CHAPTER THREE

COSTS

3.1 Introduction

The cost efficiency of a firm can be assessed by examining its costs performance. If a firm is cost-efficient, the input costs grow at a slower rate than the output rate. In many enterprising firms, minimising cost is their main objective in order to remain competitive. High operating costs incurred by a company is likely to reduce its productivity and profit level. Thus, in evaluating the performance of a company, one usually attempts to assess its cost performance.

There are several methods in which the cost performance of MCM can be determined. One method is to estimate the short run and long run costs of the company. The estimation of short run and long run costs, however, may be quite complex. For instance, in short run cost studies only those costs which vary with output should be included, but it is difficult to determine which are the costs that are directly associated with output. This problem is further aggravated by the problem of depreciation. For instance, depreciation due to obsolescence is a fixed cost and is thus difficult to distinguish from depreciation due to usage (user cost), which is a variable cost. This problem is acute if there are time lags between input purchase and output production. Short-run and long-run estimation using historical data in inflationary period also suffer from the problem of dividing increasing costs into that which is due to inflation and that which is due to changes in the scale of production. Increased input prices may be due to increased demand for inputs by the firm or may be due to changes elsewhere in the economy. Thompson and Formby (1993) maintain that only input price increases independent of the firm should be excluded from the data for cost analysis. One way out is to assume the price to be constant during the period under study. An alternative approach employed is by adopting the survivor technique.[1] The rationale behind this technique is that efficient firms (those with the lowest average cost) will survive over time. As for MCM, survival of the company depends on how well it can minimise its cost. If it operates on a high cost basis, it becomes uncompetitive and therefore, will be unable to generate profit. Since it has no influence over the price of copper, a high cost of production is not easily transferable to the price of the finished product. The cost of producing copper concentrates must be low to accommodate fluctuations of copper, gold and silver prices in the international market with reference to production cost, total cost and average unit cost of production.

This chapter attempts to highlight the cost performance of MCM with reference to the total cost and the unit cost of production. Assessment of cost efficiency can be analysed with reference to the operating cost, total cost and the average unit cost of production. It also attempts to highlight the factors which contribute to the high cost of production and the scope in which MCM

[1] See Shepherd (1967) for mechanics of application and its limitations. Also refer to Gough and Hill (1987) and Goldschmid and Mann (1974) for the details

can reduce its labour cost, material cost, cost of processing, cost of pollution preventive measures and cost of drilling and blasting. The analysis on the production cost of MCM covers the period from 1980 to 1994.[2] The operating and total cost of the company from 1980 to 1994 are shown in Table 3.1 and 3.2 respectively.

For the purpose of our analysis, the average unit cost of production is used to determine the operating cost efficiency of MCM. Since all inputs are variable inputs in the long run, we need consider only one cost function, the long run average cost. This is more appropriate measure to indicate the cost performance of the company because the long run average cost is the key indicator of a phenomenon called economies of scale. A decline in the average unit cost of production over a period of time as output increases may reflect a favourable cost performance for the company.[3] This is because the firm is said to be experiencing economies of scale.

3.2 Defining And Measuring Costs

The term "cost" can be defined in a number of different ways, and the definition varies from situation to situation, depending upon how the cost figure is to be used. In general, cost refers to the price that must be paid for an item. If a product is bought and used immediately, no problems arise in

[2] Prior to 1980 figures are not available.

[3] A long-run average unit cost is a minimum unit production cost when all technical possibilities open to the company are considered.

defining and measuring its cost. However, if the item is purchased, stored for a time, and then used, complications can arise. The problem is even more acute if the item is a fixed asset that will be used at varying rates for some indeterminate period. The cost figure that should be used in a specific application is defined as the relevant cost (Maurice & Smithson and Charles (1981). In the context of business operations, costs are viewed as a firm's actual or historical expenditures for resource inputs. Incurred expenses include labour costs, raw materials, depreciation charges and capital equipment used in production. For tax purposes, actual historical dollar outlays are the relevant costs.

For managerial analysis, however, historical costs may not be appropriate. Generally, current and projected future costs are more relevant than historical outlays. The costs that really matter for business decisions are future costs; historical costs are useful for anticipating the behaviour of costs although past costs can be obsolete indicators of the future. Historical cost statistics can be misleading unless one knows a great deal about the particular cost accounting system from which they are derived. In accounting system, it does not take into account of the opportunity costs. In economic system, opportunity costs are the true measure of an input's economic cost. It is a measure of the benefits forgone incurred by not having used the input in the next best alternative economic activity. The opportunity costs differentiate accounting cost from the economic cost. Our analysis is not intended to take into account of the opportunity cost in analysing the cost of MCM but rather to look at it in the context of financial accounting system in an ordinary business operation.

To view the concept of cost in exclusively monetary terms is to leave out a portion of what may rightfully be considered as cost. The social costs of noise and environmental pollution attributable to a firm's production activities are not easily reduced to dollars and cents. Social costs abound in many business situations, yet they never appear in an enterprise's financial accounts. Here, however, the attempt has been made to include costs spent on pollution preventive measures. The expenses is incorporated into the mine rehabilitation cost under the general expenses category.

