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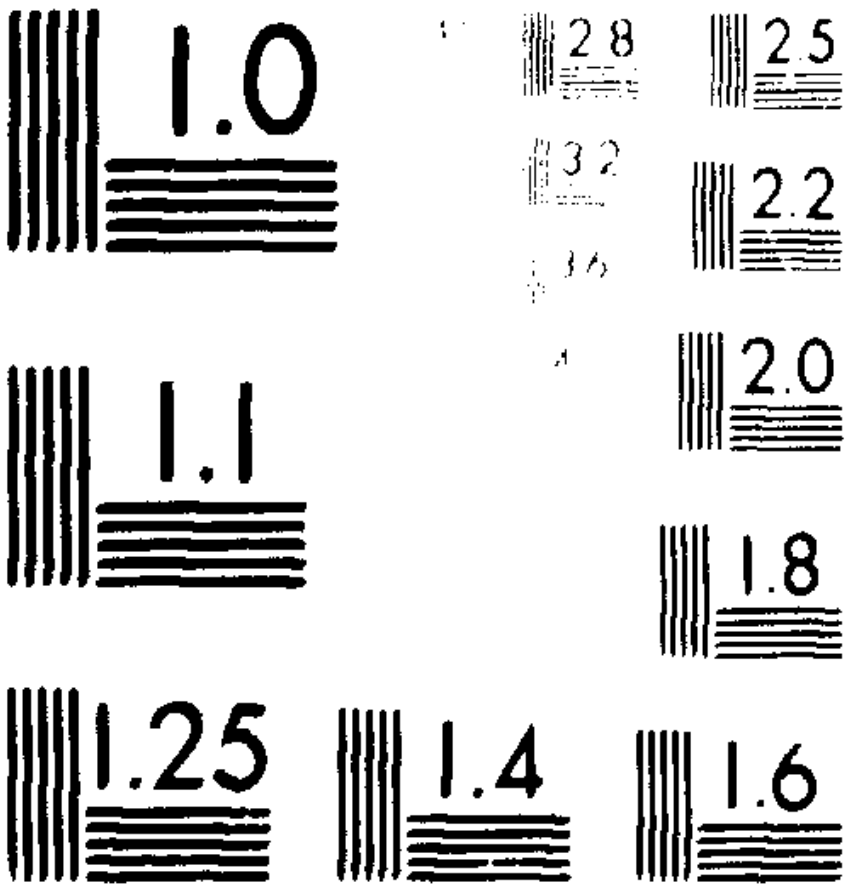

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UNIDO

ANALYSIS OF A PREFEASIBILITY STUDY FOR KOREA

UNBLEACHED KRAFT PULP MILL

UNIDO CONTRACT NO. 80/51

JT-04016

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EKONO OY

ABSTRACT

A prefeasibility study on an unbleached kraftpulp mill to supply pulp for the Korean paper industry has been evaluated. Four alternatives were investigated in the study, one mill expansion in Korea and three mill constructions abroad. It was concluded in the study that none of these alternatives were viable to be considered for implementation. This analysis proposes some smaller process changes, but the alternatives are still not viable and the conclusion made in the study can be confirmed. As concerns the Korean alternative, the study and also this analysis is based on imported chips, but it is emphasized that keen attention should be paid to the development of a procurement plan for domestic pulpwood. A sufficient amount of domestic wood could make the Korean alternative profitable. It is further recommended that the efforts to find suitable foreign candidates with sufficient raw material are continued. The whole question should be studied considering the national economy.

It was necessary to collect information from several sources for this analysis. For this purpose, a visit was made to Korea and discussions were conducted with representatives of UNIDO, Ssangyong Paper Co. Ltd. and Donghae Pulp Co. Ltd.

ANALYSIS OF A PREFEASIBILITY STUDY FOR KOREA UNBLEACHED KRAFT PULP MILL

REPORT
JT-04016 Unido
Analysis of a prefeasibility study

JJ/KKJ/rvl Otaniemi 1980-06-27 1 (36)

INTRODUCTION

On the request of the Government of the Republic of Korea, UNIDO has given assistance in executing a prefeasibility study on an unbleached kraft pulp mill to supply pulp for the Korean paper industry. H.A. Simons (International) Ltd. was designated by UNIDO to execute this study, evaluating the following three options:

A. Erection in Korea, either with entirely Korean equity capital or as a joint venture with Korean majority ownership, alongside the Donghae bleached kraft hardwood pulp mill, an unbleached kraft softwood pulp mill operating and using imported wood chips procured under long-term contracts from abroad.

B. Creation in an overseas country with softwood resources of an integrated timber production, wood extraction and pulp mill complex as a joint venture with Korean majority ownership to export all or the major part of its production to Korea.

C. Acquisition in an overseas country with softwood resources of an integrated timber production, wood extraction and pulp mill complex as a joint venture with Korean majority ownership to export all or the major part of its production to Korea.

Later on Options B and C were limited to three countries, i.e. Australia, USA and Canada.

Simons International has carried out the study and presented their final report. According to the report, it was not possible to find a suitable possibility for Option C. For Option B, three alternatives were found:

- A mill in Beerburrum, Queensland, Australia
- A mill in Eureka California, United States
- A mill in Ocean Falls, British Columbia, Canada

The main conclusion in Simons International's report is that under the conditions that prevailed at the end of February, 1980, none of these Option B alternatives were viable to be considered for implementation. The same applies to Option A.

The Government of the Republic of Korea has expressed their wish to have Simons International's report evaluated by some other companies. EKONO Oy was one of the companies designated by UNIDO to execute this evaluation.

In the meantime, the situation has somewhat change. In the Australian case, Australian Paper Manufacturers Limited (APM), with whom the joint venture was considered to be realized, has informed that they will carry out the pulp mill project with some Australian partners. The mill in Ocean Falls in British Columbia is closed by now. As Simons International mentions in their report, Ocean Falls - and also the Californian case - have some uncertainty in getting enough raw material.

All in all, it must be stated that Option B alternatives are more or less hypothetical cases. It will also be difficult to get raw material for Option A. The situation is, however, changing and therefore the comparison either to produce pulp in Korea from imported chips or to produce the pulp in countries, where raw material sources are, can be made even by comparing hypothetical cases.

Based on the UNIDO terms of reference, the Korean case is supposed to be operated by using imported wood. In appendix 2, a situation, in which a part of the raw material would come from domestic sources is considered.

EKONO has carefully analysed Simons International's report, taking different viewpoints into consideration. In EKONO's analysis, the mills are located on sites selected by Simons International and the production dimensioning is 210 000 ADt/year The process is also principally the same, actually there are three main deviations:

- Special attention has been paid to the thermal economy of the mills and to the use of secondary heat energy.
- All four alternatives have continuous type digesting.
- In the Korean case, wet pulp will be produced for domestic use.

All these measures have an effect on manufacturing and capital costs.

