

One of the more salient findings to come out of this study was the development of what the researchers termed a measure of total factor productivity (TFP). The TFP can be expressed in terms of managerial policies in the areas of equipment, quality, inventory, work force, and what the authors term "policies affecting confusion" and respective indicators (measurements) of each policy type. Table III.2 presents the TFP system. The table is presented to illustrate potential usefulness of interfirm comparisons in identifying specific production problems. An analysis of the Hayes and Clark's total factor productivity measure as used in their interfirm comparisons can be used as a basis for decision and direction on productivity-improvement programs. The interfirm comparison can serve as the basis

Table III.2. TFP interfirm comparison system.

Policy Category	Indicators
Equipment	Average age of equipment; average maintenance expense as a percentage of equipment book value.
Quality	Process waste; yield as a percentage of total input materials; intermediate and final reject rates; customer return rates.
Inventory	Work-in-process as a percentage of total materials or production costs.
Work Force	Average age and education of workers; hours of over-time per week; absenteeism rate; hiring and layoff rates; average hours of training per employee.
Policies affecting confusions	Fluctuations in production volume; number of product types produced; number of production orders scheduled; number of schedule changes as a percentage of number of production orders scheduled; number and type of engineering change orders; introduction of new processing equipment.

Source: Hayes and Clark, "Why Some Factories are More Productive Than Others," Harvard Business Review, September/October 1986, pp. 72-73.

of assessment for a total firm approach to productivity improvement and as a guideline for group or individual approaches to productivity improvement.

OMAX and Total Firm Productivity Measurement

The literature reviewed revealed a wide range of models for productivity assessment, forecasting and improvement on the individual firm level. Some focus on only one part of the process, while others attempt to integrate the stages into a comprehensive productivity model for the firm.

Edosomwan's (1986) "Productivity Management Triangle" is comprised of an information system which feeds comprehensive productivity planning, and comprehensive productivity improvement. Edosomwan and others (McClelland, 1987; Davis, 1987) stress the importance of the planning function. Edosomwan defines comprehensive productivity planning as:

> "The process by which all factors affecting an organization are considered in formulating its goals and objectives, assessing its capabilities and capacities, designing alternative courses of action for the purpose of achieving these goals and objectives, initiating necessary actions for their implementation, and evaluating the effectiveness of the plan." (7: 64).

Edosomwan divides the processes into four stages. Stage 1: the productivity planning appraisal assesses the role and weight of environmental (economic, government, legal,

technological, social, geographic) and organizational (financial status, management structure, resource requirements, distribution channels, leadership styles) factors for the company. Stage 2: strategic productivity planning focuses on long-range goals and objectives. Stage 3: tactical productivity planning centers on direct strategic decision-making in the areas of production control, inventory control, resource requirements, etc. Stage 4: operational productivity planning is directly involved with the parameters of plan implementation. Major functions of Stage 4 include programming, scheduling, budgeting, and controlling.

McClelland (1987) also emphasizes the importance of planning, arguing that one of the primary reasons for productivity improvement program failure is management's failure to plan the program and integrate its overall organizational goals and objectives (28: 10). McClelland's "time to progress" model of productivity planning fixes critical events in the planning process along a schedule (generally delineated in weeks). The first step in the process is a self-audit which assesses the organizational threats and opportunities. The next step is stating the objectives and then determining if the objectives are compatible with organizational objectives (if not, they must be reworked). The next step involves the identification of necessary resources -- human, material and

financial. Following this, a budget is established and critiqued; a tentative plan put forth; controls for the plan developed; feedback on plan parameters obtained from organization members; and finally, a forecast of the plan results is prepared (28: 11-12).

Other models focus on particular components of the planning process and seek to identify those areas in which the company could most likely benefit from the implementation of productivity improvement plans. Wiley and Campbell (1986) developed an organizational assessment survey to locate areas for productivity improvement. Their model is based on employee input and feedback and is designed to provide management with objective data on which decisions can be made. The entire process model is based on the action research model, which can be divided into the steps of problem identification by individuals, consultation, data gathering, joint problem identification, and evaluation (46: 10-12). The assessment survey itself, which provides the basis for data gathering and problem identification, measures more than thirty different factors, ranging from level of automation and skill utilization to employee satisfaction to organizational mission to the perceived need for productivity improvement (46: 12).

Highlander's (1986-87) productivity planning/ assessment model focuses on planning and assessment at the

individual business unit level. The plan, which was developed at Upjohn Company, is titled "Six Steps to Unit Productivity Improvement." As implied from the title, the process involves six major steps: 1) defining the mission of the organizational unit; 2) establishing customer expectation levels; 3) identifying required resources and inputs; 4) selecting measures of unit productivity; 5) setting improvement goals; and 6) devising and implementing improvement plans (16: 21).

Davis (1987) developed a predictive model linking productivity goals to direct and indirect labor requirements. In this model, adjusted earned hours (comprised of total earned hours and a work-in-process adjustment factor) constitute output. Input is defined as total production hours (measured for direct labor, indirect labor, salaried employee hours, and including an adjustment for downtime). Dividing adjusted earned hours by total production hours yields an "adjusted productivity measure" which is then divided by a base-year adjusted productivity measure (to account for variations caused by inflation, etc.) to yield a final productivity index (5: 162-164).

One of the most comprehensive and commonly-applied models of productivity improvement for the individual firm is the OMAX, or objective matrix. OMAX, through the use of ratios, defines and measures productive performance for work units within the organization. Riggs (1986) divides

the implementation of the OMAX process into 11 stages: commitment, support, introduction, coordination, establishment of criteria, objectives, scoring methodology, priorities, start-up, feedback, and maintenance (36: 38). The objective matrix plots the performance (scores) of work units against a set of productivity criteria (expressed as ratios). At least six or seven ratios are generally used as productivity criteria; in larger units, more ratios may be appropriate. Riggs illustrates how the productivity criteria (ratios) can be grouped into the categories of quantity, quality, timeliness, yield, utilization, and group traits. For example, the ratio of output to labor hour or case load per worker measures quantity. Similarly, the ratio of rejects to units produced measures quality. Group traits can be measured through ratios such as absent hours to total ours or accident cost to days worked (36: 42).

The objective matrix focuses on defining, quantifying, and monitoring productivity measures within individual work units. The American Productivity Center's model aims at measuring total productivity for the firm in its entirety. According to Thor (1986), "the key elements of the APC performance measurement system are profitability, productivity, and price recovery... the relationship between quantity of output and quantity of input at a point in time and over time is called productivity" (44: 25). The APC model is thus a profit-linked approach for measuring

productivity. Various models modify the specific measures in the APC approach while still using profit as the major criteria. Miller (1987), for example has developed a model which uses return on investment as the improvement criterion in the profit-linked productivity model (30: 1501).

Methods of Productivity Improvement

The models discussed thus far for total productivity improvement tend to focus on the assessment, identification and measurement of a firm's productivity, whether carried out through interfirm comparison, on a total firm basis, or through the analysis of individual work units within the firm. Such models do not speak directly to the issue of the method of productivity improvement. Models which do address this issue can be classified according to their focus on the group (and utilizing quality circles or team units) or on the individual worker. Such models, while focusing most directly on the labor sector in the firm's total productivity, also attempt to integrate the mitigating influences of the nonhuman resources (materials, finances, etc.) in the firm's productivity matrix.

Quality Circles

Traditional forms of American management systems tend to focus on improving productivity through increasing or making more efficient the quantity of goods produced. Such

a focus, however, tends to result in a trade-off of quality for quantity. As quality diminishes, overall productivity also inevitably declines (because of wasted materials, high rates of return, etc.). The perception of the close relationship between quality and overall productivity led Dr. W.E. Deming to develop the concept of quality circles. Deming's principles, which emphasized the use of statistical techniques to identify and solve quality control and production problems, were widely applied in Japanese companies and are credited with significant rises in levels of Japanese productivity and quality in manufacturing (11: 653).

Widespread fears that America was lagging behind other developed countries in productivity as well as the looming reality of U.S. trade deficits and the "invasion" of Japanese and other foreign goods into the U.S. market prompted many American companies to adopt various elements of Japanese management systems in an effort to recoup apparent losses in productivity and standards of quality. One of the elements which has been most extensively borrowed from the Japanese system has been the quality circle.

The quality circle can be viewed as a kind of "team unit" approach to quality and productivity improvement. Crocker, Chiu and Charney (1984) give this general definition of the quality circle:

> "Quality circles are a formal, institutionalized mechanism for productive and participative problem-solving among employees. Small groups of workers engage in a continuing cooperative study process to uncover and to solve work-related problems" (4: 6).

The specific objectives of the quality circle may vary according to company needs, ranging from quality improvement, productivity enhancement, and employee involvement (23: 66). According to Donald L. Dewar, former President of the International Association of Quality Circles, the underlying objective of QCs is to provide "a way of capturing the creative and innovative power that lies within the work force" (38: 9).

Quality circles have a definite structure. Most circles range in member size from six to twelve workers from the same work area. The size of the group is limited so that members function as team participants, not merely as committee members. The circle meets on a regular basis -- typically once a week for an hour or so. Participation in the quality circle among workers is usually on a voluntary basis. A facilitator, typically a supervisor from the QC work area, helps administer the group process, keeps the group focused on goals, and trains the members in problem-identification and problem-solving techniques. The facilitator is, in turn, directed by a QC leader (also drawn from management) who provides both training and goal-direction as well as serving as a liaison to upper management (17: 29-34).

For the individual organization, the quality circle is viewed as a way to improve productivity. Such improvements can be quantified by the increase in output per unit of input or in terms of the cost per unit produced. Intangible benefits of the quality circle for the company theoretically include improved employee morale, the development of managerial ability among circle leaders, improved communication within the firm, and better employee-management relations. The employee theoretically benefits from the QC in the sense that he attains a greater sense of control over the work environment and the satisfaction of seeing worker-developed solutions implemented. There are usually no direct extrinsic rewards to workers connected to QCs, although some companies do implement quality circles in conjunction with profit-sharing plans or productivity-bonus plans (4: 60-70).

The quality circle can theoretically function as an ongoing production control and monitoring system. Analyzing the Japanese system of quality circles, Hummel (1987) notes that "instead of employing inspectors throughout the manufacturing and assembly processes, every production worker in Japan serves as his own inspector, responsible for the quality assurance of what he passes along" (18: 74).

Quality circles in U.S. companies have not met with the same overwhelming success as quality circles in Japan. Several analysts, including Skinner (1986) suggest that

American companies have failed in the implementation of quality circles with their focus on the ends rather than the means to productivity improvement:

> "Recent admirers of the Japanese argue that low cost and high quality can go hand in hand. Indeed, in the right setting managers need not trade one for the other. But in an efficiency-driven operation, this logic can be a trap. When low cost is the goal, quality often gets lost. But when quality is the goal, lower costs do usually follow" (40: 57).

An analysis of the literature reveals that there are a number of reasons behind the problems perceived in American quality circles, ranging from inadequate training to the influences of management style and organizational structure. The flat structure of the quality circle (in terms of chain of command, job definition, etc.) stands in sharp contrast to the usually hierarchical structure of American corporations. Lawler and Mohrman (1987) note that a number of problems are associated with parallel structure of the quality circle:

> "The problems associated with parallel structures are significant. Since they are generally viewed as an auxiliary program they are subject to cancellation. In addition, their kinds of power and problem solving activities are limited. For example, quality circles typically have the power only to recommend innovations; the decision-making domain remains with the regular organization" (24: 43).

Encompassed within the problems of the parallel structure are the problems of management style and action. For quality circles, both top management and middle management can prove problematical. Top management may not have a real commitment to the functions of the quality

circle. Rather, they may see it as a convenient, "quick fix" placebo to address employee demands for involvement in the decision-making process (39: 37). In other cases, top management may have unrealistic expectations about QC results. While quality circles can be very effective at addressing certain problems, they are not an answer to all of the company's production ailments. Top management that expects fast and dramatic results may withdraw budget support when the quality circle fails to meet expectations.

Middle managers can also pose a threat to quality circle effectiveness if middle managers view the QC as a threat to their own job positions or power. In a sense, the quality circle may threaten to take away the role of the middle manger, who has often "worked up the ranks" to attain some position of authority. The quality circle process, which theoretically empowers the individual employee in a group setting, necessarily limits or at least changes the nature of the middle manager's power in the organization (12: 504-506).

It can thus be seen that while a quality improvement program is an important component of a total program of productivity improvement, and particularly useful on a group or team level (which in turn can interface well with an objective matrix of productivity improvement and measurement), the effectiveness of a particular technique,

such as quality circles, may be limited by the limitations and structure of the organization.

Productivity and the Individual Worker

The extent to which the success or failure of a group productivity/quality improvement program such as the QC is dependent upon both the structure of the organization and the individual needs and motivations of the worker has led analysts to recommend that programs for productivity improvement include all levels of the organization (8: 67). Focusing on all levels of the organization requires the coordination of management objectives and responsibilities and employee responses.

As noted earlier, within the literature on productivity improvement, there is considerable (indeed, perhaps disproportionate) attention devoted to labor productivity, and specifically to how to make the individual worker more productive or efficient. Again, it should be noted that a single-minded focus on increasing quantitative labor output does not necessarily result in improvements in labor quality or productivity.

Rather than this "slave driver" approach to labor productivity improvement, the bulk of current literature focuses on ways to enhance employee motivation to work as a way to improve labor productivity. Such models focus both on ways to motivate employees (motivation or quality of work life enhancement) and ways to better measure or struc-

ture work performance (performance appraisals, performance reviews).

McClelland (1986) has developed a human performance planning model. The model is based on the assumption that there are three elements which have the greatest impact on human performance and human productivity: 1) an understanding of how workers view themselves; 2) the type of activity or job being performed; and 3) the environment in which this function is performed (29: 14). McClelland's model moves through a step-by-step process of first defining the capabilities and limitations of the employees, designing a reward/incentive program, maintaining open channels of communication, and operating a feedback/appraisal system in conjunction with the motivation program (29: 15).

Employee motivation programs found in the literature draw heavily on the theories of analysts such as Frederick Herzberg. Building on psychologist Abraham Maslow's "hierarchy of needs," Herzberg formulated a two-factor theory of human motivation. Herzberg makes a distinction between factors which are necessary to prevent overt employee dissatisfaction (hygiene factors) and factors which are necessary to actually motivate the employee. Management-employee communication, in the form of praise, criticism, and feedback, play an integral role within the motivational hierarchy described by Herzberg:

> The growth or motivator factors that are intrinsic to the job are: achievement, recognition for achievement, the work itself, responsibility and growth or advancement. The dissatisfaction-avoidance of hygiene factors that are extrinsic to the job include: company policy and administration, supervision, interpersonal relationships, working conditions, salary, status and security (15: 13).

Herzberg's motivational theories can be put into practice when integrated into a total management structure. Herzberg's theories are most often integrated with Douglas McGregor's "Theory Y" management, which makes positive assumptions about the individual employee's willingness and ability to work. Arnold (1988) notes that the underlying objective of such a management system is to "have employees who think of the organizations they work for as 'we' rather than 'they'" so that "the firm's welfare will become as important to the workers as it is to management" (1: 22). Similarly, Wilkinson, Orth and Benfari (1986) observe that:

> "The assumptions about human behavior associated with McGregor's Theory Y and supported by the higher level motivational needs of Maslow, McClelland and Herzberg all point toward design of work systems emphasizing responsibility, participation and commitment of workers at all organizational levels" (47: 30).

Quality circles and team productivity units can obviously be one technique for improving productivity and enhancing employee motivation through increased participation and involvement (26: 27). Communication and feedback systems appear to be crucial to the success of any motivational program. Mischkind's (1987) model of productivity improvement has as its first step a communication audit aimed both at assessing the "channel

fidelity" of communications in the organization (e.g., do employees actually perceive what management is trying to tell and vice versa) and at clearly articulating the productivity goals of the firm throughout the organization (31: 24).

Feedback, mainly through the performance appraisal, is also a key part of the motivational process. Fox (1987) notes that the typically subjective nature of the performance appraisal process both defeats any attempts to arrive at realistic assessments of labor productivity and hampers employee performance by hindering motivation (10: 20-21). To this end, Rollins and Bratkovich (1988) recommend the implementation of "truthful, well-documented performance reviews with 'teeth', delivered by managers and supervisors who have been given specific training in how to confront difficult situations" (37: 53). The objective performance appraisal system which includes clear provisions for both punishments and rewards can improve performance and hence labor productivity by providing meaningful feedback to the employee.