In this analysis, costs are defined as:

Total Operating Cost is = wages & salaries + material cost + general expenses + depreciation

Note: Wages & Salaries include the Company's Employee Provident Fund (EPF), Social Security Organisation (SOCSO), Allowances and Bonus. General expenses refer to: Contractors, vehicle hire, consultancy, travelling, recruitment, rentals, socials, welfare, insurance, maintenance, communications, transporting of copper concentrates, transporting of material, mine rehabilitation, import duty, training & education and relevant miscellaneous expenses.

Total Cost = operating cost + head office expenses(office rental, miscellaneous) + royalty + interest + SKC interest (Sabah Kaihatsu Corporation)

$$\textbf{Average Cost} = \frac{\textbf{Total Cost}}{\textbf{Total Output}}$$

Note: Total operation cost is defined based on MCM's Financial Reports

3.3 Cost Of Production

Operating costs which are also known as production costs refer to the costs incurred in the production process. These are both cash expenditures and non-cash charges for the day to day operation of the mine and plant. The operating cost may be expressed as follows:

C = W, M, G,

where C = Total operating cost

W = wages and salaries

M = material cost

G = general expenses

The wages and salaries include overtime, allowances and bonus of workers. Material cost refers to the cost of materials used such as spare parts, drilling and blasting accessories, chemicals, grinding media, and fuel. The general expenses includes contractors, vehicle hire, consultancy, miscellaneous, rentals, import duty, insurance and transporting of copper concentrates.

Operating cost are determined by many factors. The main cost components are labour cost, material cost and general expenses. The operating cost increases if there is an increase in any of the main cost components. Between 1990 and 1993, the average labour cost accounts for 11.7 per cent of the total operating cost, general expenses accounts for 36.3 per cent and material cost accounts for 52 per cent. This shows that material cost contributed most to the changes in operating cost over the 14 year period. The percentage of labour cost, material cost and general expenses out of the total operating cost is indicated in Table 3.1.

Table 3.1

Percentage Of Labour Cost, Material Cost And General Expenses, 1980-1993

Year	Labour Cost %	Material Cost %	General Expenses %
1980	8.6	40.7	50.7
1981	8.3	46.0	45.7
1982	8.6	48.0	43.4
1983	10.1	51.9	38.0
1984	10.9	51.4	37.7
1985	10.7	51.4	37.9
1986	11.2	51.8	37.0
1987	13.2	50.6	36.2
1988	12.4	52.5	35.1
1989	13.1	52.7	34.2
1990	12.7	54.4	32.9
1991	14.6	55.8	29.6
1992	14.4	56.9	28.7
1993	15.0	61.3	23.7

Source: MCM, Annual Operating Reports, 1980-1993

A declining trend of the operating cost may indicate the company's favourable cost performance if it is accompanied by a continuous increase in output. As indicated in Table 3.2, the operating cost seems to show an increasing trend from 1980 right up to 1990.

Table 3.2

Operating Cost Of Mamut Copper Mining , 1980-1994

Year	Amount (million ringgit)	% change
1980	113,650,890	
1981	119,125,365	4.8
1982	125,922,390	5.7
1983	123,738,000	-1.7
1984	124,364,000	0.5
1985	128,033,000	2.9
1986	126,979,000	-0.8
1987	119,613,000	-5.8
1988	128,783,000	7.6
1989	129,420,000	0.5
1990	142,972,000	10.5
1991	129,878,000	-9.2
1992	129,651,000	-0.2
1993	119,201,000	-8.0
1994	119,112,000	-0.1

Source: MCM, Annual Reports, 1980-1994

The increase is due to the continuous increase in wages and salaries, and material costs.[4] Between 1980 and 1991, for instance, the labour cost increased from RM13.7 million in 1985 to 14.2 in 1986, 15.7 in 1987, 16.0 in 1988 and 16.9 in 1989. Despite the continuous increase in wages and salaries, the production cost dropped to a relatively low level in 1987 as a result of the cost saving efforts of the new management.

The low production cost in 1980 and 1981 was due to the low labour cost and low prices of materials and fuels. In 1982 the company was affected by inflation which was at the rate of 6.7 per cent and this pushed up the cost of fuel oil, diesel and imported steel rods and balls for the grinding process. A review and readjustment of staff and employee salaries were also made during this year. As a result, the production cost increased from RM119.1 million in 1981 to RM125.9 million in 1982. The production cost however, dropped slightly by 1.7 per cent in 1983 due to low world oil prices as a result of the oil glut at the beginning of 1983. This resulted in savings of some RM2.0 million in the company's fuel oil bills. Despite the low cost of fuel, the labour cost of the company increased by RM1.4 ringgit in 1983. During this period, MCM's management entered into a new three-year collective agreement with the workers' union in April 1983, which resulted in an increase of about 2.8 per cent in the workers' basic salary. The continued annual increase in labour costs combined with additional import duties on

