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INVESTMENT COST AND ECONOMIC SCALE OF AN ALUMINIUM PLANT IN INDONESIA[1/]

by

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1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO.

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SUMMARY

Many industries constructed in developing countries cannot compete with those in the developed countries. Government subsidy and protection are sometimes required to guarantee survival of such industries. This inability is due not only to the lack of skilled operators, but mainly to extremely high investment costs. A significant increase in capital investment will be noted for the erection of machinery and equipment, which of course might differ from one country to another. The main factors influencing the amount of capital investment are: (a) infrastructural conditions and facilities existing in the country concerned (b) the problem of logistics; (c) labour and manpower in general (d) acceptance of modern technology in a particular country and (e) local conditions and regulations. Due to insufficient facilities both during the development and during the operational periods of the plant, each project has to set up infrastructures by its own means. For instance, a project of $US10 million generally has to:

(a) Construct roads, bridges and a railway leading to the project site;
(b) Provide transport equipment during the construction and operation, such as trucks and trailers;
(c) Provide construction equipment
(d) Maintain repair and maintenance shops during the construction and operation periods;
(e) Construct a power plant with accessories;
(f) Provide water purification equipment;
(g) Construct a harbour or pier during the construction and operational periods;
(h) Provide equipment for telecommunication;
(i) Provide a settlement for local and non-local personnel;
(j) Build a hospital, schools, places of worship and recreational halls.

The construction of the above items does, in fact, constitute a public service.

Experience gained from project construction in Indonesia reveals that all construction equipment used during the previous construction period depreciated 100 per cent. This applies particularly to tools and equipment used to train operators, which is more easily damaged than others. For purpose of construction, equipment and spare parts - as much as 15 per cent of the total cost of equipment - are usually needed, while expenditure for maintenance costs is approximately 10 to 15 per cent of this price.

Some projects which previously never existed in Indonesia, require foreign manpower for the construction and during the trial run. Generally, all expatriated personnel participating in the project construction receive certain facilities from the recipient country, such as housing, medical treatment, local transportation and insurance. After staying in Indonesia for over one year, they are permitted to bring their families. The cost of their fares to and from Indonesia, including transportation cost of luggage, is paid by the Indonesian Government. In some instances, the amount of money spent on the expatriated personnel amounts to 10 to 15 per cent of the cost of the project.

A great number of difficulties have been encountered with machinery, equipment and technology with the result that investment costs increased. This fact was mainly attributable to the lack of Indonesian experts, particularly those skilled

in ascertaining the type and the amount of the equipment required for the entire construction and operation. Some imported equipment proved to be unfit for use and had to be substituted by other more suitable equipment. It was also noted that unnecessary extravagance occurred as a result of constructing luxurious non-productive factory units, or because of ordering too sophisticated or too automatic equipment which, when faults developed could not be repaired.

Problems of local conditions frequently forgotten by project performers, especially expatriated personnel still unfamiliar with local conditions, can increase investment costs. A project in Indonesia, for example, which did not take into account the regional situation, encountered some difficulties which resulted in having to import stones at an additional expenditure of $US831,000.

Even worse is the problem of local and international transportation, or ocean freight. This also occurs in other developing countries as transportation problems always constitute the main obstacles. For the transportation of building materials during the construction period, a project has to purchase 200 to 300 trucks at an approximate cost of $US1 million. Sometimes a train must be purchased complete with locomotive and cars and a railway line to the plant site must be built, which can amount to about $US800,000.

Harbour problems in Indonesia make the situation even worse for, apart from the Djakarta harbour, existing equipment is too simple and obsolete. Inadequate unloading equipment means that the ships have to wait quite a long time before they can be unloaded, while the already unloaded cargoes cannot be transported immediately because of transportation difficulties. All the cases and goods have to be heaped up in an open field, with the result that some of the material is lost or damaged.

The type of construction contract is very important and represents a basic factor for determining the price of the factory to be constructed. Western countries, as a rule, prefer the "Turnkey Contract", in which all performances and designs are entrusted to the contractors, until the factory achieves its full capacity. For the recipient country, this contract is advantageous because of the guarantee that the constructed factory shall reach its full capacity. On the other hand, it has disadvantages as the price or cost of the project is usually rather high owing to its risk.

Another type of contract used in Indonesia is the "Delivery and Supervision Contract". The mere task of the contractor is to design the factory, to manufacture and send the machinery and equipment to the recipient country, while the entire development of the factory and the installation of the machinery, including trial operation, is done by the recipient country. Supervision, however, will be exercised by the contractor.

Viewed at a glance, this contract seems all right, but when it is put into practice, it contains a great many difficulties both for the contractors, and especially for the recipient country. Lack of experience makes cost increase; moreover, tools sent from abroad are inadequate and are not guaranteed as being fit for local goods, especially construction and transportation equipment which is very expensive.

It can be concluded that the investment cost for factories constructed in developing countries is higher than in developed countries because:

(a) The project itself has to bear the cost of the infrastructure that has to be constructed;
(b) The perfunctory planning, both by recipient country as well as by the supplier, and the unfamiliarity of the expatriated personnel with the local conditions;
(c) For the construction of an entirely new plant in a developing country, it is necessary for some local engineers to get prior training so that, in the future, they will become counterpart for expatriated personnel.

Contents

I. INVESTMENT COSTS OF AN ALUMINA PLANT IN INDONESIA

Introduction

1. Indonesia, a nation located in the equatorial zone, is rich in natural resources such as bauxite, which has for many years been mined and exported to Japan, Europe and other countries, as raw material for alumina factories.

2. Since pre-war times the Indonesian Government has made efforts to build alumina and aluminium factories in this country; the first one in 1940 with a capacity of 22,000 tons of alumina per year. Unfortunately this project was abruptly interrupted due to the Second World War which also made it necessary to remove all equipment. Twenty years later the Government made another survey to start an integrated aluminium plant motivated by the discovery of an inexpensive source of bauxite which could be exploited for a period of 100 years. The possibility of constructing a very cheap hydroelectric power plant in the vicinity of the ore was encouraging. The location of the hydroelectric power plant was such that it would not have been necessary to construct a water reservoir or dam. Power was supplied by the presence of a waterfall 400 metres high. It was expected that a low investment would be needed for this generator, hence a very inexpensive cost for electric power.

