THE CONSUMPTION AND DISTRIBUTION OF OIL PRODUCTS IN IRĀN

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Oil products occupy an important place among consumer items because of their constant use by the public and industry. Therefore, one of the essential tasks of any nation's oil industry is to make every effort to provide these products at a reasonable price. Particularly in the developing countries where the aim is always better living conditions, the correct distribution of oil is of the utmost importance.

By the correct distribution of products we mean that any amount, at any time or place should be placed at the disposal of the consumer. Naturally, this goal cannot be attained without a well-planned distribution mechanism which should be developed in such a way as to provide the most distant areas of the country with any product at a minimum cost. One, or a mixture of transport vehicles, may be used for delivering oil products from the refineries for the markets. The choice and planning of the best means for meeting market demand is one of the most important economic problems of the oil industry.

A. Oil Production and Distribution Centres

Production centres

Production centres are the refineries where various consumable oil products are produced. At present, the following are the country's oil refineries: the Ābadān Refinery, the Kermanshāh Refinery, the Masjed Soleimān Refinery

and the Tehrān Refinery.

The Ābādān Refinery:[1] At present, the Ābādān Refinery is one of the major sources of oil production. Its average daily capacity for crude oil amounts to 430,000 barrels. Before the Tehrān Refinery was put into operation, the refining capacity for crude oil of the Ābādān Refinery, for internal consumption, reached 100,000 barrels a day.[2] From 1954 onwards the Ābādān Refinery's crude oil capacity for export increased gradually reaching 300,000 barrels a day.[3]

Despite the ever-increasing demands of the domestic market, (particularly for semi-distilled products) the National Iranian Oil Company does not think it advisable to decrease the refining capacity of crude oil for exports and increase the production capacity of oil products for internal consumption.[4] Out of the 430,000 barrel capacity of the Ābādān Refinery, 300,000 barrels are used for the production of export products, 100,000 barrels are used for internal consumption products and the remaining 30,000 is for reserves.

The Kermānshāh Refinery: This is a relatively small refinery which produces only four main oil products (gasoline, kerosene, gas oil and fuel oil) in addition to insecticide.

The requirements of the western and north western areas as far as economically feasible, are provided by the Kermānshāh Refinery and the Naft-e-Shāh Distillery through local pipelines and oil tankers.[5]

Masjed-Suleimān Filtering Equipment: This is not a refinery but is rather a complex of equipment planted near the oil tank and used to separate gas oil from crude oil. The remaining crude oil is then sent for further refining to domestic or foreign refineries.[6]

The Tehrān Refinery: was created and began operations in early 1347 (1960). About $90 million was spent on this refinery which is designed to produce the maximum amount of semi-distilled products. Its designed capacity is about 85,000 barrels a day (or an average of 81,000 barrels per calendar day); at present it runs at 98,000 barrels a day.

The crude oil for the Tehrān Refinery is provided from Ahwāz.[7]

Table 1 shows the share of each of the existing refineries in domestic production.

Table 1: Irān (1967-68). Share of main domestic producers of oil products in providing the requirements of the country (Figures are percentages of the total)

	Ābādān		Tehrān		Kermānshāh		Masjed Suleimān	
	1967	1968	1967	1968	1967	1968	1967	1968
Liquid gas	100	89		11				
Aeroplane fuel	100	100						
Fuel oil	84	40		43	16	17		
Kerosene	94	75		20	6	5		
Gasoline	98	84		14	2	2		
Gas oil	1	1		54	9	9	90	26
Tar	100	83		17				
Other products	100	72		27		1		

Source: National Iranian Oil Company, Distribution Section, *'Amaliāt-e 1968*, (Operations 1968) Tehran, 1968, p.18.

As shown in Table 1, the Ābādān Refinery produces all oil products and the Tehrān Refinery also produces all the items except for jet fuel. The Table further shows that production of most of the main oil products by the Ābādān Refinery decreased in 1968. In particular we should note that in the case of three main oil products (fuel oil, kerosene and gasoline) the total production of Ābādān and Tehrān together in 1968 equals Ābādān's production of these products in 1967. It is clear that after the commencement of the operation of the Tehrān Refinery in 1968, Ābādān would decrease its production of these three items. However, we may ask, that, in view of this decrease, what other use was made of the extra capacity of Ābādān? In recent years, the operations of the Ābādān Refinery have gradually been

transformed; its production of major products has decreased while production of other by-products such as jet fuel etc., has been increased. Higher profits from the latter products have been the most decisive factor in this change.

The future of oil refining

Ever increasing consumption and the inadequacy of existing resources has meant that projects for the creation of new refineries or the expansion of the capacity of existing ones have been approved. The following basic points should be considered in planning and choosing the site of the new refineries: (a) the capacity of the refinery should be designed to meet the requirements of the refinery's economic areas both in terms of quality and quantity; (b)care should be taken to make extra provisions for several years to come in the refining capacity of the refinery according to the economic area. In Iran, due to the size of the country and the relative distance between cities, the minimum economic refining capacity has been estimated at 50 to 80 thousand barrels per day.[8]

The site of the refinery depends on the economic feasibility of the project as regards the transportation of the original crude oil and its by products. Naturally the closer the refinery is to the consumer market the better. In order to specify the necessary equipment required in a refinery and also the level of production, the quality of the crude oil to be refined must be known, so that the proper machinery can be chosen. Crude oil exploited in Iran varies considerably and no decision has yet been made regarding the crude to be used in future refineries. Following is a brief summary of the new projects:

The Kermānshāh refinery: The Kermānshāh Refinery's reconstruction and expansion project will be ready for use towards the end of 1971. The new capacity of Kermanshah is 15,000 barrels a day.[9]

The Shirāz refinery: The Shirāz Refinery project is ready to be signed by the building contractor. Its capacity is 40,000 barrels a day, and it has been designed to produce

a maximum amount of semi-distilled products.[10]

The Lavan distillation plant: Plans are underway to build a distillation plant with a daily capacity of 20,000 barrels in Lavan island. Naphtha and other light production items of this plant will be exported as raw materials for the petrochemical industry. The gas oil produced will be used in the oil tankers, and 5,000 barrels of semi-distilled products per day will be utilized for internal consumption.[11]

The fourth refinery project: As will be discussed in the third chapter of this report, in view of the estimated level of consumption by 1979, the National Iranian Oil Company will be faced with a considerable shortage of refining capacity. It has been decided to construct a new refinery in order to meet future demand. This refinery which is to be built in 1974, is referred to as the "Fourth Refinery".

An estimation of future shortage of refining capacity

Most of these expansion projects will be completed by the end of 1971, so that by early 1972 Iran's refining capacity for the production of its internal consumption needs will be 240,000 barrels a day, (Ābadān 100,000, Tehrān 85,000, Kermānshāh 15,000 and Shirāz 40,000).[12] It should be noted that this total refinery capacity will remain the same until 1980. Table 2 shows the shortages that will occur from 1972-1979.