4 See Table 3.5 for details of wages and salaries (labour costs).

replacement machinery and hence, prices of inputs, led to the production cost rising to RM128.0 million in 1985. The primary reason for the decrease in production cost in 1986 was the low incidence of spare part replacement. The drastic cost control measure by the new management in 1987 brought the cost of production to RM119.6 million, the lowest since 1982. In 1988 the consumption of vehicle spare parts, which increased by some RM2.5 million due to frequent breakdowns and replacement of parts of worn-out vehicles, contributed to the increase in production cost. Major replacement of machine parts in the milling plant and power generator contributed an additional increase of RM1.8 million in costs. The additional expenditures incurred in the implementation of the new mine development plan that required the removal of some 24 million tonnes of waste rock per year, contributed to the increase in production cost between 1989 to 1990. The year 1990 was a difficult one from an operating point of view. Total tonnage of ore and waste mined increased by a further 42 per cent and ore to waste ratio by almost 60 per cent to 1 : 3.7. This added to the increase in production cost by 10.5 per cent compared to 1989. The increase in operating cost does not necessarily mean that MCM operates in a less cost-efficient manner. Rather, the increase of cost between 1989 and 1991 is attributed to the additional expenses which is incorporated into the production cost. The decline of the operating cost in 1993 was due to the low tonnage of ore and waste mined, that is 32.6 million tonnes compared to 45.7 million tonnes in 1992. The tonnage of ore and waste mined reduced to 18.4 million tonnes in 1994. This lead to the decrease in operating cost.

The change in quantity of production and export of copper concentrates may change the operating cost. In 1981 the output increased by 5.3 per cent. In the same year the operating cost also increased by 4.8 per cent. In 1982 output increased by 7 per cent and followed by 5.7 per cent increase in operating cost. The increase in output by 4.1 per cent in 1983 lead to the decrease of operating cost by 1.7 per cent. In 1989 and 1990, output increased by 10.9 per cent and 0.5 per cent and the operating cost increased by 0.5 per cent and 10.5 per cent respectively. In 1991 output fell by 0.6 per cent and this was followed by the decrease in operating cost by 9 per cent. Changes in the quantity of export may cause the operating costs to change. The increase in export by 10.2 per cent, 1.2 per cent, 9.5 per cent and 9.2 per cent in 1981, 1982, 1985 and 1988 lead to the increase in operating costs by 4.8 per cent, 5.7 per cent, 2.9 per cent and 7.6 per cent respectively. The decrease in quantity of export in 1987 and 1991 reduced the operating cost by 14.1 per cent and 3.1 per cent during the same period. This shows that the reduction or increase in operating costs may depend on the amount of cost incurred in transporting and shipping of copper concentrates.

Despite the fluctuation trend in operating cost, the total cost shows a decreasing trend from 1980 right up to 1994. The increase in total cost in 1990 was inevitable because of the increase in operating cost due to the additional expenses on the mine redevelopment plan The declining trend in total cost is mainly due to the reduction in royalty payment to the state government, interest payment and the service charge payment to Sabah Kaihatsu Corporation. When privatisation and restructuring of the company took place in 1987, some of the outstanding loans were converted to equity holdings thus reducing the interest payment.[5] On the other hand, payment of service charges to Sabah Kaihatsu Corporation decreased when MCM discontinued its procurement services with the company.[6] Between 1981 and 1987, the company paid royalty at the average of 16 per cent of the total sales revenue but this sum decreased to 2.5 per cent in 1990 and 1991. The amount of royalty paid to the government decreased from RM4.4 million in 1991 to RM3.9 million in 1992, RM3.7 million in 1993 and RM3.8 million in 1994. The decrease in operating cost contributed to the decrease of the total cost in 1993. Table 3.3 shows a declining trend in total cost from RM191.8 million in 1980 to RM127.2 million in 1993; a decrease of 34 per cent. The reduction in total cost after 1987 was due to the efforts taken by MCM in streamlining its operation. Table 3.3 shows that the total cost from 1987 and 1993 after MCM is privatised is lower than the total cost from 1980 to 1986. Except for 1988 and 1990, the total costs reduced from RM147,047, 600 in 1987 to RM 127,201, 000 in 1994. The average total costs between 1980 to

5 In restructuring the company in 1987, some of its former loans were converted to equity

6 One of the functions of Sabah Kaihatsu Corporation is to handle Mamut Copper Mining's overseas procurement in Japan and is paid for its service by Mamut Copper Mining. This service (procurement) was discontinued in 1988.

1986 is RM167,075,659 and RM142,503,700 between 1987 and 1994. The decreasing trend in total costs shows that MCM is able to control its cost to somewhat minimum especially after 1990.

Table 3.3

Total Cost Of The Company, 1980-1994

Year	Amount (million ringgit)	% change
1980	191,870,115.6	
1981	175,603,000	- 8.5
1982	165,800,000	- 5.6
1983	160,091,700	- 3.6
1984	160,461,600	0.2
1985	158,005,600	-1.5
1986	157,697,600	-0.2
1987	147,047,600	-6.8
1988	154,113,800	4.8
1989	145,007,200	-5.9
1990	157,405,000	8.5
1991	141,603,000	-10.0
1992	140,432,000	-1.0
1993	127,220,000	- 9.0
1994	127,201,000	-0.1

Source: MCM , Annual Reports, 1980-1994.