Conclusion

This review of literature has revealed that productivity improvement and measurement programs must take a total organizational viewpoint to achieve success. Productivity improvement programs which focus unrealistically

on only one or two factors in the productivity matrix may only result in "productivity tradeoffs" and an overall decline in organizational productivity. At the same time, techniques such as quality circles or work teams which are not supported by a management structure and a system of employee motivation and communication are unlikely to prove effective.

In Saudi Arabia, the Productivity Interfirm Comparison would be a suitable technique to begin with. This is because it helps to improve productivity at the firm level and doesn't encounter the difficulties associated with other techniques. At the same time, it can parallel the top-down mode of getting things done in Saudi Arabian firms. That is, after first getting the support and approval of top management of a firm, it can be applied to the upper levels to improve efficiency and provide more control and power to those levels; then it can be applied to lower levels.

CHAPTER IV

PIC FOR THE PARTICIPATING FIRMS

Each one of the eight Saudi cement factories was contacted, and information about PIC and the project was given. This information included items such as the following:

- Benefits and purposes of conducting the comparison
- Mechanics of applying the comparison
- The nature of PIC and the way it works
- The data collection process
- Nature and usefulness of results.

Confidentiality of the data provided by the companies was ensured to each potential participant.

As a result of these contacts many of the firms were interested. However, only three firms made a commitment, while some of the other firms apologized for being unable to take part in the project.

The next step was to invite responsible members from each of the three firms to form a steering committee. Members of the steering committee were chosen by the companies, and at a meeting with these members, a detailed explanation of the process was given and the process was discussed. A set of ratios was formed and agreed upon by the members of the committee. The meanings of these ratios

were specified, and the data required from each company was requested.

It was important that the data be agreed on from the participating firms and that the utilization of such data should be clear. The data from each of the three firms were collected and then analyzed. This data was for the year 1986 A.D. (Year 1406 on the Islamic calendar).* The following chapters contain the analyses of the data collected, the results, and the recommendations.

Benefits of PIC

Productivity Improvement

The performance of each factory was determined by two measures:

1) The production rate of the factory was compared to the capacity of the plant.
2) The increased profit through increased sales with good selling prices.

But what about the performance of the plant in comparison with another competitor? This could only be compared through a rough estimate of the market share of each one, but how good you are performing internally in

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* The start of the Islamic calendar is marked by the event of the immigration of the prophet Mohammed from Mecca to Medina on the Arabian peninsula (the year 622 A.D.). The Islamic calendar determines years according to the movements of the Moon.

terms of the productivity of the machines and the workers, the cost that is spent to produce and the return on investment that will attract people. How you can improve sales, increase productivity, stimulate performance, how can you measure these, etc. These and many other questions are in need of being answered for the sake of performance of the company.

One way to answer these questions is through the Productivity Inter-firm Comparison, using ratios to measure productivity in order to improve it by comparing performance of the company in a number of different respects with performances of other companies. Making such comparisons is the essential basic rule for PIC.

The awareness of the need to improve productivity is the purpose of PIC. Unearthing performance inefficiencies discovered by comparing performance at the firm level and directing attention towards these inefficiencies will lead to actions intended to improve performance. This, in turn, can be expected to lead to improved productivity for the company.

Prosperity for the Industry

The saying "Productivity improvement is money" is true, since the feedback on how to improve a firm's productivity performance will lead to an increase in competitiveness of the whole industry. Firms will compete with each other and try to achieve the best position in the

industry, and that competition will stimulate the participating firms to increase productivity. This, of course, takes time. Although improvement may take place immediately, but it may be several years before the measurement system enables quantifying the improvement (49:2).

Mechanics of PIC

The contact with the eight factories started in early summer of 1987 and it resulted in only three cement factories committing themselves to participation. These are:

1. Arabian Cement Company (Rabique)
2. Saudi Yamama Cement Company (Riyadh)
3. Southern Province Cement Company (Abha).

It was important to get the approval of the top management of the three companies. When contacted, the top management of all three expressed interest in the method and agreed to take part in the research. They selected representatives from their companies to form the steering committee, and a lunch meeting was arranged at a time suitable for the representatives. These members of the committee, who are all engineers, met via transcontinental phone link with the researcher in a friendly atmosphere and the process was described to them. After some discussion the committee agreed on the important ratios to be included

within the study. These ratios represent the measures of financial information and productivity that the participants feel are useful to be compared. The terms of each ratio were defined and the meanings of each were discussed. The data required to be furnished by each company in order to determine these ratios were specified, and each member was asked to supply these data. (See Appendix A for data for firm A.)

The data collected were converted into twenty ratios (see Table IV.1, p. 47). The results of these ratios will be discussed later.

The Following Step

The PIC is conducted at the firm's level, and that will highlight the areas where the management should concentrate on improving operations and making decisions to correct things. This needs to be done internally and requires the attention of the top management all the way down to shop workers. How this can be done will be discussed at the end of Chapter V.

Confidentiality

The confidentiality of the information is assured through the trust between the participating firms and the researcher. For the sake of this confidentiality, each of

Table IV.1. Set of ratios and their value assessment by three responding firms.

1986	A	B	C
GENERAL:			
1) net profit / (000) capital	3.12	186.01	114.55
2) net profit / # of shareholders	1,168.29	10,528.58	57,276.5
3) net profit / (000) total sales	14.9	422	324
4) total sales / inventory value	1.53	4.46	0.01
5) amount of cement produced / # of employees	1,370.60	1,998.29	1,131.63
6) total sales / amount of clinker produced	96.35	185.93	166.26
7) amount of clinker produced / amount of cement sold	1.55	1.05	1.02
8) current assets / current liabilities	3.68	5.78	1.76

Table IV.1. Continued

1986	A	B	C
9) current assets / (000) sales	833	702	791
CAPACITY UTILIZATION:			
10) amount of clinker produced / installed capacity	1.12	1.15	1.06
HUMAN RESOURCES:			
11) total wages & benefits / (000) # of employees	80.25	49.76	46.01
12) total wages & benefits / amount of cement produced	58.55	24.90	40.66
13) total sales / total wages & benefits	2.66	7.84	5.24
14) severance compensation / # of employees left	1,736.95	1,599.90	3,432.50

Table IV.1. Continued

1986	A	B	C
CUSTOMER CONCENTRATION:			
15) sales to 10 largest customers / sales	23.3	35.6	49.7
16) sales to 20 largest customers / sales	48.0	65.4	68.6
COST RATIOS:			
17) cost of production / Amount of clinker produced	39.13	63.71	60.42
18) cost of production / amount of cement produced	63.28	67.28	77.36
19) cost of power / amount of cement produced	28.10	19.39	23.94
CEMENT MARKETING:			
20) advertising costs / (000) total sales	0.77	0.648	1.56

the three firms is represented by a letter -- A, B, or C -- in this research. Each of the firms will be able to determine results for itself by checking its own ratios.

For the future, the PIC technique could be carried out through a third party such as the department in the national government dealing with industrial affairs of the major industrial cities, through the union of chambers of commerce, or through one or more of the nation's universities.

CHAPTER V

DATA ANALYSIS AND RESULTS

The data collected from the three participating firms were converted to the ratios in Table IV.1. These ratios are represented graphically by bar charts. The meaning of the numerator and the denominator and a brief description of each ratio accompanies each bar chart. A framework is set up to categorize the ratios in order to ease explanation. A trend for each category will be explored to help determine how the firms are doing with respect to one another. A detailed discussion of each measure (ratio) will follow, and this will provide possible reasons and/or interpretations of the differences in the values of the measures for the three firms.

Interpretation of the Charts

Before proceeding, an interpretation of the bar chart will be presented in order to explain some of the important points that are associated with these graphs. Interpretation of the charts is best illustrated by the example of the chart below (Fig. V.I), which is a bar chart for the ratio "Total wages and benefits/1000's of employees." Below the horizontal axis are the symbols representing the firms. The vertical axis is scaled, showing the range of ratio values. The number at the top of each bar represents

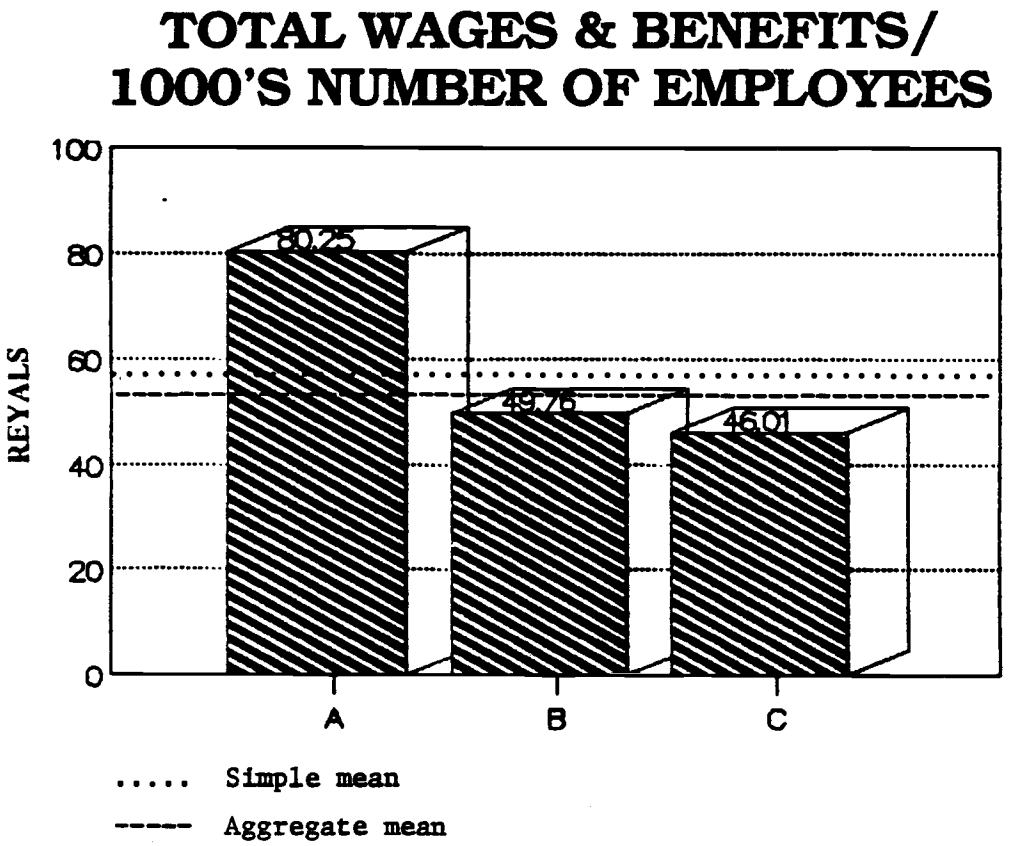


Figure V.1. Example of bar chart.

the value of the ratio for the corresponding firm. These values are presented in descending order. Since each firm knows the symbol that represents itself, each can determine its own bar and corresponding ratio value on each of the charts.

The simple and aggregate means are both shown on each of the 1986 (1406) interfirm comparison bar charts. The simple mean is just the sum of the three ratio values divided by three; however, since the simple mean does not

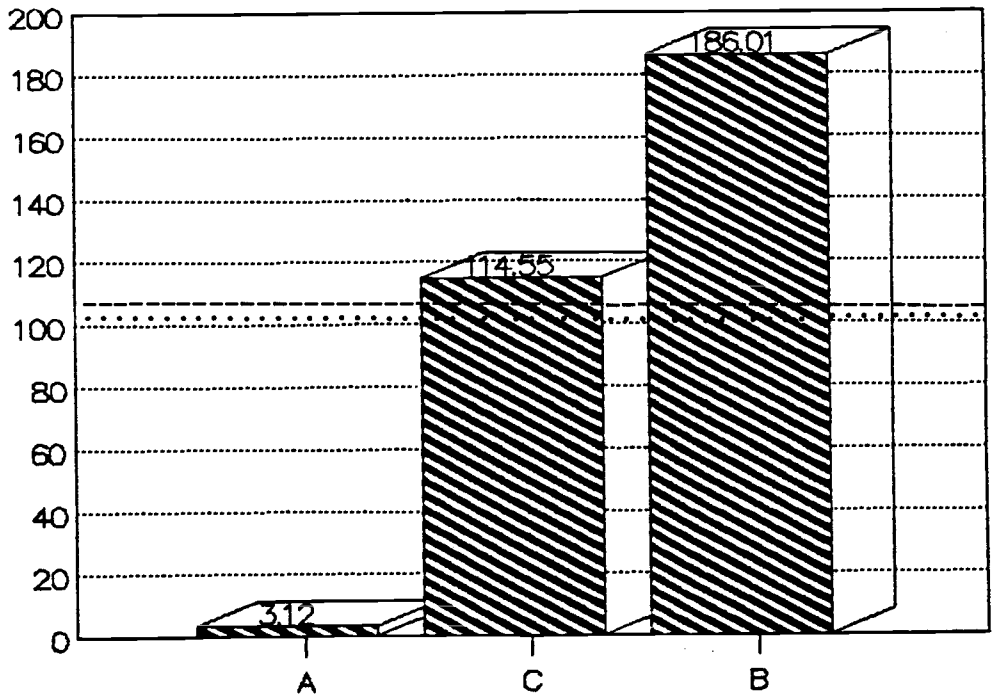
account for the differences in size of the participating firms, the aggregate mean is also shown. The aggregate mean is the sum of all numerators divided by the sum of all denominators. Bar charts that have the simple and aggregate means close together indicate that the relative sizes of the firms are about the same for that particular ratio. The aggregate mean is a weighted mean where each unit in the numerator is equally weighted, thus it is generally a better indicator of the average.

In some cases it is preferable for the value of the ratio to be low, while in others a high value is desirable. Generally, if the numerator is an expense or an abnormality such as production cost or inventory value, then it should ideally be low. If the numerator is some measure of output, such as sales or units of production, then it should be high. The same thing can be said about the denominator. In some cases it is not certain what is the desirable direction, and such ratios are presented as "information only" ratios (49:10-11).

All bar charts are arranged such that the preferred location is on the right side. It is important to note that the preference is only valid within a certain range, and it is up to each firm to define its own range.

The bar charts for the 20 ratios that were determined, along with the meanings of the numerators and denominators, and a brief discussion of each are as follows:

NET PROFIT/ 1000'S CAPITAL



..... Simple mean

----- Aggregate mean

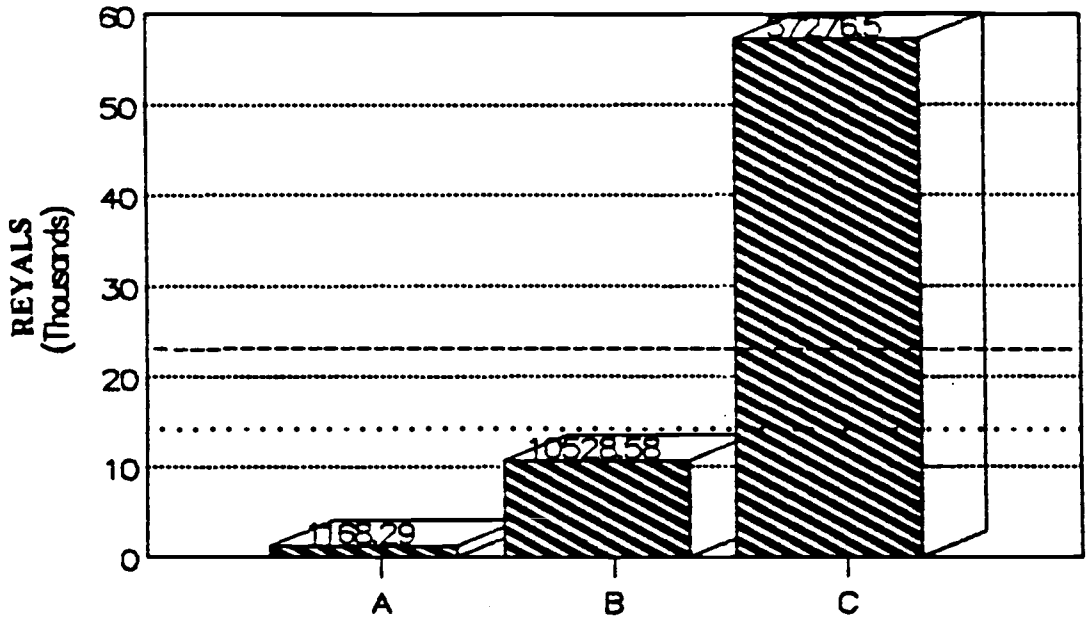
Numerator: The net profit gained from the sale of the cement produced.