In estimating the future shortage of refining capacity, in addition to the upward trend in consumption, the following point has also been considered:

> "The designed capacity of a refinery is production in one day. For the preparation and planning of long-term projects the yearly average yield of a refinery is usually taken into account. However, as shown by experience, due to halts in operations for major reparations or unforeseen events, the designed capacity decreases by 8 per cent. On the other hand, about 8 per cent of a refinery's consumption is wasted in the form of

gas or internal by-used fuel. Therefore,only 84.5 per cent of the designed capacity is used for the production of products which can be put on the consumer markets. In other words for the production of every 100 barrels of oil products, a refinery with a capacity of 118 barrels is required."[13]

Table 2: Irān (1972-79): Survey of refining capacity shortage. (Figures in thousand barrels per day)[a]

Year	1972	1973	1974	1975	1976	1977	1978	1979
Total product consumed domestically	211	229.9	251.4 241	277.2 266	304.7 293	350.6 323	353	388
Required refining capacity	249	271	297 264	327 292	360 324	414 358	395	435
Existing capacity	240	240	240	240	240	240	240	240
Shortage of capacity	9	31	57 24	87 52	120 84	174 118	115	195

(a) Figures in this table have been taken from the following two sources:
1. National Iranian Oil Company, Public Relations Office, *Seiri dar sanʿat-e naft-e Irān*, Tehran, Xordad 1348 [May/June 1967] p.53.
2. Aqdāʾi Abbās, *Pish bini masraf-e far āvordeh-hā ye naft dar keshvar va tamin-e ān* (A projection of the national consumption of oil products and their provision) National Iranian Oil Company, 1347 (1968-69). The top figure in each division have been taken from the first source. The reader should note that there is a considerable difference between the figures presented in the two sources. Both these have been calculated with allowance for the substitution of gas.

The obvious conclusion to be drawn from Table 2 is that in any case the 240,000 barrel refining capacity is barely sufficient to meet ever-increasing future needs and that this shortage will be greater during the years 1972-79. This further shows the necessity for projects for the expansion and creation of new refineries or other projects such as the substitution of natural gas.

Geographical divisions of the Distribution Department

In order to facilitate and organize the distribution of oil, the Oil Distribution Department of the National Iranian Oil Company has geographically divided the country into several zones and each zone into several districts. Each zone is made up of several branches, agents and retailers.[14] (The difference between an agent and a retailer is that the agent is the representative of the Distribution Department of NIOC, while the retailer has no such relationship with the Department. In the areas where the administration of a retail branch is not economically feasible by the NIOC itself, the agent arranges to make his sales through related agencies of the Oil Company and as a representative of NIOC he receives a certain percentage. However the official retailer buys the oil at special discount from NIOC and sells it in its branches at the official price).

In addition to the sales stations belonging to the NIOC, there are several private stations which sell oil and by-products under special license. During 1967 following the trend of the transfer of distribution into the hands of the private sector, twelve private stations were created throughout the country and thirty-six other establishment permits were issued.[15] Table 3 shows the number of zones, districts, branches, agents, selling stations and retailers in the cities and in rural areas during 1950-1968.

Table 3 shows that these divisions have changed according to the amount and type of demand and other circumstances from year to year. During recent years, the Distribution Department has divided the country into the following 5 zones:

Northern zone: includes districts such as Tehrān, Qazvin, Gilān, Mazanderan.

Northwestern zone: includes Āzarbayjān, Kurdestān and Kermānshāh.

Central zone: includes Qom, Esfahān, Shirāz, Kermān and some of their surrounding areas.

Southern zone: includes Xoramābād, Ahwāz, Bushehr, Bandar Abbās.

Eastern zone: includes Gorgān, Xorāsān and Zahedān.

Table 3: Irān (1950-68) Changes in supply centres of oil products

Description	1950	1960	1965	1967	1968
Zone	-	-	7	5	5
District	17	17	-	24	24
Branch	57	53	63	39	38
Agent	63	84	78	78	78
Sales Station	147	172	238	266	323
Out of town selling	215	927	3614	6179	6960
In-town selling	192	1345	1731	1890	1968
Total	691	2598	5731	8481	9396

Source: National Iranian Oil Company, Distribution Department, *'Amaliāt 1968* (Operations 1968) Tehran, 1968, p.26.

During this period, the number of districts have increased while branches and agents have decreased. The number of sales stations and retailers have also increased.

It should be noted that an increase in the number of smaller supply centres such as agents, sales stations and retailers can aid the expansion of the oil distribution network. After all it is through these minor centres that oil is finally made available to the consumer. On the other hand the correct selection of the proper zones, districts and branches is of the utmost importance because only the areas adjacent to the refineries can directly receive and distribute the required oil. However, because of the vastness of the country and the large distances between population centres and refineries, most of the time this system is not practical. Therefore, in the major population centres, located far from the refineries, storage tanks and other facilities are installed according to the requirements of the area. The required oil is then transported to these storage centres and distributed between the districts and branches.

In view of this arrangement, the importance of the correct division of zones, districts and branches becomes apparent in the problem of the distribution of oil.[16]

Table 4 shows the level of sales of the main four products in the five distribution zones.

Table 4: Irān. Sales level of four main products according to zones (Figures in thousand cubic metres)

Zones	Sales level of four products	Percentage of total
Northern zone	3627	46
Southern zone	897	11
Central zone	1506	19
Eastern zone	914	11
Western zone	1027	13
Total sales	7971	100

This table shows that the highest sales are in the northern zone. The central and western zones are second and third respectively. The higher concentration of population in the northern zones is the main reason for this, for it includes Tehrān; the central zone covers cities like Isfahān, Qom and Shirāz.

B: THE MEANS OF DISTRIBUTION OF OIL PRODUCTS

Evolution of the means of oil transportation

At the time in which the volume of consumption of oil products was low, and everyday life was less dependent on these products, a limited variety of oil products were taken by animals to consumption centres. At this time oil, because of transport difficulties, was scarce and was considered a luxury. An increase in the consumption of oil products, meant that these elementary means of transportation could no longer meet demand, and new means namely road vehicles had

to be employed.

The construction of railways provided more facilities but in view of the increase in demand roads and railways could not be entirely relied upon. Thus the idea of the pipeline was devised, and preparations were made to use it as a carrier of oil products.[17]

Presently, transportation facilities used by the National Iranian Oil Company consist of: rented road vehicles, water transport facilities, road vehicles belonging to NIOC, railroads and pipelines. From 1955 to 1968 the number of such vehicles more than doubled and at the same time their level of activity increased more than two fold increase.But as can be seen from Table 5, this increase has taken place along with the introduction of the pipeline.

Table 6 shows the changes in the per cent share of various transport vehicles during the period 1960-68.The percentage share of the pipeline in the total, which showed an upward trend until 1962, dropped in 1965, but resumed its upward movement in the years 1966-68. Thus in 1968,the pipeline, with a 72 per cent share, was the most widely used means of oil transport. During the same period the percentage share of railroads showed a downward trend. The reason for this is that, in the case of short and medium distances, the oil tanker often has an advantage over the railroad and in the case of medium to long distances the pipeline has replaced the railroad. The percentage share in transport by rented vehicles has not shown much change.

