A LOCATIONAL ANALYSIS OF A PHILIPPINE FUEL ALCOHOL DISTILLERY

by

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CHAPTER 1

INTRODUCTION

In Retrospect

The Philippine Government through the Philippine National Alcohol Commission (PNAC) formed the National Alcogas Program to reduce dependence on crude oil by the production of anhydrous alcohol from domestic agricultural raw materials (sugarcane, cassava, sweet potato, etc.) which is to be blended with gasoline.

According to the program, a maximum 15% of the total gasoline consumed is to be converted to alcohol by the year 1985. In order to accomplish this target, PNAC formulated a plant construction plan which calls for the construction of fourteen fuel alcohol distilleries at designated areas.

A locational analysis leading to the determination of least cost sites for each of these distilleries is important to ensure the program's viability.

Literature on the theory of industrial location points out the least cost theory as one of the major theoretical approaches available. It holds demand constant and focuses on spacial variations in cost. This approach has found application in industries where the transportation cost of assembling inputs and distributing outputs is the dominant location factor.

In fuel alcohol production, inputs in the form of agricultural raw materials comprise about 70% of total production cost. The spatial differences in transportation cost incurred in assembling and transporting the raw materials from the farm to the distillery, and the cost of distributing the alcohol from the distillery to the oil depots for blending can serve as a critical factor in analyzing the least cost sites.

Research Objective

This study looks at one of the fuel alcohol distilleries which is planned to be built at the Cavite area (a province south of Manila). The fuel alcohol distillery will have a capacity of 48 kiloliters per day and operating at 200 days per year. The agricultural raw material is sugarcane.

Specifically, the research objective focuses on the determination of a least cost site for the fuel alcohol distillery.

Methodology

Information was gathered from the released reports of the Philippine National Alcohol Commission, the Philippine Sugar Commission, and the Philippine National Oil Company.

Tabular and descriptive analyses of data will be used.

This study attempts to make use of the least cost theory model in determining the least cost site.

CHAPTER II

AN OVERVIEW OF THE PHILIPPINE ALCOGAS PROGRAM

Introduction

The use of alcohol as motor fuel either alone or as alcohol gasoline blends was technically established long ago in France, Italy, United States, Cuba, Argentina, Brazil, South Africa, and elsewhere, including the Philippines.

As early as 1922, Philippine Sugar Centrals began to use alcohol as tractor fuel. At about the some time, several companies experimented on alcohol as fuel for buses, trucks, cars, and locomotives.[1] However, with the availability of relatively cheap gasoline marketed soon after World War II, use of fuel alcohol was terminated.

Since the advent of rising oil prices in the 1970's, the Philippines is currently importing crude oil and petroleum at the rate of two billion dollars per year. The national government then enacted an energy program to realize reduction of outflow in its dollar currency. Its thrust was to develop renewable indigenous energy resources. The program of reducing imported oil is planned to increase production of domestic oil, coal and geothermal, hydroelectric, uranium and non-conventional energy. The non-conventional energy program is composed of alcogas, solar water heating, and biogas programs.

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[1] H.I. Schoemaker, "Alcohol-Gasoline Motor Fuels," Sugar News (1932): 349-354.

In February 1980, the government enacted the "Alcogas Five-Year Program" through the creation of the Philippine National Alcohol Commission (PNAC).

The alsogas program was one of the specific programs undertaken by the government which sought to introduce an 80-20 per cent blend of gasoline with anhydrous alcohol in the initial years, and the use of pure anhydrous alcohol as automotive fuel as the long run objective.[2] It aims to minimize the full dependence of the country's transport sector on petroleum.

Alcohol An An Energy Source

Alcohol is normally blended with gasoline primarily as an outlet for countries with excess farm products, thereby stabilizing product prices.

Methanol and Ethanol are the two types of alcohol generally considered as fuels. Coal and Natural Gas can be converted into liquid form (Methanol) rendering it more adaptable as a transportation fuel. However, these primary sources are depletable and the Philippines still has to locate and develop its natural gas deposits. The coal demand is such that in its solid state, supply is still short. Furthermore, Methanol and its vapors are toxic, and presents a higher health hazard than Ethanol.

Ethanol, on the other hand, has properties which are intermediate to those of Gasoline and Methanol. Thus, potential problems would be less severe.

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[2]Philippine National Alcohol Commission, Philippine Fuel Alcohol Program, Manila, Philippines, 1980.

Theoretically, Ethanol could be produced from any plant material or biomass. In practice the choices are limited to those crops which are easy to raise, those which are broadly adapted to the environment, and those which produce high amounts of sugars and starches which are readily fermentable to alcohol. Hence, the national alcogas program sees that the most relevant raw materials are sugarcane, cassava, and sweet potato. Sweet sorghum, grain sorghum, corn, rice, bananas, and pineapplies may likewise serve as raw materials depending upon the availability and relative costs, and prices.

Among the raw material possibilities, sugarcane is being afforded the first priority. This is because, as a crop, it contains enough bagasse[3] to process itself resulting to a very favorable energy balance. Secondly, the technology, manpower, and the organizational support for its production and processing are in existence.

However, using alcohol for motor fuel will depend a great deal on how much sugarcane can be planted. The Philippine sugar industry primarily exists for the purpose of making sugar and exporting it. Sugar refineries are mostly located in the areas of the Savana type climate where there are pronounced rainy and dry periods during the year. This means that sugarcane can only be cultivated 5 to 6 months a year. There are only a few areas where the climatic weather pattern permits sugarcane cultivation to about ten months.

In like manner, there is an existing Philippine sugar industry which, at present, is not producing fully because of the depressed sugar export market.

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[3]Crushed, juiceless sugarcane as it comes from the mill. It is often used for fuel in sugarmills.

The main problem facing the national alcogas program with using alcohol as a motor fuel is the cost factor: the cost of producing alcohol, including the cost of raising its foremost raw material source which is sugarcane is quite high.

To face the problem, the PNAC had grouped the national alcogas program into two components. These are the agricultural program component and the industrial program component.

The Industrial Program

Basic Models of Distilleries. The national alcogas program envisions the installation, nationwide, of 47 alcohol distilleries. Alcohol requirements will be produced from three basic models of distilleries.

Model I (Small Annexed Distillery) is a distillery attached to an existing sugar factory, having a capacity of 30 to 60 kiloliters (kl) per day. This distillery will use the by-product of the sugar mill such as molasses as raw material.

At present there are 15 alcohol distilleries[4] integrated with sugar mills with a daily capacity of 290 kl and there are 9 independent distilleries with a daily capacity of 128 kl. These figures would then add up to a total daily capacity of 418 kl of alcohol. So far, only one distillery is producing fuel alcohol for the national alcogas program. The rest are producing alcohol as potable alcohol, industrial alcohol, fine alcohol, and dehydrated fine alcohol. Fuel

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[4]H.R. Rosales, "Alcohol From Sugarcan," Paper delivered at the Symposium on Alcohol As Motor Fuel, Manila, Philippines, 1978.

alcohol is water free and may contain denaturants that would render the odor and taste unacceptable to humans.

If all the distilleries could be coperated 300 days a year, total alcohol production of 125,000 kl a year would be expected. However according to the Bureau of Internal Revenue, alcohol production was only 43% of the available distilling capacity of all the distilleries if operated in full.

On the other hand, molasses could also be used as a source for alcohol production. The average production is reported to have been 568,000 kl out of which only 24% was converted to alcohol.[5] The balance was exported abroad with a very little amount left for the production of important by-products such as animal feed.

It was also pointed out, however, that using "A" molasses instead of the final (Blackstrap) molasses for alcohol production, volume of alcohol produced will increase 2.7 time.[6]

Model II (Large Scale Distillery) is attached to the existing sugar mill or established independently, having a capacity of 120 to 180 kl per day. The raw materials for alcohol production will be sugarcane or other raw material sources such as cassava.

Model III (Small Scale Distillery) is an independent distillery which will be established in a local region having a capacity of 30 to 60 kl per day. The raw materials for this distillery will be sugarcane or cassava and/or sweet potatoes.

According to the PNAC, the initial anhydrous alcohol needed is

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[5]Ibid.

[6]F. D. Maramba and J. Banzon, "Straight Alcohol as Motor Fuel," Paper delivered at the Symposium on Alcohol As Motor Fuel, Manila, Philippines, 1978.

13,100 kl.. This represents an 8% blend. By 1985, anhydrous alcohol will be blended with gasoline at a rate of 15% for vehicle fuel (Table 1).

Distillery Establishment Plan. PNAC has also prepared the distillery establishment plan which shows the number of distilleries for each model and their corresponding target distillery capacity (Table 2). The plan seeks to have a total of 7 distilleries by the year 1982. All these distilleries will be of Model I type. The targeted annual capacity per distillery is 7,500 kl or 50 kl on a daily basis. Model II type distilleries are expected to be operational by 1983 and Model III type distilleries by 1984.

Model I type distilleries have the advantage of immediate implementation over the other models in view of either existing excess crushing capacity of the parent sugar mill and/or available sugarcane lands which would not require too much costs and time to cultivate.

Location of Distilleries. A listing of the possible areas for the location of the distilleries have been suggested by PNAC (Table 3). The areas were considered on the basis of land availability and suitability for sugarcane and other raw material sources production, proximity to oil depots and gasoline consumption centers, and the presence of infrastructure and transport systems.

The existing facilities of the oil companies would be modified to transport, store, blend, and distribute the fuel blend to existing gasoline consumers.

From the distilleries, alcohol will be stored in storage tanks.