Denominator: The amount of money invested in the facility (divided by 1000 for data presentation).

Discussion: This ratio presents the profitability of the facility in this particular year. This ratio is of great value to the shareholders.

Figure V.2. Ratio number 1.

NET PROFIT/ NUMBER OF SHAREHOLDERS



..... Simple mean

----- Aggregate mean

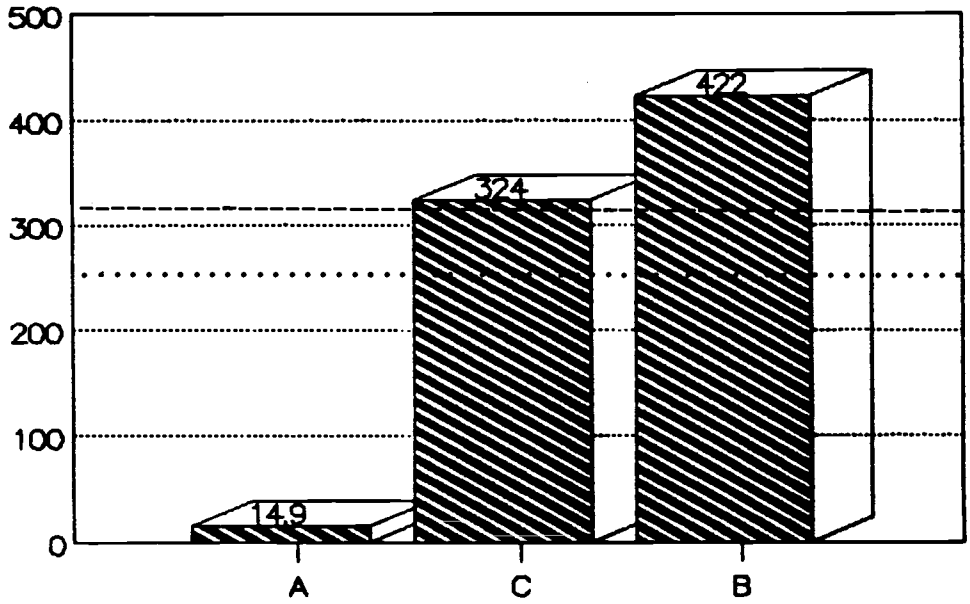
Numerator: The net profit gained from the sale of the cement produced.

Denominator: Total number of shareholders investing in the facility.

Discussion: This ratio gives a good indication of the profitability of the facility. It shows how attractive is the investment in the facility.

Figure V.3. Ratio number 2.

NET PROFIT/ 1000'S TOTAL SALES



..... Simple mean

----- Aggregate mean

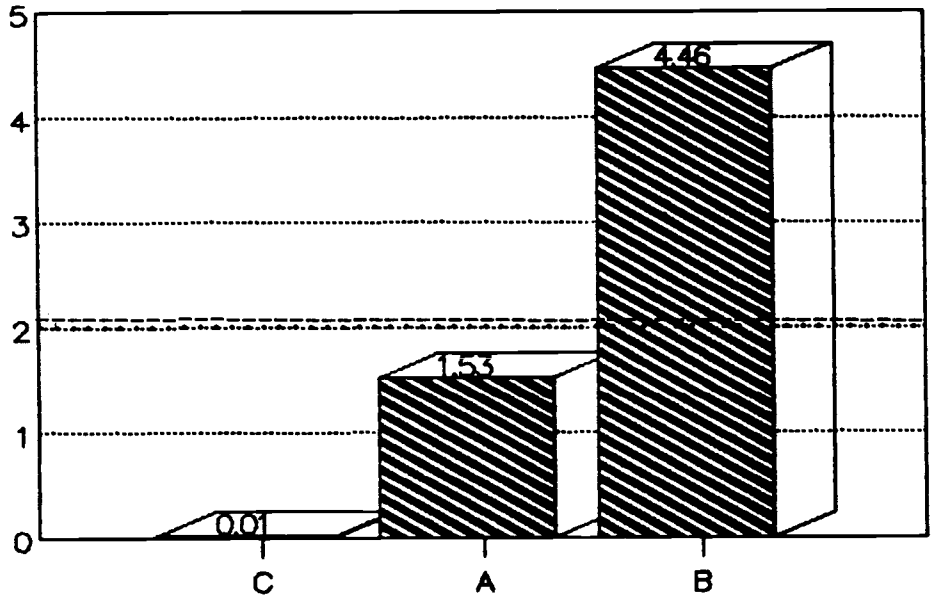
Numerator: The net profit gained from the sale of the cement produced.

Denominator: Total gross revenue from the sale of cement produced (divided by 1000 for data presentation).

Discussion: This ratio shows the effectiveness of the firm's sales and competitiveness. Greater profit from less sales means higher selling prices or lower costs, which indicates the strength of the firm in the market.

Figure V.4. Ratio number 3.

TOTAL SALES/ INVENTORY VALUE



..... Simple mean

----- Aggregate mean

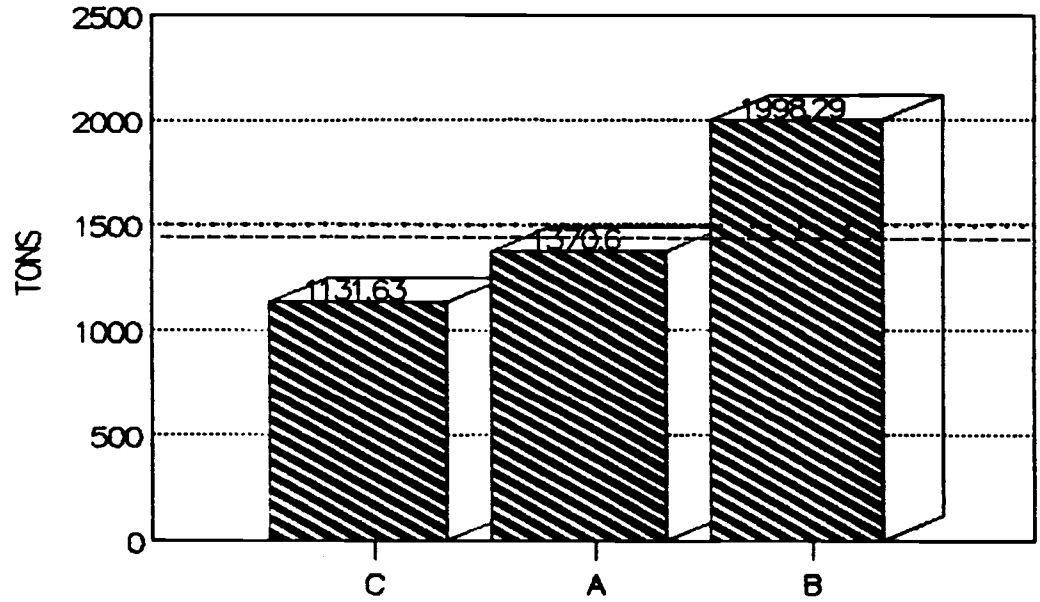
Numerator: Total gross revenue from the sale of cement produced.

Denominator: Total value of amount at storage (includes unfinished products and finished products, at the market value or cost).

Discussion: This ratio indicates the power of the firm in terms of selling what it produced and not having tied-up money in inventory.

Figure V.5. Ratio number 4.

AMOUNT OF CEMENT PRODUCED/ NUMBER OF EMPLOYEES



..... Simple mean

----- Aggregate mean

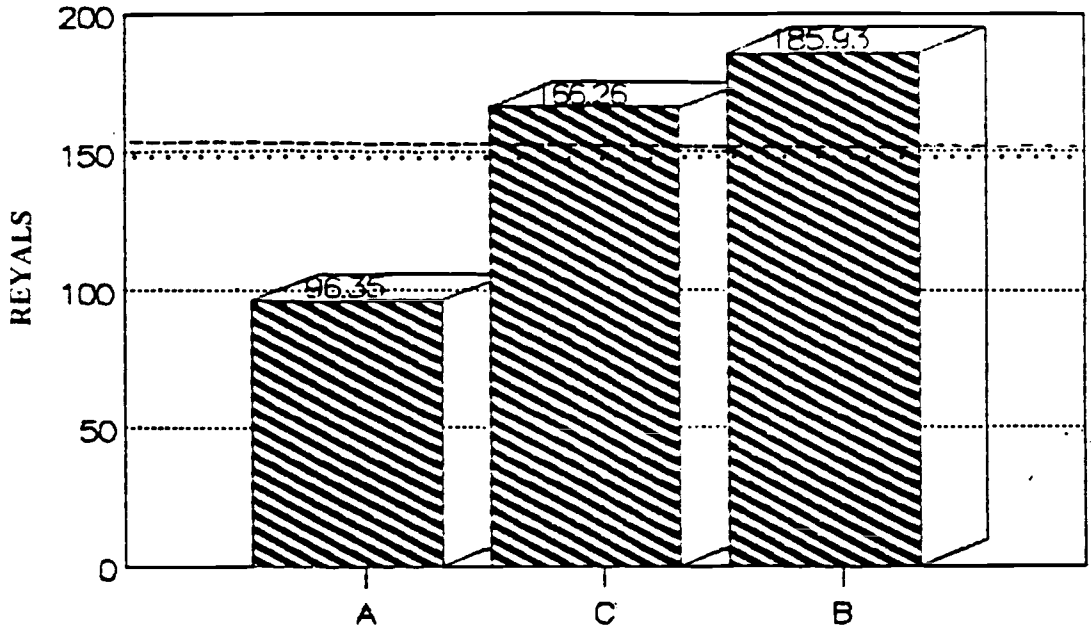
Numerator: Total amount of cement produced.

Denominator: Total regular full-time employees working for the firm.

Discussion: This ratio gives an indication of the contribution of each employee to the company. The higher the ratio the larger the capacity of production.

Figure V.6. Ratio number 5.

TOTAL SALES/ AMOUNT OF CLINKER PRODUCED



..... Simple mean

----- Aggregate mean

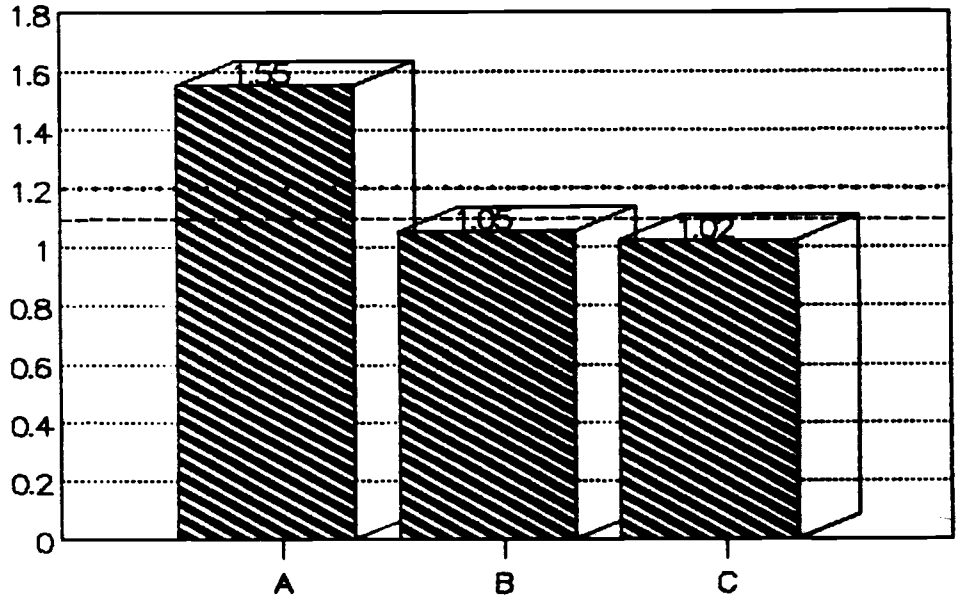
Numerator: Total gross revenue from the sale of produced cement.

Denominator: Total amount of clinker (pre-cement) already converted to cement or in inventory, awaiting conversion.

Discussion: This ratio gives the firm an indication of how successful it is in selling the produced cement from the clinker under process or in inventory. It also gives an estimated market value for clinker on hand.

Figure V.7. Ratio number 6.

AMOUNT OF CLINKER PRODUCED/ AMOUNT OF CEMENT SOLD



..... Simple mean

----- Aggregate mean

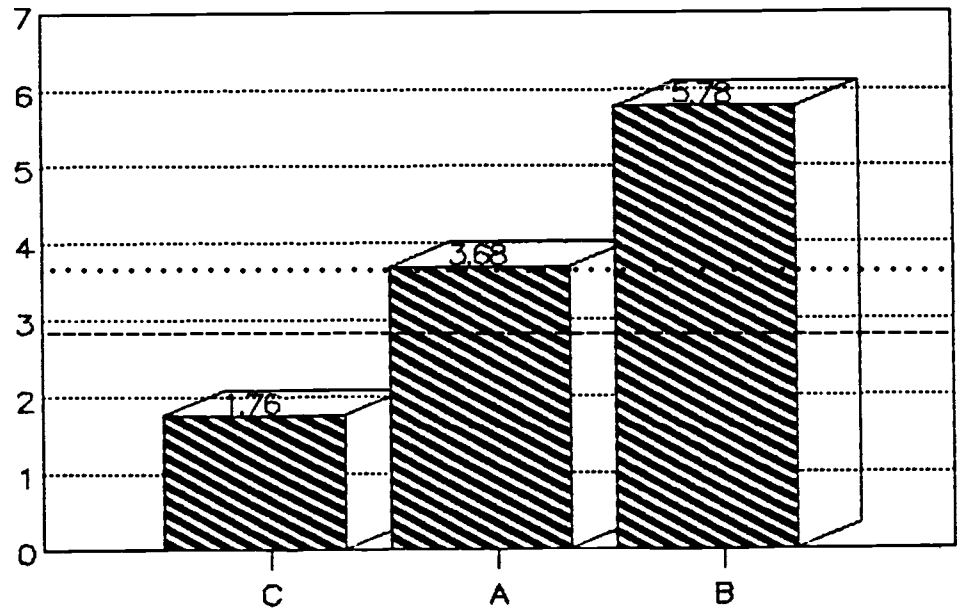
Numerator: Total amount of clinker (pre-cement) already converted to cement or in inventory, awaiting conversion.

Denominator: Total amount of cement produced and sold.

Discussion: This ratio is of great value to each firm to address their ability in selling the produced cement by reducing the stored clinker. This indicates how effective the firm is in production and sales.

Figure V.8. Ratio number 7.

CURRENT ASSETS/ CURRENT LIABILITIES



..... Simple mean

----- Aggregate mean

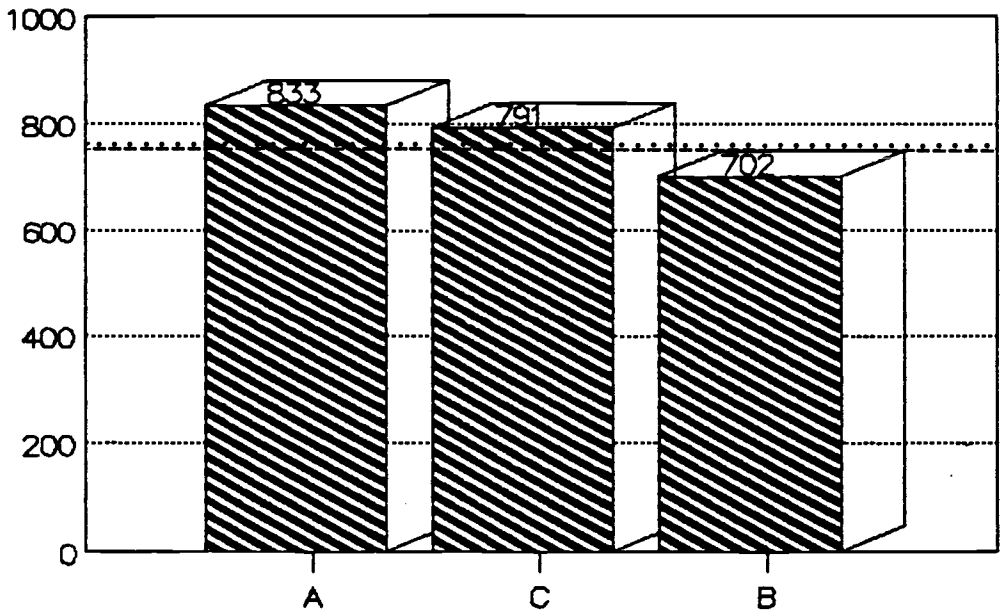
Numerator: Current assets include inventory, letters of credit for purchase of goods, accounts receivable, and cash on hand and at banks.

