Cost management and accounting of a marble quarry at Northeastern Greece

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I hereby declare that the work submitted is mine and that where I have made use of another's work; I have attributed the sources according to the Regulations set in the Student's Handbook.

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1. Abstract

This dissertation was written as part of the Executive MBA at the International Hellenic University.

This dissertation deals with the costing and cost management of a marble quarry located in northeastern Greece, an area that is the most important quarry center in the country. Analyzing the marble market and the strong brand name of Greek marbles we will mention the reasons for the continuing increase in demand for Greek marbles abroad. Then, we will refer to cost management and the ABC costing method that we will use to calculate the cost of a specific marble quarry.

Next, we will analyze in detail the production process of the quarry and the technology, the production inputs; the description of procurement program and the cost of spare parts and consumables. Then, we will describe the production organization; the departments, its responsibilities and how they interact between them. Afterwards, we will emphasize at staffing and manpower and their importance for the operation of a business and we will calculate the labor cost of the quarry. Finally, we calculate the operating cost and the total production cost by using all the available data and we propose solutions to reduce the cost of this marble quarry. At the end of our analysis, it is perceived that the activities with the highest cost are the loading and transporting of the sterile material and the transport-weighing and placement of the marble blocks and we examine ways to reduce them such as buying a dumper truck with bigger transport capacity.

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Keywords: cost management, marble quarry, ABC method, operation cost, production cost

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2. Contents

1. Introduction

In contrast to the contraction of the internal market of construction materials, which shows a decline from 2008 onwards, the marble sector all these years continues its upward trend with the main element being its export orientation up to 75-80% of the total production of the produced marble products. In the last decade, due to the recession in the Greek economy, the industry was called to redefine its role, to show extroversion and to change its strategy, mainly addressing the global market. Thus, it continued its growth course in response to the growing demand of foreign markets (Fig.1, Appendix).

The value of exports in the whole sector of marble and natural stone products, according to the data of the Hellenic Statistical Authority (EL.STAT & Eurostat) and the processing by the Ministry of Environment and Energy (MEE) in 2018 amounted to 580 million euros and the quantity and exports of marble products amounted to more than 1.1 million tons (Fig.2 & 3, Appendix). As a result, Greece holds the 4th place in the world ranking of marble exports, the 3rd place in the world in the ranking of raw marble exports (marble blocks) as Greek marble exports have almost tripled in the last 10 years (Fig.4, Appendix). The Greek marble industry, demonstrating operational readiness and quick reflexes, adopted a purely extroverted strategy which, within a decade and despite the intense competition, emerged as one of the largest exporting forces in the world.

New jobs have been created and the demand for skilled staff has increased. The marble sector leaves a strong imprint on the Greek economy, as the supply of the marble production sector to it reaches 1.27 billion euros and for every 1 euro of marble product the multiplier benefit is 2.19 euros. The sector employs about 7,000 people, while the total contribution to employment (indirectly) reaches 20,000 employees (ICAP study for the Marble Business Association of Eastern Macedonia & Thrace).

65% of raw marble exports go to the Chinese market (ICAP study), which is also the largest importer of raw marble in the world. The huge market of China is a major conquest for Greek marble and despite the slowdown in the growth of China's economy from the frantic pace of

previous years; it is a guarantee for the future availability of Greek marble products. Unfortunately, this absorption also has negative sides, since especially for China it concerns almost exclusively raw volumes of marble, as a result of which the added value is limited but we also have losses in public revenues due to different tariff policy depending on the degree of processing of the exported product.

Apart from China, important markets that absorb Greek marble are: the USA, the United Arab Emirates, Singapore, Qatar, Italy and Turkey. Especially, the USA is the No. 1 importer of processed marble from Greece and therefore a strategic partner of the Greek marble industry as 15% of Greek exports of processed marble are directed there. They are also the largest importer of processed marble in the world. Greece holds the 6th place as marble supplier at USA, following global giants such as Italy, China and Turkey (Hellenic Statistical Authority).

All the above prove that Greek marble has strengthened its brand name in international markets and has become quite attractive. It is also important to improve the competitiveness of the Greek companies with structural changes in the business model, the organization of work, quality assurance of products produced and finally the evolution from the simple processing of the sale of standard marble products to the provision of integrated solutions.

All the above resulted in companies operating in the marble industry investing over 100 million euros only in 2018 to modernize their mechanical equipment, develop new deposits and increase productivity due to the growing demand for Greek marble . A part of this amount of money was also spent on the acquisition of small and medium-sized companies by larger ones.

In this project we will deal with the costing of a marble quarry located in northeastern Greece, in the area that is considered the largest quarry center in Greece and its marbles have the highest demand. We will analyze the entire production process and its stages as well as the activities of each stage and we will propose solutions to improve cost management by managers. We will identify the processes that have the most significant impact on the cost of the production process and we will propose solutions to reduce them. Executives of marble companies will understand that transportation costs are the highest in the production process and should consider one of the proposed solutions. Also, they will realize that the cost of

transport and distribution is high but unfortunately cannot be reduced due to the distance of the quarries from the points of transshipment.

2. Cost management & ABC method

Today, the 80% of total Greek primary marble production is located in the region of Northeastern Greece, where the majority of marble companies are operated. The number of companies operating around the marble has increased and has exceeded 150 in this area. From the 5 active quarry centers of the area where more than 135 quarries are active (200 licenses) more than 90% (in quantity and value) of the total marble is exported (Ministry of Environment & Energy). As a result, it is easy to understand the reason we chose to do our research in the quarries of this area.

Given the situation prevailing in the marble industry in Greece, it is easy to understand how vital is for the managers of these companies the cost management and accounting in every decision that they take. A decision can influence the success or otherwise of the organization concerned. In particular, management can use the information it collects from the costing system to make a decision about the price it will set for a product. The management gathers the necessary information about the cost of production from the costing system they use and then according to this information they can proceed to the price-setting process. Particular interest of cost in pricing process is represented by the cost of production and its components. Knowing the cost of the individual steps of the production line, managers can check it easily so as to be always less than the selling price of the product and find ways to reduce it further to increase the company's profit margin. Cost-based pricing is intended to cover the costs of the business if the price is determined above the cost and a profit margin after the company has managed to cover its costs. Generally, cost is not the only factor affecting price setting, but the role of cost in pricing is crucial as it sets the threshold for price setting, strategies and policies.

The costing method we will use in this project is the Activity- Based Costing (ABC) Method. Activity-Based Costing (ABC) dates back to 1988 when Cooper and Kaplan took a different approach to calculating cost. Until then, "traditional" systems were the predominant ones, such as job order costing, process costing, full costing, direct costing

and standard costing (Kechras, 2009). According to Cokins (1999), the 1980s were the year in which companies began to realize the inaccuracies arising from "traditional" systems. The latter provided more basis for the costing of direct labor and direct materials, which were necessary for the production process, and not the other overheads which were characterized as an incalculable factor. The emphasis on direct labor was what really prevailed, with the distribution of overheads being done, but in an arbitrary way. In other words, the overhead was allocated in proportion to the units that the companies produced and the sales of the products. This system made "traditional" costing methods relatively unreliable because many of the resulting overheads corresponded to external activities unrelated to the main "trunk" of production. Thus, the phenomenon of either over-costing or under-costing of products was common.

Ning (2005) in his historical review on the issue of costing, states that the need to shift from "traditional" systems to a system where it would give emphasis on the distribution of overhead costs, arose due to changes in production technologies, control methods and more generally in forms of competition and the market. Over the years and with the indirect costs (overheads) in many cases exceeding 60% of the total cost, the need arose for a costing system that would respond to the unreliability of "traditional" methods (Kechras, 2009). This was the A.B.C. The information it would provide was for the direct purpose of accurately calculating the cost of support activities and as an indirect aimed at the general support of a company's strategic decisions. To this must be added the fact that companies have now produced a large number of differentiated products and as Cooper (1988) pointed out this diversity, volume, size and complexity are the factors that lead to the unreliability of "traditional" methods and the need for a new approach.