Had the pipeline not been used, other means of transport would have increased considerably. Thus if the total amount of oil consumed in 1968 had been carried by road and rail, three times the number of vehicles used in 1958 would have been necessary.[18] However, if we take account of the capital, foreign exchange, maintenance and spare parts requirements, such a project would have been unfeasible. In short, without the pipeline, the continuous provision of consumption requirements would have been impossible.

Characteristics of the pipeline

For two basic reasons the pipeline is preferable to

other means of transportation: Firstly, enough oil can be supplied through the pipeline. Secondly, this is a more inexpensive means of transporting oil.

Another advantage of the pipeline is that it is not vulnerable to changes in climatic conditions. However, unlike other means of transport, it is relatively inflexible, for after installation its direction

Table 5: Irān (1964-68): Annual per cent increase in use of pipeline compared with annual per cent increase in road transport

Year	1964	1965	1966	1967	1968
Annual per cent increase in use of pipeline(a)	18	5	17	34	24
Annual per cent increase in road transportation	12	22	23	10	10

Source: National Iranian Oil Company, Distribution Department *'Amaliāt 1968* (Operations 1968) Tehrān 1968. P.3.
(a) Per cent is in comparison with the previous year.

Table 6: Irān (1960-68):Share of various vehicles in the transport of oil produced during 1960-68

Type of vehicle	1960	1962	1965	1966	1967	1968
Pipeline	47	63	58	59	68	72
Railroads	24	19	25	22	15	12
Rented	13	12	13	15.4	14	13

Source: Qanāt-Ābādi, Mahmud,*Fa'āliat-e sherkat-e melli-ye naft dar zamine-ye xotut-e luleh va asarāt-e ān* (Activities of the NIOC with respect to the pipeline and their effects) Tehrān NIOC,Public Relations Office, 1967. p.2. For the years 1967-8 see *'Amaliāt 1968*, (Operations 1968) Distribution Department, National Iranian Oil Company, Tehrān, 1968.

cannot be changed. In addition its capacity is fixed and the type of products that it can carry are limited. However, despite these disadvantages, which occur under specific conditions, it is the cheapest and best carrier of oil and gas. The real cost of transport by pipeline varies according to destination. For example the cost of installing a pipeline in rough mountainous areas may be two or three times greater than on flat land. Furthermore, the cost of construction and operation of a pipeline depends on its capacity, transmission pressure, the manner of exploitation, the interest rate of the capital invested, and the density of the oil to be transmitted.

Economically, the best pipeline available is one through which the oil is transmitted without the aid of a pump. An example of such a pipeline is the Gachsaran - Xarg pipeline; its origin is in Gachsaran at a height of 670 metres and its destination in Xarg's storage tanks at a height of 60 metres. Due to the difference in the two altitudes, the oil flows, without the aid of a pump to Xarg and from the reserve tanks to the ship. However, this is a rare exception and the majority of pipelines carry oil from one point to another with the aid of a pump. For example the origin of the pipeline which carries refined oil from Abadan to Tehran is at sea level, and its destination at Rey storehouse, south of Tehran, is at an altitude of 1,037 metres and it passes over points where the altitude becomes as high as 2,207 metres.[19]

Although in most cases the cost of transport by sea is lower than that of a pipeline, yet in many instances, since there is no access to water or the distance between two points traversed by a pipeline is much sorter than a waterway, ships cannot be used.

Transport by pipeline has the following characteristics: The major outlay consists of capital expenses, current costs being only 20 per cent of the total cost. The capital cost includes the cost of the pipeline itself, the pumps and other fixed installations. The current cost consists of direct current expenses and interest on the capital. Direct current expenses cover the wages and salaries, rent, repairs, administrative costs etc., which are fixed, and an

electricity cost which is variable.[20]

The original capital required for the installation of a pipeline depends directly on its diametre, however, the pipeline capacity increases by more than the square of its diametre[21]. The original cost line is therefore offset by low administrative expenses during the pipeline's lifetime. If the natural conditions of the path of the pipeline are almost identical, then the cost of every ton-kilometre of pumping directly depends on the increase in the distance. In view of the high ratio of capital cost to other expenditures, economically it is more advisable to utilize the pipeline at a continued pace and at full capacity. Otherwise, since the administrative expenses of a pipeline are fixed, the transfer expenditure of every unit will increase. If the following two conditions are met, the utilization of the pipeline can be economically feasible: Firstly, the market demand must be constant; and secondly if there are any daily or seasonal fluctuations in market demand, a method of distribution which will not affect the pipeline flow must be adopted. For this purpose, store houses must be built at the origin and the destination. If such stores do not exist or their construction is not possible, then the advantage of the pipeline over other non-continuous means becomes questionable. In other words, since the pipeline unlike the oil tankers does not enjoy the required flexibility it is only through this type of equipment that its weaknesses can be overcome. Gas differs because the cost of transport by non-continuous means is in any case too high and so the pipeline is the only feasible alternative.

Another characteristic of transport by pipeline is that the higher the volume of products to be carried, the lower transport expenses, and consequently the higher the profits. This is due to the fact that with the increase in pipeline diametre its capacity increases more than its capital and current expenses. The installation cost of a pipeline does not depend much on its size, while the enlargement of the diametre and increase in capacity decreases the cost of carrying each ton kilometre. Thus the cost of transport by a 15 centimetre pipeline is double that of a 20 centimetre pipeline and four times that of a 30 centimetre one. Obviously this principle is also true of other means of transport; however the profit thus derived is much higher in the

case of a pipeline.[22]

The third characteristic of the pipeline is that its carrying cost depends on the quantity of the product.In the case of oil, the thicker and heavier the oil to be carried the higher the cost per kilometre. If we assume an index of 100 for the capacity of a pipeline carrying crude oil, the capacity of the same line will be 80 for light gas oil, 60 for heavy gas oil or 5 for some of the other products (assuming that the flow is not shut off).[23]

The flow of oil inside the pipeline depends on its density. The denser the oil the more difficult its passage. Fuel oil flows very easily, and then kerosene followed by other products according to their density. When the density of oil surpasses the 1,000 degree mark of the stack, its flow decreases rapidly and pumping it through the pipeline is no longer profitable. According to calculations made,the pumping cost of gas oil is four to five times greater than the pumping cost of crude oil through the same pipeline.[24]

The flow of liquid in the pipeline is also depends on the diametre and the decrease in pressure in each unit of distance on the length of the pipeline, better known as "pressure fall".[25] When building a pipeline, if the diametre is wide and the "pressure fall" is low, the cost will be high. However, the pumps can be placed at greater distances and consequently the administrative costs can be decreased. On the other hand, if the diametre is narrower and the pumps closer, the original capital will be lower but the subsequent cost, especially the provision of the necessary energy to run the pumps will be higher. With the rapid increases in the demand for oil, the desired capacity of the pipeline cannot remain fixed; future demand must be taken into account when designing any pipeline.[26]

The pipeline network

In view of what has just been said,the pipeline should be regarded as an organic part of the oil industry. Except the Gachsaran - Shiraz gas pipeline, the main pipeline network amounts to 3,980 kilometres or 33,154 inch-kilometres.