3. Two years later after construction the economy of the country did not permit continuation of the project. A foreign investment law was then issued by the Government to invite foreigners to invest money in order to continue the project. The Indonesian Government was willing to furnish some facilities such as a tax holiday and the right to construct and to own and operate the plant.

4. Because of numerous supporting factors to establish an alumina and aluminium factory in Indonesia such as the presence of good quality and inexpensive bauxite, low cost of land and labour, low cost of hydroelectric power and fuel, and because aluminium metal can be brought on the market in Indonesia and other countries in Asia, one can make a forecast that Indonesia will have a bright future in the aluminium industry.

Favourable conditions in Indonesia for the manufacture of alumina and aluminium

5. Aluminium plants are usually installed on sites which are most favourable for the production of low-priced energy regardless of the distance from the raw material supply or centres of distribution of the finished aluminium. As an example, in Norway the aluminium industry is in constant development in spite of the fact that none of the necessary raw materials are found there, neither is there an internal market for the finished metal. The only favourable element is the low cost of energy. A similar situation is found in Canada if consideration is given to the distance separating the Kitimat plant from the alumina supply. There is also the Fria alumina plant in Guinea situated very far from all raw material supply centres.

6. It is very rare that basic materials are found in the vicinity of aluminium plants. Generally speaking, it is necessary to transport raw materials over great distances. Bauxites from Guyana, Jamaica and Africa are used for plants in the United States in Canada and in Norway. Bauxite of Indonesia, Malaysia and Australia is shipped to Japan; alumina from Fria in Guinea and from Surinam is shipped to Europe and the United States. The price of aluminium is increased appreciably by this transportation, especially because bauxite contains about 50 per cent of unprocessable mud.

7. Conditions in the region of Bintan island in Indonesia are far more favourable since the island has bauxite reserves and there is also a supply of fuel oil near the proposed alumina plant. Thus, two essential raw materials to manufacture alumina are available in the vicinity, cheap fuel oil and bauxite. Another advantage is the fact that the vicinity offers a possibility of constructing a cheap power station.

Bauxite resources

8. Two kinds of bauxite occur in the Riau Islands, so-called "white bauxite" and "red bauxite", the first being of higher grade than the second. Their average chemical composition is:

	Al_2O_3	SiO_2	TiO_2	Fe_2O_3
White bauxite	59.90%	5.60%	0.20%	2.70%
Red bauxite	54.60%	4.50%	0.80%	10.50%

Recent investigations in the Riau Archipelago indicate that bauxite reserves of Bintan and nearby islands amount to 40 million tons of processable bauxite.

9. The reserves are of a purely hydrargillite type, the fundamental part being a component of gibbsite and only a small part is contained in goethite from which extraction of alumina is an extremely difficult task under the conditions of hydrochemical processing. It is known that hydrargillite bauxites can be easily digested under a fairly mild condition of the digestion process without recurring to the use of the complex autoclave outfit.

10. Until now bauxite export has reached a quantity of 800,000 tons per year and is almost totally exported to Japan. The F.O.B. price at Indonesian harbour is $US5.60 per ton and it is expected when this bauxite reaches Japan the price will be $US10.00 per ton. It is clear if the alumina factory is located in the neighbourhood of the ore the production cost of the alumina factory will decrease due to lower transportation costs. The price of bauxite at the mine itself is about $US4.00 per ton, thus when compared to the price of bauxite exported to Japan there is a saving of as much as $US6.00 on each ton.

Plant location

11. As already mentioned, Indonesia has been exporting bauxite for quite some time with Bintan as its port of exit existing in the region of the mines. This port was built on a scale large enough for ocean liners and is equipped with loading and unloading facilities ready for use at any moment. In any event the present state of the port and its installations are sufficient to ensure the loading and unloading of the materials and could receive ships up to 15,000 tons.

12. For the most ideal location of an alumina factory, the following can be mentioned as favourable factors: (a) location as near as possible to the mine; (b) near aluminium smelter or consumer; (c) availability of a large quantity of inexpensive raw materials; (d) inexpensive labour; (e) cheap power, fuel oil, and sufficient water supply; and (f) the presence of infrastructure. Almost all of these requirements are available at Bintan.

Land

13. It would be a problem to obtain land for industrial use of an industrialised and highly populated country because ground is scarce and very costly. In Indonesia, however, vast areas of unexploited land are still available, especially in remote areas. For an alumina plant it would not be very hard to obtain a

30 hectare of 300,000 m^2 of land. As mentioned, the cost of land in Indonesia varies according to its location but still not more than $US0.50 per m^2, hence the total cost of a 300,000 m^2 plot of land would be: 300,000 x $US0.50 or $US150,000. The difference in price is tremendous when compared with the cost of land in Europe, United States or even Japan in which countries the average price is $US50 per m^2 resulting in a total cost of: 300,000 x $US50 or $US15 million.

Building

14. In general there is a wide variance between building costs in Indonesia, depending on the location of the building and on local conditions. Prices tend to be higher in the vicinity of business and industrial areas, but are still relatively lower than in Europe, the United States and Japan. For the purpose of comparison, it is customary to express building cost on a square metre basis. This unit cost is influenced by many factors such as the type of construction, local labour, material, and the size of the building. The average price in Indonesia for a building for offices or residential use would be about $US50 per m^2 whereas for more specialised buildings with structural steel frame, masonry side walls with glass sash, concrete floor and fire resistant roof, the price would be $US60 per m^2.

Labour

15. In almost every developing country where industry is not yet advanced labour may be very cheap but skills are not developed. Based on the experiences of foreign contractors, labour can be improved and can be made more efficient when properly trained and instructed. Since labour in Indonesia is cheap, for instance unskilled labour is paid $US1.00 a day, whereas wages for skilled labour are not more than $US3.00 a day, one should take advantage of it. If possible, employment of foreign personnel should be reduced to a minimum, considering the high cost to accommodate expatriated personnel.