Additionally, O'Guin (1991) states that Activity Based Costing system essentially separates and divides the cost into two groups, the one created by the product and the one created by the customer. The first grouping includes costs directly related to the product, such as construction, design, production planning, storage, quality control, supplies, etc. The second group includes costs related to the customer. These are the costs of delivery, service, support, distribution, sales, advertising, marketing, research

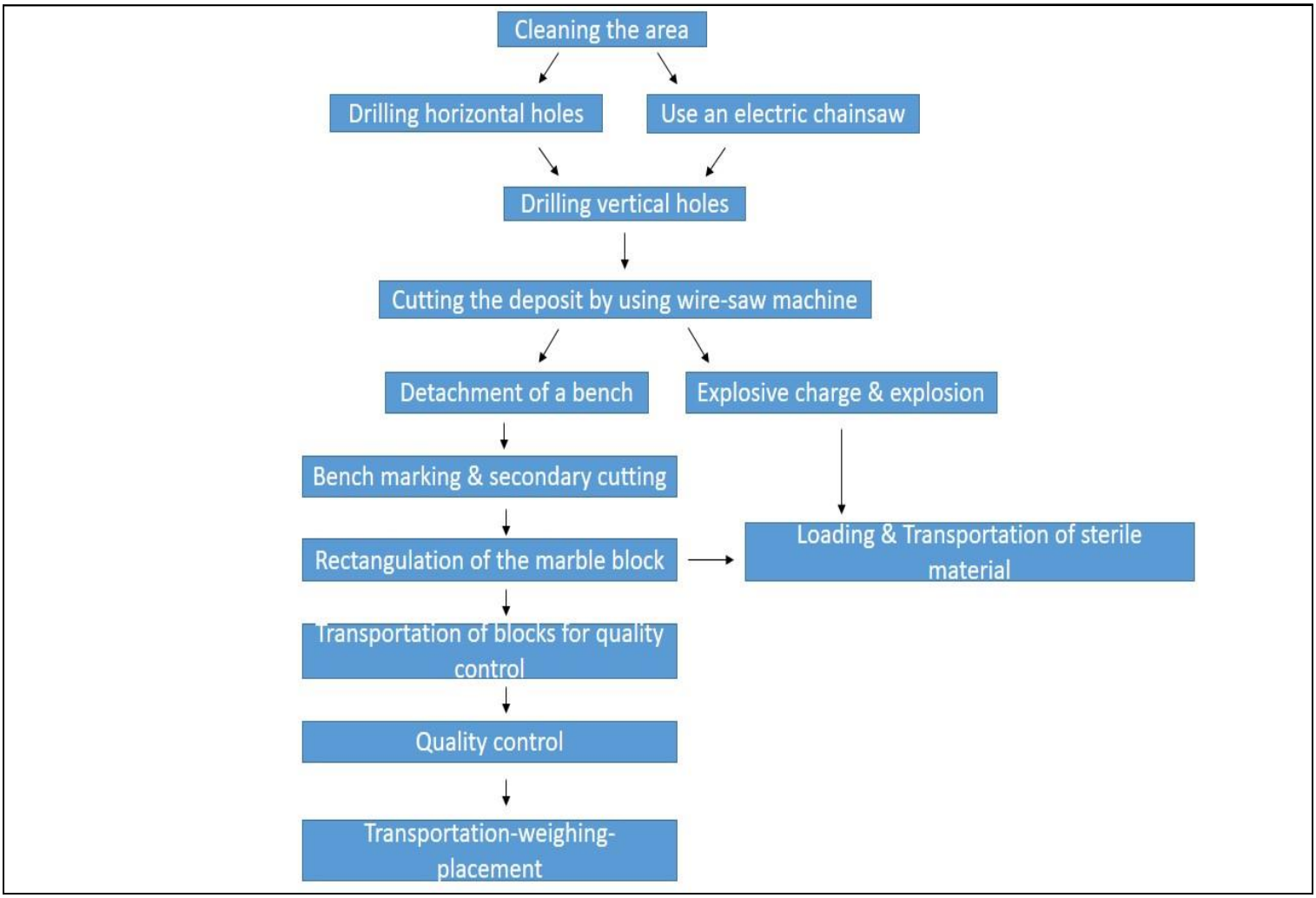
and development, etc. By using this method, we observe that the concept of cost is correlated with the customer.

Activity costing can therefore be described as a method of allocating indirect costs. The A.B.C. takes into account not only overheads related to the production process but also the costs associated with other functions which may not be directly related to production but which play an important role in a business (marketing, logistics, etc.) (Turney, 1996). Therefore activities (which can range from a simple issuance of documents and payment of bills of exchange to the maintenance of equipment and the palletizing of products) and their costs, play the most important role in this method. By assigning costs to the activities of a company, the management is in the advantageous position of controlling the causes that cause it and the degree to which this happens. So there can be a targeted approach on the part of the company to reduce costs, as long as it knows, through the ABC method, its sources of challenge.

The basic concepts that characterize the ABC method are: resources, cost objects, cost drivers, activities, resource drivers & activities, performance indicators and value chain. The validity of the information, provided by the adoption of the A.B.C. system, is a tool for the companies to take the right decision, for the critical evaluation of the product portfolio and in general for the planning of operations and activities.

3. Production process & technology

The production process includes all the processes that take place in a production line as well as the technology that is used in order to produce one or more products. During the production process, energy is consumed either in the form of electricity or by the combustion of conventional fuels. In this chapter we will report and analyze the entire production process that takes place in a marble quarry as well as the technological means used to produce marketable marble blocks. The Picture 1 presents the production process of the quarry.



Picture 1: Production process of the quarry

Cleaning of the area of the deposit to be exploited: At the beginning of the production process it is necessary to clean the area to be exploited both for the safety of the workers and the machines that will work there and for the better evaluation of the quality of the marble deposit. This is done by using small wheel loaders operated by qualified personnel.

After assessing the area to be exploited, we decide whether the quality of the deposit is good for the production of marketable marble blocks or not and this area will be blown up using explosives for the faster progress of the exploitation

Drilling horizontal holes for marble blocks production or to blow up the deposit: In this phase of the production process, the deposit is divided into equal-sized rectangular parallelepipeds 12m long, 1.7m wide and 6.5m high in the case of marble blocks production or it is drilled (only 2 horizontal drills) in the case that the deposit is not marketable and it will be exploded. The horizontal holes are made using specialized drilling machines which are handled by licensed operators.

Drilling vertical holes for marble blocks production or to blow up: In both cases the deposit will be drilled vertically with a specific type of drilling machine. In case the deposit in the specific area will be blown up, the holes will be more as some of them will be filled with explosives. This machine is operated by a licensed operator

Extraction by using an electric chainsaw: In cases where there are no 3 free surfaces in the deposit, the use of horizontal drilling machines becomes impossible. In this case we use an electric chainsaw for horizontal cutting which is used after the drilling of vertical holes.

Cutting the deposit using wire-saw machine and water: During that process, a worker uses wire-saw machine in order to cut the marble deposit first horizontally and after vertically. A diamond wire is used as a cutting tool which is passed through the holes drilled by the drilling machine in the previous step. Water is used during the cutting and the wire-saw machine is operated with electrical power.

Detachment of a bench from the deposit: After the end of the cutting process, the bench is detached from the parent rock. First, we transport fine-grained soil by dumpers which we place in front of the bench that we will extract to avoid possible breakages of the bench when it falls. This material is uniformly formed using a big wheel loader or crawler excavator. Next, two workers

remove the bench from the deposit using a water pump and an expansion bag (water pillow). Finally, a crawler excavator pushes the bench so that it falls on the soil that we had formed in the previous step.

Explosive charge and explosion: As it mentioned before in case the deposit cannot produce marketable marble blocks due to poor quality at its specific area then it is blown up using explosives. The vertical holes are filled with explosives (except those used for the diamond wire to cut the deposit) and it is blown up. Charging and blasting is done by a licensed employee for this type of work.