With the rapid rise in the consumption of oil products in various areas of the country, and considering the distance between the consumption centres and production areas, measures should be taken to meet future requirements. Several projects are at present under construction.

The Nafte-Shāh - Kermānshāh crude oil pipeline: This pipeline is designed to supply the additional requirements of the Kermanshah Refinery which is being expanded. The pipeline has an 18 inch diametre and will cover 230 kilometres. With the installation of two pumping stations in Nafte-Shah and Pata (99 kilometres from Kermanshah) up to 69,000 cubic metres of oil will be carried to the Kermanshah Refinery per month.

The Gachsarān - Shirāz Pipeline. Following the projects to distribute gas throughout the country, a new 16 inch pipeline will carry gas from Gachsaran to Shiraz. The 10 inch pipeline which is presently used to carry gas to Shiraz and its suburbs, will be used to carry crude oil to the Shiraz Refinery after necessary adaptations and before the commencement of the operation of the Shiraz Refinery.

In order to meet increasing requirements and to make full use of the present and future capacity of the Tehran Refinery, and possible increases in the needs of crude oil by the Kermanshah Refinery, it is necessary to expand the capacity of the Ahwaz-Rey crude oil pipeline. This would mean the replacement of 120 kilometres of this pipeline for higher pressure fall and the creation of three new pumping stations.

The Shāhrud Gorgān and Gonbad Qābus pipeline: An eight inch, 67 kilometre pipeline between Shahrud and Aliabad, and two branches of six-inch lines to Gorgan and Gonbad Qabus covering 88 kilometres have been designed to meet the rising requirements of these two areas due to the expansion of mechanized agriculture and the creation of related small industries. Initial research and cartography on this project have been completed.

The Rey - Tabriz pipeline: The installation of a pipeline between Tehran and Tabriz is essential in order to meet

the oil requirements of the Āzarbaijān district. Initial investigations and cartography are being completed; the pipeline will cover approximately 638 kilometres and its diametre is estimated at ten inches. In the first phase, with the aid of three pumping stations, its carrying power will be 129,000 cubic metres a month. In the second phase, with the addition of three other pumping stations, its carrying power will be raised to 189,000 cubic metres a month.

Reinforcement of the capacity of the Ezna - Isfahān and the Rey-Shāhrud pipelines: Following the policy of maximum utilization of existing equipment for oil distribution, plans are underway to install automatic pumping stations at Miāndasht on the Ezna-Isfahan line and at Semnan on the Rey Shāhrud line.

The electrification of pumping stations: Now that sufficient electricity is being produced by various dams, and electrical networks throughout the country are becoming more adequate, the electrification of pumping stations has become feasible. This process will save on the consumption of gas oil and its delivery to other consumption centres. It will also decrease the previous maintenance expenses and will pave the way for automation and distance control projects. The pumping station of Ahwāz-Sabzāb and Bidsaye have so far been electrified; parallel to the expansion of the electricity network other stations will also be converted.

In addition to these projects, other related projects such as the completion and correction of the pipeline path and necessary alteration in existing equipment have been provided for in future projects.[27]

Products carried by the pipeline

Three main products were carried by the Ābādān-Rey pipeline between the years 1336-1340; (1957/58-1961/62) these were gasoline, kerosene and gas oil. From early 1341, the pipeline facilities were used to carry various aeroplane fuels. Thus, at present there is a possibility of carrying up to nine different products by the cross-country pipeline and

sometimes by the Eznā-Isfahān line. In addition to gasoline, kerosene and gas oil, the following products are also carried by the pipeline: aeroplane gasoline (130/100 octane), aeroplane gasoline (145/115 octane), jet fuel (1-T 100),jet oil (1-T 150), solvent gasoline, super gasoline.

These products are transmitted through the pipeline by special order. Certain conditions must be maintained in the pumping station and the pipeline in order to prevent them from mixing with each other and the contents of the line must always be under pressure.

The place of origin and destination of every product along the pipeline is carefully calculated. The time of arrival of each product at its destination is predicted,and it is transferred to the proper storage at a specific time so that after tests its quality can be certified for sale.[28]

A number of tanks are installed at the end of the pipeline next to the storehouses to receive the different products and these are described in Table 7.

Table 7: Number and capacity of tanks at the storehouse adjoining the pipelines

Product	Number of tanks	Authorized capacity (million litres)
Super gasoline	1	11
Motor gasoline	31	118
Kerosene	47	225
Gas oil	66	263
Fuel oil	26	181
Jet fuel	23	47
Solvent gasoline	4	3
Mixed-polluted	28	7
Total	226	855

Source: Qanāt-Ābadi, Mahmud, *Fa'āliat-e sherkat-e melli-ye naft dar zamine-ye xotut-e luleh va asarāt-e an.* (Activities of the NIOC with respect to the pipeline and their effects) Tehrān, National Iranian Oil Company, Public Relations Office, 1967. P.37.

The existing pipeline network is utilized to carry 500

million litres of products to adjoining storehouses per month. Besides the Kermanshah and Tehran Refineries whose crude oil requirements are delivered through pipelines, two-thirds of the remaining requirements of the country are also delivered in this way. Table 8 shows the amount delivered by pipelines over the past years (figures for the operation of individual pipelines were not available).

Table 8: Irān. (1957-68) Products carried via the pipeline network

Year	Amount carried per year (thousands of cubic-metres)	Yearly output (thousands of ton-kilometres)
1957	751	323847
1958	1559	991383
1959	2322	1446028
1960	2565	1443904
1961	2567	1722526
1962	2571	2037040
1963	2934	232401
1964	3452	2597563
1965	3728	2711528
1966	4255	3125335
1967	6217	4037398
1968	8242	5200000

Source: Qanāt-Ābādi, Mahmud. *Fa'āliat-e sherkat-e melli-ye naft dar zamine-ye xotut-e luleh va asarāt-e ān.* (Activities of the NIOC with respect to the pipeline and their effects) Tehrān, National Iranian Oil Company, Public Relations Office, 1967. p.37.

As shown, the amount delivered by the pipeline has increased considerably from year to year.

The use of pipelines, pumping stations, and other installations situated in distant areas, and the proper co-ordination of the equipment in various centres requires a regular communication system. In reality, with the expansion of the pipeline network, the communications network has become an organic element of this project.[29]

The influence of the pipeline on the final cost of oil products

The cost of transportation constitutes half the price of oil products (Table 9). A decrease in this cost will, therefore, decrease the price of oil products and the installation of and utilization of pipelines is one of the most effective ways of attaining this goal.

Table 9: Irān (1967-68) Factors contributing to the final price of oil products

Factor	1967 (Rial for every cubic metre on average)	1968
The initial cost of product	305	341
Container price	42	39
Transportation cost	529	475
Distribution cost	273	257
Total	1149	1112

Source: *'Amaliāt-e 1968* (Operations, 1968) National Irānian Oil Company, Distribution Department, Tehrān, 1968.