16. Some projects in Indonesia employing expatriated personnel have to spend 10 to 15 per cent of their investment cost for such expenses as construction of housing for personnel; furniture; transportation and fuel; medical care; insurance; support of family; and round trip ticket for expatriates and families from their homes. Apart from those expenses expatriates have to be paid salaries of $US750 to $US1,500 per month. When 100 expatriated personnel are employed on an average salary of $US1,500 per month, the total payment per month is 100 x $US1,500 or $US150,000. To avoid expenditure of high wages, preference should be given to local personnel. It is necessary, however, to have a certain number of skilled

workers for construction and operation of an alumina plant. A vocational training school must be provided well in advance before workers are needed, especially for welding and maintenance.

17. As already mentioned, wages of local skilled labourers are about $US90.00 per month. When training expenses must be included, the expense for one local employee would be about $US100 per month (compare the difference with the salary of expatriated personnel which is $US1,500 per month). If three years are needed to accomplish the construction of a factory the total salary for 100 expatriated persons would be $US5.4 million. Previous experience in Indonesia has shown that as far as efficiency is concerned, one well-trained expatriated person is equivalent to two locals who have finished training. Hence 100 expatriated persons would be equivalent to 200 local persons, the total salary of 200 skilled labourers at the end of a three-year period would be $US720,000 (compared to the total salary of expatriated on an equal efficiency basis which would be $US5.4 million.)

Fuel oil

18. One very important point to be considered when planning an alumina factory is the availability of inexpensive fuel oil for calcination process. Fortunately fuel oil is one of Indonesia's richest resources and serves as a main source of income for the Indonesian Government. The price of fuel oil in Indonesia is $US0.01 per gallon and that of gasoline is $US0.11 per gallon.

Harbour

19. Harbour and transportation form, no doubt, the most critical problems in the industrial set-up of developing countries. Existing ports generally do not meet international requirements. If a harbour happens to be sufficiently equipped, there will be such congestion that an over-all slowdown of activities results. For this reason it is wise not to use an already overloaded existing port for a new project. As explained above, an alumina plant should be established near bauxite mines when adequate harbour facilities are available. An existing harbour can be utilized to capacity when it handles only bauxite going out from the local mine.

Transportation costs

20. The present amount of bauxite export is about 800,000 tons anually, most of it consumed by Japan, C & F Japanese port, the Bintan bauxite worth about $US10.00 per ton, or $US8 million for 800,000 tons anually. By establishing an alumina plant close to a mine, where the bauxite is only $US4 per ton, the total amount

of bauxite will have a value of $US3.2 million. It means $US4.8 million less than the value if the same amount of bauxite is transported to Japan.

21. Transportation cost has a significant influence on the first investment cost as well as on production costs, therefore the plant should be as close as possible to the raw material and to the market. It has been shown above that transport of bauxite over great distance is expensive. However, this is not always the case for Indonesia since transportation costs are very much distorted.

22. Transportation facilities in Indonesia are inadequate. As an example, it is more convenient and even quicker to transport goods from Hongkong to Djakarta than from Djakarta to other islands. For the alumina plant in Bintan, transportation is not really a difficult problem since it is located close to Singapore (90 miles), a fast international harbour. Most building materials are found near the mine, such as sand, limestone and construction lumber and a large oil refinery is situated near the plant so transportation costs could be kept as low as possible.

23. On the other hand, it is rather costly to transport machinery and equipment from supplier countries to the plant. It is estimated that transportation costs of goods from Europe will be $US15.00 per ton, including packaging, loading and unloading costs, insurance etc. Estimated weight for machinery and other materials for an alumina plant is about 40,000 tons so that the total freight cost will be $US600,000.

Construction equipment

24. Since the local contractors are not yet in possession of equipment that can be hired, the project itself has to supply all construction equipment complete with shop. From experience it is known that a project of $US10 million or more will need construction equipment of about $US1.5 million.

Other costs

25. There are more factors responsible for an investment-cost increase, especially if preparatory work and planning is not done in detail. But all factors that cause an investment-cost increase can be avoided if the source of difficulty is known. Factors influencing the investment-cost during construction will be considered next.

II. MAIN FACTORS INFLUENCING INVESTMENT COST OF INDUSTRIAL DEVELOPMENT IN INDONESIA

26. Many industries constructed in developing countries cannot compete with those in developed countries. To guarantee survival of plants in developing countries, government subsidy and protection are sometimes required. Inability to function independently is due not only to the lack of skilled operators, but mostly to extremely high investment costs of the factory itself, which exceed costs in developed countries. The increased expense is attributed mainly to (a) the unavailability of local facilities contributory to the construction of the project; (b) a great number of infrastructures that have to be constructed at the expense of the project; (c) local conditions unfamiliar to foreign suppliers and contractors cause obstacles to work performance and result in chain reaction problems; (d) delivery and construction contracts of the factory cause many disadvantages to the recipient country, especially concerning equipment prices and other payments; (e) utilization of equipment and technology too advanced, or importation of obsolete equipment no longer efficient; and many more local problems.

27. This paper does not consider the increase or decrease in investment cost caused by the existence of new processes and technology, or the latest discoveries of less expensive equipment or parts. Presented here are problems frequently found in Indonesia, problems that are occasionally non-technical but can increase investment costs by 100 per cent. Such problems represent a general characteristic of industrial projects in developing countries like Indonesia and probably many other developing countries that have chemical as well as metallurgical industries.

Local facilities

28. A significant increase in capital investment will be noted for erection of machinery and equipment in a developing country, which, of course, might differ from one country to another. In Indonesia this cost difference is so significantly conspicuous with that in other countries, that production costs cannot compete with the import price, except for some projects that accidentally are located in places with advantageous factors, such as power, fuel and raw materials which are extremely inexpensive.

29. This is understandable in view of the fact that all necessary facilities needed during construction are to be made available by the project itself, for instance, transportation equipment, construction equipment, power plant, harbour and even an oxygen plant.