TABLE 1

PROJECTED ALCOHOL MIX IN GASOLINE

YEAR	ALCOHOL PRODUCTION		GASOLINE DEMAND	AVE. % ALCOHOL */
	MML	MB	MB	IN GASOLINE
1981	13.1	82.4	10,187	0.8
1982	52.5	330.2	9,472	3.5
1983	163.7	1029.5	9,071	11.3
1984	209.1	1315.1	8,838	14.9
1985	234.3	1473.6	8,661	17.0

*This column represents average aggregate figures. The 8% blend in the initial years will be applied only to a certain portion of gasoline users; hence, only 1030 million barrels (MB) out of the 10,187 MB in 1981 will have an 8% gasoline-alcohol blend. For 1982, it will be 4127.5 MB out of 9472 MB gasoline demand.

Source: Philippine National Alcohol Commission

TABLE 2

TARGET DISTILLERY CAPACITY AND ALCOHOL PRODUCTION

YEAR	MODEL I		MODEL II		MODEL III		TOTAL	
	UNITS	MML/Y	UNITS	MML/Y	UNITS	MML/Y	UNITS	MML/Y
1981	2	13.1	-	-	-	-	2	13.1
1982	7	52.5	-	-	-	-	7	52.5
1983	9	91.7	3	72.0	-	-	12	163.7
1984	9	118.5	3	81.6	1	9.0	13	209.1
1985	9	118.5	3	96.0	2	19.8	14	234.3

Source: Philippine National Alcohol Commission

TABLE 3

POSSIBLE DISTILLERY SITES
AND RESPECTIVE DISTILLERY MODELS

POSSIBLE DISTILLERY SITES	TYPE OF DISTILLERY
Piat, CAGAYAN	MODEL I
Tolong, NEGROS ORIENTAL	MODEL I
Pili, CAMARINES SUR	MODEL III
Botolan, ZAMBALES	MODEL I
Mabinay, NEGROS ORIENTAL	MODEL II
Dasmarinas, CAVITE	MODEL III
Canlubang, LAGUNA	MODEL I
Bamban, TARLAC	MODEL I
La Carlota, NEGROS OCCIDENTAL	MODEL I
Bogo-Medellin, CEBU	MODEL I
Danao, CEBU	MODEL III
Pilar, CAPIZ	MODEL II

Source: Philippine National Alcohol Commission

Distilleries are encouraged to have these facilities. For large distilleries whose fuel alcohol are planned to be water transported, storage tanks are also required to be erected near ports to meet the tanker size and allow for early and late arrivals of the scheduled tankers.

Alcohol will then be transported to oil depots where the blending process will take place. From here, the blended product known as alcogas will be distributed to the different gasoline dealers.

Government Guarantees. There will be a guaranteed market for the fuel alcohol producers. At no point will it be allowed that fuel alcohol production capacities exceed the forecasted demand.

The government will also procure all fuel alcohol production at an established price for allocation to the oil companies. The established price will assure fuel alcohol producers a reasonable return on investments.

Agricultural Program

Raw Material Production Requirements. Production of raw material sources for alcohol, the corresponding financial requirements needed for raw material production, and raw material production research and development were the envisioned activities of the agricultural program component.

Although sugarcane was the preferred crop, raw material diversification will be pursued. Cassava has been considered the second priority.

The total acreage requirement for the raw material sources depends on the projected fuel alcohol production. Given the level of fuel alcohol needed for the program, PNAC estimated some 212,000 ha for sugarcane and 50,000 ha for cassava (Table 4). Furthermore, PNAC assumed to get 3500 liters of fuel alcohol per hectare of sugarcane per year.

For Model I distilleries, the sugarcane raw material needs could be satisfied by allowing some 20% increase in current production.[7] This already takes into consideration the government's conditions that the alcogas program will not adversely affect sugar production both for domestic and foreign consumption.

On the other hand, Model II distilleries calls for the development of new production areas. It was mentioned by the PNAC that agricultural development is critical and must procede distillery establishment by at least 2 years.

Model III distilleries would involve mainly small farmer participation in supplying raw material needs. Extension and research support is necessary to enable the integration of sugarcane and other raw material sources into the cropping system of the small farmers.

It was also mentioned that alcohol requirements for motor fuel can reach to at least one fourth of the gasoline requirements without increasing the current cane hectarage. This can be done by increasing the output of the existing distilleries and requiring them to produce fuel alcohol, updating alcohol production methods, and employing a different type of molasses.[8]

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[7] Philippine National Oil Commission, Philippine Fuel Alcohol Program, Manila, Philippines, 1980.

[8] *Op. Cit.*

TABLE 4
PROJECTED AREA REQUIREMENTS

YEAR	MODEL I		MODEL II		MODEL III		TOTAL (ha.)
	CASSAVA (ha.)	SUGARCANE (ha.)	CASSAVA (ha.)	SUGARCANE (ha.)	CASSAVA (ha.)	SUGARCANE (ha.)	
1981	1,222	5,030	-	-	-	-	6,252
1982	2,444	10,060	-	-	-	-	12,504
1983	3,666	15,090	2,500	10,286	-	-	31,542
1984	4,888	20.120	5,000	20,572	3,666	15,084	69,330
1985	6,110	25,150	10,000	41,144	6,110	25,140	113,654
1986	6,110	25,150	15,000	61,716	9,165	37,710	154,851
1987	6,110	25,150	20,000	82,288	12,220	50,280	196,048
1988	6,110	25,150	25,000	102,860	15,275	62,850	237,245
1989	6,110	25,150	30,000	123,432	15,275	62,850	262,815

Source: Philippine National Oil Company

Organization of Production. To ensure security of raw material supplies, all distillery models must develop and control at least 50% of the raw material needs of the distillery and the balance to be satisfied through supply contract agreements with planter/farmer organizations.

Models I and II call for plantation agriculture monoculture systems. The primary producers are by and large medium to large size planters.

Model III is based on small farm production systems. The small farmers will be organized as a planters association. Each farmer will sign a supply contract agreement stipulating among other things the nature and volume of raw materials to be produced and the supply delivery schedules agreed upon by the distillery management and the planters association.

CHAPTER III

INFORMATIONAL HIGHLIGHTS ON THE FUEL ALCOHOL DISTILLERY

Objective Area

The objective area is located at the province of Cavite and is some 50 km southwest from Manila. It is situated on a volcanic plateau formed mainly by Taal Volcano, sloping from Tagaytay Ridge in the southeast to the Manila Bay in the northwest. The plateau is highly dissected with many streams which are narrow and deep (Figure 1).

There exists two asphalt-surfaced national highways running through the objective area. There are also a few provincial roads paved with gravel. All these roads lead to Naic, a major town around the area.

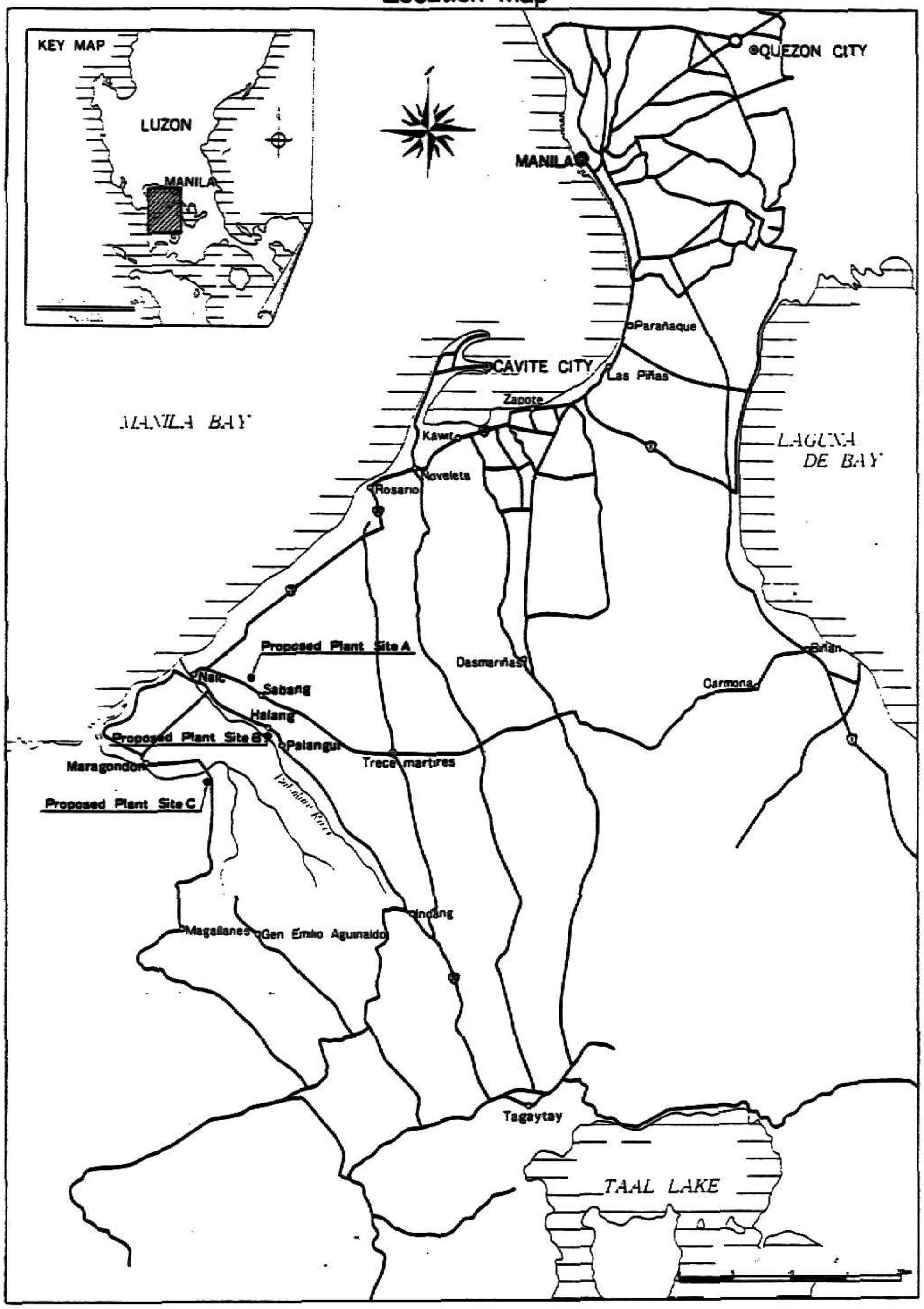
The area is about 4000 ha. This area belongs to six municipalities and one city. These are: Maragondon, Naic, Indang, Magallanes, Tanza, G.E. Aguinaldo, and Trece Martires City. It is delineated on the basis of land suitability for sugarcane cultivation. Net cultivable land is 3090 ha.