Denominator: Current liabilities include bank liabilities, accounts payable.

Discussion: This ratio shows how strong the firm is in terms of how much it has on hand and how much it owes others. This ratio is important for seeing the cash flow.

Figure V.9. Ratio number 8.

CURRENT ASSETS/ 1000'S TOTAL SALES



..... Simple mean

----- Aggregate mean

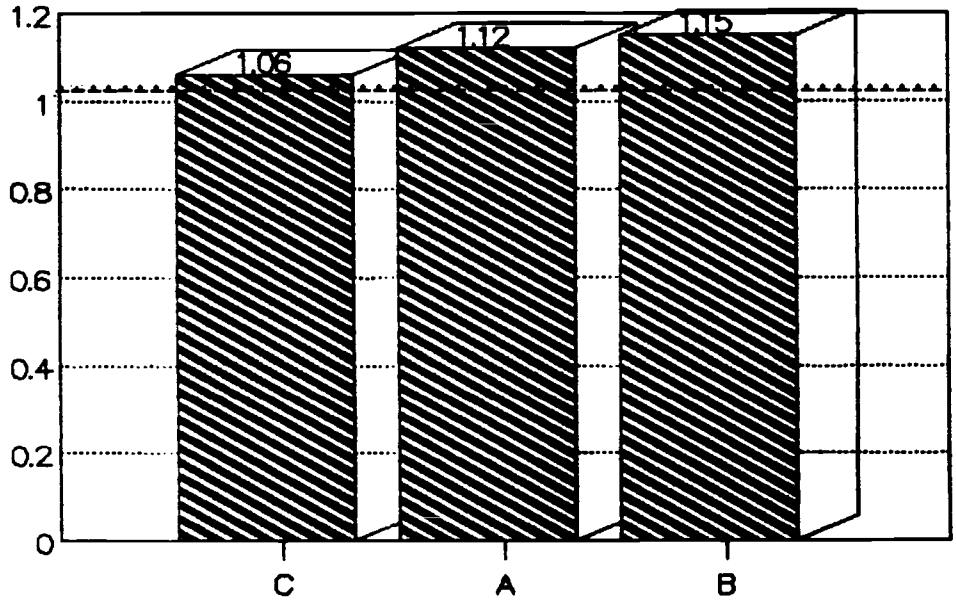
Numerator: Current assets include inventory, investment at cost, letters of credit for purchase of goods, accounts receivable, and cash on hand and at banks.

Denominator: Total gross revenue from the sale of cement produced (divided by 1000 for data presentation).

Discussion: This ratio shows the strength of the company in terms of how much it has on hand and how it is doing in sales. The higher the sales figure, the stronger the firm.

Figure V.10. Ratio number 9.

AMOUNT OF CLINKER PRODUCED/ INSTALLED CAPACITY



..... Simple mean

----- Aggregate mean

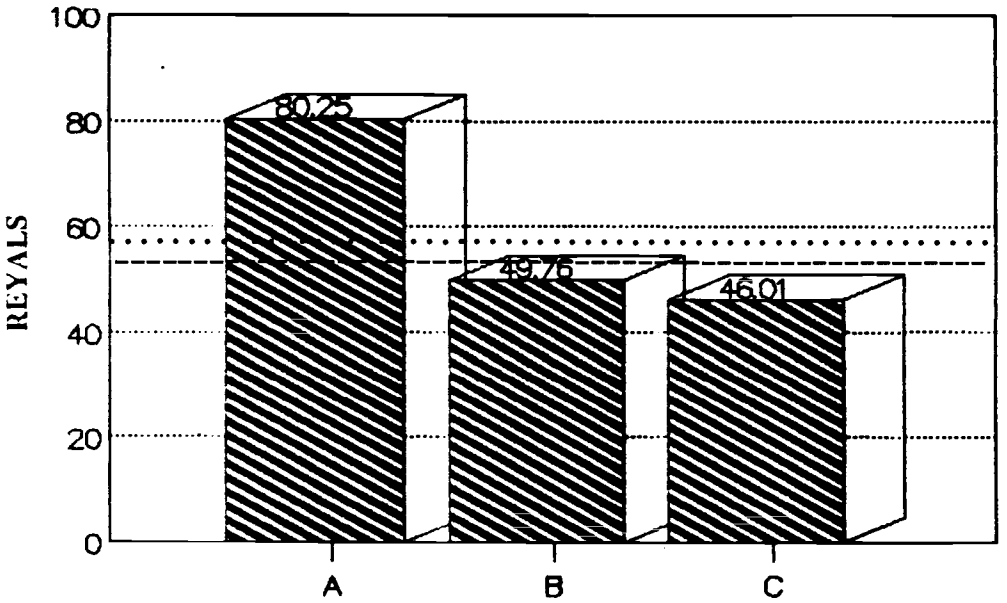
Numerator: Total amount of clinker (pre-cement) already converted to cement or in inventory, waiting conversion.

Denominator: The production capacity that is installed for each machine.

Discussion: This ratio compares actual production to the installed capacity, which indicates the efficiency of each plant and gives a measure for plants to check for market demand.

Figure V.11. Ratio number 10.

TOTAL WAGES & BENEFITS/ 1000'S NUMBER OF EMPLOYEES



..... Simple mean

----- Aggregate mean

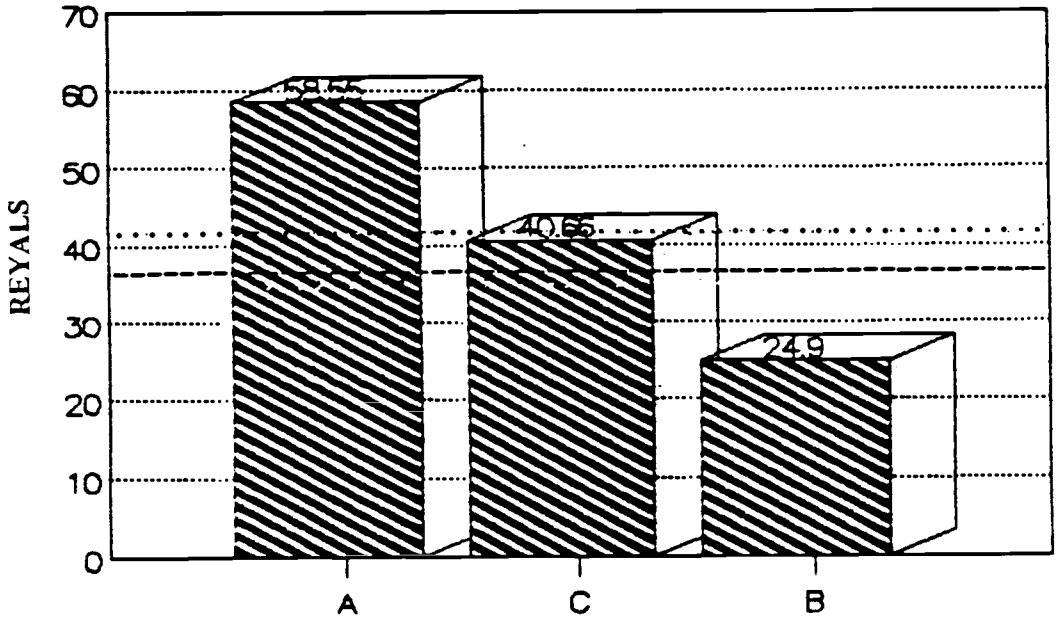
Numerator: Total salaries and wages paid to all employees in the firm (includes medical, shelter, transportation, rewards, social insurance, sick leave, holidays and vacations).

Denominator: Total employees of the firm involved in all operations (divided by 1000 for data presentation).

Discussion: This ratio gives a comparison of average wage and salary expense for all firms. There may well be a justified reason for a high ratio. For example, a firm located in a geographical region with a history of high wages and salaries must pay high wages and salaries to attract qualified workers, or there are fewer employees due to new technology used.

Figure V.12. Ratio number 11.

TOTAL WAGES AND BENEFITS/ AMOUNT OF CEMENT PRODUCED



..... Simple mean

----- Aggregate mean

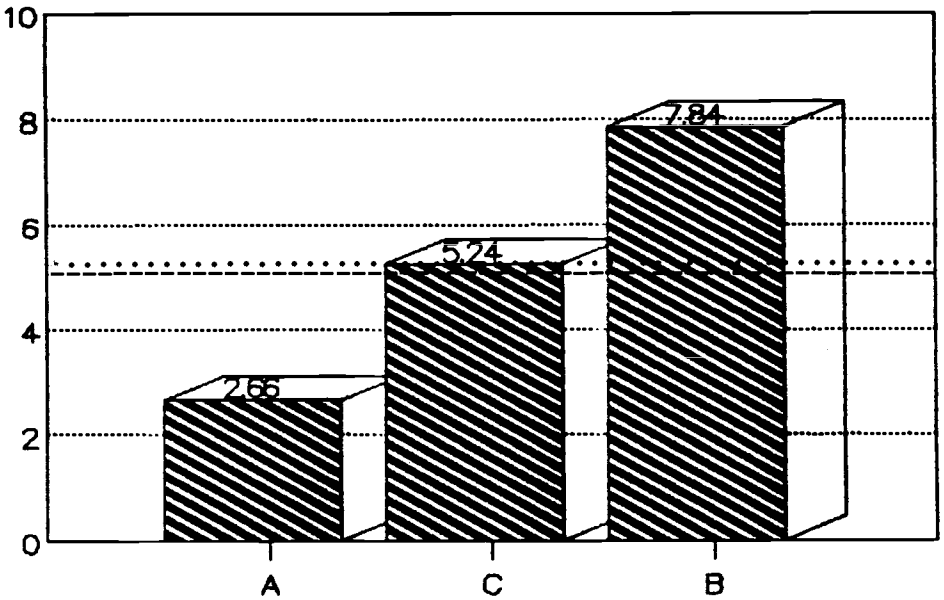
Numerator: Total salaries and wages paid to all employees in the firm (includes medical, shelter, transportation, rewards, social insurance, sick leave, holidays and vacations).

Denominator: Total amount of cement produced.

Discussion: This ratio gives each firm an idea of the labor cost required to produce one ton of cement.

Figure V.13. Ratio number 12.

TOTAL SALES/ TOTAL WAGES AND BENEFITS



..... Simple mean

----- Aggregate mean

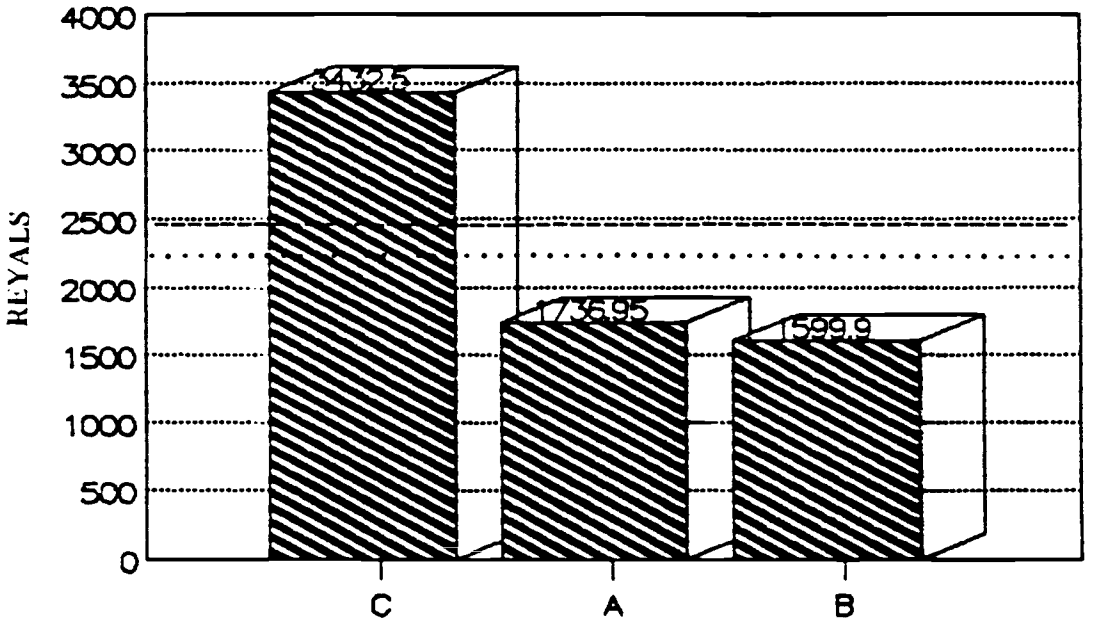
Numerator: Total gross revenue from the sale of cement produced.

Denominator: Total salaries and wages paid to all employees in the firm (includes medical, shelter, transportation, rewards, social insurance, sick leave, holidays and vacations).

Discussion: This ratio indicates the efficiency of the firm in selling more by less labor cost. The higher the ratio the more efficient the firm.

Figure V.14. Ratio number 13.

SEVERANCE COMPENSATION/ NUMBER OF EMPLOYEES LEFT



..... Simple mean

----- Aggregate mean

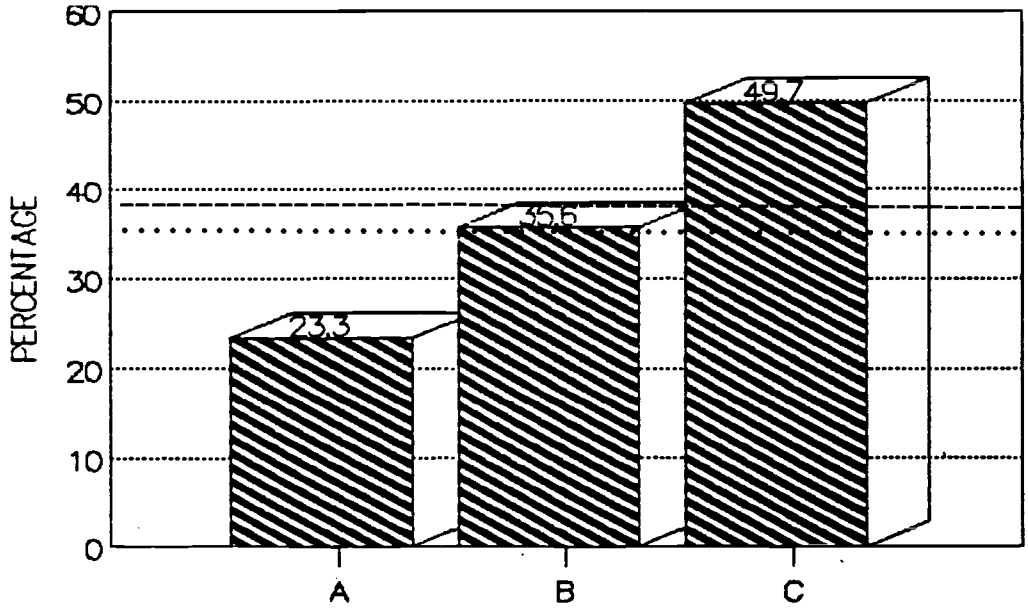
Numerator: The benefits that the employee is entitled to when he leaves the job.

Denominator: Total number of employees leaving the job (multiplied by 1000 for data presentation).

Discussion: This ratio gives the firm a picture of its position in regard to employees leaving their job and expenses associated with that. This requires the firm to investigate reasons of leaving to minimize the cost.

Figure V.15. Ratio number 14.