30. Local contractors in general are not yet in possession of equipment that can be hired, they only make labour available, while equipment must be supplied by the

project. The same applies for transportation, it is particularly difficult to find companies that have trucks for rent and heavy tools, but in the course of construction the project needs about 400 to 500 cubic metres of building materials per day. The state railway is confined to certain routes which do not even go outside big cities. Electricity cannot possibly be obtained for any enterprise as it still constitutes a problem for local use.

31. For projects up to $US5 million there is still a possibility to get additional facilities from local contractors or to use existing facilities such as harbours. But for a project of more than $US5 million the problem will be different. The following list consists of several vital infrastructures that have to be constructed by projects for categories based on total investment costs of between $US5 and $US10 million and those between $US10 and $US50 million and higher.

Investment costs between $US5 million and $US10 million

32. In Indonesia projects under $US10 million build up their own equipment and other material such as: transportation equipment during construction and operation periods, trucks, trailers, trains etc; construction equipment; repair and maintenance shops during construction and operation periods; refuelling station for cars; roads, bridges and other facilities stretching between the harbour and the plant; power plant and accessories; water purification; for certain cases private harbours complete with unloading and loading facilities; telecommunication equipment; training for local operators at home and abroad, and arrangements for foreign experts.

Projects of over $US10 million

33. Projects in this category, despite expenses similar to the less costly projects, still have to build: settlements for local workers and expatriated personnel; projects located far inland have to provide for oxygen plants; construction of hospitals, schools, worshipping places and recreational facilities; railways sometimes have to be purchased and harbours complete with loading and unloading facilities sometimes have to be built. The above list reveals the heavy burden a project in Indonesia has to bear while in developed countries such facilities need not be constructed by the project itself as they are available. For instance, transportation facilities can be hired from a transportation service, electricity can be purchased from a company and harbours already equipped with necessary facilities are always at the disposal of the project. A $US36 million steel plant in Indonesia had once spent not less than 60 per cent of the total investment cost for its infrastructures and other requirements.

Local and expatriated personnel

84. It is understandable that with the addition of work on a project the number of personnel must be increased accordingly. This was the case with the above-mentioned project which at its peak employed almost 5,000 workers. Because of its rather isolated position the project had to provide not only dwelling places but also food for its workers.

35. What is noticed frequently as being improper in personnel affairs is the abnormally big difference between wages and facilities enjoyed by expatriated persons and wages received by local personnel employed in the same position and graduated from the same level of education. In general, all expatriated personnel working in the project get facilities from the recipient country such as housing, transportation, medical care, insurance, return tickets for families, including transportation costs of luggage up to 60 kg per person over and above the free rate indicated on the ticket. When an expatriate works in Indonesia for more than one year and wishes to spend his vacation in his country, the recipient country bears the travelling expenses and transportation cost of luggage from Indonesia to the country and back. Besides these facilities, workers still enjoy wages of about $US750 to $US1,500 per month. The difference in wages and other allowances is especially noticeable when several expatriated persons have studied and been graduated from the same university as local personnel but their salaries differ almost 50 per cent.

Repair and maintenance

36. According to experience during the construction of several projects in Indonesia, tools, machinery and construction equipment that have been used in a project break down often due to poor maintenance, inexperience of workers and supervisors, unfamiliarity with the machinery and climate problems. Construction equipment from projects after being used is usually defective and useless and depreciates 100 per cent. Heavy tools and other equipment used for training operators have a shorter lifetime than usual. As a result a 15 per cent expenditure for the purchase of spare parts is necessarily taken into account, whereas maintenance cost fluctuates between 10 and 15 per cent of the equipment price.

Machinery equipment and technology

37. Bitter experiences have been encountered during industrial development in Indonesia, especially due to the lack of previous practical acquaintance with the knowledge of machinery, equipment and technolgical progress. This is due to the lack of Indonesian experts, particularly skilled in ascertaining the type and amount of equipment required for the entire construction operation. Based on the reason mentioned above, practically no detailed inspection and examination has ever been made on the

design and specification of machinery, equipment and material required. Import articles are not inspected either for quality or for specification. But this carelessness is noticed sooner or later especially when several already completed plants encounter unexpected difficulties.

38. Obviously, some imported equipment cannot be used as it ought to be because it is obsolete and no longer used even in the exporting country, particularly since spare parts are not produced any more. Still worse is the fact that with imported goods some parts and equipment are already secondhand. The selection of technology and process to be used in a certain manufacture is not less difficult than the selection of machinery and equipment. Lack of and backwardness in modern technology most often causes recipient countries to receive obsolete technology quite out-of-date and disadvantageous. The reverse however occurs when super-modern technology or a project development still to premature for the level of development in the country, causes the recipient country to be used as an experimental place for new discoveries.

39. It is an undeniable fact that many foreign companies try to export their commodities as much as possible to the developing countries, both as equipment or factories. Attracted by high-flown propaganda, the developing country orders several projects from foreign suppliers without being aware, in detail, of the ability and experience of the company concerned in the manufacture of equipment and machinery. Some plants in Indonesia have experienced such bad luck that they were compelled to stop and come to a stand-still for several years due to the discovery of errors in design and in factory construction work.

40. Unnecessary waste too often occurred as a result of constructing unproductive units in a luxurious way. Much of the equipment was even too luxurious and excessive, such as fully automatic tools that were actually not required. Such tools or instruments only add more difficulties because defects of fully automatic instruments cannot be repaired locally, work opportunity for personnel is reduced, equipment prices become extraordinarily high and maintenance cost is increased. Advice and suggestions in the above mentioned field are very hopefully expected from UNIDO experts in order that the industrial development in young countries could proceed in a proper way.

Local conditions

41. As mentioned above, carelessness in considering local conditions leads to unexpected additional expenses. Budget plans prepared by the Government for projects prove to be insufficient because prices have increased up to 50 to 60 per cent. Even a half completed rolling mill in Indonesia has shown a 100 per cent increase in its investment cost and the Government has been compelled to stop construction work.