The basis for all costs and prices in this analysis is the situation at the end of February 1980, in US-dollars. The financial summary is as follows:

	Unit	Korea	Australia	California	British Columbia
Manufacturing costs	US$/ADt	339.79	196.23	254.10	213.85
Plant capital costs	US$1000	142,600	216,300	163,700	186,700
	US$/ADt,a	679	1,030	780	889
Total Investment costs	US$/1000	177,313	245,051	187,424	212,93
	US$/ADt,a	844	1,167	892	1,012
Mill net price	US$/ADt	480	346.50	355.50	355.50
Return on investment	%	12.8	6.8	4.2	8.5
Internal rate of return	%	9.9	5.7	3.7	6.9

The fuel costs in the Korean case are remarkably reduced through the proposed process changes. The manufacturing costs in this alternative are, however, still very high and completely in another class compared with the other alternatives, due to the high cost of imported raw material.

The investment costs in the Australian case are high. It has a greenfield installation, and additionally it is so located that big investments are required for effluent treatment. It is assumed that the infrastructure will be provided by the Government.

The other alternatives can use some existing facilities reducing the investment costs.

The end user of pulp will pay the same price, not depending on the supply source. In the Korean case, all inland costs are considered, including the additional road transportation cost of wet pulp.

Return on investment and internal rate of return are low, and none of the alternatives are profitable.

The increase in capacity will naturally improve the situation, but not enough. Reducing of manufacturing costs and increasing of selling price would be needed additionally.

The use of domestic pulpwood would improve the profitability of the Korean case, and it is recommended that keen attention is paid to the possibilities of increasing the supply of domestic pulpwood as well as to the long-range plan to supply different wood raw materials for the whole Korean industry.

Efforts to find suitable candidates for Options B and C should be continued.

1. OBJECTIVE OF THE STUDY

The objective of the prefeasibility study made by Simons International has been to furnish the Government and the paper industry of the Republic of Korea with financial information on several realistic alternatives to supply unbleached kraft pulp. This information should be of assistance in reaching the decision on implementation.

The conclusion of the prefeasibility study was that none of the alternatives studied should be considered for implementation.

The objective of this analysis made by EKONO is to evaluate Simon International's report in order to form a clear opinion about the alternatives concerned and to add new arguments and experiences, if deemed necessary.

2. BACKGROUND AND JUSTIFICATION

The economic growth in the Republic of Korea has been very fast. Following selected indicators collected from the publication "Major Statistics of Korean Economy, 1979" will, for their part, clearly illustrate this growth and the role of export in this regard.

- Average annual percentage increase in gross national product, 1962-1978	9,3 %	
- Ratio of exports to GNP		
- 1962	6,0 %	
- 1970	16,0 %	
- 1978	36,7 %	
- Average annual growth rate of export value (in US-dollars), 1962-1976		41,9 %
- Average annual growth rate of electricity production 1962-1976	18,7 %	
- Average annual growth rate of industrial production, in manufacturing, 1962-1976	20,6 %	
- Production of Portland cement, 1000 metric tons		
- 1962	789,7	
- 1970	5.781,9	
- 1976	15.133,0	
- Per capita consumption of paper, kg/year		
- 1962	3,68	
- 1970	11,34	
- 1978	30,80	

The per capita consumption of paper is still relatively low. Paper production has grown from 54.825 tons in 1960 to 1.593.652 tons in 1979 and will continue growing.

The kraftpaper production in 1979 was 179.736 tons. The main raw material for this kind of paper is unbleached softwood kraft pulp. A part can be replaced by selected waste paper and this is in fact done in Korea in a certain amount. However, the use of waste paper is limited due to the high strength requirement. The fact is, the kraftpaper industry needs growing amounts of unbleached kraft pulp. Today this pulp is not produced in Korea and all must be imported.

International pulp prices are changing, depending on the market situation. Today the market is strong and the prices are high.

Simon International's report gives a clear picture of the international pulp market and the Korean paper production. As to the Korean kraftpaper industry it is of utmost importance to find a stable raw material supplier.

The wood resources in Korea are still limited. According to the Office of Forestry, Seoul, the total supply of domestic timber, fuel wood excluded is about 1.300.000 m^3 this year. This amount is mainly used as pit props in mining industry, for production of groundwood pulp and for general use, including housing, furnitures etc.; less than 100.000 m^3 is left for chemical pulp industry, i.e. for Donghae's existing mill. The second 10-year Forest Development Plan gives a supply figure of 2.289.000 m^3 domestic timber for the year 1988. The forecasted need of groundwood pulp industry this year is 1.105.000 m^3 and for pit props 718.000 m^3. This means that not much is left for chemical pulp production. This question is discussed in more detail in appendix 2 of this analysis. The figures above clearly show that there is a good reason to study carefully the possibilities of getting raw material from abroad. Option A is based on imported material. Overseas shipment of chips has already been going on for many years, especially from North America to Japan, but many other countries are also involved. There is a lot of experience of this kind of transport and facilities for chip handling.

3. CHIP PURCHASING POSSIBILITIES

As stated in Simons International's report, it is extremely difficult at present to find a source which with some certainty could satisfy the raw material need of the pulp mill expansion in Korea. The demand of softwood chips is high, and especially today, when sawmills in some chip producing countries are running with low capacity, there is a lack of chips. Competition of chips is heavy and the prices are high.

The comparison of different alternatives can naturally be made with the assumption that chips will be available, when needed. But before going further, thorough investigations should be made to clarify the actual possibilities to procure chips on long-term contracts from abroad. It might be possible that many countries and companies, some far-off, have to be used as suppliers.

4. ALTERNATIVE CASES TO CONSTRUCT AN UNBLEACHED KRAFT PULP MILL

Four alternatives have been studied in detail:

- Option A
  Expansion of the Donghae Pulp bleached kraft pulp mill. The new unbleached pulp line would use imported softwood chips.

- Option B
  Construction of a new mill abroad
  1. in Beerburrum, Queenland, Australia
  2. in Eureka, California, United States
  3. in Ocean Falls, British Columbia, Canada.

  It is possible to construct a pulp mill at all selected sites. It has not been informed which other possibilities have been considered. The requirement of Korean majority ownership in Option B joint ventures is not possible in all cases.

  It is assumed that the raw material for these alternatives will be received from sources and in species mentioned in Simons International's report. These species are suitable raw material for unbleached kraft pulp to be used for kraft paper production.

  Option B alternatives do have limited possibilities to get raw material. Taking this into account, the selected size 600 ADt/d can be justified. Generally taken, this size of mill is, however, too small if conventional raw material is used. Investment costs per produced pulp ton are still decreasing relatively fast in this size class, when the size is increasing.

  Option C or the acquisition of equity in an existing pulp mill has obviously met difficulties. It is quite understandable in the present pulp market situation that this acquisition is not easy, and if it were realized this would probably be expensive. The requirement of Korean majority can cause additional difficulties. It would be interesting to learn which of all possible pulp mills were contacted.

4.1 Expansion of Donghae Pulp Mill in Onsan, Korea

The existing mill has a capacity of 105.000 tons per year bleached kraft pulp, of which 30 % is softwood pulp according to the production program. The raw material today is partly imported, partly domestic logs and partly waste wood from domestic plywood and sawmill industry.