Bench marking and secondary cutting: At this stage of the extraction, the bench is carved by experienced personnel in order to cut it secondary and to produce as ''healthy'' and marketable marble as possible. It is obvious that at a marble deposit there are problems (fractures, cracks) which cannot be included in the marketable final product. The secondary cutting is done using a machine with a hydraulic drilling unit by a licensed operator while bolts are used at the end of the cutting to "open" the bench.

Rectangulation of the marble block: After the bench is opened, a wheel loader transports the good pieces of the bench one by one to be re-examined by the same experienced personnel who re-engraved these pieces and then cut them with a wire-machine in order to have the final marble block (product).

Loading and transportation of sterile material: At this stage of the production process the non-marketable material from the blasts, from the bench marking and the rectangulation of the marble blocks are loaded with wheel loaders in dumpers which transport them in the landfills of sterile material of the quarry. The loaders and dumpers have diesel engines and the workers are licensed operators.

Transportation of marble blocks: After the rectangulation of the marble blocks, they are transported by wheel loaders for quality control.

Quality control: The quality control of the marble blocks is done by specialized personnel which classifies the blocks in qualities while rejecting the non-marketable blocks.

Transportation- weighing- placement: After the quality control the blocks are loaded in dumpers with loaders and after being weighed, they are placed in the customers' areas.

4. Production Inputs

In economics, factors of production, resources, or inputs are describing the general inputs used to produce finished goods and services and to make profit. The utilized amounts of the various inputs determine the quantity of output according to the relationship called the production function. There are four basic resources or factors of production: land, labor, capital and entrepreneurship. The factors are also frequently labeled "producer goods or services" to distinguish them from the goods or services purchased by consumers, which are frequently labeled "consumer goods" (Samuelson et al, 2004).

There are two types of factors: primary and secondary. The previously mentioned primary factors are land, labor, capital and entrepreneurship. Materials and energy are considered secondary factors in classical economics because they are obtained from land, labor, capital and entrepreneurship. The primary factors facilitate production but neither becomes part of the product (as with raw materials) nor becomes significantly transformed by the production process (as with fuel used to power machinery). Land includes not only the site of production but also natural resources above or below the soil. Recent usage has distinguished human capital (the stock of knowledge in the labor force) from labor (Samuelson et al, 2004). Entrepreneurship is also considered a factor of production (O' Sullivan, 2003). Sometimes the overall state of technology is described as a factor of production (Perkin, 1999). The number and definition of factors vary, depending on the theoretical purpose and the empirical emphasis (Friedman, 2007).

Land as a factor: Despite the fact that mining has a small share of a country's total land use, conflict can arise at the local level where mining is perceived as competing with agriculture and livestock grazing or other land uses (Popovic, 2015). It is obvious that in the mining industry the most important factor of production is the land. A company can operate only in licensed quarries' areas that have been granted by the state for a certain time period while paying the corresponding rents to the state (7% of sales turnover). In the case of the quarry that we will analyze in this project, the company has leased the specific quarry area for the next 40 years with the right of renewal based on Greek quarry legislation. Also, the reserves

of the deposit have been estimated after sampling wells and having collected and analyzed the production of marketable material in the last decade. All this analysis led us to estimate the reserves of this deposit at 2 million tons, a large amount that helps entrepreneurship and investments.

Labor as a factor: Labor refers to the effort expended by an individual to bring a product or service to the market. Again, it can take on various forms. In our case, labor starts from the production workers, operators, technicians and foremen that are paid for their time and effort in wages that depend on their skill and training and also includes the management of the quarry, the sellers of the sales department as well as the central management of the company that tries to introduce the products of the company to the market and to sign contracts with customers to increase company's profits. As far as the quarry staff is concerned, this is characterized by experience and specialization as the company has been active in this quarry for over 25 years.

Capital as a factor: When economists refer to capital, they are referring to the assets–physical tools, plants, and equipment–that allow for increased work productivity. Capital is unlike land or labor in that it is artificial; it must be created by human hands and designed for human purposes. This means time must be invested before capital can become economically useful. By increasing productivity through improved capital equipment, more goods can be produced and the standard of living can rise. Capital goods are also sometimes referred to as the means of production because these physical and non-financial inputs create objects that can eventually be bestowed with economic value.

In the quarry that we will analyze, the owner company invests in new mechanical and electrical equipment (as will be seen from the depreciation) which consists of wheel big and small loaders, excavators, trucks, new generation wire saw machines, chainsaws, drilling machines, air-compressors, hydraulic drilling units, cars 4X4 and buses for the staff transport etc. The operating company uses equity for these investments and does not need to borrow capital.

Entrepreneurship as a factor: Entrepreneurship is the undertaking of new business ventures that may eventually become profitable companies. Some economists identify entrepreneurship as a factor of production because it can increase the productive efficiency

of a firm. Even though entrepreneurship is not land, labor or capital, most place entrepreneurs in the same critical category as more consistently identified factors of production. In case we will analyze the specific marble quarry, it was acquired by the current owner company but through pioneering ideas it managed to export it to many countries as until then it was known only in the domestic market. It is also worth noting the company's choice to acquire the specific quarry area (high reserves of the deposit as mentioned above) and not some other neighboring quarry.

4.1 Description of procurement program

The company that operates at the specific marble quarry has in its organization chart a procurement department staffed with the appropriate personnel. This department is responsible for recording the needs of the quarries by their managers (mining department, maintenance and repairs department) as well as the needs of the other departments located at the company headquarters, to request offers by doing market research from suppliers and to complete the orders. We could mention that it was mainly responsible for the purchase of consumables and spare parts.

Certainly there are some stable suppliers with whom long-term agreements have been signed in order to serve the needs of the company faster and at a certain period of time the market is researched for the prices of specific materials. In the case that the cost of an order is very high, an offer is requested from at least 3 suppliers and the completion of the order is done with the written consent of the general manager of the company. There is an order monitoring system which indicates the stage at which the order is located which is updated daily. Through this system, when the order is completed, its cost is transferred to the respective cost center so that we can manage it and to take the right decisions.

In each quarry there is an employee who works at the repair department who has the responsibility to check the orders that have been completed, to arrange them safely in the warehouse of the quarry and to charge them to the machines during their consumption. It must also check and update the logistic system whenever the quantity of a consumable item has been reduced because if a new quantity is not ordered there will be a shortage in the future. Knowing the rate at which each type is consumed can predict when there will be a shortage. The cost of supplies is estimated at about 1 million € per year.

This cost is broken down into consumable cost and the cost of spare parts. The cost of consumables is the necessary expenses borne by the production process and consists from fuel cost, the cost of explosives, the cost of cutting material, the cost of lubricants, the cost of tires and cost of other consumables like personal protective equipment, tools etc. This cost has been calculated at 750000€ per year and we present it at Table 1. The spare parts cost is the cost of spare parts used by the maintenance and repair department to repair the machineries of the quarry. This cost is 250000€ per year and it is distributed in each category of machine (see Table 2).

Table 1: Cost of consumables per year

Cost category	**Amount (in €)**
Fuel- Diesel	550000
Explosives	30000
Cutting materials	50000
Lubricants	40000
Tires	30000
Others (Work clothes, personal protective equipment, tools etc.)	50000
TOTAL	**750000 €**

Table 2: Spare parts cost per year

Machineries per category	**Amount (in €)**
Spare parts for dumpers	80000
Spare parts for big loaders	60000

Spare parts for excavators	40000
Spare parts for excavators with drilling units	20000
Spare parts for drilling machines	15000
Spare parts for small loaders	5000
Spare parts for wire saw machines & electrical equipment	30000
Spare parts for chain saw	0 €
TOTAL	**250000 €**

The data of the tables 1 and 2 are the result of their collection and processing by the procurement department. These data will be used in a next chapter to calculate the production cost of the quarry.

5. Organization Unit 1: Production Organization

In this chapter, we will describe the way in which the production of the quarry is organized. In other words, we will refer to the responsibilities of each department and how they interact with each other with the aim of the final production of marble blocks. It is very important that the departments and their staff know their area of responsibility and work together for the best result. The departments that exist in the specific production line are the following: 1) mining and production department 2) repairs and maintenance department 3) quality control department 4) procurement department 5) sales department.