Seasonal difficulties

42. Perhaps all project planners and executors employed in sub-tropical countries know that rainfall is so tremendously high that not even one week passes without rain. Consequently, any planning should take into consideration the seasonal obstruction caused by rain which permits no work for thirty days a year. There were other kinds of difficulties that one project had to undergo in the course of its development.

43. A stone and gravel quarry is the only source of supply of the project and it is located deep in the midlands and can be reached only by river. In view of the fact that the cost of river transportation is rather cheap, stones and gravel can be carried by using two tugboats and six steel deck barges. But the barges are not able to make more than two round trips per day, less than one half of the minimum normally to be expected. The failure of the operation was caused by lack of knowledge of the local conditions due to military restrictions of local authorities and a village chief who controlled and designated the area in which the gravel could be dug. After a few months, restrictions were relaxed but by that time the dry season had set in and the river level dropped to a level which limited the load to a maximum of 80 cubic metres per barge instead of 500 cubic metres per barge. As the river dropped, the navigable channel narrowed and the barges were disproportionately wide, making them difficult to handle. As all evidence indicated that local supplies were inadequate to meet the requirements, the choice of importing gravel from abroad (Singapore) could not be avoided while actually Indonesia abounds in stone mountains. The ordinary crushed stone price is around $US20 per cubic metre but as a result of such hindrances as mentioned above, the unit cost is calculated at $US31.08 per cubic metre, thus an increase of $US11.08 per cubic metre and the amount of crushed stone needed is about 75,000 cubic metres. A miscalculation caused in stone alone would raise the investment cost by as much as $US831,000.

Local transportation

44. As mentioned above, the transportation problem in developing countries continues to be the main obstacle and often constitutes a factor that causes the increase in investment cost. Such experience was noticed during the construction of a rolling mill, for which sand and gravel was needed, 200 cubic metres and 250 cubic metres per day respectively which had to be transported from quite a far off distance. Insufficient preparation and hurried planning caused a great problem. When construction work was at its peak, those two building materials proved to be quite substantially lacking. For the sake of avoiding obstruction that could lead to a chain reaction of delay, an attempt was made to get these meterials as quickly as possible. This problem could have been avoided by buying transportation equipment, namely trucks

(300 at the approximate cost of $US1 million) and a railway train, complete with locomotive and 120 cars (which amounts approximately to $US800,000).

Harbours and dispatch of materials

45. In general all harbours in Indonesia are still very poorly supplied and show a complete lack of both loading and unloading facilities, except the Djakarta harbour. As a consequence, a great deal of import goods, both for trade and for project purposes are unloaded in Djakarta. When the performance of project construction is at the most active stage, in addition to the progress in export and import trade, new harbour problems must be faced, namely the problems of congestion. Things become heaped up in open fields and so mixed that it is difficult to clear them off, and many things get lost or damaged. Ships to be unloaded have to queue up waiting for their turn. Because unloading takes so long, the allotted time runs out and as a result a fee must be paid both for storage and for the chartered ship.

46. This is the case with the overloaded Djakarta harbour, and it compelled some projects to have their materials unloaded at small harbours located nearest to the plant site; but again shortage of unloading facilities, especially cranes, makes this work totally disordered. An arriving ship has to wait for the coming of the floating crane from Djakarta. Then at least goods can be discharged but often cases are damaged as they are not sufficiently strong and hence cannot stand the dashes caused by the imperfect functioning of the old and inadequate unloading equipment. In this respect, foreign suppliers frequently forget the poor harbour condition in Indonesia especially the lack of unloading facilities with the result that many cases frequently fall down and break into pieces.

47. Delay in clearing of goods from the harbour is often due to the delay of the suppliers in sending the bill of lading which makes the procedure of clearing the goods in the harbour more difficult, so that even the already arrived goods must be stocked. All these difficulties and delays add an unexpected amount of expense. Experience shows that the cost of sending 15,000 tons of goods from Europe or America amounts to approximately 10 to 20 per cent of its material value.

Contracts covering machinery and construction works

48. The construction contract is the most important and forms the basis of work. In Indonesia, as a rule, two kinds of construction contracts are known (a) "Contract on a Turnkey performance", adopted by contractors from the Western countries; (b) "Delivery and supervision contract", usually adopted by contractors from other countries. Both kinds of contracts have their advantages and disadvantages directly affecting investment costs.

The "Turnkey contract"

49. The "Turnkey contract" states that the contractor has full responsibility in almost all aspects of construction and starting-up of the plant, but the Government retains the right to control the performance of the contractor. Prior approval by the Government was mandatory in almost all phases of the construction and operation of the plant, which include among other things: specifications of equipment and parts; procurements, including the selection of bid; arrangement for the forwarding and transportation of equipment and materials; design and engineering works, and procedures for cold test, start up, performance test and process guarantee test.

50. The advantages of this kind of contract are:

(a) The recipient country has the guarantee that the plant will be erected and delivered by the contractor and will operate at full capacity;

(b) Contractors are able to make detailed planning without being disturbed by interior problems such as contingent change of government leadership (ministers) which frequently bring about new development policies and delays in receiving money from the Government as a result of bureaucracy and complicated procedures;

(c) The presence of a bonus and penalty clause for various performance guarantees produces a driving force for the contractor to furnish the project in the shortest possible time.

51. On the other hand some disadvantages of the Turnkey contract are:

(a) Because of their big responsibility contractors usually charge higher prices (for instance, a project in Indonesia is worth nearly two times the price in America, of which 32 per cent is contingencies);

(b) To get their bonus contractors are inclined to employ foreigners in spite of the fact that such personnel is available at home; these expatriated persons receive much better wages, have better facilities, the expenses of which are borne by the recipient country (for example, a project employing 125 expatriated persons requested $US4.7 million, 15 per cent of the total investment cost);

(c) Only very few local personnel take part in designing and even in construction work with the result that local engineers are deprived of the opportunity to gain experience in the development of Indonesia.

In view of the disadvantages mentioned above, an attempt has been made to find other contractual systems and conditions that could omit these unprofitable factors.