SALES TO 10 LARGEST CUSTOMERS/ TOTAL SALES



..... Simple mean

----- Aggregate mean

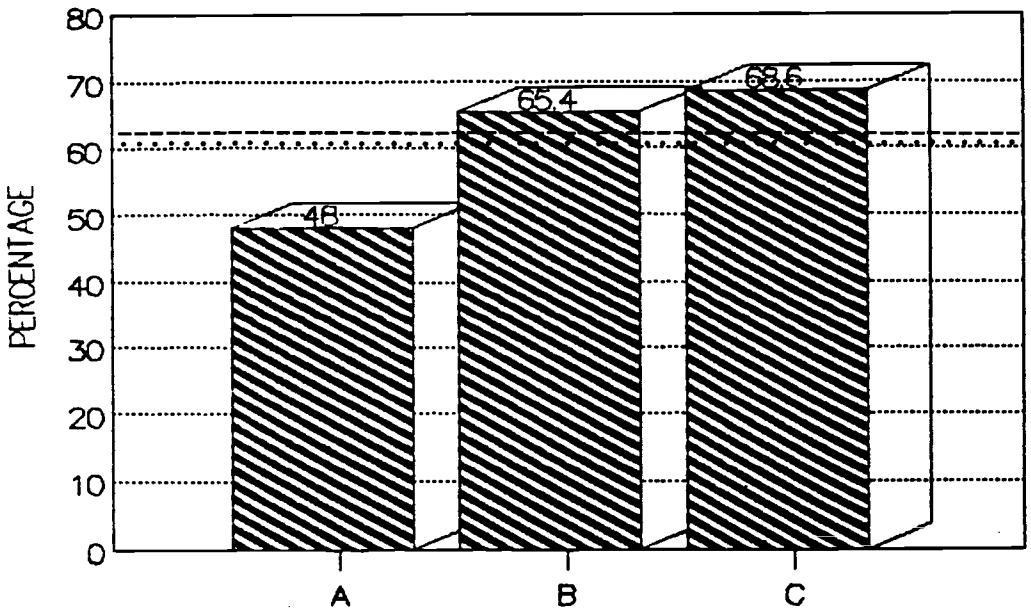
Numerator: The total gross revenue from the sale of cement to the 10 largest customers.

Denominator: The total gross revenue from the sale of cement produced.

Discussion: This ratio gets the firm's attention on how great its sales are for its 10 largest customers, which are their most important customers. This might help guide the firm in expanding its customer base if it wants to be on the safe side in the future.

Figure V.16. Ratio number 15.

SALES TO 20 LARGEST CUSTOMERS/ TOTAL SALES



..... Simple mean

----- Aggregate mean

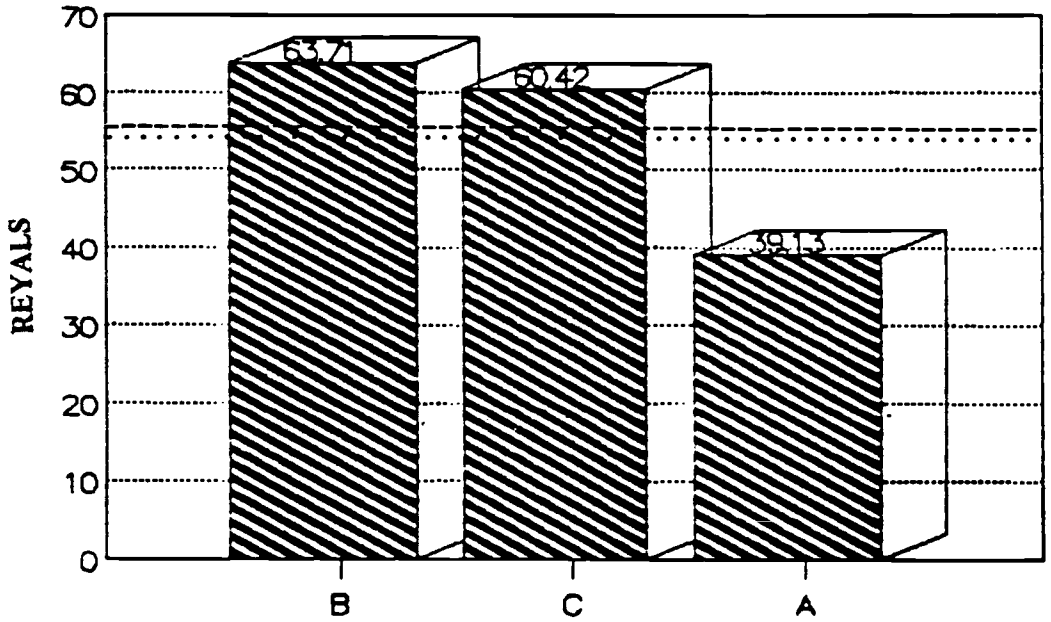
Numerator: The total gross revenue from the sale of cement to the 20 largest customers.

Denominator: The total gross revenue from the sale of cement produced.

Discussion: This ratio follows the previous one in showing where sales are concentrating. By comparing total revenues to revenues from these 20 largest customers, it might show the need for an expansion of the customer base.

Figure IV.17. Ratio number 16.

COST OF PRODUCTION/ AMOUNT OF CLINKER PRODUCED



..... Simple mean

----- Aggregate mean

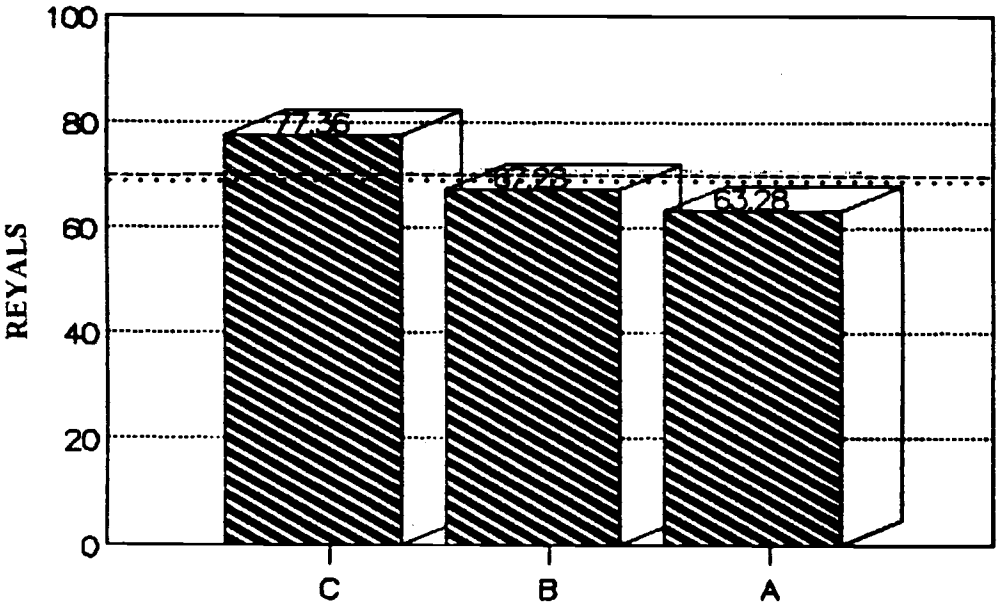
Numerator: The cost incurred in production (includes raw materials, machinery, power and maintenance).

Denominator: Total amount of clinker (pre-cement) already converted to cement or in inventory, waiting conversion.

Discussion: This ratio gives each firm an indication of how much it costs to produce one ton of clinker.

Figure V.18. Ratio number 17.

COST OF PRODUCTION/ AMOUNT OF CEMENT PRODUCED



..... Simple mean

----- Aggregate mean

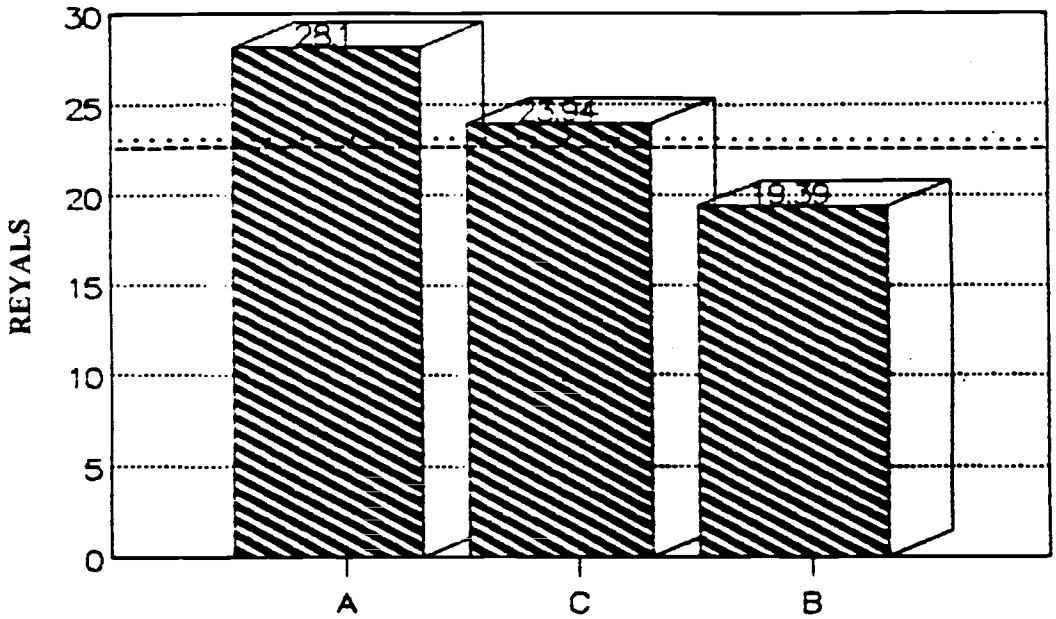
Numerator: The cost incurred in production (includes raw materials, machinery, power and maintenance).

Denominator: Total amount of cement produced.

Discussion: This ratio gives each firm an indication of how much it costs to produce one ton of cement.

Figure V.19. Ratio number 18.

COST OF POWER/ AMOUNT OF CEMENT PRODUCED



..... Simple mean

----- Aggregate mean

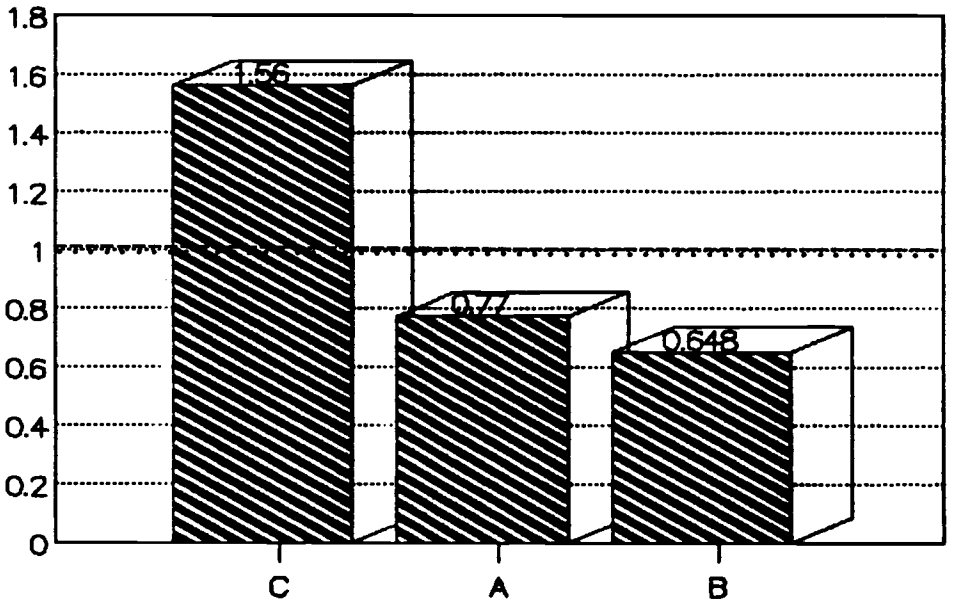
Numerator: The cost of power required to run the firm (includes electricity and fuel).

Denominator: Total amount of cement produced.

Discussion: This ratio gives each firm an indication of the cost of power required to produce one ton of cement.

Figure V.20. Ratio number 19.

ADVERTISING COSTS/ 1000'S TOTAL SALES



..... Simple mean

----- Aggregate mean

Numerator: Labor and material expenses associated with advertising.

Denominator: Total sales revenue (divided by 1000 for data presentation).

Discussion: This ratio gives a good comparison of the importance of advertising for each firm. Also it gives the firm an indication of the effectiveness of advertising in promoting sales.

Figure V.21. Ratio number 20.

The Framework

Productivity may be simply represented by dividing the output by the input, which, in general, amounts to dividing results by resources. However, for the ratios used in the interfirm comparison, we can have input-related ratios, output-related ratios, and productivity-related ratios.

The input-related ratios are those where both the numerator and the denominator are costs incurred in the operation, or resources required to be used for production, such as invested money.

The output-related ratios are those in which both the numerator and the denominator are benefits accrued from the operation, such as sales, profit, or production which have resulted from using resources.

The productivity-related ratios are those where the numerator is an output and the denominator is an input, such as production and cost, sales and cost, or profit and capital. For the sake of suitable measurement we could sometimes invert the ratio to have input divided by output, such as dividing cost of production (input) by amount produced (output) to see how much it costs to produce one unit of production ("ton" in our case here).

Our framework is to categorize the ratios that we have (20 ratios) under these three types (see Table V.1).

Table V.1. Categorization of ratios.

Input-related ratios	Output-related ratios	Productivity-related ratios
11) Total wages & benefits / 000 # of employees	2) Net profit / # of shareholders	1) Net profit / 000 capital
14) Severance compensation / # of employees left	3) Net profit / 000 total sales	4) Total sales / Inventory value
	6) Total sales / Amount of clinker produced	5) Amount of cement produced / # of employees
	7) Amount of clinker produced / Amount of cement sold	8) Current assets / Current liabilities
	9) Current assets / 000 total sales	12) Total wages and benefits / Amount of cement produced
	10) Amount of clinker produced / Installed capacity	13) Total sales / Total wages and benefits
	15) Sales to 10 largest customers / Total sales	17) Cost of production / Amount of clinker produced
	16) Sales to 20 largest customers / Total sales	18) Cost of production / Amount of cement produced
		19) Cost of power / Amount of cement produced
		20) Advertising costs / 000 total sales

Trend Examination

The Input-Related Ratios

Examining the two bar charts for the two input-related ratios, "Total wages and benefits/000 of employees" and "Severance compensation/Number of employees left," one can see that Firm A is in the last position with respect to the other two firms in terms of paying wages. (First position is the position to the right in the bar charts; this is the preferred position.) Firm A, however, in spite of the fact that it has a smaller number of employees working and a smaller number left (587 and 20 respectively), falls between the other two firms in terms of paying compensation. Firm B falls between the other two firms in terms of paying wages and is in the first position in terms of paying compensation. It is between the other two firms in terms of number of employees working and number left (791 and 26 respectively). Firm C is in the first position in terms of paying wages to employees, but even though it has the largest number of employees working and has the largest number of employees left (1100 and 41 respectively), it is in the last position in terms of paying compensation. (See Figure V.22, following page.)

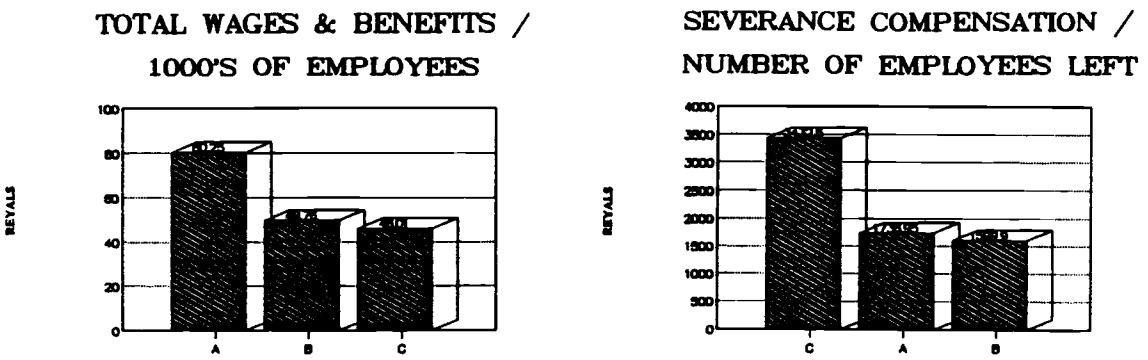


Figure V.22. Ratios number 11 and 14, representing firms in the given orders of the input-related ratios.

The Output-Related Ratios

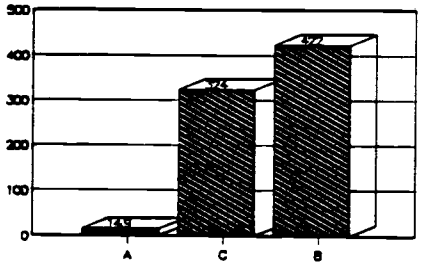
There are eight bar charts representing the output-related ratios. These are presented in Table 4 on the following page, with ratios grouped according to respective position order held by the three firms. (See also Figures V.23, V.24 and V.25.)