5.1 Mining & production department

The mining and production department is responsible for the legal exploitation of the deposit in accordance with the approved technical studies, the environmental impact studies and the general environmental legislation. Its goal is to produce as many marble blocks as possible with the least cost that will be available for sale following the safety regulations in accordance with the quarry legislation and the regulation of mining and quarrying to avoid accidents at work. This is achieved through the optimal use and organization of the available means of production (loaders, excavators, trucks, wire-saw machines, etc.) and the continuous training of staff. The head of the department is the quarry manager who is a mining engineer and also performs the duties of the safety technician. In his responsibilities are the planning of the exploitation according to the provisions mentioned above and safety regulations for the quarry workers. In order to achieve the optimal design and productivity of the quarry, the manager has the project foreman who is responsible for the distribution of machinery and workers in the quarry sectors. The foremen essentially follow the plan of the manager and try to execute him, always having as a priority the safety of the workers and the machines. On a daily basis, the foremen report to the manager the work schedule and the activities of the previous day. The quarry has 2 quarry masters, one in the morning shift and one in the afternoon shift. Also, the quarry manager cooperates with the repairs and maintenance department so that it intervenes immediately in case of a machine failure and plans together with the head of the repairs and maintenance department, the maintenance of the machines

so that they work without problems and increase their life time. Also, the mining and production department is in constant contact with the procurement department for the status of the orders of consumables and spare parts as knowing their delivery times can more easily plan the progress of the projects.

5.2 Repairs and maintenance department

This department essentially operates by supporting the mining and production department and effectively solving the breakdowns that have arisen in the mechanical and electrical equipment of the quarry. Its proper operation and speed of response in repairing the failures of the equipment is very important thus, the failures and the requirements for their restoration are recorded daily. It consists of technicians and an electrician. The head of the department is an electrical engineer and is the one who coordinates the activities of the department after consultation with the mining department. Also, it is in contact with the procurement department for ordering spare parts which are necessary to repair the machineries and to know the estimated delivery time of them.

5.3 Quality control department

This department is responsible for the quality control of the produced marble blocks. Essentially, it checks whether the marbles are marketable and categorizes them into corresponding qualities. It consists of very experienced staff as it is easy to understand how important it is to offer the customer a product that meets a predetermined and consistent level of quality. The difficulty in this work lies in the fact that marble is a natural decorative material. The deposits do not constantly produce the same material as in other production lines, with the result that the quality control is always very meticulous. Another difficulty of quality control is the inability to control the interior of the marble. There is not yet technological means for this to happen so the quality control staff only monitors the block perimetrically. This raises the possibility of incorrect estimation and evaluation of the block for this and as mentioned above this department consists of very experienced staff. This department administratively belongs to the quarry manager.

5.4 Procurement department

The procurement department is based at the company's headquarters. It is a very important pillar in the production process as it serves the needs of the mining department and the repairs and maintenance department. It is in constant communication with these two departments, receives from them the orders of consumables and spare parts and informs them about the status of the orders and the possible delivery times. Also, if the amount of an order is too large, it necessarily takes offers from at least 3 suppliers in order to choose the best one. What he always takes into account is that any product he orders must have European certification and meet the specifications of European directives and standards and its use is safe.

5.5 Sales department

The sales department is responsible for selling the products produced to customers. It is in contact with the quarry manager to know not only the daily production of the quarry but also his estimate for the production of the quarry in the near future, e.g the production of the next quarter. Essentially, the actions of this department depend on the production of the quarry and its goal is to keep customers satisfied by providing them with high sales services and to be in a hurry and search for new markets and customers. Customer support should remain a priority for this department as any information they receive about the product purchased and processed by customers should be automatically transferred to the mining department.

6. Organization Unit 2: Staffing and Manpower

The most efficient development and operation of the business requires coordination, effective management of all financial and technical means and the maintenance of a role structure. This is the purpose of the organization. The key factor to more efficient use of means is the human factor that plays the most important role today as businesses grow in a competitive environment. Staff is the most vital part of the business and this can be easily seen if we think that people create ideas, launch developments and direct business activities. Staffing is a process that includes anticipating workforce needs, selecting the right staff, developing and training them, evaluating them and determining pay. So its importance for maintaining the workforce in the company is clear.

Since there are organized societies, there is also the problem of organization as a separate function that includes the planning, coordination and control of individuals to achieve a common goal. Today, along with the evolution of organizational thinking, the human factor has been upgraded and acquired the position it deserves. It is also understandable that the success of the company depends on the composition of the human resources at its disposal. That's the reason why companies are looking for executives who will adapt to new situations quickly and will be able to lead the business in the future.

Staffing as a main administrative function deals with the search for the right personnel, their selection, training and placement in the appropriate position so that the employee feels happy and performs to the maximum and is motivated to constantly evolve. If all this happen then it is certain that the productivity of the company will increase. In the case that we will analyze below, the manager of the quarry is the one who chooses how the personnel will be staffed.

Staffing is a subsystem of the organization of the company and concerns how each company must be staffed to have the expected results. The human factor plays a key role in all this. Effective staffing is linked to productivity and the ultimate achievement of the business goal. No company or organization can hope to be more productive unless it requires the right

knowledge, techniques and experience for its human resources to be able to deal with potential problems.

In the case of the quarry that we will analyze in this project, the staffing of the personnel is based on the annual production target and the available machinery. It would be absurd to hire staff without the need for higher marble production or without available technological means. The annual production target of this quarry is 65000 ton of marble blocks in different qualities and the available technological means are the above:

- 4 big wheel loaders
- 4 excavators
- 3 dumper trucks
- 2 excavators with hydraulic drilling unit
- 5 wagon drills for horizontal drills
- 2 drilling machines for vertical drills
- 4 small wheel loaders
- 1 chainsaw
- 27 wire-saw machines

The permanent staff of the quarry consists of 20 people, who work in different job positions such as machine operators, foremen, quarry workers, quality controllers, technicians and electricians, quarry master etc. To achieve the annual production goal a total of approximately 700000 ton should be mined. Having evaluated the capabilities of the existing staff (experience) it was estimated a total of 70 people could achieve this goal. This staff would work in 2 shifts, the morning shift and the afternoon shift. The morning shift would work 6 days a week while the afternoon shift would work 5 days. In other words, there should be more staff in the morning shift that would cover the needs for 6-day work. As it is known, in Greece and according to the labor legislation, the employees work 5 days a week and in total up to 40 hours. Also in the afternoon shift not all self-propelled machines can be

available as it is necessary to lubricate them every 16-24 hours depending on their age and total operating hours. For this reason, an employee was hired in the afternoon shift with the responsibility of lubricating the machines. At the table 3, the organization chart of the two shifts is represented:

Table 3: Organization chart of the 2 shifts

1st shift (morning shift)	2nd shift (afternoon shift)
1 Quarry master	1 Quarry master
3 foremen	1 foremen
2 assistant foremen	4 machine operators (excavators, dumpers & wheel loaders)
10 machine operators (excavators, dumpers & wheel loaders)	1 technician & 1 oiler
3 technicians, 1 electrician, 1 welder (repair & maintenance department)	1 chain saw operator
6 drilling machines operators	1 drilling machine operator
1 shot firer	12 wire saw machines operators
2 chain saw operators	
21 wire saw machines operators	
1 accountant	
1 weighing officer - secretary	
2 quality controllers	
TOTAL= 50 employees	**TOTAL= 20 employees**

The afternoon shift was deemed necessary because the distance between the main field of the deposit from the areas where we repose in the sterile material is very large resulting a delay at the transfer of sterile material and the slowing down of the production process. Also, another reason is the delay in cutting of the deposit with the use of wire saw machines; as the hardness of the marble is high and requires more time to cut it compared to the softer marbles. Finally, the operators of the machineries as well as the wire saw operators are fewer in the afternoon shift in relation to the number of machines.