"Delivery and supervision contract"

52. Prompted by the desire to have technicians reach the same level as their counterparts in other industrially developed countries, and by the desire that the investment cost be reduced to a minimum, the Government is looking for contractors

who are willing to develop projects under a different system. Some countries happen to cherish the principle of "Delivery and supervision contract" because:

(a) The supplier will carry out planning and designing work;

(b) The supplier will deliver construction, technological equipment and machinery requested for the project inside the factory fence;

(c) The supplier will supervise the construction in civil work and steel structure, installations of machinery and electrical equipment and trial operations.

53. While on the other hand the recipient country must:

(a) Submit all necessary data and information required by the supplier for planning and designing work;

(b) Perform at its own expense and by its own means all construction work including civil and steel structures;

(c) Install machinery and electrical equipment and perform trial run operations as well as provide manpower, local building material, electric energy, water, roads and transport facilities;

(d) Provide for all objects outside the fence of the main project, though it has a direct technological connexion with the technological equipment inside the main building; and

(e) Assume all responsibilities and consequences thereof.

54. And how does this new contract turn out? In fact, for certain kinds of projects that have never been constructed before in Indonesia, this contract proves to be satisfactory and many of the expenses can be lowered. But the case will be quite different with big projects still foreign to Indonesia, where efforts to reduce investment costs could result in an increase of prices. In the case of insufficient experience in the development of alien projects the Government has to send for foreign manpower according to the amount proposed by the contractor or supplier. Their expenses are continually high because of their great number, together with their families, and all their transportation expenses and daily facilities made available to them by the recipient country. All these expenses are substantially increased; much higher than those for expatriated persons requested by the Turnkey project. As has been mentioned above, the "Delivery and supervision contract" contains a statement that the customer himself is responsible for all objects outside the factory fence, even those with a direct technological connexion with the main building. This involves unsolvable difficulty, because commodities from certain countries are very hard to get in the marketplace, as they have never been exported to Indonesia. It is likewise as difficult to get their substitutes from other countries due to the difference in specifications. In addition to insufficient equipment required for objects outside the factory fence, there is still a need for additional accessories and construction equipment not included in the contract list.

As previously said, lack of experience in the construction of new projects, apart from the absence of Indonesian experts who are already familiar with the equipment imported from other countries, make this "Delivery and supervision contract" so incomplete that complementary equipment must be purchased.

55. It was noted that during the construction of a certain project under the "Delivery and supervision contract" a shortage of construction equipment and materials for building mechanism was equal to about 60 per cent of the entire necessary equipment; exclusive of objects outside the factory fence, such as infrastructures that still had to be purchased, since they were not included in the "Delivery contract". When this insufficiency was found out, there arose a new problem of how to make additional "foreign currency" available. As a consequence, the entire work was delayed causing an interminable chain reaction. But who is to be blamed, for the contract reads: "All consequences and responsibilities lie on the recipient country".

56. It can be concluded that "Delivery and supervision contract" will turn out successfully only if the recipient country has had experience; factors which are entirely alien are risky and investment costs could increase over normal limits.

III. ECONOMIC SCALE OF AN ALUMINA PLANT IN INDONESIA

57. In view of the previous analysis, an Indonesian alumina plant is expected to be able to compete with alumina prices from other countries due to the many advantageous factors such as the excessively low prices of raw and building materials, ideal plant location, low wages of labour, and the practically insignificant price of land. Such being the case, what would be the decisive factors of the economic scale for an alumina plant in Indonesia?

58. This decision depends not entirely on the most economic price of the equipment process alone, but necessarily on the following factors as well:

(a) Availability of raw materials for a certain period of time;

(b) Whether the export of alumina could substitute the export of bauxite;

(c) The extent of consumers abroad and at home;

(d) The amount of alumina being processed into aluminium metal by means of cheap electric power in Indonesia;

(e) To what extent could an alumina plant affect the national standard of living; and

(f) Lowest investment cost.

Availability of raw materials

59. A factory will not be economic if it operates less than its allotted lifetime; or, if, at a certain time, more expensive raw materials have to be imported in order to continue the production. In Indonesia approximately 40 million tons of reserve ore bauxite of processable quality are estimated to exist. It is to be expected that the prospective alumina plant should be able to operate for thirty years at least; in other words, it should not have a capacity of more than:

$$\frac{40{,}000{,}000 \text{ bauxite}}{30 \text{ years}} = 1{,}222{,}222 \text{ tons of bauxite per year}$$

or about 600,000 tons of alumina per year; that is to say, the alumina plant that is going to be constructed should have a maximum capacity of 600,000 tons of alumina per year.

Can export of alumina substitute the export of bauxite?

60. When the alumina plant begins production it could be predicted that the export of Indonesia's bauxite will surely be affected both quantitatively and qualitatively. It would even be possible that this export would be entirely stopped. A question arises, in such a case, as to what country would succeed Indonesia to supply the bauxite lacking because of this halted export. Could it be Malaysia or Australia? Would Malaysia, whose bauxite has the same type as that of Indonesia, increase her export? So far, Indonesia exports 800,000 tons of bauxite per year, the majority of which is consumed by Japan. However, it is deemed necessary to consider whether Indonesia could possibly substitute her export of bauxite with alumina of equal amount, that is, 800,000 tons of bauxite being identical with 400,000 tons of alumina. In this case a consideration to produce 400,000 tons of alumina per year has to be taken into account.

What is the extent of consumers, abroad and at home?

61. The fact that a great number of alumina and aluminium industries have been set up recently makes it necessary to consider which market would be the most interesting and profitable to the Indonesian alumina plant? Considered from the demand as well as from the transportation point of view, it is the Asian market that seems to be the most favourable, especially those countries that already possess the alumina smelter such as Formosa, India, Japan and Korea. In 1971, alumina and aluminium production in these four countries is estimated to be as follows:

Estimation of alumina and aluminium production in 1971

Country	Tons alumina consumed	Tons aluminium produced	Tons alumina shortage	Tons alumina excess
India	260,000	195,000	31,600	-
Formosa	70,000	33,300	-	-
Japan	780,000	526,800	253,200	-
Korea	27,000	13,500	-	-
Total	1,137,000	768,600	284,800	-
Australia	1,020,000	155,300	-	709,400
Europe	2,870,000	1,919,400	968,800	-

Source: Iron Age Metal Working International, May 1967 vol. 6, no. 5

62. The above table shows that the Asian market could still consume 284,800 tons of alumina per year, while Australia, on the other hand, would, by then, produce more alumina than she herself requires. In spite of the fact that the European market still needs alumina, yet, because of such an enormous distance from Indonesia, and in addition, because of the existence of the alumina plant in Africa which is much closer to Europe, this European market is not so interesting. As a result, the market that is probably of access is Asia herself with a requirement of 284,800 tons alumina per year.