When constructing the mill, the expansion has already been taken into account. There are many facilities which can be used, when constructing and operating the expansion.

In the case of expansion, a harbour with breakwater must be constructed. A suitable place has already been considered. The harbour is supposed to be provided by the Government.

Road connections are good and it will be easy to construct railway, if deemed necessary.

4.2 Construction of a pulp mill in Beerburrum, Queensland, Australia

In the Australian case, the idea was to construct a pulp mill together with Australian Paper Manufacturers Limited (APM). The situation has, however, now changed, and it has been recently informed that APM has formed a consortium with some Australian companies to construct the mill. Thus, the possibility of constructing a mill in Beerburrum can be handled only as an example of constructing a mill in Australia at a similar site.

The selected mill site is well located in relation to the pulpwood plantations. Roughly a half of the wood need can be satisfied by the plantations; the rest must be contracted from State Forests and from sawmills. The raw material situation seems to be reasonably good.

The site has good road and railway connections as well as water supply and electric power connection. A disadvantage is the high cost of effluent treatment, caused by the long distance from sea.

This alternative is a greenfield installation and as such it differs from the others. The necessary infrastructure is supposed to be provided by the Government.

4.3 Construction of a pulp mill in Eureka, California

The site as such is suitable for mill construction and has certain advantages, i.e. existing chip handling equipment, dock, water and natural gas pipeline connection as well as good road and railway connections. An additional benefit is the possible interconnection with the Humbolt Bay Power Company.

Some difficulties might occur regarding the environmental side, but this applies to most other cases as well.

Limited wood resources may cause problems. There are already some mills in this area and it is not very easy to get the additional amount needed for a 210.000 tons per year pulp mill. The site owner, North Coast Export Cooperative Inc. (N.C.E.C.), is owned by some sawmill companies which also have own timberland. The chips shipped by N.C.E.C. today to Japan are obtained within an area with 160 km radius from the shipping point. To satisfy a mill of 210.000 ADt/year, they need more than they can get today within this area. The transport distances will be longer than today - as pointed out by Simons International - and this will cause additional costs. The cost of inland transport can easily grow to a remarkable portion of the chip price at the mill. A separate study on this subject would be necessary.

4.4 Construction of a pulp mill in Ocean Falls, British Columbia

It has recently been informed that the Ocean Falls newsprint mill has been closed. The woodroom will be renovated to produce chips and logs. The pulp mill will possibly be considered later. Some studies concerning the future of the Ocean Falls are being made.

The acquisition of wood seems to be the problem also here. Accessible areas have largely been logged out.

The site has advantages as concerns the existing facilities; a hydro-electric power plant, good quality water and a dock for ocean vessels are available. The community and the industrial tradition in Ocean Falls are also an advantage.

Road or railway connections do not exist.

5. PROCESS AND LAYOUTS FOR ALTERNATIVE CASES

5.1 General

Generally taken, the processes in the different alternatives are similar following the conventional principles and lines described in detail in Simons International's report. When comparing the four alternatives with each other, the only process difference of some importance is that in the Korean case wet pulp is produced and in other cases dry pulp for export is produced. Other differences are smaller and mainly caused by the supply form of the raw material and, on the other hand, by the use of existing facilities. In the Australian and Californian cases, the heavy requirements for effluent treatment have been considered, and the system will be equipped with BOD-treatment. It is best to make a reservation to implement this kind of waste water treatment also in other cases later on.

In all cases special attention will be paid to the thermal economy of the mill and to the use of the secondary heat energy produced by or in the process. This will cause increase in the investment costs, but when considering the high price of energy, this solution may be justified. Through these measures, the use of primary energy can be minimized which is important, especially in cases, in which high-cost imported fuel is used for steam generation.

In the following, the main features of the process are discussed. Mostly they are the same as in Simons International's report, but they are repeated in this connection, because they form the basis for the capital cost estimate.

5.2 Wood handling

In all alternatives chip piles will be used, bulldozers do the reclaiming from the piles and belt conveyors will transport the chips through the screening station to the digester. The overzise material from the screening is crushed or rechipped. The fines are screened out to be used as fuel.

5.2.1 Korean case

The Government is assumed to take care of the construction of the harbour with necessary breakwater. It may be that all chip carriers do not have their own unloading equipment. The harbour will therefore be equipped with a special crane designed for this purpose.

Chips are stored in two or more piles according to species, age or other criteria.

At present, Donghae Pulp's existing mill does not have the possibility to burn waste wood at the mill site. In this analysis it is assumed that this possibility will be found and a reasonable compensation will be received. Many companies are burning wood instead of expensive import fuel.

The amount of wood is about 400.000 BDU per year, all imported as chips.

5.2.2 Australian case

The main part of the total yearly requirement of about 400.000 BDU comes to the site as logs by road or rail. Slashing and drum barking is arranged.

5.2.3 Californian case

All wood is received as chips from N.C.E.C.'s chip export terminal.

5.2.4 British Columibian case

About 2/3 of the yearly demand of about 400.000 BDU will come as logs and the rest as chips from sawmills.

Two separate barking and chipping lines are arranged according to the size of logs.

5.3 Pulp line

In all cases the process includes a continuous digester and diffusion washing, equipped with heat recovery equipment. Non-condensible vapors will be conveyed to the lime kiln for burning.

Knots from the knotters are returned for recooking. Three-stage pulp screening and four-stage pulp cleaning are arranged. After the thickener, the pulp is pumped to the high-density tower and further to the drying department.

5.3.1 Korean case

Because the mill will produce pulp for domestic use only, it is assumed in this analysis that the end product of the pulp mill will have a dryness of 45 %. This will increase the transport costs and have a decreasing effect on the mill net sales price as discussed later. Manufacturing costs will, however, decrease more. Additionally, the investment will be smaller.

The mill will be equipped with two wet lap machines, both having a capacity of 300 ADt/d. Machines of this size are easily obtainable.

The finishing system is designed for 800 kg bales. Lift trucks are used for handling and storage.

5.3.2 Australian, Californian and British Columbian cases

The drying machine has a fourdrinier wet end and an airborne dryer section.

The finishing line is designed for 200 kg bales. In the warehouse, lift trucks are used for handling and storage.

In the Australian case, the pulp is transported by rail to Brisbane to be shipped by ocean vessels further to Korea.

In the Californian case, barges are used to transport the pulp from the warehouse to the ocean vessels in the present chip loading terminal.

In British Columbia, the bales can be transferred directly from the warehouse to ocean vessels.

5.4 Chemical recovery

The evaporation plant in all cases has six effects, except in the Californian case only 5. Stripping of foul condensates is arranged.

Low odour type recovery boiler is equipped with supplementary fuel burners. The electrostatic precipitator will be installed.

Recausticizing is of conventional design, equipped with green liquor and white liquor clarifiers.

Oil will be used as fuel for the lime kiln in Korea and in British Columbia. The Californian case will use natural gas and the Australian case gas produced from coal at site. Odorous gases from stripping and other sources as well as turpentine will be burnt in the lime kiln. The stack is equipped with an electrostatic precipitator.