Table 10 shows transport costs by various means between 1960 and 1968.

Table 10: Irān (1960-68): Carriage of oil products via various vehicles (Rials per ton-kilometre)

Type of vehicle	1960	1962	1965	1966	1967	1968
Pipeline	0.45	0.41	0.40	0.40	0.35	0.27
Railroads	1.2	1.2	1.06	1.08	1.12	1.14
Rented	1.83	1.67	1.6	1.51	1.47	1.54

Source: Qanāt-Ābādi, Mahmud. *Fa'āliat-e sherkat-e melli ye-naft dar zamine-ye xotut-e luleh va asarāt-e ān* (Activities of the NIOC with respect to the pipeline and their effects) Tehrān, National Irānian Oil Company, Public Relations Office, 1967. P.12.
For figures for 1967-68 see *'Amaliāt 1968* (Operations 1968), Tehrān, National Irānian Oil Company, Distribution Department, 1968. P.19.

In calculating the average cost of transport by pipeline in 1968, the output of the crude oil pipeline supplying fuel and waste for the Tehran Refinery has also been taken into account. The average cost of transport by pipeline during 1968, (excluding the above pipeline)was Rls.029 for each ton-kilometre. Thus the average transport cost in 1968 decreased by 12.2 per cent as compared with 1967.[30]

The two main conclusions to be derived from Table 10 are that the cost of transport by pipeline is considerably less than that by other means (almost one-third less than transport by railroad and one-fifth less than transport by rented vehicles in 1968) and that, during this period, the cost of transport by pipeline decreased gradually while that of railroads increased and transport by rented vehicle fluctuated.[31]

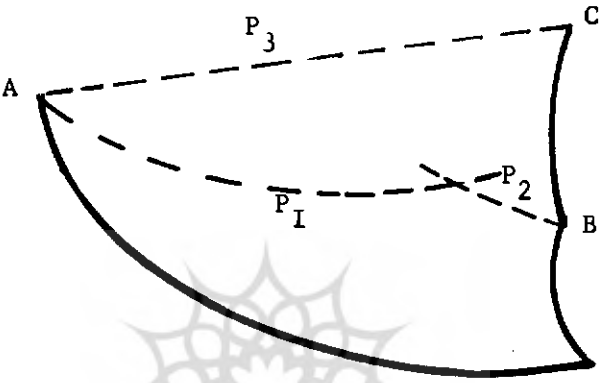
With the lowering of the overall cost of oil products, a decision to stabilize their price becomes quite possible. The first consequence of such a policy would be a rise in the consumption of products and a subsequent increase in government revenues. Stability in the price of oil products also has the following effects: (a) It will create confidence among private investors and lead to the development of new industries; (b) The cheapness and reliability of oil products will result in an expansion in the production of industrial establishments which use oil as fuel; (c) The lowering and stabilization of the prices of oil products will affect the provision and expansion of the electricity grid for urban areas. Electricity plants, whether they use turbines or diesel motors, need reliable fuel at a reasonable price.[32]

In view of our discussion of the pipeline and the part it can play in decreasing the final cost of oil, it would seem at first glance that maximum use of the pipeline should be made before its carrying power diminishes. However, further investigation shows that in practice there are certain limitations to this plan. In this respect, the following points should be noted:[33]

Consider two parts of the pipeline such as AB and BC (Figure 1). It is assumed that they have equal carrying

power.[34] Point X is one of the delivery destinations. The goal is to deliver oil to points X and C, assuming that the maximum capacity of the pipeline ABC equals all the requirements of point C. The cost of carrying one ton of products

Figure I



from A and B to destination X by a means other than the pipeline is assumed to equal P_1 and P_2 rials respectively; and the cost of transporting one ton of products from A to C by means other than the pipeline is assumed to equal P_3 rials. There are two alternatives:

A. If oil is transported by means other than the pipeline from A to destination X, since no oil leaves the pipeline at point B, an amount of oil equal to the total capacity of the pipeline ABC can also be delivered to point C. Because of the low level of transport costs by the pipeline, this cost is assumed to be zero. Thus according to the first alternative, the cost of transport and delivery of oil to X and C equals P_1.

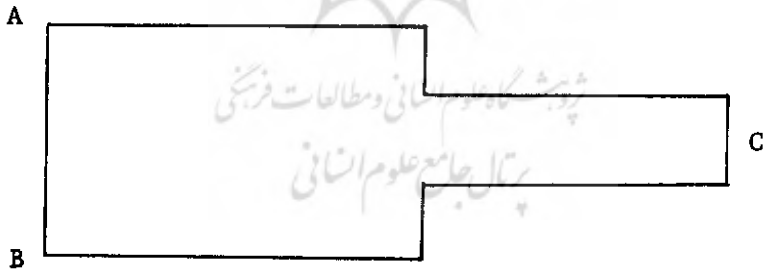
B. If the requirements of destination X are taken from the pipeline at point B and then transported to X, the remaining amount of oil (from the total pipeline capacity ABC) can be carried to point C. However since this cannot meet all the requirements of C (the requirements of C equal the total pipeline capacity of ABC), the remaining requirements have to be provided from point A by means other than

the pipeline. In this situation, assuming that the cost of delivery by pipeline is zero, the cost of transport will be $P_2 + P_3$.

Thus, there are two courses of action for this imaginary system: Disregarding the points already discussed, in order to make a decision we must compare the two costs of P_1 (relating to the first alternative) and $P_2 + P_3$ (relating to the second alternative). If $P_1 < P_2 + P_3$, the first solution should be adopted, and maximum use should be made of all parts of the pipeline ABC. However, if $P_2 + P_3 < P_1$ (because of lower cost, distance, or both), the second solution is more reasonable. Thus the principle we discussed earlier does not always hold - and this difficulty is true of some of the cross-country pipeline.

Now let us consider two parts, AB and BC (Figure 4), and assume that the maximum power of AB is greater than BC.

Figure 2

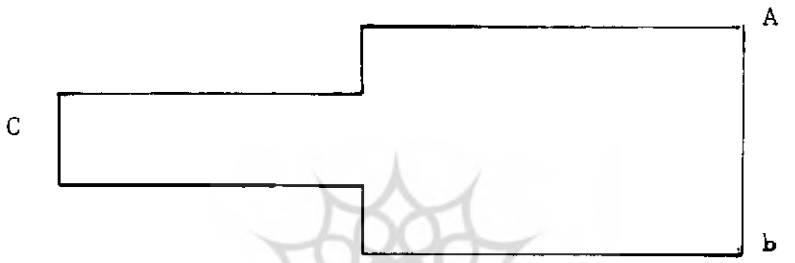


If point B is not equipped with loading installations it is inevitable that the maximum carrying capacity of AB cannot be used (for example, the Arak storage unit in the cross-country pipeline).

Now let us assume that the maximum carrying power of AB is less than that of BC. If B is not equipped with evacuation installations, inevitably the maximum carrying capacity of BC cannot be used. It is possible that there may be no need to use the maximum capacity of BC (for example,

the Shāhrud-Mashad pipeline). The determination of whether the time has arrived for full utilization of BC or not, is a problem in itself requiring extensive calculation because the transport costs for all points adjacent to B and C and C and B should be calculated and compared separately.