3.4 Unit Cost Of Production

If a firm reaps economies of scale, the average unit cost of production tends to decrease as output increases in the long run. A decreasing average unit cost per tonne of copper concentrates over time may suggest that MCM is cost-efficient. The MCM's average unit cost of production per ton of copper concentrates from 1981 to 1994 is shown in Table 3.4. The figure shows a fluctuating average unit cost from 1981 to 1987. The average unit cost started to increase from 1988 to 1990. However, it started to fall in 1992 until 1993. The average unit cost in 1993 is the lowest achieved by MCM since 1981.

The changes in the average unit cost of production are determined by the changes in output and total costs. If output remains constant, an increase or decrease in total costs will cause the average unit cost of production to change. MCM encourages higher production of copper concentrates. Thus it is more appropriate to examine the factors that contribute to the change in costs. Between 1981 and 1994, the changes in the average unit cost of production were associated with the costs arising from the increase in the consumption of spare parts, cost saving exercise introduced by the new management and the expenses incurred on the mine new development plan.

The average unit cost per tonne decreased from RM1459.4 in 1981 to RM1203.3 in 1987 or by 17.5 per cent. Despite an increase in the unit price of materials input and in salaries in 1982, continuing cost saving efforts by management coupled with improved operating performance all round helped the company to successfully reduce mine site production cost per tonne of copper concentrates

Due to the global recession and the consequential adverse effects on the funding position of the company, replacement of heavy vehicles and mining equipment; most of which had reached the end of their useful life, was inevitably delayed. The continued use of old vehicles and equipment in the year 1983 resulted in an increase in the cost of spare parts and overhauling costs; which came up to RM1.2 million, while output fell by 5.3 thousand metric tonnes. As a result the average cost per tonne increased from RM1287.7 to RM1296.9.

Table 3.4

Average Cost Of Production Per Tonne Of Concentrate, 1981-1994

Year	Amount (M$)	% change
1981	1,459.4	
1982	1,287.7	-11.7
1983	1,296.9	0.7
1984	1,306.9	0.8
1985	1,235.7	-5.4
1986	1,367.7	10.6
1987	1,203.3	-12.0
1988	1,684.2	39.9
1989	1,429.1	-15.1
1990	1,544.2	8.1
1991	1,381.3	-10.5
1992	1,340.8	-2.9
1993	1,194.0	-10.9
1994	1,208.3	[illegible].1

Source: MCM . Annual Reports, 1980-1994

Despite the low level of output and a continued increase in input prices, stringent cost control at the milling plant resulted in savings of $4.8 million which contributed to the decrease in the unit cost of production in 1985. The continuous cost-saving efforts by the new management such as effective purchasing, better pollution control measures and increase in mechanisation brought the average unit cost down to its lowest in 1987, the lowest unit cost achieved by the company since 1981. However, the average unit cost per tonne increased from RM1203.3 in 1987 to RM1684.2 in 1988, or by 39.9 per cent. The increase was due to the additional capital injected for the implementation of the mine redevelopment plan when the production of copper concentrates remained significantly low. A new development plan, which was started in 1989, resulted in additional operating expenses. Since additional expenses for the new mine's development were incorporated into the operating cost, the unit cost per tonne increased. Thus the high total cost accompanied by the relatively low output between 1988 and 1990 pushed up the average unit cost of production. As a result of the increase in output and the decrease in total cost between 1992 and 1993, the average unit cost declined from RM1381.3 in 1991 to RM1194 in 1993. The decrease in total output in 1994 pushed up the average unit cost of production

The changes in the unit cost per tonne of copper concentrates between 1981 and 1994 are attributed not only to the changes in mechanisation, consumption of spare parts and additional expenses spent on mine development plan but also due to the changes in labour cost, materials cost, cost of pollution, preventive measures and processing cost.

3.4.1 Labour Cost

The continuous increase in labour cost from 1980 right up to 1991 as shown in Table 3.6 may have pushed up the unit cost of production. The increasing trend of labour cost from 1980 up to 1991 is due to the annual increment of basic salaries for workers and new recruits. However the increase in labour cost may have been offset by the higher labour and capital productivity and thus its impact on the unit cost is negligible. The increase in total factor productivity from 1987 to 1993 may have offset the increase of labour productivity during this period. Though labour productivity declined between 1990 and 1993, total factor productivity increased as shown in Table 2.5. The increase in total factor productivity is due to the increase of capital productivity between 1987 to 1993. Labour cost constitutes only about one-quarter of the total cost. Thus impact of the increase in labour cost to the unit cost is negligible. Labour cost for the twelve year period is shown in Table 3.5.