With regard to occupation, 80% of the total households are farmers. Landless workers make their living primarily as farm laborers and occupy about 17% of the total households. Labor force available is estimated at 379,600 man-days per year.

The sugarcane area was about 1,200 ha in 1978. It decreased to less than half (550 ha) in three years due to the lower price of sugar, higher price of farm inputs, and higher transportation cost

FIGURE 1

Location Map



from the farms to the mill. The farmgate price of sugarcane is ₱160 per ton excluding transportation cost from the farm to the mill.

The present cropping pattern shows that upland rice occupies 62% of the area and is grown from May to November. Corn gets 11% and is grown from June to September followed by peanut cultivation in late October. Sugarcane now only occupies 18% of the area.

Sugarcane Development Plan for the Area

The sugarcane production and transportation plans of the objective area are established to be corresponding to the operation program of the distillery.

Production plan of sugarcane is divided into two system: individual farms and an estate farm. Under the individual farms, most part of the sugarcane production is planned by the cultivation of the individual farms under contract with the distillery. Harvesting and transportation of the farm produce will be carried out in accordance with the plans established with the distillery. The total area for individual farms is 2640 hectares.

The estate farm, on the other hand, is provided by the distillery to produce raw materials solely for its needs. A 400 hectare land area is envisioned.

In total, 3040 hectares are earmarked for the sugarcane development plan (Table 5).

To coincide with the distillery's operation, planting of sugarcane will be done from November to February and harvesting from November to May.

TABLE 5

SUGARCANE AREA AND YIELD
FOR EACH RAW MATERIAL SOURCE

RAW MATERIAL SOURCE	SUGARCANE AREA	% of TOTAL	SUGARCANE YIELD
Trece Martires City	762 ha	25	39,624 tons
Naic	48	2	2,496
Indang	40	1	2,080
Magallanes	300	10	15,600
Maragondon	840	28	43,680
GE Aguinaldo	50	2	2,600
Palangui	1000	32	52,000
TOTAL	3040	100	158,080

Source: Philippine National Alcohol Commission

Since the capacity of the distillery is planned at 48 kiloliters of alcohol production per day (approximately 60.84 tons), 790 tons of sugarcane should be harvested and transported to the distillery daily. 44 units of six-ton trucks are needed at a rate of three trips each. These trucks will be provided and operated by the distillery.

Fuel Alcohol Distillery Site

PNAC has enumerated three possible sites for the alcohol distillery. These are:

Candidate Site A: near Sabang

Candidate Site B: near Halang

Candidate Site C: near Maragondon

The distances of each candidate site from each raw material source and the oil depot is shown in Table 6.

The transportation cost of raw material (sugarcane) was estimated at ₱0.80 per ton-km. The amount of sugarcane needed per ton of alcohol is 17.99 tons.

Oil Depots

The alcohol produced by the distillery will be shipped to oil depots where blending with gasoline will take place.

The neares oil depot is located at Rosario, Cavite. The oil companies will incur an estimated ₱1.267 per ton-km of transportation cost.

TABLE 6
DISTANCES FROM CANDIDATE SITES

UNIT: KILOMETER

	RAW MATERIAL SOURCES							DEMAND POINT
CANDIDATE SITE	MARAGONDON	NAIC	INDANG	MAGALLANES	PALANGUI	GE AGUINALDO	T. MARTIRES	OIL DEPOT
A	17.1	6.3	35.1	38.4	16.2	36.3	15.3	30.6
	(11.7)*	(5.1)	(24.9)	(22.5)	(6.6)	(21.9)	(13.8)	(19.5)
B	15.0	8.4	21.9	36.3	3.0	34.2	28.2	32.7
	(10.8)	(6.9)	(19.2)	(18.3)	(1.8)	(17.1)	(15.0)	(22.8)
C	7.2	18.0	44.1	14.1	25.2	12.0	37.8	42.3
	(5.4)	(9.3)	(21.0)	(12.9)	(7.2)	(10.8)	(16.2)	(28.8)

*Numbers in ( ) are straight line distances

Source: Philippine National Alcohol Commission

CHAPTER IV

A THEORETICAL FRAMEWORK FOR LEAST COST LOCATION STUDY

Transfer Cost

The activities of an alcohol distillery can be divided for our purposes into three stages:

1. procurement: purchasing and assembling the necessary raw materials (sugarcane) and supplies to the site of processing
2. processing: transforming the materials into more valuable forms (products); in this case, the distillery transforms the sugarcane into alcohol.
3. distribution: selling and delivering the products

From the standpoint of procurement, the location of an alcohol distillery may be evaluated in terms of the prices at which various q uantities of raw materials are purchased. Shipment of some materials from other sources is generally involved. Greater distances from sources of materials usually means higher procurement cost.

Location, from the standpoint of distribution, requires the need of a demand schedule regarding the distillery's output. However, under the alcogas, the government purchases the alcohol and allocates it to the various oil companies for blending. Distribution and procurement costs ordinarily have one feature in common. They nearly always depend on the transportation of the final product or raw materials. And when distribution and procurement are taken together, they are simply referred to as transfer operations.

To be viable, the alcohol distillery needs to respond to transfer or transport costs by seeking to reduce them. Procurement cost can be lessened by moving to a point with better access to raw material sources such as sugarcane production areas. Distribution costs can be lessened by moving to a point with better access to demand areas such as oil depots or blending stations.

Processes in which there is a considerable loss of weight or which entail a higher transfer cost per ton-kilometer on materials than on products are likely to be located close to the material source. On the other hand, processes in which there is a considerable gain of weight or which entails a higher transfer cost per ton-kilometer on products are likely to be located in markets or demand areas.

Assumptions

In examining the influence of transport costs on the location of the fuel alcohol distillery, it would be worthwhile to begin by postulating a radically simplified world.

It will suffice to assume the following:

1. There is one product (alcohol) which uses one raw material (sugarcane).
2. The raw material is transportable for which there is at least seven sources.
3. The distillery ships its product to a single market (oil depot). The market is concentrated at a point rather than geographically extensive.

4. The cost of transporting the raw material is the same in all directions.

5. The cost of transporting the product is the same in all directions.

The Ideal Weight Concept

Alfred Weber, considered the "father of location theory," advanced the ideal weight concept where transport costs are viewed as the primary determinant of plant location.

The ideal weight for a raw material source is calculated by multiplying the number of tons of input required per ton of output times the transport rate per ton-kilometer of the input. The ideal weight for the market is simply one ton of output times the transport rate of the output.

In a one raw material-one market case that is being dealt with, the distillery will locate at the raw material source it the ideal weight of the raw material is greater. Likewise, it will locate at the market if the ideal weight of the product is greater.

Let:

w_s = tons of raw material needed to make one unit of the final product

w_m = weight of one unit of the final product in tons

t_s = rate per ton-km to transport the raw material

t_m = rate per ton-km to transport the final product

Then:

$$S = (w_s)\ (t_s)$$

$$M = (w_m)\ (t_m)$$

It follows that if

$$S > M$$

the distillery will prefer location at s to location at m, and if

$$S < M$$

the distillery will prefer location at m to location at s.

A Basic Least Cost Model

Raw Material Transport Cost Model. The fuel alcohol distillery has three alternative locations (A, B, and C) and requires one input or raw material (sugarcane) which has seven sources (1, 2, 3, 4, 5, 6, and 7).

The distance of source 1 to location A is k_{A1}; the distance of source 1 to location B is k_{B1}; and the distance of source 1 to location C is k_{C1}. In other words, the distance of a raw material source to a particular distillery location is k_{ij} where i is the distillery location and j is the raw material source.

The transport cost per ton-km (t) of the raw material is spatially invariant. Hence, the transport cost per ton from the raw material source to the distillery location is found by multiplying t times k_{ij}.

Since each possible distillery location will obtain all raw material supplies from each and every raw material source, the total transport cost per ton of raw material from each source to the distillery location is the summation of the product of to and k_{ij}. Of course, this holds if each raw material source will supply the same volume of raw materials.

Let T_i be the total transport cost per ton of the raw material from each source to each of the distillery location. Then,

$$T_i = \sum_{j=1}^{N} (k_{ij})(t) \text{ for each distillery location } i$$

The preceeding equation comprise a situation that illustrates the conditions that determine the raw material transport cost per ton for each distillery location. Its structure can be illustrated in Figure 2.

<u>Finished Product Transport Cost Model</u>. The alcohol which the distillery will produce will be transported to the oil depots at a certain demand point (D).