5.5 Steam and power generation

The recovery boiler will supply steam at 64 kg/cm^2 and 450°C.

5.5.1 Korean case

The need of steam in producing wet pulp is so small that the recovery boiler can satisfy the mill's total need and even generate some steam to the existing mill and thus replace a part of the steam generated by the existing power boiler using oil or fuel. The supplementary oil burners in the recovery boiler are dimensioned to generate full boiler steam output. A power boiler will not be installed, but facilities for fuel oil handling will be increased.

The installation of a power boiler using hog fuel as fuel may become actual later on, but this matter belongs primarily to the existing mill and will be not discussed in this analysis.

A 16 MW turbogenerator with extraction pressure of 12,5 kg/cm^2 and back-pressure of 4.5 kg/cm^2 will be connected with the existing auxiliary condenser.

The electrical system will be interconnected with the existing mill which has a connection with the outside grid.

The feed water system will also be connected to the respective existing system.

5.5.2 Australian case

In addition to the electric power generated by the 16,25 MW turbine, some power is supplied by the public utility company.

The power boiler burning hog fuel, supplemented by coal, will be dimensioned to generate 35 tons steam per hour.

5.5.3 Californian case

The electric and steam net of the mill will be integrated with Humboldt Bay Power Company's system. This will supply the necessary extraction and back-pressure steam as well as the electric power.

5.5.4 British Columbian case

The existing power boiler rated at 63 tons per hour on hog fuel is rather big for the pulp mill's need. It is assumed that it can be used to generate the steam needed in addition to the steam of the recovery boiler. The steam of the power boiler can possibly be used for the need of the nearby community as well.

It is assumed that the existing hydroelectric power plant can supply so much electric power that a 7 MW turbogenerator is sufficient.

5.6 Water supply and distribution

The mill will be designed paying attention to minimizing the use of water. The daily use will be 35.000 m^3.

5.6.1 Korean case

The raw water line coming to the existing mill has a sufficient capacity considering also the expansion. A new storage pond has to be made. The system will be connected to the existing water system, and some additional clarification and filtration capacity will be constructed.

5.6.2 Australian and Californian cases

It is assumed that the water will be supplied by a public utility to a storage tank at mill site. No additional treatment will be required.

5.6.3 British Columbian case

Existing facilities can be used.

5.7 Effluent treatment

Mechanical treatment will be arranged in all cases.

A separate sewer system will be arranged for different waste waters like acid effluent, basic effluent, fiber containing water, non-fiber water. In all cases, a reservation for the BOD-treatment will be made, and in the Australian and Californian cases this will be implemented. Effluents will be conducted to ocean by using an underwater diffusion pipe. In Australian case, the length of the overland pipe is about 20 km.

5.8 Fire protection

A modern system will be provided. The chip feed to the digester, the dry end of the drying department and the pulp warehouse will be equipped with a sprinkler system.

In the Korean case, the system will be connected with the fire protection system of the existing mill; a new pump station is not needed.

In British Columbia, a part of the existing facilities can be used for the new pulp mill.

5.9 Shops, store, offices

5.9.1 Korean and British Columbian cases

Existing facilities will be used, and some tools and satellite stations serving operation and quality control as well as maintenence will be added.

5.9.2 Australian and Californian cases

Necessary offices, repair shops, stores, laboratory, canteen and other personnel facilities will be provided.

6. MANUFACTURING COSTS

In this analysis, the basis for the estimate is the price and the cost level at the end of January, 1980. The same figures have been used for wood costs as in Simons International's report. Some changes have been made in other unit costs, based on the information received from suppliers or users. However, the influence of these unit cost changes in the total manufacturing cost is by no means significant.

6.1 Wood raw material

The international supply and demand situation has a strong effect on chip prices, and recently a strong movement has taken place in this area. In theory, the market price for the chips of the same quality from Northern California and British Columbia should be the same. In practice, the local conditions can have a strong significance. Because it is today to a very high degree uncertain, from which sources the wood chips to the Korean mill can be purchased and the supply situation also in other cases is somewhat unclear, the same wood prices as in Simons International's study have been used in this analysis. The ocean freight cost of US $ 50 per BDU is justified.

In the Korean case, the ocean shipping, the handling of chips and the additional storage time will cause additional wood losses. For the safe operation of the continuous digester it has been estimated that one percent of the fines will be removed in chip screening. This is a disadvantage compared to batch digesters, but the continuous digester is still justified regarding the mill's thermal economy. Considering all this, the total wood losses in chip shipping and screening will be 3.7 % in the Korean case.

Taking into account the losses in wood handling and barking as well as the fiber losses in the process, the wood consumption will be as follows:

	Korea	Australia	California	British Columbia
BDU/ADt	1,92	1,90	1,87	1,90
BDU/year	403.200	399.000	392.700	399.000
m^3/year	1.018.500	892.500	984.900	1.131.900

As already mentioned earlier, it has been assumed that the same species as given in Simons International's report will be used.

6.2 Fuel

The elaborated heat balance below shows the mills' need of primary heat energy and the need of power boiler steam.

Heat balances

	Unit	Korea	Australia	California	British Colombia
Steam generation from recovery boiler	Gcal/ADt	3.35	3.15	3.35	3.35
Need of electric power	kWh/ADt	630	670	640	670
Electric power generation	MW	15.75	16.25	16.0	7.0
Steam for power generation	Gcal/ADt	0.63	0.65	0.64	0.28
Steam for mill use	"	2.72	2.50	2.71	3.07
Mill use of primary heat energy					
- Digester, washing, screening	"	0.75	0.75	0.75	0.75
- Evaporation	"	1.00	0.95	1.20	1.00
- Power plant	"	0.50	0.50	0.50	0.50
- Drying	"		0.90	0.90	0.90
- Heating&ventilation, miscellaneous	"	0.20	0.15	0.15	0.20
Mill's use (without lime kiln)		2.45	3.25	3.50	3.35
Recovery boiler steam in surplus	Gcal/ADt	0.27			
Power boiler steam needed	Gcal/ADt		0.75	0.79	0.28
"	Gcal/h		18.75	19.75	7.0

In the Korean case, the power boiler steam is not needed and the new recovery boiler can even supply steam to the existing mill. This action is supposed to be compensated according to the equivalent price of fuel oil.
The amount of steam supplied corresponds to fuel oil amount of 31 kg/ADt.

In other cases, power boiler steam is needed. This steam is generated by burning hog fuel and in Australia additionally also coal.

In the Korean case, no new power boiler will be needed. For the start-up purposes etc., the recovery boiler in the Korean case obviously needs more auxiliary fuel than in the other alternatives. It has been estimated that this additional need will be 5 kg/ADt, which means 1050 tons per year.

For the lime kiln and the recovery boiler control, 60 kg/ADt oil or an equivalent amount of gas is used.

6.3 Electric power

The estimated need is as follows, kWh/ADt:

	Korea	Australia	California	British Columbia
Wood and chip handling	30	40	20	40
Digester, washing, screening	200	200	200	200
Power plant, evaporation	160	160	150	160
Drying	150	180	180	180
Recausticizing	30	30	30	30
Water, lighting, miscellaneous	60	60	60	60
	630	670	640	670
Own generation	630	650	640	280
Purchased		20		390

6.4 Chemicals

The consumption figures given in Simons International's report will be used.