Table 3.5

Labour Cost, 1980 - 1994

Year	Amount (million ringgit)	% change
1980	9.8	
1981	9.9	1.0
1982	10.9	10.0
1983	12.5	14.7
1984	13.6	8.8
1985	13.8	1.5
1986	14.2	2.9
1987	15.8	11.3
1988	16.0	1.3
1989	16.9	5.6
1990	18.2	7.7
1991	19.04	4.6
1992	18.6	-2.3
1993	17.9	-3.8
1994	17.1	-4.5

Source: MCM . Financial Reports, 1980-1994, Unpublished

3.4.2 Cost Of Raw Materials

The change in the price of raw materials is also a significant factor that contributes to the change in production cost. This can be illustrated as follows: the unit cost of production would be equal in 1990 and 1991 if the production quantity of concentrates, usage of inputs and price of inputs remained unchanged. If, however, the prices of inputs were to decrease in 1991, (other things being equal), the unit cost of production will decrease due to the price effect. The figure shown on Table 3.6 indicates the changes in the unit price of major raw materials for MCM of which most of the prices decreased over the years. The changes may have contributed to the changes in total operating cost hence, the unit cost of production. Although the prices of chemicals and grinding media increased, the prices of drilling and blasting accessories, lubricants, gases, diesel and fuel declined over the years. The decrease in the prices of machinery spare parts contributed to the decrease of cost. Prior to 1987, about 90 per cent of the total materials purchased went to Nissho Iwai Corporation (NIC), a (Japanese) Tokyo-based company. (Mitsubishi Metal Corporation has a substantial share in NIC but its share proportion, however, has never been revealed to the public). Usage of local products was discouraged except for miscellaneous items. Genuine materials for equipment and machinery spare parts that were very expensive were bought from Japan. However the sources of materials were localised after 1987 to reduce the payment for import duty. This is one of the main reasons for the decline in the average unit cost of production. The decrease in the average unit cost of raw materials in 1991 could also be one of the factors that led to the decrease in the average unit cost per tonne of concentrates produced, that is from RM154.4 in 1990 to RM138.1 in 1991.

Table 3.6:

Unit Price Of Materials, 1984-1991

Descriptions Of Item	Unit Price (RM)					
	1984	1985	1986	1987	1990	1991
Anfo (ton)	1.32	1.28	1.47	1.16	0.91	1.02
Emulite (ton)	-	-	9.40	9.94	12.7	11.6
Detonator (piece)	4.25	4.5	4.15	4.68	5.3	5.3
Starter Rod (piece)	4,100	4,100	4,100	4,132.	5,166	2,400
Button Bit (piece)	2,850	2,935	1,456.1	1,467.6	2,284	1,771.6
Extension Rod(piece)	4,370	4,370	4,300	4,300	5,505.	4,786.9
Collectors (ton)	14, 360	13,159.3	13,682.1	15,618.5	15,293.5	14,195.7
Forther (ton)	4,230	4,865.8	4,828.3	4,994.3	4,454	4,557.3
Depressent (ton)	6,300	6,505.2	7,371.1	9,702.3	10,781.0	10,450.0
Flocullent (ton)	8,150	7,976.7	8,970.7	11,257.8	8,533.5	8,222.6
Hydrated Lime (ton)	420	420	440.3	424.7	441.0	455.0
Grinding Rod (ton)	1,380	1,150	1,223.1	1,163.4	1,320.0	1,460.0
Ball 50mm (ton)	1,640	1,370	1,584.1	1,469.2	1,550.0	1,713.0
Ball 25mm (ton)	1,690	1,744	1,854.6	1,859.5	1,750.0	2,090.0
Fuel Oil 'L' (ton)	560	528.4	397.9	346.6	387.0	421.2
Diesel (litre)	0.60	0.58	0.47	0.45	0.43	0.57
Gasoline (litre)	1.01	1.10	0.9	0.8	0.96	1.1
Kerosene (litre)	0.64	0.63	0.53	0.51	0.57	0.65
Lubricants (litre)	634.0	620.4	310.87	302.1	416.6	555.3
Tyres (piece)	7,017.1	6,672.3	8,255.9	9,783.4	11,696.4	8,831.4
Gases (cylinder)	103.0	103.0	85.3	75.3	71.5	58.9
Steel Plate (piece)	160.3	162.1	127.2	281.5	546.7	434.2

Source: MCM , Price List Of Operating Supplies Reports, 1984-1991,Unpublished

3.4.3 Cost Of Pollution Preventive Measures

Mining activities, especially that of the open pit type is known to cause some deterioration of the surrounding environmental quality, particularly that of nearby water bodies and overlying atmosphere. As a result of the mining operations, a number of waste products and potential environmental problems are generated. These are:

a. domestic water-borne effluent from offices, workshops and living quarters.

b. dust from roads, dumps and equipment exhaust emissions.

c. mill tailings resulting from the ore after the metallic minerals have been extracted.

Due to the above waste products, the mining operation over the years has been the target of criticisms largely for despoiling the environment. Criticisms mainly centred on soil erosion, water and dust or air pollution. In 1978 the State Economic Planning Unit reported that 810 hectares of padi fields in nine Ranau villages were damaged by tailings and silt originating from the mine pit caused by a rupture of tailing pipelines and erosion of waste dumps in 1976 This was the worst environmental tragedy due to mining operation ever recorded in Malaysia. The company has since spent RM12 million to redesign the system to prevent the incidents from reoccurring. [7]

Following the incident in 1976, a report made by the Agriculture Department in 1978 established that out of 810 hectares of land affected by Mamut's pollutants, only 230 acres were completely damaged. MCM paid RM12 million as compensation to the affected landowners About 673 affected landowners from 13 villages received a yearly compensation before it was discontinued in 1987 when MCM took over management. On 7 November 1992, some 500 residents from the 13 villages held a peaceful demonstration to demand further compensation from MCM. They argued

[7] Refer Borneo Mail. (15 Aug 1990). " Mamut Copper Mining The Facts "

that the previous compensation was paid by Overseas Mineral Resources Development and MCM which took over the company should continue with the payment. The farmers brought this matter up to the government authorities for settlement after MCM refused to pay their claims. However, there is no settlement made on this matter until today. The farmers seem to be silent on this issue and there has been no official meeting between farmers and government authorities to discuss over these claims.