The distance of each distillery location to the demand point is k_{iD}. The transport cost per ton-km (tr) of the final product is spatially invariant. Hence, the transport cost per ton of the product from a distillery location to the demand point is the product of tr and k_{iD}. Then,

$$Tr_i = (k_{iD})(tr) \text{ for each distillery location } i$$

FIGURE 2

RAW MATERIAL TRANSPORT COST MODEL

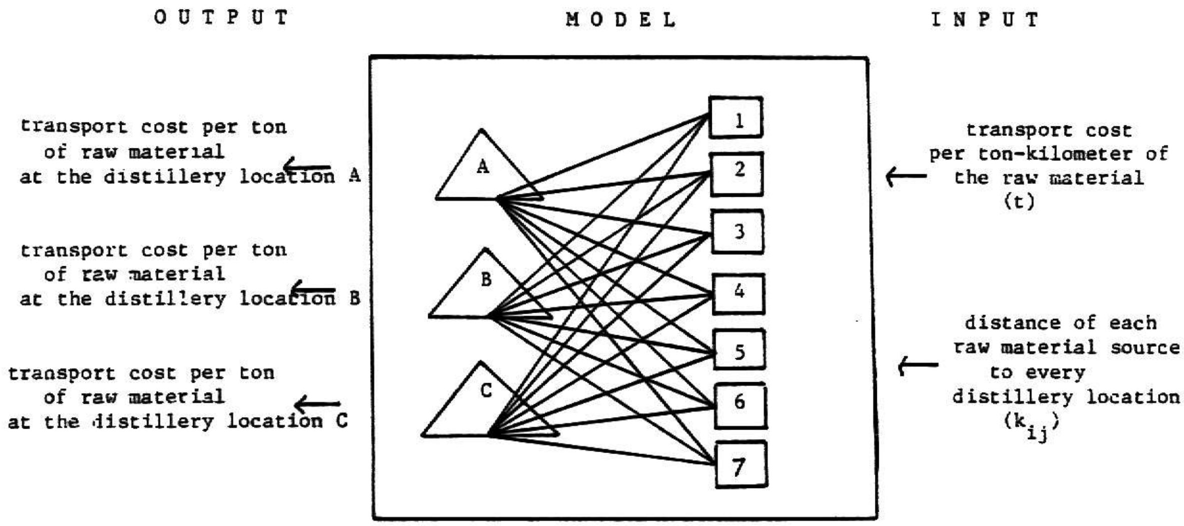
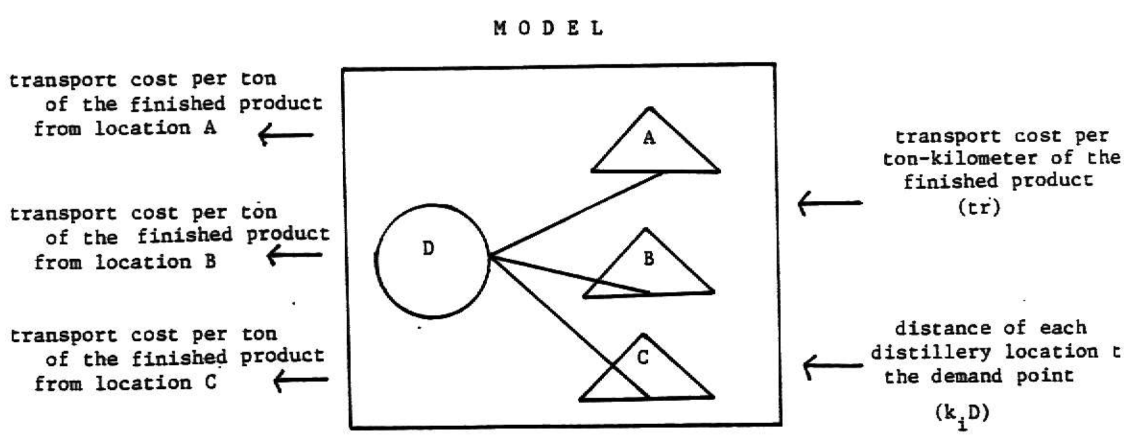


FIGURE 3

THE FINISHED PRODUCT TRANSPORT COST MODEL



Least Cost Distillery Location. The least cost distillery location would be where the sum of the T_i and Tr_i is minimum.

In notation form, let this be:

$$T_i = T_i + Tr_i$$

This equation takes into consideration the distance and raw material transport cost per ton from every raw material source, and the distance and finished product transport cost per ton from each distillery location to the demand point.

Hence, it considers raw material and finished product shipments respectively.

A Modified Least Cost Model

A modified model may be obtained by considering the amount that each raw material source are likely to provide. For instance, source 1 may provide more than source 2. Source 2 may provide more than source 3 and so on.

In this case, the basic raw material transport cost model should be modified.

Let q_j be the amount if tons which a raw material source will provide to any of the distillery locations.

The raw material transport cost from a source to a distillery location will then be obtained by multiplying the amount of raw material (q_j) times the transport cost per ton-km of the raw material (t) times the distance of a raw material source to a distillery location (k_{ij}).

Again, since each possible distillery location will obtain all raw material requirements from each and every raw material source, the transport cost of the raw material from each source to a distillery location is the summation of the product obtained above.

Let T_i' be this raw material transport cost. Then,

$$T_i' = \sum_{j=1}^{N} (k_{ij})(q_j)(t) \text{ for each distillery location } i$$

This finished product transport cost model may be modified by expressing its previous basic equation in terms of peso value. This is done so that the unit of measurement of the finished product transportation cost is the same as the modified raw material transport cost.

Let q_D be the amount which the distillery will transport to the demand point. (It must be remembered that all the finished product are bought and consumed). Then, the transport cost of the product from a distillery location to the demand point is obtained by multiplying the amount of finished product (q_d) times the transport cost per ton-km of the finished product (tr) times the distance of each distillery location to the demand point (D).

Let $T'r_i$ be this modified finished product transport cost.

Then,

$$T'r_i = (k_{iD})(q_D)(tr)$$

The modified distillery least cost location would be where T_i' and $T'r_i$ are minimum.

In notation form, let this be:

$$T_i' = T_i' + T'r_i$$

This modification takes into consideration the amount of raw materials which each raw material source is able to supply.

Variations In Distances

The distance from a raw material source to a distillery location is a measure of the distance travelled in transporting the raw material to the distillery using existing highways.

Such a situation also follows when the finished product is transported to the demand point.

However, another least cost location test can be made by assuming straight line distances which could generally be made possible by a road construction development program. The raw material and the finished product will then likely be transported in relatively shorter distances compared to existing roads.

Such a situation could easily fit the models described earlier by modifying the k_{ij} and k_{iD} components. The shortest distance will be measured from each raw material source to every possible distillery location; and from each distillery location to the demand point.

Under this premise, the following question could be tested: Will the least cost site obtained from the previous models change?

Isotimes and Isodapanes

Another basic and simple way to understand the alcohol distillery location problem is by considering that in the absence of production cost differences, the best location will be at the point of minimum transport cost which may be at a material source, at the market, or at an intermediate point.

The least cost location is found by constructing isotims around given material and market points. Isotims are lines of equal raw material transport cost or finished product transport cost.

As these isotims are formed, they tend to touch one another. The points where raw material isotims and finished product isotims touch one another represent total transport cost. These points are then used to form isodapanes. Isodapanes are lines connecting points of equal total transport cost. They are useful in identifying least cost locations.

The raw material transport cost is expressed as a function of distance. It also follows for the finished product transport cost. The raw material transport cost may be obtained by multiplying the transport cost per ton-km of the raw material and the weight that is transported from a raw material source. This refers to the cost per unit distance that will be incurred in transporting a given weight of raw material from the source to the distillery.

The finished product transport cost is also expressed as a function of distance. It is expressed by multiplying the transport cost per ton-km of the finished product and its weight. This also represents the cost that will be incurred in transporting a given weight of a finished product per unit distance.

In mathematical terms, let:

x_j = the total weight of raw materials (tons) that each raw materials source j will supply to the distillery

Q = the weight of the finished product that will be transported to the demand point

t = transport cost per ton-km of the raw material (it is spatially invariant)

tr = transport cost per ton-km of the finished product (it is spatially invariant)

I_j = raw material transport cost per kilometer from each source j

H_D = finished product transport cost per kilometer

Then,

$$I_j = (t)(x_j)$$

$$H_D = (tr)(Q)$$

The raw material transport cost (I_j) will increase as distance from each raw material source (k_j) increases. The finished product transport cost (H_D) will increase as the distance from the demand point (k_D) increases.

Hence, raw material isotim from a raw material source j travelling a certain distance k_j is obtained by multiplying I_j time k_j. In like manner, finished product isotim from the demand point D travelling a certain distance k_D is obtained by multiplying H_D times k_D.

Raw material isotim 1 = $(I_j)(k_{j1})$; Finished product isotim 1 = $(H_D)(k_{D1})$

Raw material isotim 2 = $(I_j)(k_{j2})$; Finished product isotim 2 = $(H_D)(k_{D2})$

.
.
.

Raw material isotim N = $(I_j)(k_{jN})$; Finished product isotim N = $(H_D)(k_{DN})$

The Linear Programmin Approach

This approach is finally applied to determine the distance that has to be traveled from each raw material source and from the demand point that will minimize transport cost.

It will be done as follow-up tool of the isotim and isodapane approach.

The objective function is then expressed as:

$$\min TC = I_1k_1 + I_2k_2 + I_3k_3 + I_4k_4 + I_5k_5\ I_6k_6 + I_7k_7 + H_Dk_D$$

Subject to the following constraints:

$k_1 + k_D$ = distance (kilometers) from source 1 to the demand point

$k_2 + k_D$ = distance (kilometers) from source 2 to the demand point

$k_3 + k_D$ = distance (kilometers) from source 3 to the demand point

$k_4 + k_D$ = distance (kilometers) from source 4 to the demand point

$k_5 + k_D$ = distance (kilometers) from source 5 to the demand point

$k_6 + k_D$ = distance (kilometers) from source 6 to the demand point

$k_7 + k_D$ = distance (kilometers) from source 7 to the demand point

note: each $(k_j + k_D)$ are fixed but the individual k_js and the k_D are allowed to vary until the minimum transport cost is obtained.

CHAPTER V

EMPIRICAL ANALYSIS

Ideal Weights

Each possible distillery location will obtain all raw material requirements from seven different areas. The transport cost per ton-km is spatially invariant. The distance of each possible distillery site from each of the seven different raw material sources differs. Likewise, the amount of raw material that each source will provide differs (Figure 4).