One can see that Firm A is in the last position in all of these ratios except for the ratio of the production of clinker to the installed capacity, where falls between the other two firms. Firm B and Firm C alternate with each other in the first and second positions.

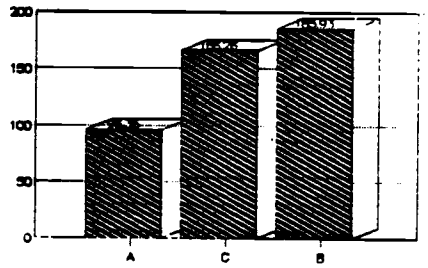
Table V.2. Grouping of output-related ratios according to firm position order.

Firm Position order		Ratio
A, C, B	3)	$\frac{\text{Net profit}}{\text{000 total sales}}$
	6)	$\frac{\text{Total sales}}{\text{Amount of clinker produced}}$
	9)	$\frac{\text{Current assets}}{\text{000 total sales}}$
A, B, C	2)	$\frac{\text{Net profit}}{\text{\# of shareholders}}$
	7)	$\frac{\text{Amount of clinker produced}}{\text{Amount of cement sold}}$
	15)	$\frac{\text{Sales to 10 largest customers}}{\text{Total sales revenue}}$
	16)	$\frac{\text{Sales to 20 largest customers}}{\text{Total sales revenue}}$
C, A, B	10)	$\frac{\text{Amount of clinker produced}}{\text{Installed capacity}}$

NET PROFIT /
1000'S TOTAL SALES



TOTAL SALES /
AMOUNT OF CLINKER PRODUCED



CURRENT ASSETS /
1000'S OF SALES

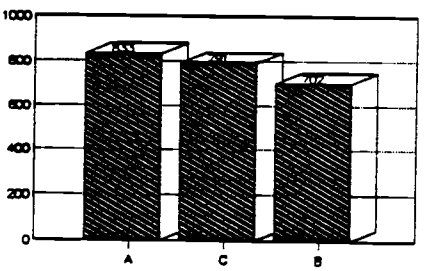
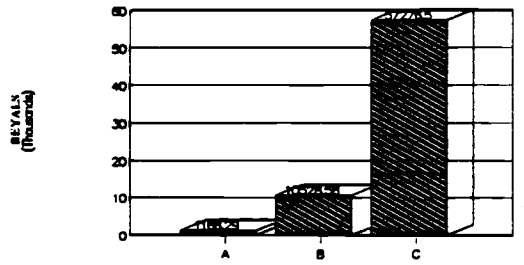
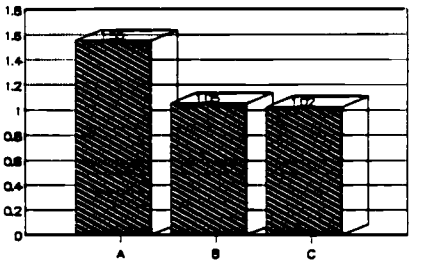


Figure V.23. Ratios 3, 6, and 9 representing firms in the order A, C, B of the output-related ratios.

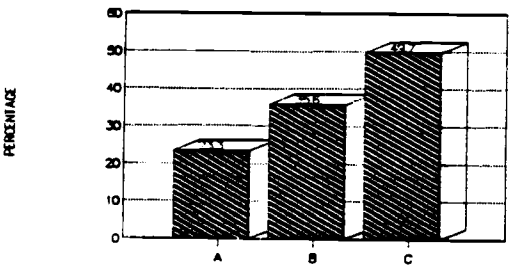
NET PROFIT / NUMBER OF SHAREHOLDERS



AMOUNT OF CLINKER PRODUCED / AMOUNT OF CEMENT SOLD



SALES TO 10 LARGEST CUSTOMERS / TOTAL SALES



SALES TO 20 LARGEST CUSTOMERS / TOTAL SALES

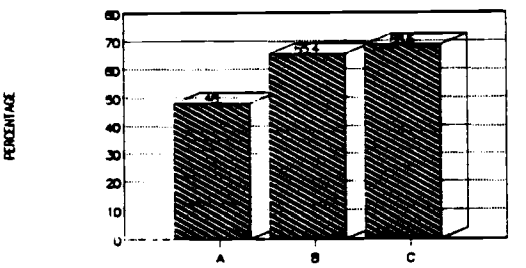


Figure V.24. Ratios 2, 7, 15, 16 representing firms in the order A, B, C, of the output-related ratios.

AMOUNT OF CLINKER PRODUCED / INSTALLED CAPACITY

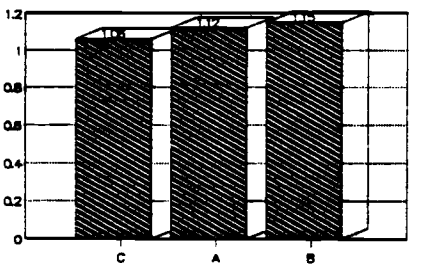


Figure V.25. Ratio 10 representing firms in the order C, A, B of the output-related ratios.

The Productivity-Related Ratios

Table 5 presents a summary of the ten bar charts for productivity-related ratios, with ratios grouped according to respective position order held by the three firms.

Table V.3. Grouping of productivity-related ratios according to firm position order.

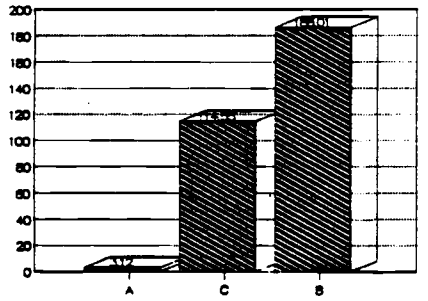
Firm Position order		Ratio
A, C, B	1)	Net profit / 000 capital
	12)	Total wages and benefits / Amount of cement produced
	13)	Total sales / Total wages and benefits
	19)	Cost of power / Amount of cement produced
B, C, A	17)	Cost of production / Amount of clinker produced
C, A, B	4)	Total sales / Inventory value
	5)	Amount of cement produced / # of employees
	8)	Current assets / Current liabilities
	20)	Advertising costs / 000 total sales
C, B, A	18)	Cost of production / Amount of cement produced

One can see that Firm A is in the first position for the first four ratios above because of the high cost associated with paying wages, lower sales, and lower production of cement than the other two firms. In spite of this, it spent the least amount on power. Firm B is in the first position in the first and third sets of ratios above (Figs. V.26 and V.28), but is in the third position in terms of the ratio of cost of production to amount of clinker produced (Fig. V.27). It is between the other two firms in terms of the ratio of cost of production to amount of cement produced (Fig. V.29). Firm C is between the other two firms in the first and second set of ratios, while it is in third position in the third and fourth set.

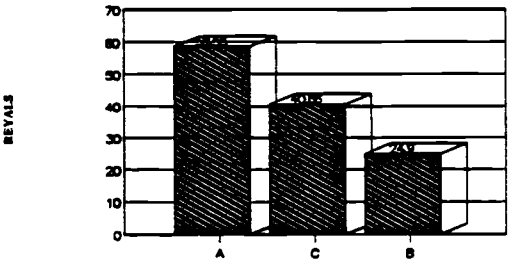
Overall, Firm A is in the first position in two of the productivity-related ratios. It is between the other two firms in four of the productivity-related ratios and one of the output-related ratios. It is in the third position in the input-related ratios, in most of the output-related ratios, and in four of the productivity-related ratios.

Firm B is in the first position in one of the input-related ratios, in four of the output-related ratios, and in most of the productivity-related ratios. It is between the other two firms in the other input-related ratio, in four of the output-related ratios, and in one of the productivity-related ratios. It is in third position in only one of the productivity-related ratios.

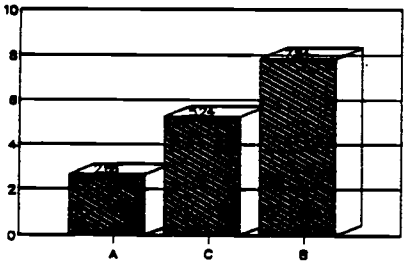
NET PROFIT / 1000'S CAPITAL



TOTAL WAGES & BENEFITS / AMOUNT OF CEMENT PRODUCED



TOTAL SALES / TOTAL WAGES & BENEFITS



COST OF POWER / AMOUNT OF CEMENT PRODUCED

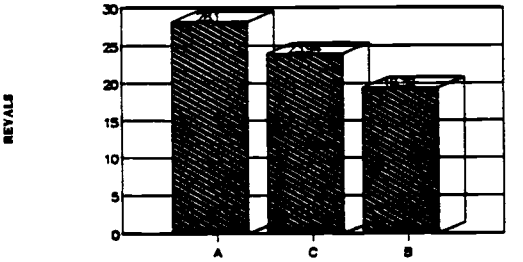


Figure V.26. Ratios 1, 12, 13, and 14 representing firms in order A, C, B of the productivity-related ratios.

COST OF PRODUCTION / AMOUNT OF CLINKER PRODUCED

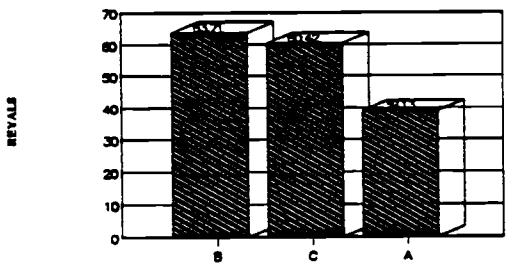


Figure V.27. Ratio 17 representing firms in the order B, C, A of the productivity-related ratios.

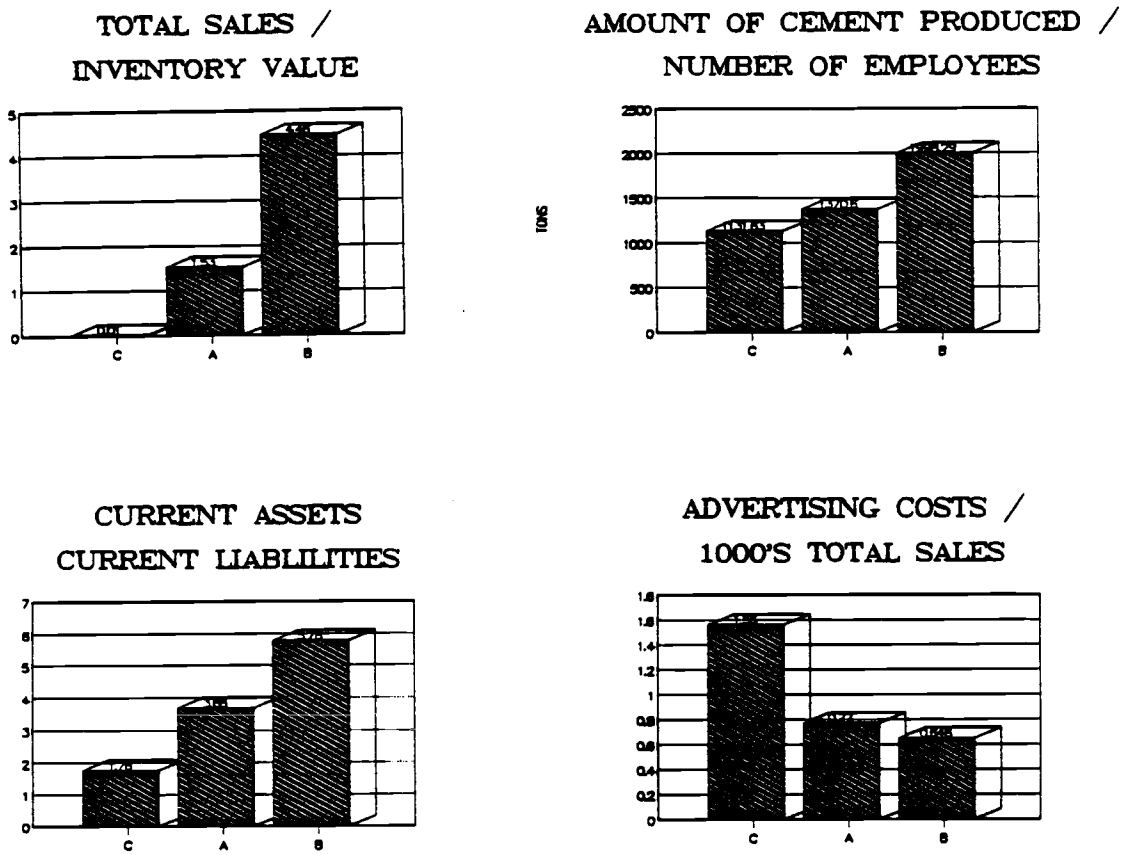


Figure V.28. Ratios 4, 5, 8, 20 representing firms in the order C, A, B of the productivity-related ratios.

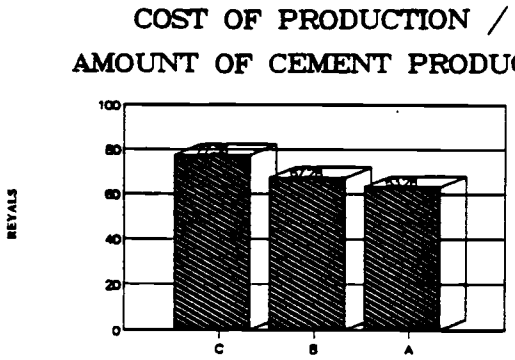


Figure V.29. Ratio 18 representing firms in the order C, B, A of the productivity-related ratios-

Firm C is in the first position in the first ratio of the input-related ratios and in four of the output-related ratios. It is between the other two firms in three of the output-related ratios and in five of the productivity-related ratios. It is in the third position in the second input-related ratio, in one of the output-related ratios, and in five of the productivity-related ratios.

From the above, Firm B is seen to be in a higher position than the other two firms in most of the ratios.

Discussion of Each Measure

The Input-Related Ratios

The ratio "Total wages and benefits/1000's of employees" (#11)* (Fig. V.12) indicates the average annual wages and benefits that each employee receives. As mentioned earlier, Firm C is in the first position with respect to this ratio, even though it has the highest cost and the highest number of employees. Firm A is in the third position in spite of the fact that it has the minimum cost and the minimum number of workers, while Firm B falls between the other two. A reason for this positioning may be the fact that Firm C is located in an area where the labor market is down because of the abundant opportunities to find a job so that the firm can hire many people at low

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* Ratio numbers in parentheses are taken from Table IV.1.

wages and salaries. Another reason is that Firm C may have cheap labor from sources abroad, which gives it a better position with respect to its competition. Firm A may be located in an area where there are not many opportunities for jobs, so the firm is forced to hire expensive labor. It might be important for the firm to look for cheaper sources. Other reasons may be the hiring of people with degrees, hiring skilled labor, or hiring non-Saudi experts who are paid high wages; so the firm may wish to consider these. Firm B may look for similar reasons in attempting to improve its situation. It is recommended that Firm A look into the reasons for its position and attempt to determine ways to improve it.

The ratio "Severance compensation/Number of employees left" (14, Figure V.15) indicates the average annual compensation that each employee who left the job receives. Firm C is in third position in this regard. It has the highest number of employees who left their jobs, which is to be expected in comparison to the high number of employees that the firm hires. However, the causes for leaving the job should be investigated. The high cost may be associated with the leave of people from administrative positions or with non-Saudi experts who receive high salaries and who have worked a long time for the firm.

The Output-Related Ratios

Examining the two ratios that concern the net profit of the firms, "Net profit/Number of shareholders" (2, Fig. V.3), and "Net profit/1000's total sales" (3, Fig. V.4), we see that Firm B is in the first position in terms of profit, but that the average share of each shareholder is lower than it is for Firm C. This is due to the higher number of shareholders investing in Firm B. The average shares of each shareholder is high for Firm C, and that gives it a strong position in keeping current investors and attracting new ones. Firm A is in the third position in this regard, and this may be due to lower sales, high inventory of unprocessed clinker, and less production. It has a weak position in regard to return on investment. The firm should investigate the reasons for this performance in order to improve its situation.

The ratio "Total sales/Amount of clinker produced" (6, Fig. V.7) indicates a rough estimation for the price of one ton of clinker produced. The amount of clinker produced may already be converted to cement and sold or stored, or may be stored in a bulk form awaiting conversion. Each firm tries to increase its production of clinker, converting it to cement and then selling it, while at the same time each tries to avoid inventory caused by unprocessed clinker. Firm B is in the first position for this ratio. It has the highest sales value and also the

highest clinker production. Three percent of its sales go to a neighboring country. Firm C has the next highest sales value and the next highest clinker production, while Firm A is lowest in each category.