Between 1975 to 1990 nearly RM60 million had been spent by the company on waste disposal and control measures. The single biggest symbol of the company's effort to protect the environment is the construction of the dam located 900 meters below the mine. It is to this dam that the company sends tailings from the mine through 16 kilometer long pipelines. At the dam, the sand is separated from the tailings. The slime sinks to the bottom and clear water flows over the spillways to join the river systems.

Besides redesigning the tailing pipelines, MCM is also trying to plant vegetation in the waste dump areas, tailing dam and exposed slopes to minimise soil erosion. It is part of the company's effort to take note of the environment factors such as rehabilitation and reafforesation of exposed slopes. However, to get vegetation to grow on these slopes is yet to be seen because of the absence of nutrients in the soil and the latter's looseness which is compounded by the heavy water run off during the rainy season which in turn creates a serious soil erosion problem. In 1995 MCM spent about RM340,000 for rehabilitation and reafforesation.[8]

The expenditure spent on preventive measures represents a significant cost to MCM but it is justified by the need to ensure that unwelcome pollution and disturbances caused by the company's activities are kept to a practical minimum. This results in relatively high costs per tonne of copper concentrates produced. The high total cost in the early 1980s may also be due to compensation paid to the farmers. However, the company's refusal to pay additional compensation brought the total cost down between 1988 and 1991.

3.4.4 Cost Of Processing

The changes in the unit cost per tonne of copper concentrates may not be attributed primarily to the additional expenses of the redevelopment plan, labour cost, pollution preventive cost and prices of materials. Although the increase in volume of output tends to lower MCM's average cost, but due to the ore's characteristics; which is basically complex, the effect of volume quantity on cost may or may not necessarily lead to a reduction in unit cost.[9] The costs of processing the copper concentrates vary depending on the ore's characteristics. Ore that contains substantial green serpentinite resulting in a

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8 Refer Annual Report and Accounts For The Year Ended 30 June 1995

9 Increase in volume may decrease unit cost of production if a firm reaps economies of scale (see Goldschmid, Mann and Weston 1974) p 59

greater consumption of chemicals in particular; hydrated lime, depressent and aerophine 3418, incurs a greater processing cost. However, the cost arising from this process may be insignificant and minimal because the technique used in selecting ore supplying areas to blend different types of ore, reduces usage of chemicals. The blending technique could also be one of the factors that caused the reduction in the unit cost of processing in 1991. On the basis of this analysis, one can draw conclusions that the change in the unit cost of production does not solely depend on the volume of output produced. In the absence of green serpentinite, large volumes of output produced may lead to a reduction in the average unit cost because non green serpentinite type of ore requires little usage of chemicals, which in turn leads to a low processing cost. The above factors may have contributed to the low average unit cost between 1981 to 1987. Although the average unit cost between 1988 to 1990 increased, it cannot be viewed as cost inefficiency because the increase may have been caused by the additional operating expenses spent on the mine's redevelopment. The increase in the average unit cost of production may only be temporary for it may decrease in the long run. In 1993, for instance, the average unit cost decreased by 14.0 per cent compared to 1991.

3.5 Scope For Economies Of Scale

The returns to scale analysis in chapter two indicates that MCM operates on an increasing returns to scale.[10] From our observation of MCM's average

[10] Increasing returns to scale is said to exist when the change in output is more than

unit cost, its declining trend over the years as the MCM expands its size seems to perhaps show that MCM may be reaping some economies of scale. It is interesting to examine the factors that contribute to economies of scale in MCM.

Economies of scale may be broadly defined as the reduction in the long run average costs brought about by efficient production on a large scale. In theory, a larger mining operation is said to be able to produce a large quantity of output with minimum costs in the long run. The reason is that in the long run all factors vary unlike in the short run where factors are fixed. This can be illustrated with a simple example. If, let's say, 10 tonnes of copper concentrates are produced at the cost of RM5,000, it may be possible to produce 20 tonnes of copper concentrates at the cost of RM7,000. This is assuming that automatic and sophisticated machinery is employed and fully utilised. Although the total cost has actually increased, that is, from RM5,000 to RM7,000, what is clearly indicated is that the average cost has decreased. Such an incident may occur in a large scale production.

There are several factors that might influence the scale economies in MCM. Among the major factors are the following:

(i) technical factors governing the degree of mechanisation or investment intensity — these factors are the type of production process for example, drilling, blasting, hauling, processing; the physical nature of the

proportional to the change in input. It emphasises production relationships that give to rise to output increases that are greater than the corresponding increase in the input or scale of production.

material inputs and the product, for instance; a greater degree of mechanisation where materials are uniform. Production technology may also be the source of scale economies in MCM.