63. Even though the utilization of aluminium metal is still at its early stage, yet, considering a population of 105 million people, the future market should not be doubted. Statistics of aluminium metal consumption in Indonesia show a progressive increase and in 1971, it is to be expected that the requirement will amount to around 71,000 tons per year, which means a consumption of 0.66 kg per capita. These 70,000 tons of aluminium are derived from 140,000 tons of alumina.

The amount of alumina being processed into aluminium by means of cheap electric power

64. A possibility has been stated above of exporting alumina from Indonesia to the Asian market as it is more favourable to Indonesia considered from the transportation and from the cost points of view. This alumina export will be successful only if the price and quality of the Indonesian alumina could exceed that of the Australian alumina. If price competition could not be won, then the next rivalry has to be carried out in the production of aluminium metal, as Indonesia has resources of cheap electric power, such as the Asahan waterfall from Lake Toba. This hydroelectric power is located not far from the bauxite mine, which means short transportation of alumina and convenient electricity. This power plant is expected to be able to

produce 500 MW with an electric cost of about $USO.125 up to $USO.189 per kWh. Electric power that can be produced by this plant is estimated at 2,500 million kWh/year. If the amount of electric power required to produce one ton of aluminium is about 18,000 kwh, then the maximum capacity that can still be processed by the above mentioned plant is:

$$\frac{2,500,000,000 \text{ kWh/year}}{18,000 \text{ kWh/ton}} = 140,000 \text{ tons Al/year;}$$

or equal to: 280,000 tons alumina per year.

To what extent could an alumina plant affect the national economy?

65. For industrial development in a developing country, the following considerations have to be taken into account: to what extent will the national economy be affected by the construction of such a plant and what will be the capacity of this new plant in order to enable the establishment of other industries? It is a fact that the existence of an alumina plant will directly or indirectly affect the availability and the price of the caustic soda in the home country; fuel oil distribution and existing power facilities. It must also be considered whether water consumption by the alumina plant will obstruct irrigation or agriculture. As a consequence of an extraordinary amount of soda being used by an alumina plant, it is considered necessary to produce at home the entire soda requirements, provided that production cost is less than the import price.

66. According to calculations arranged in Indonesia, the most economic capacity for a caustic soda plant is 100,000 tons per year Domestic consumption by existing industries is about 70,000 tons per year. Thus the available amount of caustic soda that can still be used by the alumina plant and other needing industries is around 30,000 tons per year. It is expected that the alumina plant itself could be allocated 25,000 tons NaOH per year. The amount of soda needed for the processing of bauxite into alumina is estimated to be as much as 10 per cent of the amount of the alumina.

Therefore, the available soda can produce:

$$\frac{100}{10} \times 25,000 \text{ tons/year} = 250,000 \text{ tons alumina/year}$$

IV. CONCLUSIONS

67. From the above considerations it can be concluded that:

(a) In view of the existing amount of reserve ore, the capacity of an alumina plant should not be bigger than 600,000 tons per year

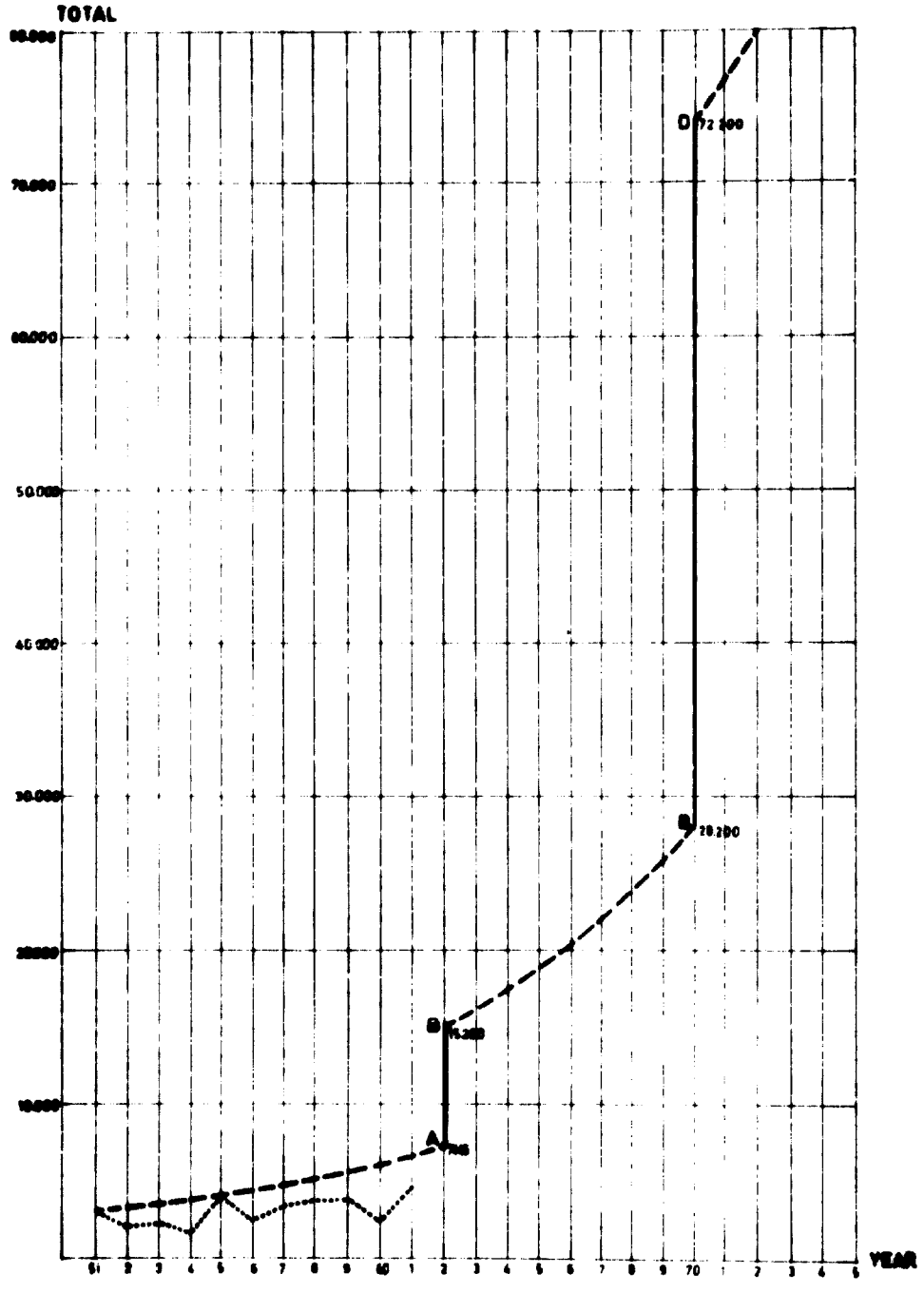
(b) If alumina is intended for export only, and will substitute the export of bauxite, then its production should be 400,000 tons per year