6.5 Personnel

Donghae pulp mill has slightly over 400 people at their mill site today, which means about 4 men per one thousand yearly tons. The respective figure in Simons International's report in the Australian and British Columbian cases is 1.26 and in the Californian case 1.20, which are good figures. It can be expected that in the long run the number of people in Donghae pulp mill will decrease, but on the other hand it is clear that a part of the existing mill's personnel can be used for the operation and maintenance of the possible expansion. At this stage, the amount of additional people needed for the expansion can be estimated to 175.

Labour costs have been estimated based on wage levels, including benefits in respective countries.

6.6 Other fixed costs

In the Australian case, it is supposed that the local policy to amortize the infrastructure through utility changes can be applied.

The estimation of insurance costs is based on a recent calculation of insurance requirements in a similar case.

Overhead costs have been roughly estimated.

Unit Consumptions

		Korea	Australia	United States	British Columbia
Pulpwood and chips	BDU/ADt	1,92	1,90	1,87	1,90
	m^3/ADt	4,85	4,25	4,69	5,39
Saltcake	kg/ADt	55	55	55	55
Limestone	kg/ADt	35	35	35	35
Fuel oil					
Kiln&recovery	kg/ADt	65			60
Power boiler					
Natural gas					
Kiln and recovery	m^3/ADt			57	
Coal					
Kiln and recovery	kg/ADt		122		
Power boiler			32		
Hog fuel					
Power boiler	BDt/ADt		0,18	0,25	0,09
Electric power					
Total	kWh/ADt	630	670	640	670
Purchased	kWh/ADt	-	20	-	390
Water	m^3/ADt	56,8	56,8	56,8	56,8
Labor force					
Hourly	Men	150	201	190	201
Salaried	Men	25	63	63	63
Total		175	264	253	264

Unit Costs for Materials & Utilities. $ U.S.

		Korea	Australia	United States	British Columbia
Pulpwood and chips	$/BDU	141	57	84,50	62
	$/$m^3$	55,92	25,50	33,51	21,90
Saltcake	$/kg	0,299	0,099	0,09	0,098
Limestone	$/kg	0,0313	0,056	0,024	0,008
Fuel oil	$/t	228,57	-	-	113,95
Natural gas	$/$m^3$	-	-	0,116	-
Coal	$/t	-	27,75	-	-
Hog fuel (purchased)	$/BDt	-	-	10,00	-
Electricity	$/kWh	-	0,0311	-	0,005
Water	$/$m^3$	0,0258	0,182	$ Million per year	-

Cost per Air Dry Metric Ton, U.S.$

	Korea	Australia	United	British Columbia
Variable costs				
Pulpwood and chips	270,72	108,30	158,02	117,80
Saltcake	16,45	5,45	4,95	5,39
Limestone	1,09	1,96	0,4	0,30
Fuel oil	14,86	-	-	6,84
Natural gas	-	-	6,60	-
Coal	-	4,27	-	-
Hog fuel (purchased)	-	-	2,50	-
Purchased electricity	-	0,62	-	195
Water	1,47	9,30	5,00	-
Materials and supplies	20,00	23,00	20,00	23,00
	324,59	152,90	197,91	155,28
Fixed costs (annual, $ 000)				
Labor (hourly and salaried including benefits)	1.200	5.300	6.600	6.600
Local taxes	1.000	100	2.000	2.000
Insurance	600	900	700	800
Overhead	2.000	2.800	2.500	2.900
	4.800	9.100	11.800	12.300
Fixed cost per ADt	22,86	43,33	561,9	58,57
Compensation of steam supply	-7,66			
	339,79	196,23	254,10	213,85

7. SELLING PRICE OF PULP

C&F price of US $ 430/ADt in Korea will be used as a basis. Additional costs in Korea are US $ 84 and thus, the delivered cost to the customer would be $ 514/ADt. The average length of transport distance from Onsan to the three mills producing kraft paper at present is about 360 km, which means an inland transportation cost of US $ 17.00 when road transportation is used. Railway freight would be only $ 5.40, which clearly shows that attention should be paid to the possibility of using railway. This, however, also depends on the railway connections in customers' plants. In this analysis, road transportation has been taken into account. When producing wet pulp with dryness of 45 %, the inland transportation cost will be US $ 34/ADt. The net sales prices of the mill in the four alternatives are then following:

Korea	US $/ADt	480.-
Australia		346.50
California		355.50
British Columbia		355.50

8. CAPITAL COSTS

The cost level at the end of January 1980 has been used as a basis.

The cost estimate is based on experiences received in connection of some recent projects, on some budget quotations for similar equipment and on the wage and cost level in the alternative countries. The prices of main equipment mainly follow the international level.

Concerning items, of which EKONO does not have detailed information on local conditions, the same figures as in Simons International's report have been used and in such cases this principle has generally been applied also to the other alternatives concerned.

Escalation and cost of land has not been included in the capital cost estimate.

8.1 Korean case

Following existing facilities can be used in the expansion:

- incoming electric power line, main transformer
- mill water treatment, partly
- auxiliary condenser
- saltcake and lime rock storages
- fire pump station
- main office, canteen
- repair shop, stores
- mobile equipment.

The expansion will be connected witn the existing mill-water system, the electric system and the mill air system.

Local equipment and material will be used to the same extent as it was used, when the existing mill was constructed. A Korean engineering company will participate in the detail engineering of piping, tanks, electrification and areas connected with civil construction.

The harbour is not included in the cost estimate, with the exception of the crane for chip unloading. Likewise, the railway connection is excluded.

8.2 Californian case

The existing chip handling facilities decrease the costs. For the turbo-generator and the power boiler, only incremental costs are taken. The present dock will be used.

8.3 British Columbian case

It is assumed that following facilities can be at least partly used fo. the new pulp mill:

- water supply
- mill air system
- hog fuel boiler
- hydro-electric power plant
- pulp warehouse
- dock
- fire pump station
- office, canteen
- repair shop, stores
- mobile equipment.