6.1 Estimation of labor costs

The estimation of labor costs by distinguishing it into:

A) Production labor costs (variable cost)

B) Support staff labor costs (fixed cost)

The support staff labor cost are: the cost of repair & maintenance department, the cost of quality control department, the labor cost of the accountant of the quarry and the weighing officer. The cost of quarry support staff is estimated at a total of *195000€ per year* or *3€ per ton* of marketable marble. The following table shows the average labor costs per hour and staff specialization (variable costs)

Table 4: Average labor costs of staff per hour

Staff specialization	**Average labor cost per hour**
Quarry master	12 €/hr
Foremen	11 €/hr
Machine operators (big loaders, dumpers, excavators)	10 €/hr
Drilling machine operators	8 €/hr
Assistant foremen	9 €/hr
Chain saw operators	6,5 €/hr
Wire saw machine operators	6 €/hr
Shot firer	7,5 €/hr

The reason we will use in our calculations the average labor cost per staff specialization is to simplify the calculations as all employees are paid based on their job position, experience and productivity. The hourly labor costs listed in the table above reflect the current wage situation of the staff.

7. Operating Cost and Total Production Cost

The purpose of costing is to provide managers with the necessary cost-related information. If we focus on the usefulness of costing, that is, the help it can offer to a manager, we will notice that the cost calculation must be done so that the information provided helps him in matters related to the costs that he wants to attend. This means that the usefulness of costing depends on the need for information. In other words, a costing system does not make sense, which, no matter how detailed, calculates costs that no one takes into account. Nor would it be right to say that cost is the only factor an executive will consider when managing a business or part of a business. What can be said with certainty is that a competent manager will not attempt to run a business without first having the best cost information.

Many decisions are better when they are based on correct cost information. The troubleshooting is at every managers' daily professional life for example, if it is in the interest of people to replace machines in the production of a product, if machine installations can be used more profitably by concentrating productive effort only on certain products, if sales prices could remain the same or should be modified etc. Costing does not only help in finding the cost of one product, but also in finding out how much this product should have cost. In other words, it indicates whether there are losses so that it is possible to take immediate measures to avoid these losses and to make the productive operation of either the whole plant or a part of it more efficient.

In addition to the help that costing can provide in decision making, an effective costing system is essential to controlling and planning a business. The control is intended to verify that the desired production volume is carried out at the lowest possible cost in relation to the planned quantity of product produced. All costs or losses are identified and therefore controlled based on the information provided by the costing system. These various expenses or losses may not be of much interest when a company is going through a period of high sales volume and high profits. However, in times of great competition or general recession, the

company must have the way to control all its activities in order to be able to operate even in the smallest profit margins.

The purposes pursued by systematic costing are:

• Finding the most accurate result of the business

• The pricing policy making

• Controlling the efficiency of the production process

• Finding the degree of productive activity in which the company achieves the most favorable costs

As mentioned in a previous chapter, the costing method we will use in this project is the Activity Based Costing (ABC) Method. For our calculations we will use the data of the tables of the previous chapters and the activities and technology means that take place and use for the production of marble blocks are those mentioned in the chapter 3. We also know the product inputs, labor costs and overhead costs of the quarry so we will calculate the cost of production of the quarry. To these cost we will add the general administration costs and the costs of sales and distribution in order to find the operating cost of the quarry. To the operating cost we will add the financing costs and depreciation and finally we will calculate the total production cost that we are interested in. All these data has been collected from the accounting department of the company, the daily reports of the quarry and from the procurement department.

7.1 Cost of consumables

In order to calculate the cost of production of the quarry, first we have to calculate the cost of each machine per operating hour. The cost of a machine, except from labor cost, consists from the cost of consumables and spare parts. When we refer to the cost of consumables, we mean the cost of fuel - energy, lubricants, cutting materials, tires and explosives. Below we will analyze these costs and distribute them to each machine

7.2 Fuel- energy cost

At the table 5, we present the operating hours of each category of machine annually, the fuel-energy consumption for the same time period and the average fuel consumption per

operating hour. These data have been collected from the fuel input-output system of the company while the consumption of the wire saw machines and the chain saw machine was calculated based on the consumption of the manufacturer and the charge per kW by the electricity supplier.

Table 5: Fuel-energy cost of the machineries per operating hour

Fuel- energy cost			
Machineries per category	**Operating hours annually**	**Fuel- energy consumption annually**	**Average fuel consumption per operating hour**
Big wheel loaders	7250 hrs	217500 lit	30 lit/hr
Excavators	3150 hrs	81900 lit	26 lit/hr
Dumper trucks	7230 hrs	144600 lit	20 lit/hr
Excavators with hydraulic drilling unit	3000 hrs	45000 lit	15 lit/hr
Wagon drills for horizontal drills	3000 hrs	39000 lit	13 lit/hr
Drilling machines for vertical drills	1600 hrs	12000 lit	7,5 lit/hr
Small wheel loaders	4000 hrs	10000 lit	2,5 lit/hr
Chain saw machine	720 hrs	43200 kW	60 kW/hr
Wire saw machine	29280 hrs	1083360 kW	37kW/hr

The fuel used by the engines of the machines is diesel and its average purchase price is 1 €/lit. The chain saw and the wire saw machines use the electricity for their operation and the cost per kWhr is estimated at 0,03 €.

7.3 Cost of lubricants

The cost of lubricants consists from the cost of engine oil and the cost of grease. In the machines used in the specific quarry, they are lubricated with grease every 20 hours and the

engine oil is changed every 750 hours. The table 6 shows the amount of grease consumed in each machine during greasing and the amount of engine oil that is changed every 750 hours. It is noted that the cost of grease is 1,5 €/lit and engine oil 10 €/lit.

Table 6: Quantity of lubricants used in each machine category per lubrication

Machineries per category	**Quantity of grease in each lubrication (lit)**	**Quantity of engine oil in each oil change (lit)**
Big wheel loaders	1	70
Excavators	0,5	40
Dumper trucks	1	70
Excavators with hydraulic drilling unit	0,5	20
Wagon drills for horizontal drills	0,1	15
Drilling machines for vertical drills	0,1	15
Small wheel loaders	0,2	20
Chain saw machine	0,1	-
Wire saw machine	0,05	-

Knowing the quantity of lubricants used in each lubrication time, the operating hours of the machines and the purchase prices of grease and engine oil, we can calculate the cost of lubricants per operating hour. These calculations are presented at the tables 7 & 8.

Table 7: Cost of grease lubrication per operating hour

Machineries per category	**Operating hours annually**	**Times of grease lubrication annually**	**Cost of grease lubrication per operating hour**
Big wheel loaders	7250 hrs	363	0,07 €/hr
Excavators	3150 hrs	158	0,07 €/hr
Dumper trucks	7230 hrs	362	0,05 €/hr

Excavators with hydraulic drilling unit	3000 hrs	150	0,025 €/hr
Wagon drills for horizontal drills	3000 hrs	150	0,005 €/ hr
Drilling machines for vertical drills	1600 hrs	80	0,005 €/hr
Small wheel loaders	4000 hrs	200	0,1 €/hr
Chain saw machine	720 hrs	36	0,005 €/hr
Wire saw machine	29280 hrs	1465	0,002 €/hr

Table 8: Cost of engine oil per operating hour

Machineries per category	**Operating hours annually**	**Times of engine oil change annually**	**Cost of engine oil per operating hour**
Big wheel loaders	7250 hrs	10	1 €/hr
Excavators	3150 hrs	4	0,5 €/hr
Dumper trucks	7230 hrs	10	1 €/hr
Excavators with hydraulic drilling unit	3000 hrs	4	0,25 €/hr
Wagon drills for horizontal drills	3000 hrs	4	0,2 €/hr
Drilling machines for vertical drills	1600 hrs	2	0,2 €/hr
Small wheel loaders	4000 hrs	6	0,3 €/hr
Chain saw machine	720 hrs	No diesel engine	-
Wire saw machine	29280 hrs	No diesel engine	-

Knowing the cost of grease lubrication and the cost of engine oil per operating hour, we can calculate the cost of lubricants of each machine per operating hour. The calculations are presented at the table 9.