(c) It is estimated that within the next three years a shortage of 284,000 tons alumina in the Asian market will occur; in Indonesia the aluminium requirement is expected to amount to 70,000 tons per year, equal to 140,000 tons alumina per year.

(d) If cheap electric power is available and used as the first principle in the establishment of an alumina plant, then, at its first stage, that power plant can produce 280,000 tons of alumina per year.

(e) Considering the possibility of using caustic soda from the soda factory which is being constructed in Indonesia, the capacity of the alumina plant is 250,000 tons per year.

ALUMINIUM CONSUMPTION IN INDONESIA

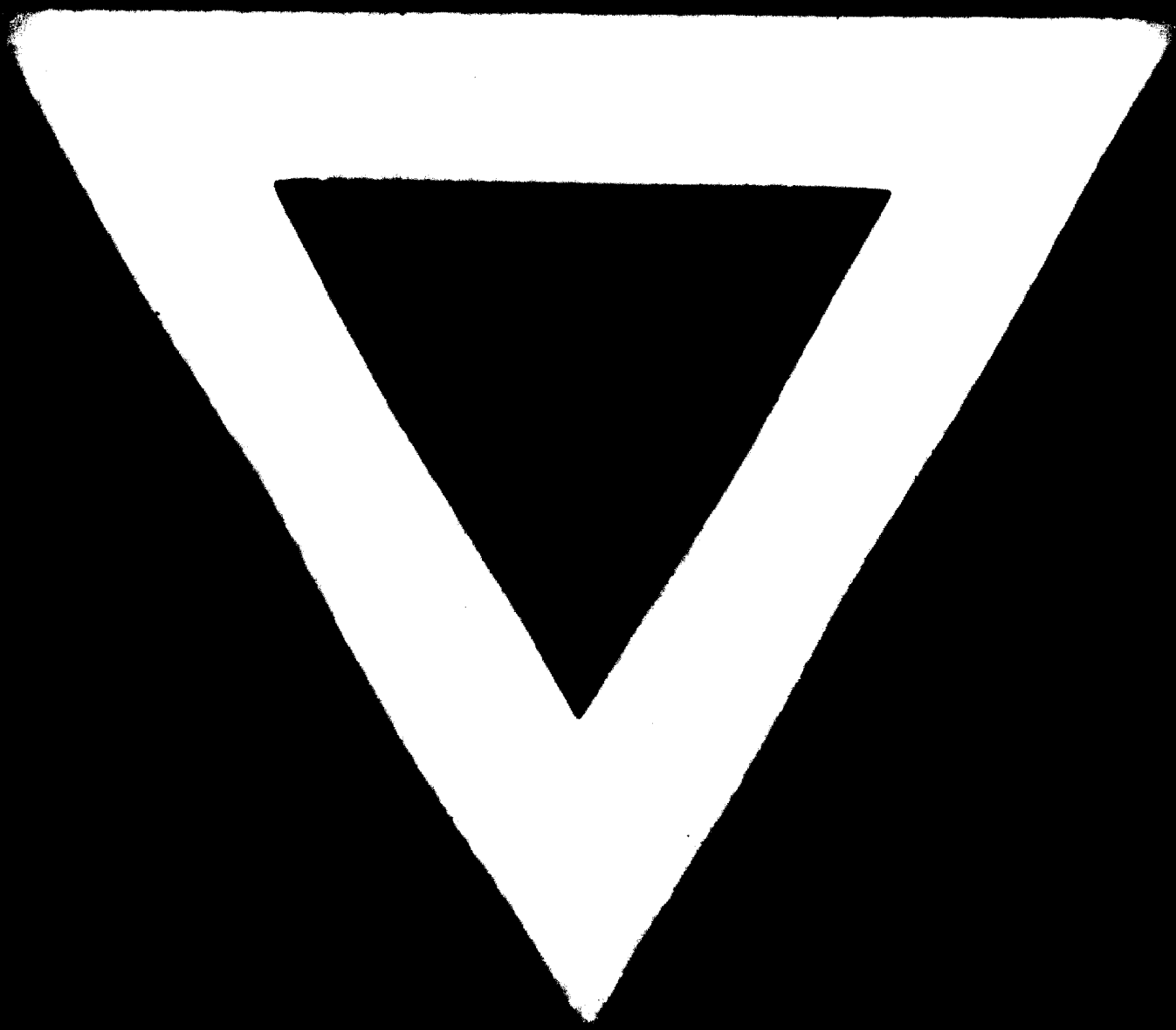


- - - - - Import with 8% increased annually

..... Imported by Government

A - B Consumption in 1962

C - D Actual requirement



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