(ii) Non - technical factors --- Cost of material's input, management and division of labour or specialisation.

3.5.1 The costs Of Drilling And Blasting

The cost of producing the copper concentrates includes the cost of drilling, blasting and hauling, and milling. The economics of mining operations are determined by the cost of drilling, blasting, hauling and milling (processing).

Effective drilling and blasting reduces the costs of mining operation. In MCM, the current excavation rate is 400,000 cubic metres per month and about 90 per cent of this is blasted with the rest loosened by bulldozers. Primarily, drilling is performed by four rotary drill rigs equipped with a downhole percussion drill. The 190 mm diameter holes are drilled in a 7 m x 7 m staggered pattern and the 165 mm diameter holes in a 6 m x 6 m pattern. The drilling machines used are mostly of the crawler-type. With the downhole drill and the 165 mm button bit, the penetration rate is 35 meters per hour in a solid porphyry ground and about 30 per cent slower in a near surface broken ground. There has been little scope for improving the cost performance of drilling except to use a hard-resistence high quality down hole drill or button bits. Recently, however, the mining engineers conducted a test comparison among different brands and manufacturers namely; Ingersoll - Rand Bit (USA), Rock Drill Bit (USA) Mitsubishi Bit (Japan), Kreb (Germany) and Sandvick Bit of Sweden. The test concluded that cost saving of 15 per cent is obtained by using Sandvick Bit which has a better penetration in a solid porphyry rock. This indicates that the cost of drilling can be reduced by using better quality equipment.

Blasting performance can determine the cost performance of mining operation. Between 1975 and 1990, MCM used ANFO (Ammonium Nitrate + Fuel Oil) as one of its blasting components. The primer was made of a piece of dynamite and an electric detonator. The performance was less effective not only because it resulted in more ground vibration and flyrocks but also because its fragmentation was weak. Secondary blasting was inevitable and hence additional costs were incurred. Due to the inferior performance and the high cost of the detonating cord system, the company acquired the latest in blasting technology; the Primadet system. With the non-electric signal tube initiation system Primadet, there is considerably less noise, less ground vibration, less fly rocks and better fragmentation.[11] According to the senior mining manager, these features are of great benefit to the pit operations because they leave behind a stable wall as the pit progresses

11 Better rocks fragmentation do not require secondary blasting. Rocks can be delivered direct to crusher.

to deeper levels.[12] It increases blasting tonnage, safely and efficiently, thereby achieving a lower overall cost. Blasting cost has decreased by 13 per cent in 1991, 13.2 per cent in 1992 and 13.6 per cent in 1993.

Blasting is carried out daily at an average of three to four blasts per day and each blast produces 30,000 tonnes of material. In the last five years, annual output of material blasted has increased steadily from 16.4 million tonnes in 1989 to 26.8 million tonnes in 1990, 40 million tonnes in 1991, 40.8 million tonnes in 1992 and 41 million in 1993. The increase in output blasted was due to the effective drilling and blasting. MCM is now using Sandvik Bit that has proven to have better penetration. Better penetration enables MCM to drill more holes per day to be blasted. The new blasting technique improved rock fragmentation and therefore eliminates secondary blasting. Thus not only the blasting tonnage increase but cost saving is also obtained.

The cost of blasting defined by the type and amount of explosive to be used cannot be separated from the cost of drilling defined by blasthole geometry when the objective is to minimise total costs. The cost of explosive is in direct proportion to the weight of the explosive required to break a unit mass of rock. The cost of drilling at a given diameter will be roughly proportional to the blasthole volume required for a given explosive to break a unit mass of rock . This again leads to the conclusion that when comparing

[12] See Mamut Quarterly Copper Magazine, 1992.

explosives with the same cost on a weight-strength basis, the one with the highest volume or bulk strength will be more economical. There is an obvious benefit in increasing the loading density of straight ANFO resulting in increased bulk strength and reduced blasthole volume and thus reduced drilling costs The total blasting costs, which comprises the costs of explosive and drilling, can be represented by the following function:

$$Ct = \frac{1}{S} \cdot Ce + \frac{1}{(P)(S)} \cdot Cd$$

Ct = total blasting cost

Ce = cost of 1 kg explosive (when loaded)

Cd = cost of drilling 1 dm3 blasthole volume

S = weight strength of explosive

P = loading density of explosive

Source: Economics of Mining, Asia Pacific Mining Journal, June 1990

In MCM, experience has shown that using straight ANFO tends to be the most cost effective. However, increasing drilling costs favour the use of aluminised ANFO (ammonium nitrate is added with aluminium), when the gain in weight strength and bulk strength outweigh the explosive's cost. Aluminised ANFO has been tested at the mine but the result has proved to be insignificant because its usage leads to raising the cost of explosive

To sum up, the high quality of drilling accessories and ammonium nitrate, and improvement in blasting technology appears to be an important factor in reducing the total cost of blasting in MCM

3.5.2 Extraction And Hauling costs

The cost of extraction and hauling, to a large extent, depends on the type of ore to be extracted and its location, and the number of serviceable and efficient machines such as loaders, excavators and trucks that are available. Frequent breakdown of machines increases the cost of hauling. In the case of ore that is located in relatively soft rocks, hauling of a larger quantity of ore is possible. The cost is low because soft rocks require less power and fuel. Ores which are located in areas of hard rocks are expensive to extract. As such ore supplying areas are selected to make up a blend of half porphyry ore and half serpentinite and siltstone ore. This is done to compromise factors like rock hardness, stickiness, grain size, and floatability which can affect milling efficiency for example, talc materials present in green serpentinite usually result in poorer flotation performance. On the other hand, porphyry ore has a higher mill recovery rate. Blending techniques reduce the processing costs and thus contribute to better economies of scale in mining operation.