Another ratio which is similar to the previous one but differs in terms of the type of quantity in the numerator is "Amount of clinker produced/Amount of cement sold" (7, Fig. V.8). This ratio indicates the efficiency of each firm in terms of converting the produced clinker into cement, selling it, and having neither clinker nor cement left over in inventory. Firm C is in the first position in terms of this ratio in spite of the fact that it was in the second position for the previous ratio ("Total sales/Amount of clinker produced"), and Firm B is in the second position in spite of the fact that it was in the first position in terms of the previous ratio. This might be an indication of better selling prices for Firm B.

The ratio "Current assets/1000's of sales" (9, Fig. V.10) indicates the strength of the firm in terms of its worth compared to its sales for the specified year. It is better for the firm to have high sales value. Firm A is in the third position in this regard, while Firm B is in the first position and Firm C is between the other two. Firm A needs to increase its sales value and should look for good means to do so. It needs to work hard to minimize the value of inventory. It also needs to find effective means

to collect its accounts receivable and improve its liquidity situation at the banks in order to facilitate the letter of credit. Firm C should also find effective ways to collect its accounts receivable and minimize its inventory value. Firm B is doing well with respect to cash liquidity. However, it needs to minimize its inventory value in order to minimize its current assets value.

The ratio "Amount of clinker produced/Installed capacity" (10, Fig. V.11) enables each firm to check on how it is doing in comparison to its installed capacity. From the bar chart it is obvious that all of the firms are exceeding their capacities. This may be due to the war between domestic producers and importers to lower prices and compete effectively. Each firm should check to determine if it is actually required to produce above capacity and whether the excess amounts of clinker produced will affect machine life and maintenance and/or will be a burden on inventory. This ratio is also controlled by the market size and demand.

The two ratios "Sales to 10 largest customers/Total sales" (15, Fig. V.16) and "Sales to 20 largest customers/Total sales" (16, Fig. V.17) indicate where the concentration of sales exists for each firm. These ratios show each firm whether the current situation does or does not agree with the company policy in terms of broadening the customer base. For Firm C, 49.7% of its sales go to

the 10 largest customers and 68.6% of its sales are made to the 20 largest customers. This might be consistent with firm policy in concentrating its sales to certain customers, but if not, the situation should be reviewed in order to avoid "putting all of the eggs in one basket," which represents a high risk and the uncertainty associated with it. For Firm B, 35.6% of its sales go to the 10 largest customers and 65.4% go to the 20 largest (nearly double the sales to the 10 largest). These figures also need to be examined with respect to company policy. For Firm A, 23.3% of its sales go to the 10 largest customers, while 48% of its sales are made to the 20 largest (double its sales to the 10 largest). It seems that the customer base for this firm is wide, which may be because most of the sales go through individual retailers. These retailers deliver a full truckload of cement, then distribute it by their own. Still, company policy should be examined in order to determine whether it is preferable to deal with such customers on an extensive basis or whether larger customers are preferred. These ratios provide an opportunity for each firm to review its selling policy in preparing for future business transactions.

The Productivity-Related Ratios

The ratio "Net profit/1000's capital" (1, Fig. V.2) indicates the profitability of each facility. It shows the

return on investment for the specified year, giving the net gain for each reyal invested in the facility. Firm A is in the first position with respect to this ratio, with a return of three reyals for every one thousand reyals invested (10 shares, with every share worth 100 reyals). Firm C is in the second position, with a return of 114.5 reyals for every one thousand invested. Firm B is in the third position, with a yet better return of 186 reyals for every one thousand invested. Firm A should determine reasons for low profitability and try to find good means for increasing profits, otherwise its facility won't be attractive to investors. Firm C has a better profit, and Firm B is doing the best among the three firms, which indicates its strength in the business and its being attractive to investors.

The ratio "Total sales/Inventory value" (4, Fig. V.5) indicates the sales revenue (output) to the value of inventory (input). Inventory is considered as tied-up money, but it is included in the assets value of the company. Firm B is in the first position with respect to this ratio, with a sales revenue four and a half times the inventory value. Firm A scored the second position with a sales revenue one and a half times the inventory value. Firm A should increase its sales and try to minimize the inventory value. Firm C scored the third position. It is doing poorly in the ratio, with sales revenue one tenth of

its inventory value. Regardless of its sales revenue, which is high and falls after the sales revenue of Firm B, it should, during the next year, attempt to find good means to minimize its inventory value.

It seems that all the firms should give attention to the value of the inventory that they carry and plan to minimize it in the future.

The ratio "Amount of cement produced/Number of employees" (5, Fig. V.6) indicates the average productivity of each employee. It shows how each contributes to the whole process of production in terms of how many tons of cement each employee is contributing to. This is a function of the number of employees that each firm has. Firm C has the largest number of employees, Firm B follows, and Firm A has the fewest. Firm C is in the third position, which is reasonable when considering the number of its employees compared to those of the other two firms, but still it can improve its position by trying to minimize the work force if that won't affect the production and the whole operation. Firm A is in the second position although it has the minimum number of employees. It should check its level of production and try to improve it to have competitive figures for employee productivity. Firm B is in the first position, and that indicates its strength in employee productivity and the level of utilization of the work force.

The ratio "Current assets/Current liabilities" (8, Fig. V.9) is a measure of a desirable financial value, the current assets, to a nondesirable financial value, the current liabilities. The current assets include some items that the firm would like to have a high value associated with, such as the cash on hand and at banks, which repre - sents the liquidity situation of the firm and which helps the firm a good deal. It also includes other items that the firm does not like to have a high value associated with, such as inventory and accounts receivable. Firms try to increase the first (liquidity situation) and decrease the latter two. The current liabilities include bank liabilities, accounts payable to people and companies that the firm is dealing with, dividends and dues to the shareholders, and advance payments from customers. Each firm tries to have its current assets greater than its current liabilities. The ratio indicates the financial performance of each firm in the specified year, and this performance involves the entire operation of cement manufacturing. Firms can compare themselves with one another to determine who has been successful in that year. Firm B is doing better than the other two firms in this ratio, scoring the first position for the ratio, while Firm A is in the second position, and Firm C follows. Firm B has the highest value of current assets, followed by Firm C and then Firm A, while Firm C has the highest value in

current liabilities, followed by Firm B and then Firm A. Firm C has current liabilities that are high at over half of the value of current assets, so it should review its liabilities situation to minimize it and restore itself to a better position.

The ratio "Total wages and benefits/Amount of cement produced" (12, Fig. V.13) is a measure of cost of employees (input) to the amount of cement production (output). Of the cement produced, some is sold and some is stored awaiting sale. The ratio shows the cost of employees incurred in producing each ton of cement. As mentioned earlier, Firm A pays the highest wages, Firm B the second highest, and Firm C the lowest. Firm B is in the first position in this ratio, with minimum labor cost per ton, which implies that it has the highest cement production. Firm C is in the second position in spite of paying minimum wages, and this is because of producing less than Firm B. Firm A is in the third position, which is obvious since it pays the highest wages and produces a lower amount. Firm A should look for good and possible means to minimize its labor cost.

The ratio "Total sales/Total wages and benefits" (13, Fig. V.14) is a comparison of sales accrued from the operation (output) to the cost of wages and benefits employees receive (input). It shows a proportionality of revenue gained from sales to one type of cost incurred in

the operation. Firm B is in the first position, with sales revenue nearly eight times the cost of wages and benefits. Firm C came in the second position with sales revenue five times the cost of wages and benefits. Firm A, with sales revenue more than double the cost of wages and benefits, was in third position. Firm A must check on ways to improve its sales performance and/or try to minimize its wages and benefits costs by seeking cheaper labor. Firm C also needs to check for possible ways to minimize its labor cost.

The ratio "Cost of production/Amount of clinker produced" (17, Fig. V.18) is a comparison of cost incurred from production (input) to the amount of clinker produced (output). Of this clinker produced some of is already converted to cement and some is stored awaiting conversion. The ratio shows the cost of production incurred in producing each ton of clinker. Firm A is doing well in this regard, scoring the first position. It has the lowest production cost per ton of clinker among the firms, which indicates that the firm is running its production effectively. This might be due to using cheap raw materials, or because it has inexpensive machines, or because it has good machines that need minimum maintenance. These are good things to keep doing and reflects good production per - formance which will help in the competitive market; however, the firm should also attempt to improve the other

measure to have a good overall performance. Firm C is in the second position and Firm B in the third position. There is little difference between the cost of production between these two firms, but there is a lot of difference between the two and Firm A. However, this is not enough to judge that Firm A is doing better than the other two firms, for the other costs incurred in the process. This will be clear from looking to the previous ratio and the next two ratios.

The ratio "Cost of production/Amount of cement produced" (18, Fig. V.19) is a comparison of cost incurred from production (input) to the amount of cement production (output). Of this cement produced, some is sold and some is stored awaiting sale. The ratio shows the cost of production incurred in producing each ton of cement. This cost is greater than the cost of production of clinker. The difference between the two costs represents the production cost of converting each ton of clinker to a ton of cement. The order of firms for this ratio differs from the previous ratio, "Cost of production/Amount of clinker produced," but still Firm A is in the first position, though the differences among the firms is not great. Firm B is in the second position for this ratio while being in the third position for the previous ratio. Firm C is in the third position while scoring the second position in the previous ratio. The production cost incurred in converting

clinker into cement caused the change in the order of the firms. This cost is the highest for Firm A, second highest for Firm C, and lowest for Firm B. Firm A should check the causes for the increase in the production cost of conversion and look for possible ways to minimize it. Firm C should also consider checking for reasons for the increase in this cost. Firm B is doing very well in this regard, which encourages it to maintain such performance.

The ratio "Cost of power/Amount of cement produced" (19, Fig. V.20) is a comparison of cost for power needed to run the whole operation of cement production (input) to the volume of cement production (output). Firm B is in the first position for this ratio, where it is doing a good job in minimizing spending for power. Firm C follows with Firm A in the third position. This cost is included in the cost of production. Although Firm A had the least production cost of the three firms, it spent the highest on power among the firms, and it seems that cost for power cost is the greatest cost incurred in production for Firm A. It is recommended that the firm check its consumption of power and try to minimize it as much as possible. Firm B is spending the least for power of the three firms and this amount seems to be a reasonable part of production cost. Firm C is also spending a reasonable amount on power as part of the production cost which was the highest among the

firms. It should, however, check for possible ways to minimize such costs.

The ratio "Advertising costs/1000's total sales" (20, Fig. V.19) is a measure of an input to an output: the cost of advertising to sales. It gives each firm an idea of the proportionality of the cost incurred in promoting sales to the sales resulting. Firm A incurred the least cost of the three firms and gained the minimum sales, yet it scored the second position for this ratio. Firm B is in the first position where it has the largest sales revenue and an advertising cost that falls between that of the other two firms. Firm C scored the third position because it has the highest advertising cost, however, its sales revenue is less than Firm B's but greater than Firm A's.

Each firm should check the efficiency of its advertising performance and make sure that the spending will give good results and improve sales. Firm C may take into consideration the difference in location when it compares its advertising spending with Firm B's and the proportionality of advertising spending to sales revenue that Firm A is dealing with.

As a result of these detailed discussions, each firm could set a plan to improve its productivity and situation by focusing its attention on the areas where it is doing poorly in comparison with the other firms. It is

important, when doing so, that firms consider many variables such as the age and size of the company, environment, and the economy; but the important things are for the firms to look to improvement, to fulfilling the needs of the domestic market by replacing the imported amounts of cement with Saudi-produced cement, and to competing with one another to offer good prices for the consumer while maintaining high product quality.

It should be noted that there is another technique, called Productivity by the Objective Matrix, that helps to plan for productivity improvement within the plant. This technique can track improvement in individual ratios over the period of planning. It helps in clarifying the mission and objectives of the firm, enriches communications and gives directions and weights measures of productivity. The technique generates a single productivity index that summarizes net results of operation actions. The Objective Matrix (OMAX) is one of the programs that the Oregon Productivity Center is conducting in the United States, and it has been successful. Awareness of the technique is increasing among U.S. firms, and many of those using it are reporting productivity increases. The discussion of this technique is beyond the scope of this research (see index for OMAX format).

CHAPTER VI

DIFFERENCES BETWEEN SAUDI ARABIA AND THE UNITED STATES AND THEIR EFFECTS ON THE MEASURES

In the United States, the interfirm comparison has been used successfully as a method to improve productivity by the Oregon Productivity Center. In this research we are examining the usefulness of the PICs to firms in Saudi Arabia. Since there are many differences between Saudi Arabia and the United States in the way business is done, PIC ratios that are applicable to firms in one country may not be so applicable to those in the other. In this chapter some of the differences between the two countries will be addressed, and at the same time some of the impacts of these differences on the criteria of measurement will be discussed. At the end of the chapter the specific measures used for the cement firms in Saudi Arabia will be listed alongside those used by the Oregon Productivity Center, for the sake of direct comparison (see Table VI.1).

General Differences

Capital

The government in Saudi Arabia encourages people to invest by building their own industrial firms. It subsidizes many industrial projects through various means, including giving land needed for the project free of charge or charging only a nominal sum for rent. Also, electricity

and water required are charged at low fees. The government will lend capital needed for the project, up to 50% of the fixed assets, setup costs, and working capital, provided that the investor provide at least 25% of the costs (which can be raised from the selling of shares). In addition, the government provides free and/or low import tariffs (custom duties) for machines, parts, raw materials, etc. It facilitates issuing visas for foreign workers to enter the country and stay. If the firm decides to expand in the future, the government will also subsidize any expansion of the project in the future.

The funding of these projects is done through the Saudi Industrial Development Fund. This loan is provided free of interest. The only direct cost of the loan is the salary that the firm must pay to the officer who is assigned by the government to follow up the development stages of the project. Repayment of the loan is required within fifteen years. Payments are scheduled according to the expected cash liquidity of the proposed project. This reflects the need for monitoring the cash flow situation for the firm to be able to pay back the scheduled amounts of the borrowed money. This is represented in the need for the ratio "Current Assets/Current Liabilities" (8), where the cash liquidity is included in the current assets. None of the firms, of course, wants the scheduled payment to be

included in the current liabilities, which it will not be as long as payments are kept current.

Conditions with respect to raising capital in the United States are different, with investors depending on themselves to provide money for the firm, raising money through selling stock, and/or borrowing, with interest, capital required from banks.

Employment Law

The rules that govern the employees in Saudi Arabia are set by the government and apply to people working both in the government and the private sector. These rules are for the purpose of protecting the worker's rights and regulating relations between the owner or management of the business and the employees. The rules, determined by the religion of Islam, which Saudi Arabia follows, are published in a book called Labor and Workman Law. Each firm or business must know and abide by these rules, and they serve to protect workers' rights. There is therefore no necessity for unions in Saudi Arabia.

When an employee begins to work for a firm in Saudi Arabia, he and the firm sign a contract concerning the rules and conditions of employment. This includes job descriptions, salary and benefits, period of employment, reasons for firing (stated in the Labor and Workman Law), and every detail that governs the relation between the employee and the firm. This contract is required by law

and sets out many of the general conditions of employment; however, the firm and the employee have the freedom to work out some of the details of the agreement among themselves as long as these do not violate the general rules.

If a dispute occurs between the two parties the Office of Labor and Work will solve it. Every employee has the right to file a complaint with this office if a problem occurs which and cannot be solved by the two parties. Strikes, boycotting, demonstrations are not allowed by the law.

Employees are either Saudis or non-Saudis from all the countries around the world. Many non-Saudis, including technical experts from more industrialized nations, work in Saudi companies. The non-Saudi experts typically receive high wages and substantial benefits in order to make the positions attractive to them. The non-Saudi worker is entitled to special benefits such as housing (either money for rent or a house provided by the firm), tickets for a round trip or one way trip back to his home country for himself and his family, and transportation (either money or a car provided by the firm). Both the Saudis and the non-Saudis are entitled to salaries, paid vacations, pensions, and compensation when leaving the firm in the form of severance pay. Health care is also included (either through paying medical bills or having a health center within the firm building). This is in addition to the free

health care provided by the government hospitals and care centers. Unlike the United States, there are no insurance companies involved in the process. Employees are paid salary mostly on a monthly basis, although sometimes weekly, according to the agreement signed in the contract.

There are no jobs held by women in industrial firms or companies. Women, by Islamic law, work only in jobs where any interactions will be only with other women -- positions such as teaching in all-girl schools or working as a seamstress. The only exceptions are in the case of doctors and nurses in hospitals and most care centers.