Table 9: Cost of lubricants per operating hour of machines

Machineries per category	**Cost of lubricants per operating hour**
Big wheel loaders	1,07 €/hr
Excavators	0,57 €/hr
Dumper trucks	1,05 €/hr
Excavators with hydraulic drilling unit	0,275 €/hr
Wagon drills for horizontal drills	0,205 €/hr
Drilling machines for vertical drills	0,205 €/hr
Small wheel loaders	0,4 €/hr
Chain saw machine	0,005 €/hr
Wire saw machine	0,002 €/hr

7.4 Cost of cutting materials

The cost of cutting materials is charged only at chain saw and wire saw machines which use these materials during their operation. The table 10 presents this cost per operating hour of these machines.

Table 10: Cost of cutting materials per operating hour

Machineries	**Operating hours annually**
Chain saw	720 hrs
Wire saw	29280 hrs
Total	30000 hrs
Cost cutting materials	50000 €
Cost per operating hour	**1,66 €/hr**

7.5 Cost of tires

The cost of tires refers only to machines that have wheels and need to be replaced or repair. The data was collected by the procurement department. At the table 11, we present this cost per operating hour of the machines.

Table 11: Cost of tires per operating hour

Machineries	**Cost of tires annually**	**Operating hours**	**Cost of tires per operating hour**
Big wheel loaders	10000 €	7250 hrs	1,3 €/hr
Dumper trucks	15000 €	7230 hrs	2 €/hr
Excavators with hydraulic drilling unit	5000 €	3000 hrs	1,6 €/hr

7.6 Cost of explosives

Explosives as mentioned in the previous chapter are used in areas where the quality of the marble deposit is very poor and not marketable. The quantity of the deposit in which explosives are used during its extraction is estimated at 350000 tons per year while the cost of explosives per year is 30000 €. As a result, the cost of explosives per ton of extraction by using them is **0,08 €/ton**.

7.7 Cost of other consumables

This category includes consumables used by workers in the production process. These materials are the means of personal protection of workers, their clothing and tools. The cost of other consumables is 50000 € per year when the total production is 65000 ton as a result the cost per marketable marble ton is **0,7 €/ton**.

The table 12 presents the cost of consumables of the machineries per operating hour.

Table 12: Cost of consumables of the machineries per operating hour

Machineries per category	**Fuel-energy cost per hour**	**Cost of lubricants per hour**	**Cost of cutting materials per hour**	**Cost of tires per hour**	**Total cost of consumables per hour**
Big wheel loaders	30 €/hr	1,07 €/hr	-	1,3 €/hr	32,37 €/hr
Excavators	26 €/hr	0,57 €/hr	-	-	26,57 €/hr
Dumper trucks	20 €/hr	1,05 €/hr	-	2 €/hr	22,05 €/hr
Excavators with hydraulic drilling unit	15 €/hr	0,275 €/hr	-	1,6 €/hr	16,9 €/hr
Wagon drills for horizontal drills	13 €/hr	0,205 €/hr	-	-	13,2 €/hr
Drilling machines for vertical drills	7,5 €/hr	0,205 €/hr	-	-	7,7 €/hr
Small wheel loaders	2,5 €/hr	0,4 €/hr	-	-	2,9 €/hr
Chain saw machine	1,8 €/hr	0,005 €/hr	1,66 €/hr	-	3,5 €/hr
Wire saw machine	1,1 €/hr	0,002 €/hr	1,66 €/hr	-	2,7 €/hr

7.8 Cost of spare parts

In a previous chapter, specifically in Table 2, we referred to the cost of spare parts per machine category. Knowing the hours of the machines, we can calculate the cost of spare parts per operating hour. The table 12 presents this cost.

Table 13: Spare parts cost per operating hour of machineries

Machineries per category	**Operating hours annually**	**Spare parts cost annually**	**Spare parts cost per operating hour**
Big wheel loaders	7250 hrs	60000 €	8,27 €/hr
Excavators	3150 hrs	40000 €	12,7 €/hr
Dumper trucks	7230 hrs	80000 €	11,06 €/hr
Excavators with hydraulic drilling unit	3000 hrs	20000 €	6,66 €/hr
Drilling machines	4600 hrs	15000 €	3,26 €/hr
Small wheel loaders	4000 hrs	4000 €	1,25 €/hr
Chain saw machine	720 hrs	0	0
Wire saw machine	29280 hrs	30000 €	1 €/hr

Knowing the labor cost per hour, the cost of consumables and spare parts per hour of the machineries, we can calculate the total cost of machineries per operating hour. We would like to underline that the machine operators operate only the big wheel loaders, the excavators, the dumper trucks, the drilling machine operators only the drilling machines and the assistant foremen only the small wheel loaders. We use table 4 for the average labor cost per hour of the staff.

Table 14: Total cost of machineries per operating hour

Machineries per category	**Labor cost per hour**	**Cost of consumables per hour**	**Spare parts cost per operating hour**	**Total cost of machineries per operating hour**
Big wheel loaders	10 €/hr	32,37 €/hr	8,27 €/hr	50,64 €/hr
Excavators	10 €/hr	26,57 €/hr	12,7 €/hr	49,27 €/hr
Dumper trucks	10 €/hr	22,05 €/hr	11,06 €/hr	43,11 €/hr
Excavators with hydraulic drilling unit	10 €/hr	16,9 €/hr	6,66 €/hr	33,56 €/hr

Wagon drills for horizontal drills	8 €/hr	13,2 €/hr	3,26 €/hr	24,46 €/hr
Drilling machines for vertical drills	8 €/hr	7,7 €/hr	3,26 €/hr	18,96 €/hr
Small wheel loaders	9 €/hr	2,9 €/hr	1,25 €/hr	13,15 €/hr
Chain saw machine	6,5 €/hr	3,5 €/hr	0	10 €/hr
Wire saw machine	6 €/hr	2,7 €/hr	1 €/hr	9,7 €/hr

Using the production process diagram of the previous chapter (Picture 1, chapter 3) we will analyze each activity separately in order to calculate the cost of the quarry per ton of marketable marble. Then we will add the general administration costs and the sales and distribution costs and the rent costs we will find the operating cost of the quarry. To this cost if we add the financial cost and depreciation we will calculate the total production cost. The specific gravity of this marble is 2,71 ton/m^3.

Cleaning of the area of the deposit to be exploited: This activity starts following the instruction of the quarry master and the foreman (they supervise this activity) and done by the assistant foreman using a small loader and lasts 10 minutes. The cleaning is done in order to extract 500 m^3 of marketable marble.

Cost/500 m^3: (10/60) *X* (12+11+13,15) = 6 € /500 m^3= 0,012 €/m^3= *0,03 €/ton*

Drilling horizontal holes for marble blocks production or to blow up the deposit: This is activity is used for the 95% of the annual extraction. For the drilling of horizontal holes the operator needs about 5 hours to complete the holes for the extraction of 500 m^3.

Cost/500 m^3: 5 *X* 24,46 €/hr= 122,3 € /500 m^3= 0,25 €/m^3= 0,68 €/ton

Extraction by using an electric chainsaw: This is activity is used for the 5% of the annual extraction. The operator needs 16 hours to complete the activity for the extraction of 250 m^3.

Cost/250 m^3: 16 *X* 10 €/hr= 160 € /250 m^3= 0,64 €/m^3= 1,73 €/ton

Average cost of drilling horizontally and using chainsaw= (95% *X* 0,68 €/ton) + (5% *X* 1,73 €/ton) = *0,73 €/ton*

Drilling vertical holes for marble blocks production or to blow up: The time that the operator needs to complete this activity is 2.5 hours for the extraction of 500 m^3.

Cost/500 m^3: 2.5 *X* 18,96 €/hr= 47,4 € /500 m^3= 0,1 €/m^3= *0,27 €/ton*

Cutting the deposit using wire-saw machine: If our target is to extract 500 m^3 from the deposit then a wire saw machine should cut horizontally and vertically for 22 hours and the assistant foremen should use a small wheel loader for 2 hours totally.