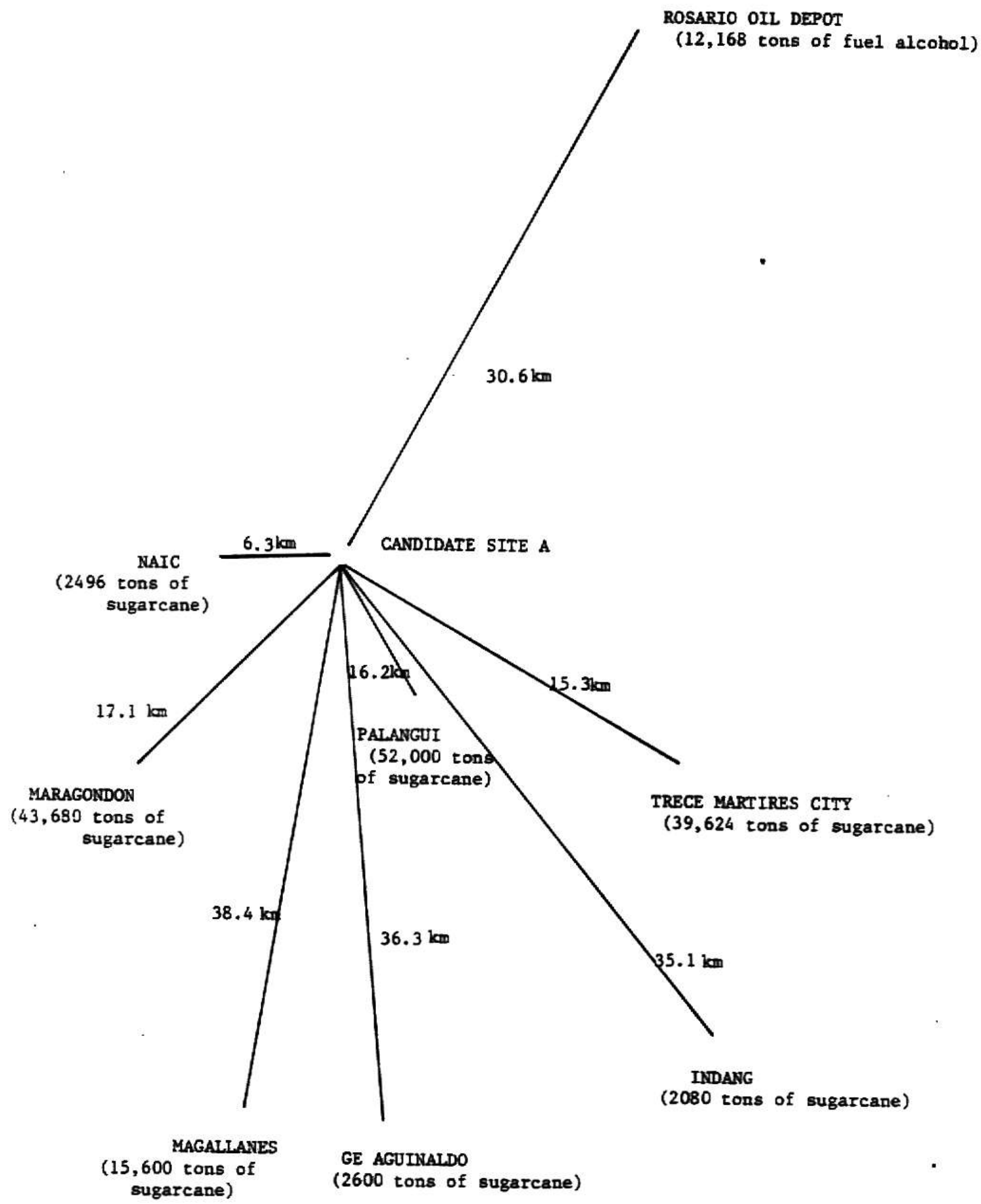
Given this situation, the least cost distillery location was evaluated on the basis of ideal weights following Alfred Weber's approach. Calculating the total ton-kilometers from various raw material sources resulted in the identification of raw material sources as possible locations of the distillery (Table 7). This implies a raw material orientation. Hence, the distillery is preferably located near raw material sources.

The significance of the ₱ 10.39 ideal weight value for sugarcane sources as against ₱ 1.267 for the market arises from the reduction of transport costs which will be achieved by location near the sugarcane sources.

The Three Candidate Sites

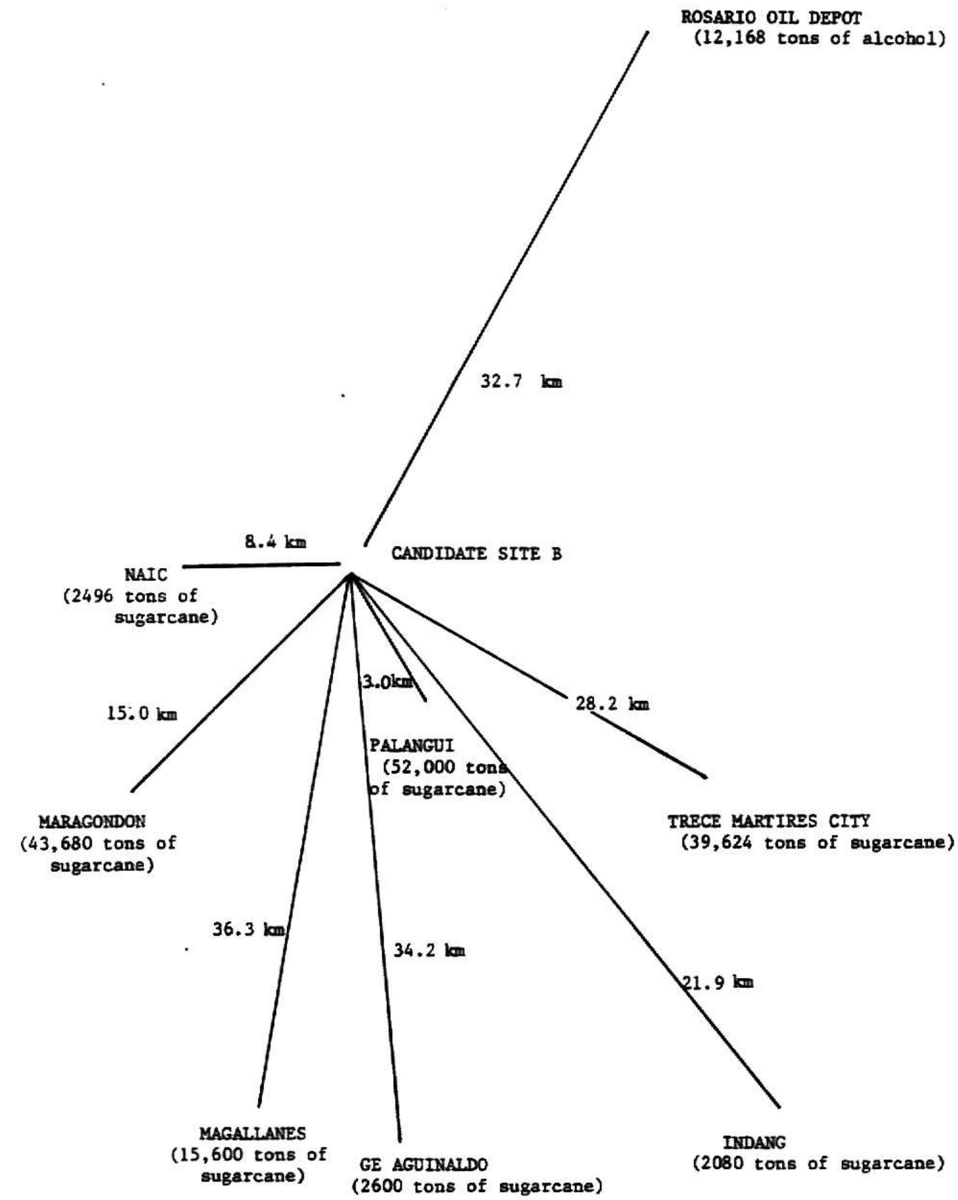
The three candidate sites were evaluated on the basis of raw material transport cost, finished product transport cost, and total transport cost (raw material + finished product transport cost).