Direct capital costs mechanical
in US $ 1000

	Korea	Australia	California	British Columbia
Site works	3.700	10.000	7.500	8.300
Mill water storage & treatment	1.900	200	200	
Effluent treatment	2.500	24.000	8.800	3.600
Power distribution, including middle voltage distrib.	2.800	3.500	3.400	2.800
Wood&chip handling	7.000	8.200	2.800	21.800
Hog fuel handling		2.000		1.800
Digesting, washing, screening	21.800	22.800	23.800	24.500
Drying&bale handling	12.000	16.100	16.800	17.300
Recovery boiler house, incl. precipitator and pressure air station	16.200	18.300	19.100	19.700
Turbo-generator&heat energy distrib.	7.100	8.200	5.500	6.700
Evaporation	5.900	6.800	6.500	7.300
Power boiler		4.000	500	
Coal handling&gas producer		2.000		
Recausticizing	7.000	8.100	8.400	8.600
Warehouse&mobile equipm.		400	300	100
Repair shop, stores, laboratory	100	700	700	500
Non-process buildings	100	500	400	
Ship loading&dock			1.900	
Total	88.100	135.800	106.600	123.000

Direct capital costs, structural
in US $ 1000

	Korea	Australia	California	British Columbia
Site work	1.000	300	300	800
Mill water storage&treatment	500	300	300	
Effluent treatment	600	2.000	2.100	300
Power distrib. incl. middle voltage distrib.	100	100	100	100
Wood&chip handling	1.700	1.900	1.300	5.500
Hog fuel handling		400		500
Digesting, washing, screening	3.200	4.500	4.500	4.800
Drying&bale handling	2.000	4.300	4.300	4.600
Recovery boiler house, incl. precipitator&pressure air station	3.500	4.900	4.900	5.300
Turbo-generator&heat energy distribution	400	600	300	600
Evaporation	500	700	600	800
Power boiler		2.000	100	
Coal handling&gas producer		500		
Recausticizing	1.300	1.800	1.800	2.000
Warehouse	400	1.200	1.600	700
Repair shop, stores, laboratory	100	1.700	1.200	700
Non-process buildings	300	1.100	400	100
Ship loading&dock			800	500
Total	15.600	28.300	24.600	27.300

Indirect capital costs
in US $ 1000

	Korea	Australia	California	British Columbia
Spare parts	2.300	2.300	1.400	1.600
Temporary construction facilities	1.600	3.300	2.600	2.300
Field administration	2.100	3.300	2.600	3.000
Engineer's and vendors' coordination and supervisvion at site	2.000	1.000	500	500
Engineering and procurement, incl. studies	8.300	13.100	10.500	12.000
Export packing & ocean freight	4.600	5.000		
Import duty	5.000	4.500		
Total	25.900	32.500	17.600	19.400

Plant capital costs
in US $ 1.000

	Korea	Australia	California	British Columbia
Direct costs, mechanical	88.100	135.800	106.600	123.000
structural	15.600	28.300	24.600	27.300
Total direct costs	103.700	164.100	131.200	150.300
Indirect costs	25.900	32.500	17.600	19.400
Direct+indirect costs	129.600	196.600	148.800	169.700
Contingencies	13.000	19.700	14.900	17.000
Plant capital costs	142.600	216.300	163.700	186.700
Plant capital costs US $ per ADt/a	679	1.030	780	889

9. WORKING CAPITAL

It is of utmost importance for the safe operation of the mill to have well secured raw material supply. Because the raw material in the Korean case is, however, very expensive, all the necessary measures should be taken to decrease the amount of storaged wood. It is therefore proposed that only 8 weeks' wood chip supply will be taken, when calculating the working capital. Other items are the same as in Simons International's report and thus, the working capital will be following, in US $ 1000:

	Korea	Australia	California	British Columbia
In full operation	18.170	11.500	12.000	11.350
At start-up	10.000	3.300	3.200	3.100

10. PREOPERATING AND START-UP COSTS

The training has an important role in the preoperating phase. In the Korean case, the operating bleached kraft pulp mill gives a good possibility for training and most of it can be done at the existing mill. In other cases, the training must be executed at other mills. It can be assumed that in Australian, Californian and British Columbian cases a considerable part of operators do have earlier experience and do not need so much training.

Another remarkable item is the salaries and wages of personnel engaged during the preproduction period, the trial runs and start-up.

Preoperating costs
in US $ 1000

	Korea	Australia	California	British Columbia
Salaries&wages (excl.training)	1.000	1.400	1.400	1.400
Training, incl.salarieswages	800	400	400	400
Travelling&transportation	500	500	300	400
Communication, office costs, authority contacts etc.	600	1.000	1.000	1.000
Insurance	600	900	700	800
	8.500	4.200	3.800	4.000

Trial runs and start-up costs
in US $ 1000

	Korea	Australia	California	British Columbia
Salaries&wages	500	1.200	1.200	1.200
Operating losses, additional consumption of materials and utilities	500	300	300	300
Vendors' supervisors	1.000	200	200	200
Miscellaneous	200	300	300	300
	2.000	2.000	2.000	2.000

11. FINANCING

In this analysis, equity investment was assumed to be 30 % as in Simons International's report. In Korean case 55 % of long-term loans are supposed to be local loans and 45 % foreign loans.

A construction period of 36 months was taken for all cases. 15 % of the total investment costs is to be paid in the first year of construction, 50 % and respectively 35 % in the second and in the third year. If an interest rate of 21 % is used for Korean loans and 12 % for foreign loans, the interest during construction is:

Korea	US $	19.213.000
Australia		19.251.000
California		14.724.000
British Columbia		16.693.000

The insterest of short-term loans can be assumed to be 21 % in the Korean case and 15 % in the other cases.

Depreciation can be calculated by using straight-line depreciation method and following rates:

Korea:	Buildings	2,5 % per year
	Vehiches	25 % " "
	Machinery	8,33 % " "
Australia:		7,5 % per year
California:	Buildings	2,22 % per year
	(first year	150 % D.D.B)
	Mechanical	9,53 % per year
	(first year	200 % D.D.B)
British Columbia:	Structures	5 % per year
	Vehiches	20 % " "
	Machinery	10 % " "
	Temporary buildings	10 % " "

If the figures above are used, the average depreciation per or year during the four first years of operation would be

Korea	7.5 %	of plant capital cost
Australia	7.5 %	"
California	10 %	"
British Columbia	9 %	"

12. TOTAL INVESTEMENT COSTS

	Unit	Korea	Australia	California	British Columbia
Plant capital costs	US$1000	142.600	216.300	163.700	187.700
	US$/ADt,a	679	1.030	780	889
Working capital before start-up	US$1000	10.000	3.300	3.200	3.100
Preoperating and start-up costs	"	5.500	6.200	5.800	6.000
Interest during construction	"	19.213	19.251	14.724	16.693
Total investment costs	"	177.313	245.051	187.424	212.493
	US$/ADt,a	844	1.167	892	1.012

13. PROFITABILITY ANALYSIS

The cost and price level at the end of January 1980 has been used. All costs and prices are in US-dollars. The following exchange rates have been used:

1 US-dollar = 580 Korean won
1 US-dollar = 0.90 Australian dollars
1 US-dollar = 1.17 Canadian dollars.

It has been assumed that the production would be 75 % of the nominal capacity during the first year of operation, 90 % in the second year and 100 % thereafter.

13.1 Comparison of Options B

In the Australian case, two alternatives were taken into this comparison, i.e. the base case and another one, in which the plant capital cost was US$ 20.000.000 smaller.