Cost/500 m^3= (22 * 9,7 €/hr) + (2 * 13,15 €/hr) = 240 € /500 m^3= 0,48 €/m^3= *1,3 €/ton*

Detachment of a bench from the deposit: In order to detach a bench of 125 m^3 from the deposit, the quarry master first gives a command to the foreman and the operators of the machines. The machines used in this activity are an excavator and a big loader for about 30 minutes. The foreman also instructs two workers to help the detachment the bench.

Cost/125 m^3= (30/60) *(12+ 11+50,64+49,27+12) = 67,5 €/125 m^3= 0,54 €/m^3= *1,46 €/ton*

Explosive charge and explosion: Explosives as well as the work of the shot firer is prerequisite for the production of 65000 tons of marble. The cost of explosives is 30000 € and the labor cost of shot firer is 15000 € (250 working days per year).

Cost/ 65000 marketable tons= 30000 € + 15000€= 45000€ or *0,75 €/ton*

Bench marking and secondary cutting: The bench marking is done by the assistant foreman and it needs 30 minutes and the secondary cutting needs an excavator with hydraulic drilling unit for 4 hours for 125 m^3 of extraction.

Cost/125 m^3= ((30/60) *X* 11) + (4 *X* 33,56) = 139,74 €/125 m^3= 1,1 €/m^3= *3 €/ton*

Rectangulation of the marble block: After the command of the quarry master a big loader and an excavator take the large marble blocks and place them for recheck by the foreman while the assistant foreman places a wire saw machine for their rectangle. In this process, the

loader and the excavator work together for half an hour, the foreman and the assistant foreman with the small loader also work for half an hour while the rectangle lasts 8 hours for 125 m^3 of marble.

Cost/125 m^3= (0,5 *X* 50,64) + (0,5 *X* 49,27) + (0,5 *X* 11) + (0,5 *X* 9) + (8 *X* 9,7)= 137,5 €/125 m^3= 1,1 €/m^3= *3 €/ton*

From the 350000 tons that detached annually from the deposit, only 65000 tons are marketable (18,5%), the rest along with the sterile blasting material are deposited in the landfill.

Transportation of marble blocks for quality control: The quarry master commands the operator of the big loader to transport the marble blocks for quality control. For 250 m^3 marketable marble the operator needs 1 hour.

Cost= 12 € + 50,64 € = 62,64 €/250 m^3= 0,25 €/m^3= *0,68 €/ton*

Loading and transportation of sterile material: The loading and transportation of sterile material is done using a big loader and a dumper. A dumper route takes 20 minutes while the loader takes 5 minutes to load it. The total quantity of sterile material annually is 635000 tons. If the dumper truck transports 40 ton per route then there are 15875 routes per year.

Cost per route= (5/60) *X* 50,64 + (20/60) *X* 43,23= 18,62 € per route

Total loading & transportation cost= 18,62 *X* 15875= 296000 € or *4,54 €/marketable ton*

Transportation- weighing- placement: The quarry master commands 2 big loaders and 3 dumper trucks to transport the marble blocks for weighing and placement. For this activity, we need 2 hours all the above machineries and only 1 loader is used for weighing and placement for 300 m^3 of marketable material.

Cost of transportation 300 m^3= 2 *X* ((50,64 *X* 2)) + (43,11 *X* 3)) = 461,22 €= 1,55 €/m^3

Cost of weighing and placement 300 m^3= 1,5 *X* 50,64= 75,96 €= 0,25 €/m^3

Total cost= 1,55 + 0,25= 1,8 €/m^3 or 4,87 *€/ ton*

By adding all the above costs we calculate the cost of the quarry per marketable ton.

Cleaning	0,03 €/ ton
Horizontal drilling & chain saw	0,73 €/ ton
Vertical drilling	0,27 €/ ton
Wire saw cutting	1,3 €/ ton
Detachment of the bench	1,46 €/ ton
Explosive charge and explosion	0,75 €/ton
Bench marking and secondary cutting	3 €/ton
Rectangulation of the marble block	3 €/ton
Transportation of marble blocks for quality control	0,68 €/ton
Loading and transportation of sterile material	4,54 €/ton
Transportation- weighing- placement	4,87 €/ton
Cost of other consumables	0,7 €/ton
Support staff labor cost	3 €/ton
TOTAL	24,33 €/ton

7.8 General Administration Expenses

The General Administration Expenses of the company amount to 2 million euros and the turnover of this quarry is the 5% of the company's turnover so 2000000€ * 5%= 100000€ or 100000€/65000= 1,53 €/ton

7.9 Costs of sales and distribution

Cost of sales= 65000 €
Cost of distribution= 975000 €
Total cost= 1040000 €
Cost per ton= 16 €/ton

7.10 Total Cost

Operation Cost of the quarry = 24,33 + 1,53 + 16= *41,75 €/ton*

The financial cost is 0€ because the company uses own funds to cover the quarry's expenses. The depreciation is 420000 € per year or 6,45 €/ ton and the rents to the Greek state is 7% of the turnover of the quarry; equal to 350000 € or *5,3 €/ton.*

Total production cost= 41,75 + 6,45 + 5,3= **53,5 €/ton.**

7.11 Gross Profit Margin of the quarry

Assuming that the average selling price of this marble is 100 €/ton, then we can calculate the gross profit margin of this investment for 65000 ton of selling product. Gross profit margin is a metric analysts use to assess a company's financial health by calculating the amount of money left over from product sales after subtracting the cost of goods sold (COGS).

Gross Profit Margin = (Net Sales – COGS)/ Net Sales

Net sales = 65000 ton *X* 100 €/ton = 6500000 €
COGS= 65000 ton *X* 53,5 €/ton = 3477500 €

Gross Profit Margin = 0,465 or **46,5%**

8. Conclusions

The total production cost is 53.5 € per ton of marketable marble. From the costs of the quarry, the most costly activities are the loading and transporting of the sterile material and the transport-weighing and placement of the marbles. The company should therefore be found a way to reduce the cost of these procedures. A good idea is to find an area closest to the main deposit in which they can repose the sterile material. As a result, they will minimize the time needed a dumper truck for one route and at the same time they will transport much more of this material. Another idea is to buy new dumper trucks with bigger transport capacity so as at the same time, they can transport much more quantity of sterile material. If this new dumper trucks do not consume much more oil per operating hour a potential purchase should be considered. Finally, the sales department should consider whether there is a market that can absorb a large amount of discarded material which is currently transported as sterile material which will result in not only an increase in revenue but also a reduction in sterile material.

Moreover, in order to minimize the cost of the transport-weighing and placement, the company should examine the purchasing a weighing system on the loader forks so that they do not need to be transported to the weighbridge and then placed in the correct position resulting in a reduction at the cost of this activity.

The cost of transportation and distribution is very high but unfortunately there is no way to reduce it as the quarry is located far from the trans-shipment points. Also the cost of rent is something that cannot be reduced because it is stable at 7% of the turnover; it is a mandatory condition in the lease agreement of the quarry area by the state. Moreover, it is very important for this investment that the financial cost is zero due to financial capacity. Finally, the gross profit margin is very good for the quarry and shows us the profitability of this investment that can be even better if the executives manage to reduce the total production cost.

Conclusively, this quarry is a very good investment for the operating company as apart from the significant reserves of the deposit, the production costs remain low compared to other marble quarries and following the suggestions mentioned above can be further reduced. . This gives a significant advantage to business executives to pursue a different sales policy in order to increase the company's profits and seek new markets.