FIGURE 4
CANDIDATE SITE A



Note: not drawn to scale

FIGURE 5
CANDIDATE SITE B



Note: not drawn to scale

FIGURE 6
CANDIDATE SITE C

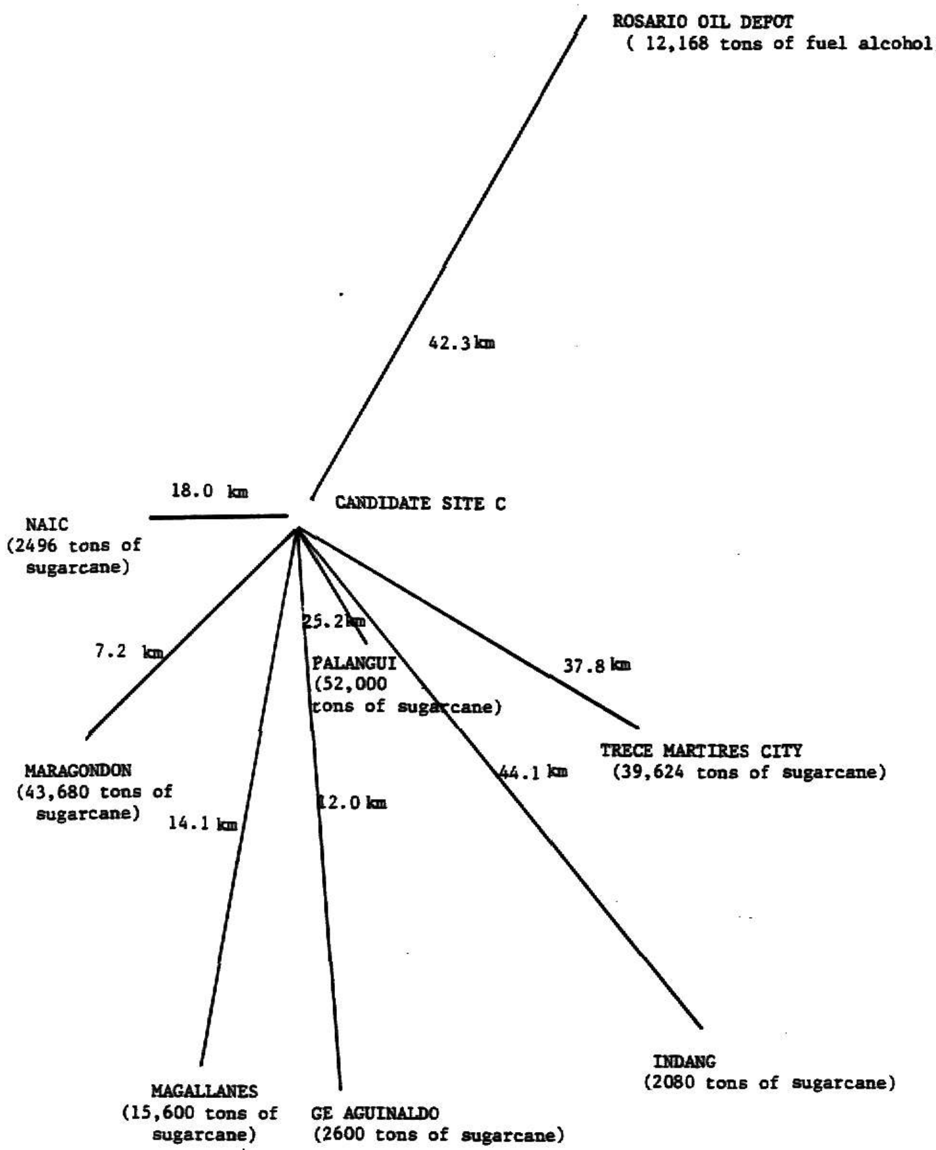


TABLE 7

IDEAL WEIGHTS FOR RAW MATERIAL SOURCES AND MARKET

		WEIGHT (tons)	TRANSPORT COST PER TON-KM	IDEAL WEIGHT
<u>Sugarcane Sources</u>				
SOURCE	MARKET			
MARAGONDON	ROSARIO	12.99	0.80	10.39
NAIC	ROSARIO	12.99	0.80	10.39
INDANG	ROSARIO	12.99	0.80	10.39
MAGALLANES	ROSARIO	12.99	0.80	10.39
PALANGUI	ROSARIO	12.99	0.80	10.39
GE AGUINALDO	ROSARIO	12.99	0.80	10.39
T MARTIRES	ROSARIO	12.99	0.80	10.39
<u>Market</u>				
SOURCE	MARKET			
MARAGONDON	ROSARIO	1.0	1.267	1.267
NAIC	ROSARIO	1.0	1.267	1.267
INDANG	ROSARIO	1.0	1.267	1.267
MAGALLANES	ROSARIO	1.0	1.267	1.267
PALANGUI	ROSARIO	1.0	1.267	1.267
GE AGUINALDO	ROSARIO	1.0	1.267	1.267
T MARTIRES	ROSARIO	1.0	1.267	1.267

By using actual highway distances, Candidate Site B has the least raw material transport cost while Candidate Site A has the least finished product transport cost. The former site, nevertheless has the lowest total transport cost (Table (). It is 8.7% lower than Candidate Site A and 32% lower than Candidate Site C.

By using straight line distances, similar results were obtained. Candidate Site B has the least raw material transport cost and A has the least finished product transport cost. The lowest total transport cost was again observed in Candidate Site B (Table 10).

An attempt was also made to determine what happens if each of the raw material sources can provide an equal volume of raw materials to the distillery. Results indicate that Candidate Site B has the lowest raw material transport cost and Candidate Site A has the lowest finished product transport cost. Once again, Candidate Site B has the least total transport cost (Table 11).

These results reflect that Candidate Site B is the least cost site in terms of transport cost. The lower finished product transport cost of Candidate Site A is not enough to offset its higher procurement cost.

The test that was initially used here took into consideration the role of the weight of the raw material volume that must be transported from each raw material source to the distillery under actual highway distance. This allowed the transport cost per kilometer of the raw material to vary from one source to another. To save on raw material transport cost, the distillery should be located close to the raw material sources that supplied more raw material tons. From

TABLE 8

PROCUREMENT AND DISTRIBUTION COST

UNIT: THOUSAND PESOS

CANDIDATE SITE	RAW MATERIAL PROCUREMENT COST							DISTRIBUTION COST
	MARAGONDON	NAIC	INDANG	MAGALLANES	PALANGUI	GE AGUINALDO	T. MARTIRES	
A	597.542 *	12.581	58.406	479.232	673.920	75.504	484.995	471.730
	(400.845) #	(10.185)	(41.434)	(280.800)	(274.560)	(45.552)	(437.446)	(300.612)
	/308.933/	/113.818/	/634.127/	/693.745/	/292.674/	/655.806/	/276.414/	/471.730/
B	524.160	16.775	36.442	453.024	24.800	71.136	893.912	504.103
	(377.395)	(13.779)	(31.949)	(228.384)	(74.880)	(35.568)	(475.485)	(351.485)
	/270.994/	/151.757/	/395.652/	/655.806/	/54.199/	/617.867/	/509.469/	/504.103/
C	251.597	35.946	73.382	175.968	1048.320	24.960	1198.222	652.097
	(188.698)	(18.572)	(34.944)	(160.992)	(299.520)	(22.464)	(513.524)	(443.981)
	/130.077/	/325.193/	/796.723/	/254.735/	/455.270/	/216.795/	/682.906/	/652.097/

*Numbers in ( ) are straight line distances

#Numbers in / / assumed equal volume of raw material shipment from each source

TABLE 9
TRANSPORT COST OF EACH CANDIDATE SITE

UNIT: THOUSAND PESOS

CANDIDATE SITE	PROCUREMENT COST	DISTRIBUTION COST	TRANSPORT COST
A	2382.180	471.730	2853.910
B	2020.249	504.103	2524.352
C	2808.395	652.097	3460.492

TABLE 10
TRANSPORT COST OF EACH CANDIDATE SITE
USING STRAIGHT LINE DISTANCES

UNIT: THOUSAND PESOS

CANDIDATE SITE	PROCUREMENT COST	DISTRIBUTION COST	TRANSPORT COST
A	1490.822	300.612	1791.434
B	1237.440	351.485	1588.925
C	1238.714	443.981	1682.695

TABLE 11

TRANSPORT COST OF EACH CANDIDATE SITE
CONSIDERING EQUAL VOLUME OF RAW MATERIAL SHIPMENT

UNIT: THOUSAND PESOS

CANDIDATE SITE	PROCUREMENT COST	DISTRIBUTION COST	TRANSPORT COST
A	2975.517	471.730	3447.247
B	2655.744	504.103	3159.847
C	2861.699	652.097	3513.796

Table 5, these sources are Palangui (52,000 tons), Maragondon (43,680 tons) and Trece Martires City (25,000 tons). Around 85% of the sugarcane needed by the distillery are supplied by these sources.

Table 6 shows that in two out of the three major raw material sources, Candidate Site B is closer than Sites A and C.

The second test considered straight line distances. Results again suggest that Candidate Site B is the least cost site. An examination of Table 6 agains shows that Site B is closer to the major raw material sources than A and C using straight line distances.

The third test was done to isolate the effect of the weights of the sugarcane that needs to be transported. In other words, it ignored the presence of major raw material sources and only considered the role of highway distance on the determination of the least cost site. Again, Candidate Site B has the least total transportation cost.

Other Possible Distillery Sites

Each of the raw material sources were examined as other possible locations for the alcohol distillery.

Results show that there is one raw material source location (Naic) that offers a lower transport cost than Candidate Site. Transport cost is lower by 14% in Naic compared to Site B. Furthermore, this location offers both a lower raw material transport cost and finished product transport cost than any of the candidate sites.

By looking at the location mag (Figure 1), it can be seen that Naic lies near the intersection of two highways. It is relatively

TABLE 12
DISTANCES FROM OTHER POSSIBLE DISTILLERY SITES

UNIT: KILOMETERS

CANDIDATE SITES	RAW MATERIAL SOURCES							DEMAND POINT
	MARAGONDON	NAIC	INDANG	MAGALLANES	PALANGUI	GE AGUINALDO	T. MARTIRES	OIL DEPOT
MARAGONDON	-	10.8	36.9	21.3	18.0	19.2	30.6	35.1
NAIC	10.8	-	28.8	32.1	9.9	30.0	19.8	24.3
INDANG	36.9	28.8	-	55.4	18.9	31.2	20.1	45.6
MAGALLANES	21.3	32.1	55.4	-	39.3	7.8	53.4	56.4
PALANGUI	18.0	9.9	18.9	39.3	-	47.1	30.8	34.2
GE AGUINALDO	19.2	30.0	31.2	7.8	47.1	-	51.3	54.3
T. MARTIRES	30.6	19.8	20.1	53.4	30.8	51.3	-	25.5

Source: Philippine National Alcohol Commission

TABLE 13

PROCUREMENT, DISTRIBUTION, AND TRANSPORT COSTS AT OTHER POSSIBLE DISTILLERY SITES

UNIT: THOUSAND PESOS

CANDIDATE SITES	RAW MATERIAL SOURCES							PROCUREMENT COST	DISTRIBUTION COST	TRANSPORT COST
	MARAGONDON	NAIC	INDANG	MAGALLANES	PALANGUI	GE AGUINALDO	T.MARTIRES			
MARAGONDON	-	21.568	61.402	265.824	748.800	39.936	969.989	2107.519	541.102	2648.621
NAIC	377.395	-	47.924	400.608	411.840	62.400	627.640	1927.807	374.609	2302.416
INDANG	1289.434	57.513	-	691.392	786.240	64.896	637.150	3526.625	702.970	4229.595
MAGALLANES	744.307	64.104	92.185	-	1634.880	16.224	1692.727	4244.427	869.462	5113.889
PALANGUI	628.993	19.770	31.450	490.464	-	97.968	976.329	2244.974	527.227	2772.201
GE AGUINALDO	670.924	59.910	51.917	97.344	1959.360	-	1626.159	4465.614	837.086	5302.700
T. MARTIRES	1069.286	39.541	33.446	666.432	1281.280	106.704	-	3196.689	393.107	3589.796

less distant to the Rosario Oil Depot than any of the candidate sites and fairly accessible to the other raw material sources.