The summary of the calculation results is as follows:

	Unit	Australia base case	Australia smaller investm.	California	British Columbia	Korea
Plant capital cost	US$1000	216.300	196.300	163.700	186.700	155.000
Total investment cost	"	245.051	223.346	187.424	212.493	185.036
Pay-off period	year	12	12	12	12	11,0
Return on investm.	%	6,8	8,8	4,2	8,5	11,7
Benefit-cost ratio		0,8	0,9	0,7	0,9	1,0
Internal rate of return (Discounted cash flow rate)	%	5,7	7,1	3,7	6,9	9,2

It can be seen from the figures above that none of the alternatives are profitable. The internal rate of return in the British Columbian case and in the Australian case with smaller investment costs are about the same and clearly better than in the Californian case and in the Australian base case.

Appendix 1 presents the summary of the computer run result.

The Korean case was taken here just for the comparison, under assumption that interest rates could be lowered to the foreign level; because this would probably mean more foreign equipment and higher investment costs, the plant capital cost was estimated to US $ 155.000.000 instead of the US $ 142.600.000 given in paragraph 12.

When the selling price of pulp was increased by US $ 50 per ton, the calculation showed the following results:

	Unit	Australia base case	Australia smaller investm.	California	British Columbia
Return on investment	%	13,5	16.0	13,0	16,0
Internal rate of return	%	10,4	12,0	10,0	12.0

The price increase of US $ 50 per ton is not enough to make these alternatives profitable and most probably the increase should be in the range of US $ 100 as already stated by Simons International.

13.2 Different manufacturing costs in the Korean case

Five Korean alternatives were compared with each other. The same capital costs as in paragraph 12 have been used, but the manufacturing cost used is different, so that the influence of the decreasing manufacturing costs on the profitability could be analysed.

	Unit	Manufacturing costs US$/ADt				
		339,79	339.79 -10 %	339.79 -20 %	339.79 -30 %	339.79 -40 %
Pay-off period	year	12	9,0	6,5	5,2	4,4
Return on investm.	%	12,8	18,9	24,7	30,3	35,6
Benefit-cost ratio		0,9	1,1	1,4	1,6	1,8
Internal rate of return (Discounted cash flow rate)	%	9,9	13,8	17,3	20,5	23,4

If the manufacturing costs in the Korean case can be lowered with 30 % i.e. about US $ 100 from the figure elaborated in paragraph 6, the return on investment would be 30,3% and the internal rate of return 20,5%, which would make this alternative viable.

Appendix 1 presents the summary of the computer run results.

13.3 Profitability summary

Compared to Simons International's report, some changes in the process have been proposed in this analysis. This has caused changes in the manufacturing and in the capital costs. The situation is, however, still the same as stated by Simons International: none of the alternatives are profitable.

In the Australian case, another site where the investement in effluent treatment would be smaller could be found. As, however, seen from the figures in paragraph 13.1, even then the profitability is not attained. On the other hand, the wood cost could be higher, if another site is selected.

In the Californian case, the cost of raw material is mainly determined by export chip prices and not much can be done to reduce the variable manufacturing costs. In this respect, the British Columbian case, in which lower wood price has been used, offers even less possibilities.

In the Korean case, the proposed process changes have caused a significant reduction in the fuel oil consumption, and variable manufacturing costs can practically be further decreased only by decreasing the wood cost. If 50 % of the raw material could be domestically supplied, a reduction of about 49 US-dollars in the manufacturing unit cost could be reached. This, however, is still not enough. If wet pulp is produced in the Korean case, the inland transportation of pulp will cost about US$ 34/ADt, when road transportation is used. If railway transport is arranged, the corresponding figure will be only US$ 10,80/ADt, and a saving of about 23 US$/ADt can be obtained.

The increase in capacity will naturally improve the situation, but more is needed. If the selling price of pulp would be roughly US $ 100 higher, the profitability could be possible to reach. In the Korean case a price increase of US $ 80 per ton would be sufficient, if railway transport is used.

14. NATIONAL ECONOMY BENEFITS

Capital requirements for job creation are:

Korea	US$ 1.013.200/job
Australia	928.200/ "
California	740.800/ "
British Columbia	804.900/ "

If, in the Australian case, a site with easier effluent treatment solution could be found and the plant capital cost would be 20 million US-dollars less, the capital requirement in Australia would be US$ 846.000/job.

The engineering and construction phase will give additional employment in engineering, manufacturing and construction. The mill-related operations will indirectly generate some additional work in other services.

In the Korean case, significant savings in foreign exchange will occur. The following calculation can be made for the first full-production year, in US$:

Savings:

- 210.000 tons of pulp per year, US$ 430/ADt	90.300.000
Foreign currency needed for operation and debt service	
- wood, 403.200 BDU per year, US$ 141/BDU	56.851.000
- fuel oil, US$ 14,86/ADt	3.121.000
- foreign loan repayment	5.078.000
- interest in foreign loan	6.093.00
	71.143.000

Net savings in foreign exchange will be about US$ 19.000.000 per year. The savings will increase, when the loan repayment advances.

The use of domestic pulpwood in the Korean case would bring additional benefits.

The expansion of Donghae pulp mill will improve the economy of the existing mill, especially if the bark of domestic pulpwood could be used to substitute fuel oil.

15. CONCLUSIONS AND RECOMMENDATIONS

15.1 Conclusions

Simons International's report on an unbleached kraft pulp mill and the four alternative mill cases have been evaluated and the conclusions of this report can be confirmed:

- satisfactory pulp quality can be attained in each alternative
- none of the alternatives are profitable under the conditions of the end of January 1980
- the Korean alternative would bring significant benefits considering the national economy.

The situation concerning the Australian alternative has changed, and a pulp mill will be constructed at the selected site by others. Considering this, all four alternatives do include uncertainties as concerns the sufficient supply of raw material and a yearly capacity of 210.000 ADt is therefore justified in this analysis.

The process changes proposed in this analysis have caused changes in the manufacturing costs as well as in the capital costs. The manufacturing costs vary from US$ 196/ADt in Australia to US$ 340 in Korea. The consumption of fuel oil was reduced remarkably in Korea. The plant capital costs range from US$ 143 million in Korea to US$ 216 million in Australia. The corresponding total investement costs are US$ 177 million in Korea, which means US$ 844 per annual air dry ton of pulp, and US$ 245 million in Australia, corresponding to US$ 1.167 per annual air dry ton.

If the selling price of pulp would be US$ 80/ADt higher than it was, the Korean case could be profitable. The other alternatives need even higher price increase. In this connection it must, however, be pointed out that all calculations are based on the cost and price level which prevailed at the end of January 1980. Since then, rapid changes have taken place in this area, especially as concerns raw material and, in the Korean case, interest rates which are now very high.

The profitability of the Korean alternative could be improved by using domestic wood raw material.

As long as the Republic of Korea has only a very limited amount of domestic wood raw material, the raw material cost for the Korean paper industry will be higher than in countries with wood resources. Additionally in those countries, unbleached kraft pulp is more and more produced in big units with strong tendency for vertical integration.