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10.Appendix

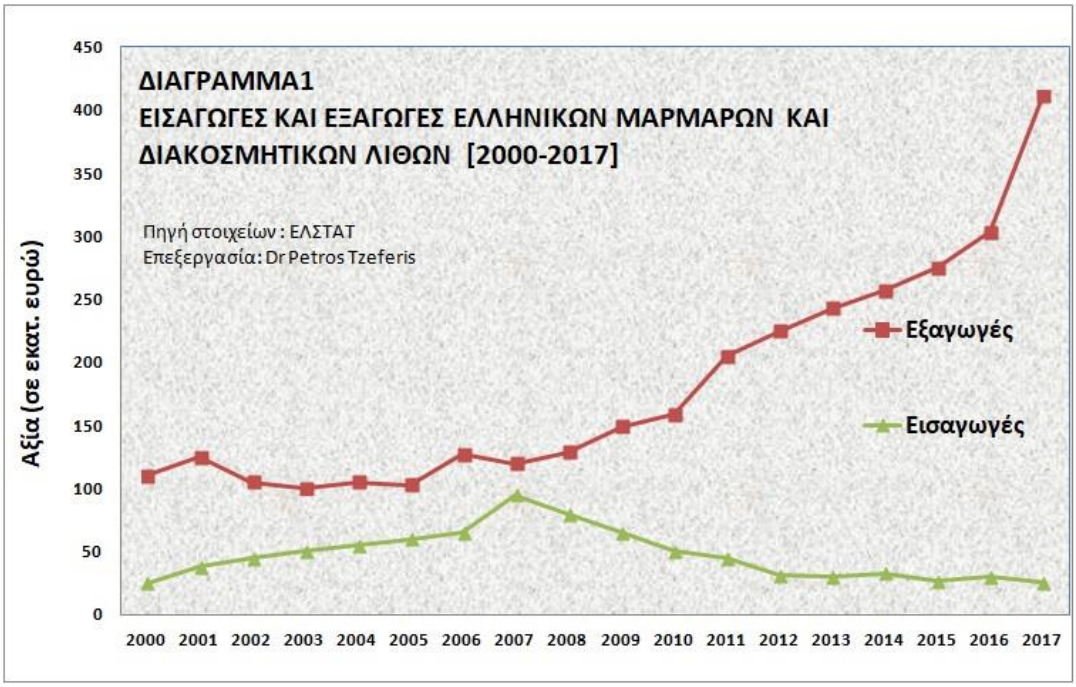

Figure 1: Imports & Exports of Greek Marble 2000-2017 (Source: Hellenic Statistical Authority)

Figure 2: Export value of Greek marble products (Source: Hellenic Statistical Authority)

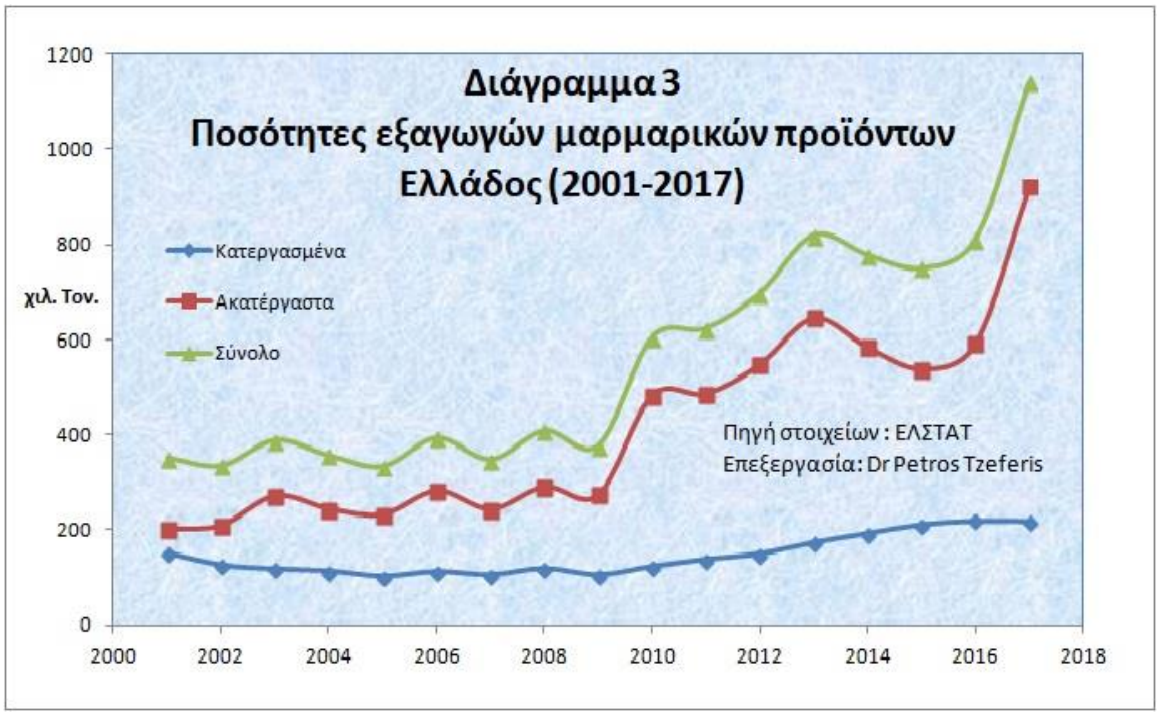

Figure 3: Quantities of export Greek marble products (Source: Hellenic Statistical Authority)

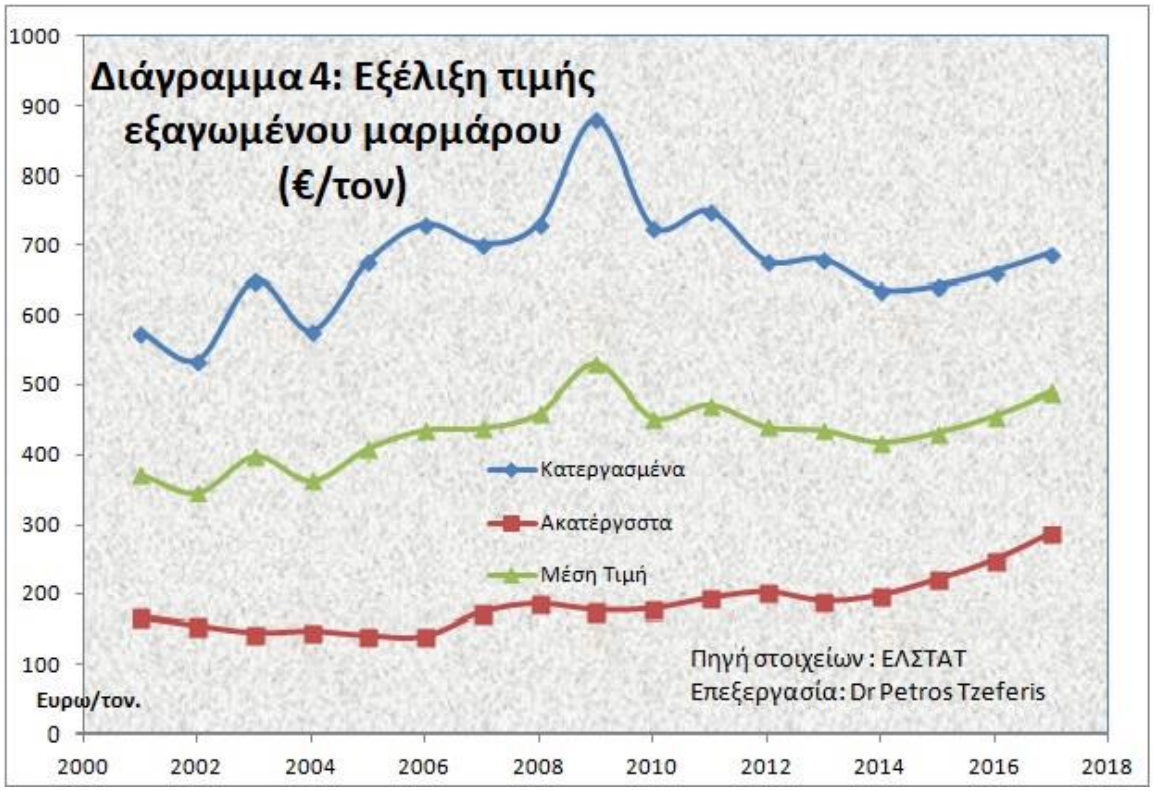

Figure 4: Price of exported marble (€/ton) (Source: Hellenic Statistical Authority)