Compared to Candidate Site B, Naic is closer to two out of the three major raw material sources. Based on the information obtained, it could not be fully explained why Naic was not chosen as one of the candidate sites. A possible explanation could be that factors other than transport cost were considered in listing the candidate sites.

One of these factors may be the government's plan of initiating development in the areas surrounding the candidate sites. It must be recalled that these areas are favorable for sugarcane production but the cropping area for sugarcane has decreased to less than half in three years. It is due to the lower price of sugar, higher price of farm inputs, and higher transportation cost from the farm to the mill.

Isotim and Isodapane Analysis

Other possible sites were determined using the isotim and isodapane analysis. Results show that Naic lies in an isodapane having a lower transportation cost thant Candidate Site B's isodapane.

The isodapane mapping procedure shown in Figure 7 signifies that Naic belongs to a set of points which have a lower transport cost than Candidate Site B. This result supports the earlier finding that Naic has a lower transport cost than Site B.

It must be recalled that the isotim-isodapane approach assumed that transport is equally possible in all directions. Hence, isotims have been constructed in the form of evenly spaced concentric circles.

TABLE 14

PROCUREMENT COSTS OF SUGARCANE PER KILOMETER

UNIT: THOUSAND PESOS/KILOMETER

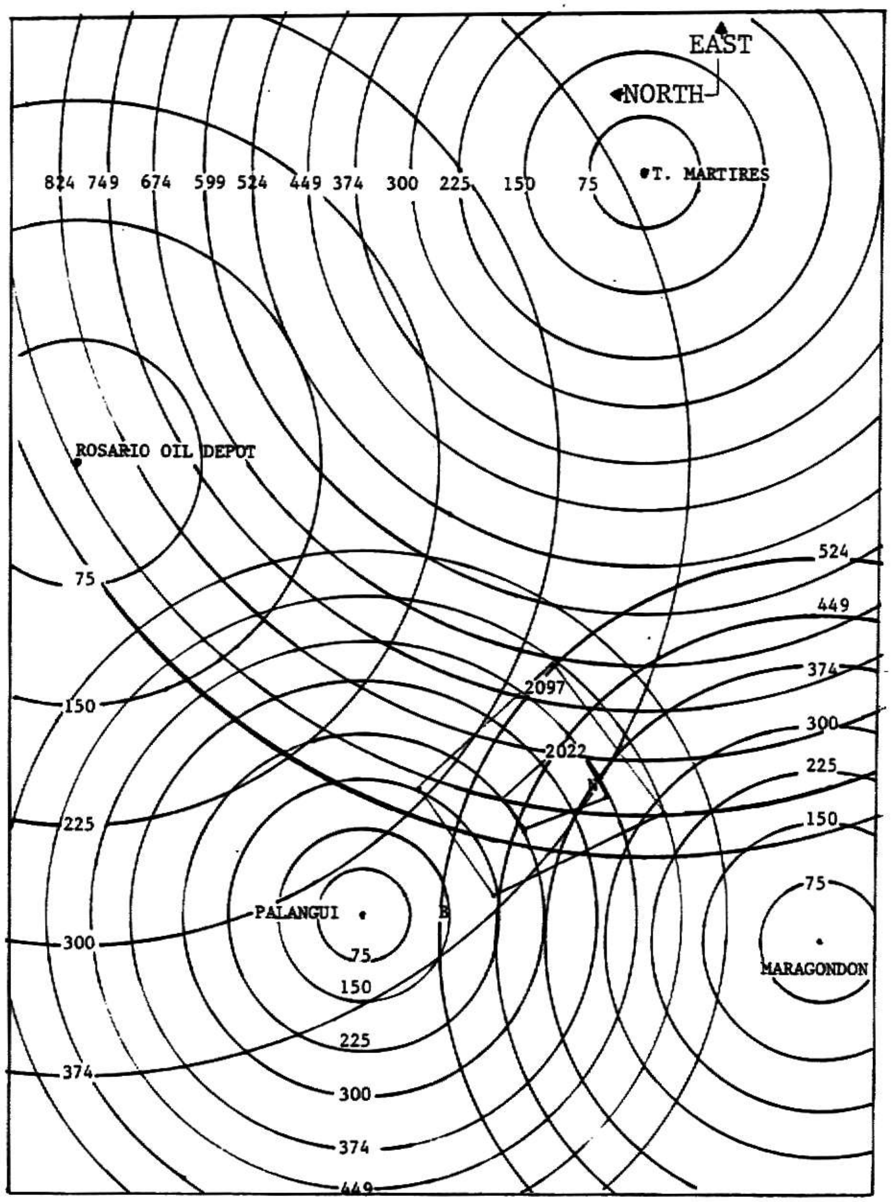
RAW MATERIAL SOURCE	PROCUREMENT COST PER KILOMETER
MARAGONDON	34.944 (18.066)*
NAIC	1.997 (18.066)
INDANG	1.664 (18.066)
MAGALLANES	12.480 (18.066)
PALANGUI	41.600 (18.066)
GE AGUINALDO	2.080 (18.066)
T. MARTIRES	31.699 (18.066)

*Numbers in ( ) assumed equal volume of raw material shipment from each source

TABLE 15
DISTANCES AND ISOTIM VALUES

ISOTIM VALUE (thousand pesos)	74.922	149.844	224.766	299.688	374.610
DISTANCE FROM: (in kilometers)					
MARAGONDON	2.144	4.288	6.432	8.576	10.720
NAIC	37.517	75.034	112.551	150.068	187.585
INDANG	45.025	90.050	135.075	180.100	225.125
MAGALLANES	6.003	12.006	18.009	24.012	30.015
PALANGUI	1.801	3.602	5.403	7.204	9.005
GE AGUINALDO	36.020	72.040	108.060	144.080	180.001
T MARTIRES	2.364	4.728	7.092	9.456	11.820
ROSARIO Oil Depot	4.860	9.720	14.580	19.440	24.300

FIGURE 7
ISOTIMS AND ISODAPANES



The Linear Programmin Approach

The linear programmin approach was used to determine the distance that has to be travelled from each raw material source and the demand point so that transport cost is minimized.

Results show that the minimum transport cost could be achieved if a zero distance will be travelled from Naic (a raw material source). This implies that the least cost distillery site is at Naic. This supports the results of the isotim-isodapane approach and another previous finding that Naic is preferred than Candidate Site B as the least cost site.

This approach has also facilitated the determination of a least cost point inside a low cost isodapane, and has strengthened the finding that Naic is the least cost site.

Further Insights on Transport Cost

The way in which transport per ton-km is related to distance of shipment may also depend on the mode of transport. For instance, trucking rates tend to be proportional to distance, railroad rates tend to increase at a decreasing rate with respect to distance, and water shipping rates also tend to increase at a decreasing rate with respect to distance.[9]

This means that for short hauls trucks tend to be most economical, for medium-distance hauls rails tend to be most economical, and for long-distance hauls shipping by water tends to be most

[9] H. O. Nourse, Regional Economics (New York: McGraw-Hill Book Company, 1968), pp. 69-70.

TABLE 16
RESULTS OF THE LINEAR PROGRAMMING APPROACH

EXECUTOR. MPS/360 V2-M11 B2/256

SECTION 1 - ROWS

NUMBER	...ROW..	AT	...ACTIVITY...	SLACK ACTIVITY	..LOWER LIMIT.	..UPPER LIMIT.	.DUAL ACTIVITY
1	/	BS	1700.33400	1700.33400-	NONE	NONE	1.00000
2	D1	EQ	35.10000	.	35.10000	35.10000	34.94400-
3	D2	EQ	24.30000	.	24.30000	24.30000	109.05100
4	D3	EQ	45.60000	.	45.60000	45.60000	1.66400-
5	D4	EQ	56.40000	.	56.40000	56.40000	12.48000-
6	D5	EQ	34.20000	.	34.20000	34.20000	41.60000-
7	D6	EQ	54.30000	.	54.30000	54.30000	2.08000-
8	D7	EQ	25.50000	.	25.50000	25.50000	31.69900-

EXECUTOR. MPS/360 V2-M11 B2/256

SECTION 2 - COLUMNS

NUMBER	.COLUMN.	AT	...ACTIVITY...	..INPUT COST..	..LOWER LIMIT.	..UPPER LIMIT.	.REDUCED COST.
9	X1	BS	10.80000	34.94400	.	NONE	.
10	X2	LL	.	1.59700	.	NONE	111.04800
11	X3	BS	21.30000	1.66400	.	NONE	.
12	X4	BS	32.10000	12.48000	.	NONE	.
13	X5	BS	9.70000	41.60000	.	NONE	.
14	X6	BS	30.00000	2.08000	.	NONE	.
15	X7	BS	1.20000	31.69900	.	NONE	.
16	X8	BS	24.30000	15.41600	.	NONE	.

economical (Figure 8). Furthermore, the exact distance at which one mode of travel becomes more economical than another will depend on the particular rates, the type of commodity, direction of haul, and volume and size of shipment.