15.2 Recommendations

Following recommendations are made:

a) Highest attention should be paid to increasing the supply of domestic pulpwood.

b) Long-range wood supply problem for the whole Korean industry should be carefully studied, including logs, lumber, hardwood etc.

c) As concerns Option B, i.e. a joint venture pulp mill abroad, contacts with owners of the present alternatives should be maintained and further investigations made to find new realistic alternatives with sufficient raw material sources.

d) In spite of all, there might be some existing mills in the world which could be considered as Option C, i.e. acquisition of equity. It is recommendable to continue the efforts to find suitable candidates.

c) It is important to study thoroughly national economic calculations and comparisons concerning the supply and production of pulp, paper and energy, in order to clarify which materials and articles should be domestically produced, which should be produced abroad and which should be imported, regarding the national economy at present and in the future.

APPENDIX 1

Profitability calculation sheets

PROJECT COST ANALYSIS

RUN DATE
1980-06-2[illegible]

ANALYSIS OF A PREFEASABILITY STUDY FOR KOREA
PROFITABILITY OF UNBLEACHED KRAFT PULP MILL

UNIDO
JT-84016/GCP

INTEREST PER CENT BEFORE DISCOUNTING YEAR 0,00
INTEREST PER CENT AFTER DISCOUNTING YEAR 12,00

		KOREA 155,000,000 USD	AUSTRALIA 216,300,000 USD	AUSTRALIA 196,300,000 USD	CALIFORNIA 163,700,000 USD	BRITISH COLUMBI 186,700,000 USD
PRES VALUE OF THE VENTURE	(N)	8*163	39*911-	18*206-	50*920-	20*387-
PAY OFF PERIOD	(A)	11,8	> 12,8	> 12,8	> 12,8	> 12,8
RETURN ON INVESTMENT	(%)	11,7	6,8	8,8	4,2	8,5
ANNUITY ON INVESTMENT	(N)	27*167	35*979	32*792	27*518	31*199
ANNUITY ON NET INCOME	(N)	28*366	30*119	30*119	20*042	28*205
BENEFIT-COST RATIO		1,0	0,8	0,9	0,7	0,9
DISCOUNTED CASH FLOW RATE	(%)	9,2	5,7	7,1	3,7	6,9
COMPARISON FIGURE		100,0	688,9	423,8	823,8	449,7

*** E K O N O / PROJECT SERVICES

PROJECT COST ANALYSIS

RUN DATE
1988-06-29

ANALYSIS OF A PREFEASABILITY STUDY FOR KOREA
PROFITABILITY OF UNBLEACHED KRAFT PULP MILL

UNIDO
JT-84016/GCP

INTEREST PER CENT BEFORE DISCOUNTING YEAR 0,00
INTEREST PER CENT AFTER DISCOUNTING YEAR 17,00

		KOREA + 0 %	17 %	KOREA = 10 %	17 %	KOREA = 20 %	17 %	KOREA = 30 %	17 %	KOREA = 40 %	17 %
PRES VALUE OF THE VENTURE	(N)	16'414-		22'947		62'305		101'665		141'822	
PAY OFF PERIOD	(A)	> 12,0		9,0		6,5		5,2		4,4	
RETURN ON INVESTMENT	(%)	12,8		18,9		24,7		30,3		35,6	
ANNUITY ON INVESTMENT	(N)	33'303		33'303		33'303		33'303		33'303	
ANNUITY ON NET INCOME	(N)	30'220		37'613		45'005		52'398		59'790	
BENEFIT-COST RATIO		0,9		1,1		1,4		1,6		1,8	
DISCOUNTED CASH FLOW RATE	(%)	9,9		13,8		17,3		20,5		23,4	
COMPARISON FIGURE		211,6		183,7		155,8		127,9		100,0	

APPENDIX 2
Use of domestic wood raw material in the expansion of Donghae pulp mill.

USE OF DOMESTIC WOOD RAW MATERIAL IN THE EXPANSION OF DONGHAE PULP MILL

The first 10- years forest development plan in Korea was completed mainly successfully in 1978 and the second plan was launched in 1979 for years 1979-1988. According to this new plan, the domestic timber supply will grow from 1.270.000 m^3 in 1978 to 2.289.000 m^3 in 1988. The projected figure for 1990's is 2.950.000 m^3.

According to the Office of Forestry, Seoul, the domestic timber supply of 1.277.000 in 1980 will be used as follows:

- pit props	600.000 m^3
- groundwood pulp	308.000 "
- general use (construction, housing etc.)	309.000 "
- chemical pulp	60.000
	1.277.000 m^3

It has also been informed that in 1988 the groundwood pulp industry would need 1.105.000 m^3 timber, and 718.000 m^3 will be used as pit props. This would mean that in 1988 only 466.000 m^3 could be available for other use.

The pulpwood availability study, made by Reid, Collins and Associates Limited, Vancouver in 1975, estimates that domestic softwood logs would be available for chemical pulp mill from the year 1983. In this year, 24.000 m^3 could be supplied; the amount would gradually increase, reaching 360.000 m^3 in 1990. It is said that a conservative approach was used in the study.

A feasibility study about pulpwood supply from Yeongdeog-region was recently made by Forest Research Institute, Seoul. This region is located about 150 km north from the existing Donghae pulp mill. The study estimates that 51.000 m^3 softwood logs annually on the average could be supplied for pulpmaking from this region during the 15 first years; a supply figure 38.400 is given for the first year. The implementation of this procurement plan has not yet started.

This year about 100.000 m^3 domestic softwood logs from several different sources will be used for Donghae's existing pulp mill.

The amount of softwood chips from sawmills has been estimated to 100.000 m^3 per year by e.g. Reid, Collins and Associates in their study mentioned above. This figure applies to the year 1980; somewhat higher figures are given for later years. These chips can be used in Donghae existing pulp mill, but they will probably not satisfy their whole need.

Based on the above mentioned studies and information as well as on the present situation at Donghae existing mill, it can be assumed that a part of the raw material for the expansion can be supplied from domestic sources. The total need is 1.018.500 m^3 per year. During the first year of operation, i.e. 1983, only a small portion, maybe less than 10 %, can be domestic. Later on, the domestic share will increase, but even in 1994 it can hardly be more than 50 %.

The wood cost was analyzed in the feasibility study of pulpwood supply from Yeongdeog-region. As a result, a chip cost of US$ 75/BDU at the mill was given. At present, the wood comes from other sources and is more expensive. Considering also the alternative use of wood as fuel, an average estime of US$ 90/BDU is used in the following, and it is assumed that a part of the wood raw material for the mill expansion would be supplied from domestic sources.

Raw material supply		Unit cost US$/BDU		Raw material cost US$/ADt	Total manufacturing cost US$/
domestic %	foreign %	domestic	foreign	of pulp	ADt of pulp
	100		141	270,72	339,79
10	90	90	141	260,93	330
50	50	90	141	221,76	290,83

Even if 50 % of the raw material is domestic, it can be seen that the manufacturing costs can be decreased by less than 50 US-dollars per ton.

The groundwood pulp industry is competing with the chemical pulp industry of domestic softwood sources. Groundwood pulp is mainly produced for newsprint paper manufacturing and uses much energy, generated of foreign fuel. Regarding the national economy, a calculation comparing different possibilites to supply the nation with newsprint paper as well as with kraftpulp and kraft paper by domestic production, production abroad or by buying from abroad would be justified.