Figure 3



In view of the above, and considering the fact that the carrying conditions of various products differ, the complications involved become more apparent and these problems can only be solved through modern mathematical methods.

C. The Consumption of Oil Products

It should be remembered that the goal of a systematic organization of the oil distribution network is the provision of consumer needs. Therefore, the level of and changes in the public's fuel requirements must be studied carefully. In this section, a survey will be made of the consumption of oil products in Iran, the rate of consumption in the past, and factors affecting it in the future.

The consumption of oil products in the past

Before nationalization of the oil industry, the consumption of oil products was in a chaotic state. Domestic

distribution was a monopoly of the former Anglo-Iranian Oil Company which made little effort to expand the distribution network because only very low profits were to be gained from the domestic sale of oil. Consequently not only was the level of consumption low, but also most people were not even acquainted with the various oil products available. The oil industry stood in a relationship of isolation to other parts of the economy and the sole purpose of exploitation was the provision of Western Europe's needs.

After the nationalization of the oil industry in Iran, the internal distribution of oil products became the most important duty of the National Iranian Oil Company. With the removal of previous bottlenecks, NIOC was obliged to distribute oil products throughout the country. Thus the nationalization of oil began a new era in the distribution of oil products to the domestic market.

In order to determine the trend of consumption of oil products in the past, a survey will be made of the rate of consumption of four main products (gasoline, kerosene, gas oil and fuel oil) separately, and then total consumption will be studied (Table 11):

Consumption trends of major products

Gasoline: Table 11 shows the consumption of this product during the period 1929-1969. The average yearly increase in the consumption of gasoline during the period 1927-37 was about 35 per cent. During the Second World War the consumption of this product rose still more.

After the nationalization of the oil industry, gasoline consumption rose at a faster rate so that during the period 1950-59 it more than doubled (the rate of increase was 2.6). However during the interval of 1960-63, the rate of increase in consumption slowed-down. NIOC publications attribute this to the economic crisis of 1960-63. After this crisis the consumption of gasoline once more enjoyed an upward trend. However during 1965, due to an increase in official prices, consumption decelerated.[35]

Table 11: Irān (1929-1969): Consumption of oil products (Figures in thousand cubic metres)

Year	Gasoline	Kerosene	Gas oil	Fuel oil	Total consumption
1929	12	15	-	6	33
1931	17	10	-	9	36
1933	36	25	-	20	81
1935	57	40	4	26	127
1937	94	56	13	28	191
1939	91	79	21	89	280
1941	95	84	25	108	312
1943	120	95	46	232	493
1945	98	123	39	277	588
1947	164	164	46	327	701
1950	240	290	100	400	1000
1951	250	300	120	450	1200
1952	262	336	130	500	1300
1953	300	400	150	600	1500
1954	330	480	170	700	1800
1955	380	530	280	800	2000
1956	430	600	300	850	2200
1957	464	713	385	870	2500
1958	520	730	540	900	2900
1959	590	800	700	1000	3400
1960	627	976	856	1147	2862
1961	644	1099	984	1222	4258
1962	664	1171	1083	1259	4464
1963	702	1258	1158	1268	4715
1964	740	1436	1349	1507	5485
1965	714	1470	1593	1712	5984
1966	800	1530	1881	1979	6802
1967	854	1808	2185	2238	7822
1968	943	1990	2467	2577	1810
1969	1066	2338		3490	239134

Source: Figures for the years 1929-50 have been taken from Nemati, Qolām Hossein, *Barresi-ye eqtesādi va ejtemā'iye towzi-ye mavād-e nafti dar Irān* (An economic and social survey of the distribution of oil products in Irān) Tehrān University, Faculty of Economics, P.210.

For the years 1950-60 see Farxān, Hushang, *Moqāyse-ye masraf-e mavad-e nafti dar dah sāl-e gozashteh* (A comparison of the consumption of oil products over the last decade) Tehrān, n.d. p.3. For 1960-68 see National Iranian Oil Company, Distribution Department, *'Amaliāt-e 1968* (Operations in 1968), Tehrān, 1968. Figures for 1969 have been taken from class notes.

During 1968 the consumption level of gasoline rose again, to 943,000 cubic metres, considerably more than the figures for the previous years. The reason for this rapid rise may be the extensive production of domestically - made cars, and the banning of the use of diesel-motor cars. The same factors were also responsible for the increase in gasoline consumption during 1969, so that with a rise of 13 per cent it reached 1,066,000 cubic metres.[36]

During the period 1950-68, the gasoline consumption index rose from 100 to 193.3 in 1957 to 292.5 in 1963, and to 392.9 in 1968. Thus during this period the consumption of gasoline quardrupled. (Table 12)

Table 12: Irān (1950-68), Consumption index of oil products (Base year 1950)

Year	Gasoline	Kerosene	Gas oil	Fuel oil	Total Index
1951	104.1	103.4	120	112.5	120
1952	109.1	115.8	130	125	130
1953	125	137.9	150	150	150
1954	137.5	165.5	170	175	180
1955	158.3	182.7	280	200	200
1956	179.1	206.8	300	212.5	220
1957	193.3	245.9	385	217.5	250
1958	216.6	251.7	540	225	290
1959	245.8	255.8	700	250	340
1960	261.2	336.5	856	286.7	386.2
1961	268.3	378.9	989	305.5	425.8
1962	276.6	403.7	1083	314.7	446.3
1963	292.5	433.7	1158	317	471.5
1964	308.3	495.1	1349	376.7	548.5
1965	297.5	506.8	1593	428	598.4
1966	333.3	527.5	1881	494.7	680.2
1967	355.8	623.4	2185	559.5	782.2
1968	392.9	686.2	2462	644.2	881

Source: Table 11.

Kerosene: Since it is a domestic fuel, kerosene is one of the most widely used products in Iranian cities. The main reason for the rise in its rate of consumption is its substitution for vegetable and animal fuels. In addition factors

such as per capita income, population increase, the expansion of oil-using equipment and geographical expansion in the distribution of oil products, have contributed to its higher consumption.

The utilization of kerosene expanded after the nationalization of oil, so that during the period 1950-59 its consumption increased by 2.8. During 1960-63 its consumption decelerated (NIOC cites the economic crisis of 1960-63 as the cause) but from 1964 resumed its upward trend reaching 1,990 cubic metres by the year 1968, exceeding estimated consumption by 3 per cent.[37] The early winter of 1968 was the main factor responsible for the rise in kerosene consumption at that time. During 1969, consumption rose by 17.3 per cent over this figure: an increase attributed to the previous year's premature cold.[38]

As shown by the changes in the kerosene consumption index, (Table 12), during the period 1950-68, the consumption of this product has increased almost seven times.