The average cost of extracting ore accounts for as little as RM1.56 per tonne if 103,642 metric tonnes are extracted and as much as RM2.00 with

70,000 metric tonnes.[13] If the tonnage of hauling increases, the average cost tends to decrease. Thus MCM seems to gain economies of scale if a large scale extraction is undertaken.

3.5.3 Material Cost

Diversification of sources for materials reduces material cost as discussed earlier Besides source diversification, MCM enjoys economies of scale by other means; for example, by buying material in bulk more cheaply. Hauling and processing of ore in large quantities at a low cost are possible with cheaper materials

Purchasing large quantities of identical components (for example raw materials) usually enables the buyer to get better terms. So a large company has some buying advantages over a small one. The expenditure of MCM on raw materials is quite substantial. In 1991, for instance, the monthly average of raw materials purchased was RM3.9 million. MCM obtained discounts from buying material in bulk (see table 3.7) Thus the price of raw materials can be maintained through price discounts. Table 3.7 shows the amount of discounts obtained from major items purchased by MCM for the year 1989 and 1990

13 The Mamut Monthly Operation Reports, unpublished

Table 3.7

Discount Gained From Bulk Purchase, 1989 - 1990

Name Of Item	% discount obtained
Fuel oil	11.5 per tonne
Diesel	10.9 per litre
Lubricants	10.0 per litre
Chemicals	8.5 per tonne
Ball Liners	6.8 per set
Grinding Media	5.8 per tonne
Ammonium Nitrate	6.7 per tonne

Source: MCM , Monthly Purchase Reports, 1989-1990, unpublished

MCM used the system of 'consignment stock' to reduce inventory cost. Consignment means "pay as used". This system operates on the basis of mutual agreement in which the suppliers replenish their stocks as and when required by MCM. The advantage of this system is that the company eliminates transportation, interest and stock holding costs. Spareparts and tyres for heavy trucks are on a consignment basis. MCM is currently studying if the consignment system can be extended to other stock items such as chemicals and lubricants. This is a worthwhile study because in 1991 MCM had about RM28 million worth of spares and materials on stock. If, for instance, the stockholding cost can be reduced by 50 per cent, the saving is RM1.4 million per year based on an interest rate of 1.5 per cent above the base lending rate of 8.5 per cent.[14] This is a respectable sum as it is about the same as the profit for one month in the 1991/1992 period.

A 'contract-buying' arrangement with suppliers may help to save costs. MCM uses this mode of purchasing to maintain the price of materials from increasing as a result of price shock due to an oil crisis or inflation. A contract-buying arrangement is made with major suppliers like Tractor Malaysia Berhad -- a supplier of caterpillar parts; Induchem-- a supplier of Depressents; Oriental Construction--a supplier of Hitachi Parts and Tokyo Rex-- a supplier of Terex Parts. Contract-buying arrangement requires Mamut Copper Mining to buy materials from suppliers within a specific time, normally about one year. The supplier, on the other hand, agrees not to increase his price within the time stipulated in the agreement. This mode of purchasing is effective particularly during inflationary periods to maintain and reduce material costs.

It appears that scope for better scale of economies for MCM can be achieved by using high quality equipment and accessories for drilling and hauling, better technology in blasting and effective mode of purchasing. Some of these have already been implemented and are in use in the mining operation.

[14] See company's internal memorandum, January 1991. This document is confidential and unpublished.

3.6 Scope For Reducing Cost

The higher production cost between 1980 and 1994 was due to the increase in material cost and labour cost. Other factors that contributed to the higher cost were the higher volumes of ore and waste mined, quantity of output produced and export, cost of pollution and preventive measures, and the expenses spent on the new mine development plan. These were the main factors that contributed to higher production cost. Reduction in cost was attributed to the decrease in the payment of royalty, price of materials, general expenses and lower volumes of output and export.

The cost of production can be redued by improving the productivity of all inputs including the existing capital goods. The unit cost of production can be reduced by intensifying the capital inputs to mechanise manual tasks. This requires reliable equipment and a high level of technology. Reduction in total unit costs of production can also be achieved without having to increase capital inputs. This includes changes in material prices that can be done through an effective mode of purchasing. It appears from the analysis that an increased use of high quality machines for hauling and loading, better explosives and blasting techniques, high quality chemicals, effective modes of purchasing, and better preventive techniques to minimise pollution, reduce the average unit cost of production. Whilst these measures are implementable and workable, the problem of reducing costs associated with the treatment of ore may still remain.