A listing of the variety of transport modes are as follows:[10]

railroads (all classes of traffic)

water carriers (all classes of traffic)

highway vehicles (all classes of traffic)

pipe lines (bulk liquids and gases)

aircraft (where speed is essential and surface area is difficult

pack animals (in difficult terrain)

belt, cable, or rail conveyors of various types (short distances)

human carriers (short distances and small quantities)

self-delivery (livestock and self-propelled vehicles)

On any given type of transport mode, transport costs generally increase less rapidly than in proportion to distance. This is primarily because terminal costs and other related expenses are independent of the length of haul.

This tendency of transport costs to taper off with increasing distance is characteristic of all transport modes but relatively much more marked in those which need a heavy investiment in terminal facilities. Generally then, transport modes with relatively low terminal cost and high line-haul cost have an advantage for shorter hauls.

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[10]E. M. Hoover, The Location of Economic Activity (New York: McGraw-Hill Book Company, 1963), pp. 15-16.

Transport modes involving high terminal, pick-up, and delivery expenses and low line-haul costs are in a position to be effective for longer hauls.

In transporting the sugarcane from the raw material sources to the fuel alcohol distillery, it was planned that six-ton trucks will be the mode of transport. In the analysis, the raw material sources were viewed as assembly points where the sugarcane coming from the different farms are brought for final shipment to the distillery.

However, one potential area of inquiry may arise and that is, the possibility of using a cheaper transport mode that could transport the sugarcane from the farms to the assembly point or to some other points between the farm and the distillery.

To examine this, consider the raw material sources as circular areas with the assembly point as the midpoint. The radius of each of these circles will be the average distance from a sugarcane farm to an assembly point. Now, given this, could a transport mode other than a truck be capable of delivering the sugarcane at a cheaper transport cost? If so, how far could the economic haul distance be?

A question similar to this was tackled in a development project in east central Philippines. The suggested transport mode was the "bullet cart". A "bullet cart" is an indigenous transport mode that travels on rails (similar to a cargo railcar but having no roofs and sides) and initially pushed by men until it gains speed. It is used in the provinces for moving people and things at short distances.

A proposed transport mode, such as a "bullet cart," may be generally evaluated by looking at it as an investment. The importance of investiment analysis is critical for the investments are long lived and commonly exercise a decisive influence on the way in which the distillery will operate and the communities around it live and grow. The essence of such analysis is the comparison of a future stream of receipts from a transport mode with the future pattern of costs, so that a decision can be made on which transport mode is financially most attractive or whether indeed the community may prefer to reject the alternative in favor of expenditure elsewhere.

Normally the tools of analysis will be calculating the rate of return, the net present value, and undertaking a cost-benefit analysis.

From the point of view of the distillery, the future stream of receipts will be the net positive change in revenues as a result of a reduction in transport cost. From the point of view of the community, these receipts may take the form of higher family income by enhancing job opportunities, and mobility factors through the construction of roads or railways.

Costs will include fixed outlays such as moving stock (trucks and bullet carts) and roads (or railways). Variable costs such as operating and maintenance expenses constitute the other part of the future pattern of costs.

By roughly comparing the investment decision between a truck and a "bullet cart," it can be inferred from Table 17 that a truck is more likely to be preferred than a "bullet cart" from the assembly points to the distillery. From the individual farms to the assembly points, both a truck and a "bullet cart" may be used.

FIGURE 8
TRANSPORT COST GRADIENT

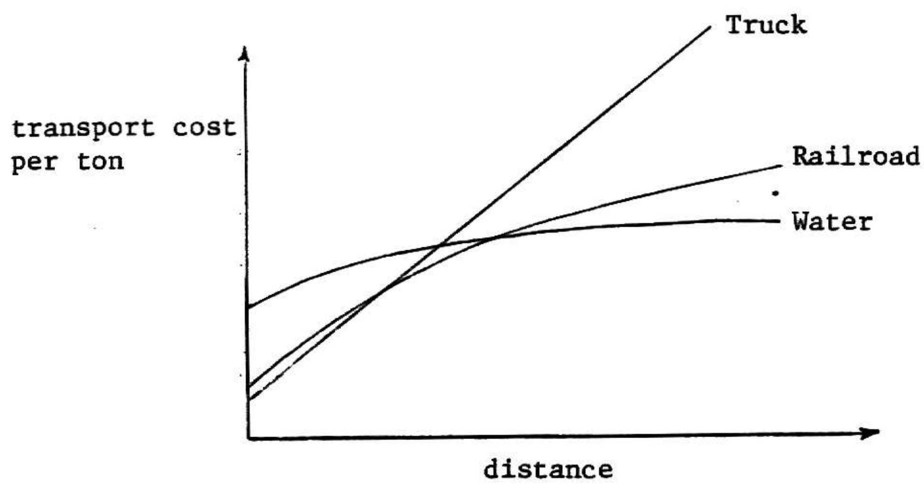

FIGURE 9
TRANSPORT COST GRADIENT
WITH "BULLET CART"

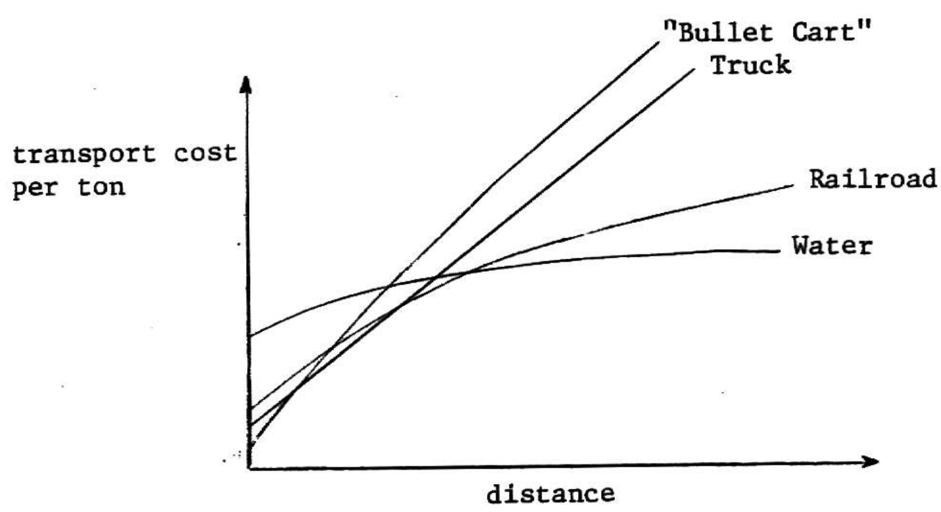

TABLE 17
GENERAL COMPARISON OF
TRUCKS AND "BULLET CARTS"

RAW MATERIAL SOURCE	DISTANCE OF FARMS TO ASSEMBLY POINT	FUTURE STREAM OF RECEIPTS		MOVING STOCK		OTHER FIX INVESTMENTS		VARIABLE COSTS	
		TRUCKS	"BULLET CARTS"	TRUCKS	"BULLET CARTS"	TRUCKS	"BULLET CARTS"	TRUCKS	"BULLET CART"
MARAGONDON	1.635 km	Good	Better	High	Low	High	High	High	Low
NAIC	0.391	Better	Good	High	Low	Low	High	High	Low
INDANG	0.357	Good	Better	High	Low	High	High	High	Low
MAGALLANES	0.977	Good	Better	High	Low	High	High	High	Low
PALANGUI	1.784	Good	Better	High	Low	High	High	High	Low
GE AGUINALDO	0.399	Better	Good	High	Low	Low	High	High	Low
T MARTIRES	1.557	Better	Good	High	Low	Low	High	High	Low

A hypothetical transport cost gradient for a "bullet cart" was drawn (Figure 9) and compared to other transport modes. This shows that a "bullet cart" may be less expensive to use for shorter distances compared to a truck. However, an actual empirical test must be conducted to verify this hypothesis.

The least cost location of a fuel alcohol distillery may not be greatly affected by considering another relatively cheaper transport mode. But such a situation poses a potential area for further inquiry.

CHAPTER VI

CONCLUSION

The least cost site for a fuel alcohol distillery is proferably to be located near raw material sources. The findings of this study suggests that weight losing processes tend to locate near the sources of their materials.

Of the several possible distillery location, raw material source NAIC has been selected as the least cost site. It has a lower transport cost than any of the candidate sites and is relatively nearer major raw material sources. Likewise, it is fairly less distant to the Rosario Oil Depot.

However, it must be emphasized that transport cost was the only factor considered in evaluating a least cost site.

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A LOCATIONAL ANALYSIS OF A PHILIPPINE FUEL ALCOHOL DISTILLERY

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AN ABSTRACT OF A MASTER'S REPORT

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The objective of this study was to determine a least cost site for a Philippine fuel alcohol distillery. It utilized the least cost theory of industrial location as the major theoretical approach. This approach has found application in industries where the transport cost of assembling inputs and distributing outputs is the dominant location factor.

Fuel alcohol is alcohol obtained from any plant material or biomass, and is used as motor fuel either alone or as alcohol blends.

In order to help reduce its dependence on crude oil, the Philippines planned to construct distilleries to convert sugarcane and other crops to fuel alcohol. To ensure viability, a locational analysis leading to the determination of least cost sites for each of these distilleries is important. This study analyzed one such distillery which is planned to be built near Manila.

Weber's ideal weight concept was initially applied to determine whether the fuel alcohol distillery will locate at the raw material source or at the market. A transport cost model was formulated and used to evaluate three candidate sites and several potential distillery locations. The isotim-isodapane and linear programming approaches were further applied to determine the least cost location.

Results identify raw material sources as possible locations. Among the three candidate sites, Site B had the least total transport cost. However, NAIC (a raw material source) had a lower transport cost than any of the candidate sites. This finding was later supported by the results of the isotim-isodapane approach. The linear programming analysis eventually and finally pinpointed NAIC as the least cost distillery location for a Philippine fuel alcohol distillery.