Gas oil: From 1947 onwards, consumption of this product has increased at a rapid pace. By 1959 the consumption of gas oil had advanced seven-times over the level of 1950. The increase in consumption of this product is a consequence of greater utilization in various industries and its substitution for fuel oil on the railways. During the interval between 1964-67, the consumption of gas oil grew at a rate of 16 to 18 per cent a year. And between 1950 and 1968 it increased 25 times.

Fuel oil: During the Second World War, the Allied forces created industries in Irān which increased the consumption of fuel oil in the cities. Thus the level of consumption of this product increased from 40 thousand cubicmetres in 1938 to 300 thousand cubic metres in 1943.[39] After the War, its consumption decreased but later in 1947 it resumed a rapid upward trend due to the increase in population, and the expansion of urban centres. Eventually it was established as an industrial fuel. During the period 1950-59 alone its consumption increased by two and a half. Its rate of increase remained stable during the years 1960 to 63 amounting to 40 thousand cubic metres a year, but in 1964

the consumption of this product suddenly rose by 250 thousand cubic metres over the preceding year. This trend continued during subsequent years and and consumption reached 2.57 million cubic metres by 1968. During 1968, out of the total fuel oil consumed, about 28.5 per cent was used in urban centres and for non-industrial purposes, 27.6 per cent was used by industries other than electric power, sugar and brick kilns, which used 17.6, 15.3 and 11 per cent of the total supply respectively. The Ministry of Water and Electricity estimates that the electricity industry's future demand for fuel oil will rise sharply due to the expansion of industry and the general expansion of the electrical grid. It can be expected that the electric power industry will gradually become the most important and largest consumer of fuel oil. Table 12 shows the changes in consumption of fuel oil in greater detail.

Total consumption: It can be concluded from what has been said that the total rate of consumption of oil products has steadily increased during the period under review. During the period 1950-59 alone, total consumption increased three times. In the years 1960-63 it decreased, but regained its upward trend in 1965.

In 1967 total consumption reached 7.82 million cubic metres rising over the preceding year by 1.02 million cubic metres. This unprecedented rise can be attributed to the following factors: (a) increases in the production of domestically-made cars and a consequent rise in the consumption of gasoline; (b) the considerable upsurge in the consumption of kerosene in 1967; (c) the considerable increase in the consumption of liquid gas in 1967; (d) the June 1967 War in the Middle East which resulted in foreign aircraft using Irān's air ports for re-fuelling.

Factors affecting the trend of oil consumption in Irān

A study of the factors affecting consumption enables us to clarify the consumption situation and make better predictions for the future.

Population increase: One of the most influential

factors affecting the consumption of oil products is population increase. At the present the population of Iran is 29 million. Assuming a natural yearly growth of 2.5 to 3 per cent, Irān's population will double in 28 years.[40] This increase will not only affect future consumption trends but it will also further complicate the problem of the supply of oil products.

Urbanization: One of the phenomena of contemporary Iran's economy is the migration of rural dwellers to the cities and the expansion of city-dwelling. In the 1335 (1956) census, the total number of centres with a population of more than 5,000 was 186. In 1345 (1966) this figure reached 235.[41] The rate of increase of the population of the urban areas of Irān is 4.4 per cent a year, a much higher figure than that for rural areas which is 1.4 per cent.[42] The rapid tendency towards city-dwelling will naturally cause an increase in the consumption of oil products for oil-consumption is not prevalent in rural areas where animal and vegetable fuel are used.

Per capita income: From the point of view of income elasticity of demand, the oil products used by the public can be divided into two groups:

The first group includes products whose consumption increases both horizontally and vertically as a result of a rise in per capita income and increased purchasing power. For example, the increase in per capita income influences the rise in the consumption of kerosene in two ways. On the one hand it enables the consumer to enjoy a larger income, and for example to purchase more space-heaters or new facilities such as water-heaters (vertical increase of consumption). On the other hand, it creates new consumers who cause a horizontal rise in the consumption market.

The second group consists of those products whose consumption rises only horizontally as a result of a rise in per capita income. For example in the case of gasoline, the rise in per capita income is one of the least effective factors in its vertical consumption rise. This is because, from the point of view of automobile owners, many other factors such as the possibility of travel, good roads and other

factors must exist before the rise in per capita income can cause a vertical increase in the consumption of gasoline. However, the rise in per capita income can be very effective in increasing the horizontal consumption of this product, so that, as soon as the financial possibility exists, people start to buy automobiles.

Interesting conclusions can be drawn from the calculation of the income elasticity of demand for oil products at constant prices for the years 1959-68. Table 13 shows that the income elasticity of demand for fuel oil and gas oil is considerably higher than for other products. The level of the figures for these two products, which provide a major portion of the required power of the country,is very important. Among the four main products, gasoline is the only product whose elasticity is less than one, and this is possibly due to the fact that the ownership of private vehicles is till beyond the purchasing power of most Iranian households.[43]

Table 13: Irān - Income elasticity of various oil products

	Income elasticity of demand
Fuel oil	1.70
Kerosene	1.40
Gasoline	0.72
Gas oil	2.80
Other products	4.37
Total	1.82

Source: Bānk Markazi Irān, *Annual Report and Balance Sheet of Bānk Markazi Irān* at the end of Esfand 1347 (March 21st 1968) p.208.

The price change factor: One of the factors affecting the trend of consumption of oil products in Irān is changes in their price. The experience of 1966 proves this point.

In November 1964 the government raised the prices of

gasoline, kerosene, fuel oil and the tax on vehicles using gas oil. This change in price caused considerable fluctuation in the consumption of these four products, particularly in the consumption of gasoline. In December 1964, the consumption of gasoline decreased by 38 per cent over the same month of 1963 as compared with its forecasted consumption disregarding the price change. This shows the high demand elasticity of gasoline. With a decrease in prices of gasoline and kerosene a month later, the consumption of kerosene improved, and although the expected increase did not occur, yet price-wise the conditions were made favourable enough for the consumption of this product to reach its normal level. However, although the price of gasoline was lowered by 2 rials per litre, yet its consumption did not show any noticeable change so much so that in January 1965 it even dropped by 13.8 per cent as compared with the same period of the previous year. If this decrease is added to the 7 per cent expected rise in gasoline consumption for 1965 decrease in consumption of this product, taking into account its natural growth, amounts to 20.8 per cent.

It is interesting that after changes in prices, the consumption of gas oil continued to increase. Thus its sale during December 1964 advanced by 18.4 per cent over December 1963 and in February 1965 it rose by 7 per cent over the respective month of the previous year. (The increase can be attributed to the rise in gasoline prices, which created a trend towards the use of gas-oil consuming vehicles).

The government's fiscal and trade policies. As a result of the government's protective policy for domestically made cars, their sales have increased annually. Because of the large supply of automobiles in the market, the sale of gasoline will also increase. This trend will continue until the automobile market has been saturated. This policy can be included among the factors affecting the rate of fuel consumption. In addition, measures taken to probihit the import of light diesel trucks and gas-oil vans will also influence the consumption of the above product.

Substitution: The effect of this factor on the rate of consumption can only be partially measured. In the case of

the consumption of oil products in Irān, the following substitutes are available:

:gas oil for fuel oil on the railways.