These rules and laws reflect the need to have the wages and benefits of all employees summed together in the ratio, and to separate the severance leave which is a high figure, especially if the employee who left the company is non-Saudi and worked as an expert for a long time with the firm for a high salary. They also reflect the reasons for high wage costs in spite of having small number of workers, which also indicates the high number of non-Saudi workers as experts who gain high salary and benefits. Also they reflect the difficulty in cutting the work force since it is not easy to fire employees without following the reasons for firing specified by the law.

Employee conditions in the United states are quite different. Employers in the private sectors have rules established by the firms or by the worker unions, and

employees in the government are governed by federal laws. Where unions exist, the rights of workers are protected by the unions and any new benefits are normally negotiated on and agreed upon by both union and management. Filing grievances, striking, bargaining, impasse, boycotting, paying dues, mediating, fact-finding, and arbitration are terms associated with union practices and are familiar terms in the United States, but are much less common in Saudi Arabia. Where unions do not exist, firms or company have their own rules and a contract may or may not be signed. These situations have the impact of separating wages from benefits or fringe costs when dealing with ratios associated with employee cost. Also, the working hour unit is used in these ratios.

Marketing

Marketing is much less important in Saudi Arabia than in the United States. Advertising is done on a small scale in newspapers and magazines, but customers in Saudi Arabia often find it hard to compare prices and have to drive to the source of goods or telephone in order to find out the prices of items they are interested in buying. In other words, in Saudi Arabia it is the customers who are considered to be responsible for reaching the buyers instead of the buyers reaching the customers. Also, the Saudi Arabian customer finds it difficult to get a competitive price because of the ineffective selling policies of

sellers. One way sometimes used to reach customers is through salesmen but these are generally not trusted by the customers.

The distribution channels in Saudi Arabia are mostly through wholesalers then retailers then to the customers. However, in some cases the customer who buys directly from the firm or factory, then becomes a seller. Also, in some cases the company will have its own shop in the market to sell directly to the customers. Thus in Saudi Arabia all channels can be in competition with each other.

These practices have their reflection in the ratios. Although advertising is included in the Saudi Arabian ratios, there is no consideration of marketing in the measures. The fact that Saudi Arabian businesses are often not interested in forming a large customer base and are interested in obtaining large customers is also reflected in the ratios, those which deal with the portion of sales to the 10 largest and 20 largest customers.

In the United States marketing is much more effective. Customers are reached by the sellers by all different means, T.V., radio, telephone, newspapers, magazines, and other printed materials, and by salespeople. The customers don't have to spend much time looking for the product. Firms follow a wide range of policies to motivate sales. Customers are considered very important and their happiness

and satisfaction is of greater interest to manufacturers and sellers than is the case in Saudi Arabia.

This approach to marketing and the customer is reflected by the inclusion of marketing expenses and advertising costs in the ratios used in the United States. Also, customers are considered a good measure to be included in many ratios, especially in service firms.

Other Differences

There are other differences between the two countries that may have an implicit effect on differences in determining the values that are input in the ratios used by the two countries or may have an effect in the consideration of the meaning of the countries' respective ratios. One of these concerns taxes. Most businesses do not need to consider taxes in Saudi Arabia (with the exception of major oil companies). Rather, in determining net profit the important thing is to pay the Zakah which is required by Islam law (paying 2.5% out of the profit which goes to the needy and poor people, which is a social responsibility). In the United States, however, taxes are an important item for all companies, and are required at different levels, at the corporate or firm level as well as at the individual level.

Inflation is another difference between the two countries. It is not generally considered at the firm

level it Saudi Arabia (though it may be at the government level). Firms do not monitor inflation periodically and it is not an important issue. In the United States, on the other hand, inflation is a well known economic measure that every firm and individual looks for. It can be expected to be taken into account in many of the calculations that United States firms make in inputting values to the ratios

Safety is required by law in Saudi Arabia and the fire department looks after it, but it is not usually a large concern for the Saudi Arabian firm and is not used in the ratios. In the United States, though, safety is important to meet the safety measures set by OSHA (Occupational Safety and Health Administrations) and it often represents a substantial cost to the U.S. firm. Safety is thus an item which appears in the U.S. ratios and not in those for Saudi Arabia.

Computers are used on a very small scale in some Saudi Arabian firms, which why computers is not a measure in the ratios. But in the United States the computers are used on a large scale in nearly all firms and data processing is a major expense for many U.S. companies; therefore items reflecting these costs appear in the U.S. ratios.

Associations for firms are not found in Saudi Arabia except for the Chamber of Commerce which all firms and establishments are affiliated with. This makes it difficult to find a specialized third party to take part in

the process of confidentiality such as was necessary in the present research project. In the United States, however, it is much easier to find an association for a particular industry or business. Such an association can act as a third party and thus ease the process of confidentiality.

Finally, it should be mentioned that in Saudi Arabia the managers prefer financial information in comparing firms, although they are also interested in productivity measures. In the United States, however, managers prefer the productivity information when comparing firms although there is some financial information present in the ratios.

The Differences in Measures

The ratios used in PIC vary from one industry to another and from one country to another, but there are some similarities. Table VI.1 expresses ratios used by the three Saudi cement firms participating in the PIC, ratios used by the Oregon Productivity Center and notes some of the differences. The table summarizes the differences that were discussed in the preceding pages.

Table VI.1. Comparison of ratios used in Saudi Arabia with those used in United States.

Saudi Arabia	U.S.	Differences
GENERAL:		
1) $\frac{\text{Net profit}}{\text{1000's capital}}$		No profit mentioned in U.S. ratios
2) $\frac{\text{Net profit}}{\text{Number of shareholders}}$	$\frac{\text{Actual rate of return}}{\text{Targeted rate of return}}$	Profit distributed to attract shareholders, vs. rate of return
3) $\frac{\text{Net profit}}{\text{1000's total sales}}$		
4) $\frac{\text{Total sales}}{\text{Inventory value}}$		
5) $\frac{\text{Amount of cement produced}}{\text{Number of employees}}$	$\frac{\text{Amount produced}}{\text{production labor hours}}$	Hours worked, not number of employees
6) $\frac{\text{Total sales}}{\text{Amount of clinker produced}}$	$\frac{\text{Total sales revenue}}{\text{units produced}}$	

Table VI.1. Continued

Saudi Arabia	U.S.	Differences
7) Amount of clinker produced / Amount of cement sold		
8) Current assets / Current liabilities		Important for the scheduled payment of the capital borrowed from the government, not used in the U.S.
9) Current assets / 1000's of sales		
	Value added / Employees	Value added not used in Saudi Arabia
	Customer service cost / Customers	Customers not not included in ratios in Saudi Arabia except in sales. But for the U.S. it is important to know how well the customers are being served.
	Customers / Employees	
	Wage & salary expenes / Customers	
	Plant investment / Customers	

Table VI.1. Continued

Saudi Arabia	U.S.	Differences
	Administration and general expenses / Customers	
	Customers / Vehicles	
	Customer service distribution / Customers	
	Uncollected revenues / Customers	
	Data processing operating equipment / Customers	
CAPACITY UTILIZATION:		
10) Amount of clinker produced / Installed capacity		Standard for both Saudi Arabia and

Table VI.1. Continued

Saudi Arabia	U.S.	Differences
HUMAN RESOURCES:		
11) Total wages and benefits / 1000's of employees	Wage and salary expense / Employees	Use hours to determine costs. Differ in benefits -- In Saudi Arabia (tickets, housing, medical, no union) -- and way of paying salary or hourly.
12) Total wages and benefits / Amount of cement produced	Fringe benefits / Hours worked	
13) Total sales / Total wages and benefits	Production / Production labor hours	
14) Severance compensation / Number of employees left		
CUSTOMER CONCENTRATION:		
15) Sales to 10 largest customers / Total sales		Differ in concentration. Saudi Arabian companies prefer big custome
16) Sales to 20 largest customers / Total sales		

Table VI.1. Continued

Saudi Arabia	U.S.	Differences
COST RATIOS:		
17) Cost of production / Amount of clinker produced		
18) Cost of production / Amount of cement produced	Production O&M expense / Units produced	Same
19) Cost of power / Amount of cement produced		
CEMENT MARKETING:		
20) Advertising cost / 1000's total sales	Distribution O&M expense / Units produced	Differ in including markeing and distribution in U.S.
	Marketing and sales expense / Revenue	

Table VI.1. Continued

Saudi Arabia	U.S.	Differences
	$\frac{\text{Marketing and Sales Expesne}}{\text{Units sold}}$	
SAFETY:	- OSHA Frequency rate	
	- OSHA Security rate	
COMPUTERS:	$\frac{\text{Data processing operating expense}}{\text{Sales}}$	
	$\frac{\text{Data processing operating expense}}{\text{Customers}}$	
	$\frac{\text{Data processing capital investment}}{\text{Employees}}$	
	$\frac{\text{Data processing capital investment}}{\text{Customers}}$	
	$\frac{\text{Employers}}{\text{Computer terminals and micros}}$	

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

One can conclude and argue that Productivity Interfirm Comparison (PIC) is applicable to firms in Saudi Arabia. It is a useful technique to identify potential areas for improvement or exploitation. The cement industry could benefit a great deal in this regard, especially since it is one industry in which Saudi Arabia could fulfill its goal of self-sufficiency. In fact, it is expected to export cement for importing markets in Africa, the Middle East, and East Asia.

Saudi Arabia, as a developing country, is in need of such methods that can also be applied in other industries and help to bring about greater prosperity, civilization and welfare for the people of the country. In helping firms to increase productivity, application of PIC would also be of use in helping the country carry out future plans of replacing oil income with agricultural (especially wheat), mining and industrial goods (especially petrochemicals). Higher productivity would also mean improved prosperity for the people and would help the country to catch up with industrialized and developed countries.

It is strongly recommended that participating firms mentioned in this research continue using this method in coming years and try to convince the other cement firms of

the country to participate in such studies. This can be done through the Oregon Productivity Center at Oregon State University in the United States. The firms could also affiliate with the Asian Productivity Organization (APO) with any other productivity interfirm program conducted in a developed country. The firms can, in addition, consider lobbying at the Ministry of Industry and Electricity to have this technique approved.

It is strongly recommended that the firms learn about the objective matrix OMAX to improve productivity within the firm. Firms could assign people to train in this method, possibly by having experts in the field to train staff in conducting this method (see Appendix C).

It is recommended for the Ministry of Industry and Electricity to establish centers for productivity measurement and improvement or to contract with centers in the United States or the United Kingdom to apply these methods (PIC and OMAX).

I recommend further research in PIC at the firm's level and at the international level between Saudi Arabia and other developed and developing countries to exchange experiences and for mutual benefits.

Finally, it is recommended to conduct further research in PIC in other firms and industries in Saudi Arabia (especially petrochemicals). Further investigation of the use of OMAX for Saudi firms should also be investigated.

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APPENDICES

APPENDIX A

Data gathered for Firm A for the year 1986 (1406)

Total wages and benefits ($)	47,108,000
Number of employees	587
Severance compensation ($)	34,739
Number of employees left	20
Net Profit ($)	1,869,260
Number of shareholders	1,600
Total sales revenue ($)	125,366,000
Amount of clinker produced (tons)	1,301,203
Amount of cement produced (tons)	804,543
Amount of cement sold (tons)	813,817
Current assets ($)	104,421,008
Current liabilities ($)	28,345,063
Capacity (tons)	1,160,000
Sales to 10 largest companies ($)	29,169,151
Sales to 20 largest companies ($)	60,223,013
Advertising cost	97,000
Inventory value	81,811,330
Cost of production	50,913,898
Cost of power	22,608,151
Loan of government	400,000,000
Capital	600,000,000

APPENDIX B

Specifications and Meanings of Data Gathered from the Year 1986 (1406)

Criteria	Definition
Total wages and benefits	Total salaries and wages paid to all employees in the firm, for Saudi and non-Saudi employees, includes medical, shelter, transportation, rewards, social insurance, sick leave, holidays and vacations. Wages and benefits are paid on a monthly basis (in Reyals).
Severance Compensation	The benefits that the employee is entitled to when he leaves the job (award for the period of the workman's service), for Saudi and non-Saudi employees. By the law it is half a month's pay for each of the first five years and one month's pay for each of the subsequent years. The last rate of pay shall be taken as the basis for the computation of the award (Reyals).
Number of Employees	Total number of employees of the firm involved in all operations, currently hired, Saudi and non-Saudi. Includes people in the administration and shop-floor with all specialties (persons).
Number of Employees Left	Total number of employees who have left the job but have not been fired, and who are not currently hired, Saudi and non-Saudi (persons).

Criteria	Definition
Capital	The amount of money invested in the facility. It consists of the capital the first (original) investors have to start the business and the shares offered to public investors (Reyals).
Loan of Government	Subsidy given by the government to help in establishing the business. It is a loan for a long period. Payment should be scheduled to pay this money back free of interest over a period of 15 years maximum (Reyals).
Number of Shareholders	Total number of shareholders investing in the facility. The capital is divided into shares with a certain price, and the first (original) investors who establish the company and the general public are entitled to buy these shares (persons).
Current Assets	A financial measure that includes: Cash on hand and at banks, inventory value, accounts receivable, Letters of Credit (LC) for purchases of goods, and may include investment in other business (Reyals).
Current Liabilities	A financial measure that includes: Bank liabilities, and accounts payable, such as dividends and dues to the shareholders and advance payments from customers (Reyals).
Inventory Value	Total value of amount at storage which includes unfinished products (i.e. clinker), finished products

Criteria	Definition
Inventory Value (Cont.)	(i.e., cement). It also includes cementg bags, fuel and others. The value of the inventory is calculated at cost or at market value (Reyals).
Total Sales	Total gross revenue from the sale of cement produced. The sale prices depend on quantities sold, and if quantities get bigger the price goes lower (Reyals).
Cost of Production	The cost incurred in production, which includes raw materials, machinery, power and maintenance (Reyals).
Cost of Power	The cost of power required to run the firm, which includes electricity and fuel (Reyals).
Advertising Costs	Labor and material expenses associated with advertising. Includes ads in the newspapers and signs.
Installed Capacity	The production capacity that is installed for each machine. It is known when the facility is first set up (specifications from manufacturers). Each firm in Saudi Arabia should state this in its publications.
Amounts of Clinker Produced	Total amount of clinker (pre-cement) already converted to cement or in inventory, waiting conversion (tons).
Amount of Clinker Produced	Total amount of cement produced, already sold or in inventory (tons).
Amount of Cement Sold	Total amount of cement produced and sold.

APPENDIX C

OMAX

The objective matrix is an effective productivity measurement and improvement technique. It is easy to understand and implement at all levels in the firm. It has many potential benefits, such as: Easy format (see following page), clarifies organizational mission, goals and communications, measures group efforts, focuses on productivity improvement measures, monitors several criteria, adapts to change, accounts for tradeoffs and summarizes net results.

Materials and help are provided by the Oregon Productivity Center, which is an extension of the Industrial Engineering Department at Oregon State University. Mailing address and phone number are:

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U.S.A.
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Step 1. Major criteria impacting productivity in a given area are identified, appropriate measures determined for each, and the resultant monitors entered in the boxes slanted across the top.

Step 2. The current level of performance in the area is calculated for each criterion and the ensuing numerical results entered at a level corresponding to a score of 3. (Note the scores listed vertically at the right of the Matrix.)

Step 3. Based on broad organizational goals, productivity objectives are established for all criteria. These quantitative targets are entered at a level corresponding to a score of 10.

Step 4. Step-wise goals, or mini-objectives, are then determined and the squares from score levels 3 to 10 are filled in with these successive "hurdles."

Step 5. At the same time, flexibility to account for tradeoffs or occasional slack periods is recognized, and figures are inserted in the squares below score level 3. Quotients associated with anything less than minimum likely performance correspond to a score of 0.

Step 6. Since some criteria are more important than others, weightings are assigned to each. The sum of these weights equals 100, and can be distributed in any informative fashion (see Weight row). This step defines the productivity mission of the area in question.

Step 7. At the conclusion of every monitoring period, the actual measure for each criterion is calculated and placed in the "performance" boxes on Row A. The level that these achievements represent is then circled in the body of the Matrix and associated with a score of from 0–10. Scores are entered in the appropriate box on Row B at the bottom of the Matrix. Each score is then multiplied by the weight for that same criterion, to obtain a value, listed on Row C. The sum of all values yields a productivity index for the period. Over time, the movement of this single index tracks the net results of productivity efforts in the area of interest.