:fuel oil for coal and the utilization of electric power produced from hydro-electric power in sugar refineries.

:gas oil for gasoline, or vice versa, according to decisions made regarding the price or prohibitions on imports of vehicles using gas oil.

:the substitution of gas, which in recent years has effectively influenced the rate of consumption of other oil products. Although its future is not clear, yet gas will continue to exert its effects in the future consumption of oil products.

The expansion of industry: The industrial sector is one of the major consumers of oil products, and industrial expansion will naturally result in an increase in the utilization of these products. This factor has contributed to some extent to increases in the level of consumption of oil products in recent years.

For example, during the five-year period 1964-68 which corresponded to the Third Development Plan, the total consumption of oil products increased 1.9 times and industrial expansion can be considered a major factor in this.

A consumption estimate of oil products in Irān

The Distribution Department of the National Irānian Oil Company has made an estimate of the consumption of oil products within the next decade. This is based on an analyses of the increase in consumption of each of the four main products in the past (both on an absolute basis and according to per capita consumption); a study of the increase in the consumption of oil products within a specific period in the past; and a consideration of future projects and industrial installations. (See Table 14)

Table 14: Irān. Consumption estimate of oil products for the next ten years (thousand barrels per day)

	1968	1970	1972	1974	1976	1978	1979	Annual increase (per cent)
Gasoline	16	19	23	27	32	39	42	9
Semi-distilled	79	98	120	149	185	238	253	11.1
Fuel oil	44	58	83	88	119	145	164	12.6
Other products	10	11	13	17	20	24	27	11.2
Total	151	186	239	281	356	436	486	11.4

Source: Aqdai Abbas, *Pish-bini-ye masraf-e far avordeh-he-ye naft dar keshvar va tamin-e an* (A projection of the national consumption of oil products and their provision) National Iranian Oil Company, Public Relations Office, 1347 (1968-69).

The rate of increase for the all-oil products within the next decade has been estimated at 11.4 per cent. During this period the rate of increase for fuel oil (12.6 per cent) will exceed that of all other products. Since the growth rate for the past decade has been 13 per cent,[44] this represents a slight decline in growth. However, since it is not clear on the basis of what year these percentages have been calculated, no real comparison can be made.

Following is a separate consumption estimate for the four main products of gasoline, kerosene, gas oil and fuel oil.

Gasoline: The best way of determining the level of gasoline consumption is to study each consumer sector separately. Each sector will be influenced by its own particular conditions and characteristics from the point of view of future consumption.

At present, the largest consumers of gasoline are automobiles. Under present conditions, because of the considerable difference in prices of gasoline and gas oil, gasoline-using vehicles cannot be substituted for those using

gas oil. However, because of the government's decision to prohibit the import and manufacture of diesel trucks and vans, it is possible that gasoline will replace a part of the present gas-oil consumption.

In view of the fact that the automobiles are the most important consumers of gasoline, the Distribution Department has made an estimate of the future consumption of this product based on an estimate of the future increase in the numbers of automobiles.

The capacity of the market for new automobiles has been estimated at 85 thousand by 1979,[45] taking into account the needs of both the public and private sectors and government decisions regarding imports. Assuming that the per capita consumption of each automobile is about 2,800 litres a year gasoline consumption by 1979 has been estimated at 2.2 million cubic metres (a yearly coefficient of 7.8 per cent). In addition to this coefficient, in order to provide for any further future requirements, the Distribution Department has set the average coefficient increase of 9 per cent in consumption of gasoline during 1969-79. The level of consumption of this product would amount to 2.43 million litres by 1979 according to the latter coefficient.[46]

Kerosene: The level of consumption of kerosene varies sharply with climatic conditions each winter. Because of the unpredictability of climatic changes, an exact estimate of the consumption of kerosene is not possible. Taking into account the income elasticity of demand for this product, the Distribution Department has estimated that the total consumption and per capita consumption of kerosene will be 2.97 million litres and 18 litres respectively by 1972. Taking the consumption of 1.8 million litres in 1967 as a base, the average rate of increase for the years 1967-72 has been estimated at 10.4 per cent. The average rate of increase for kerosene for the years 1973-77 has been forecasted at 10 per cent per year, and 8 per cent for the years 1978-79. All these estimates are theoretical and based on the following assumptions:[47] (i) The consumption of kerosene in the cities will gradually reach saturation point; and (ii) the fuel situation in rural areas will remain the same.

Gas oil consumption: The different areas of consumption of gas oil in various sectors and the specific conditions of each sector have been taken into account when estimating the consumption of gas oil. In future years, the conditions governing the various gas-oil consuming sectors will change drastically. There will be a relative slow-down in consumption of gas oil in agriculture because of the greater utilization of electricity (the use of electric motors instead of diesel pumps in irrigation), and a sharp drop in the consumption of gas oil in the industrial sector (because of the substitution of government produced power for private power plants).

In view of these factors, the Distribution Department estimates that the consumption of gas oil will rise from 2.462 million cubic metres in 1968 to 8.845 million cubic metres in 1979 an average yearly increase of 12.3 per cent. If the consumption of gas oil in the irrigation industry were not replaced by the power produced by the Ministry of Water and Power the average rise in the consumption of gas oil would amount to 14 per cent a year.

Fuel oil: Keeping in mind the trend of finding substitutes for various liquid fuels and the specific condition of each consuming sector as well as the forecasts of the Ministry of Water and Power, concerning the transfer of industrial units to state-produced power, the level of consumption of fuel oil for 1979 has been estimated at 13.5 million cubic metres. Taking the consumption figure of 34.9 million cubic metres in 1969 as a base, the average annual rate of increase for 1969-72 has been estimated at 12.3 per cent.

Table 15 shows the estimate of the ratio of consump- of major oil products to total consumption. According to the calculation of the Distribution Department of NIOC, the total consumption of oil products will rise from 167,200 barrels per day in 1969 to 239,134 barrels per day in 1972 (at the end of the Fourth Development Plan), to 393,534 barrels per day in 1977 (at the end of Fifth Development Plan), and finally to 485,762 barrels a day by 1979. Assuming that the prices remain fixed, and that the power to be produced by dams by 1979 is also taken in to account, the total consumption of liquid oil products (before the

substitution of gas) will amount to 555,000 barrels per day of liquid oil products.[48]

Table 15: Ratio of consumption of major oil products

	1950	1960	1969	1975		1979	
White gasoline	24	18	14	15	16	15	15
Semi-distilled products	33	48	53	63	61	65	64
Fuel oil	39	30	29	19	20	17	18
Other products	4	4	4	3	3	3	3

Source: Notes taken from the Oil Seminar. Farvardin 29th 1349 (March 19th 1969) Faculty of Economics, University of Tehran.
This table has been prepared assuming the following substitutes following replacements:

Year	Replacement of fuel oil by natural gas (barrels a day)	Replacement of semi-distilled products by gas (barrels a day)
1975	52,100	13,300
1979	97,700	16,300

Per capita consumption and distribution: If the level of consumption is surveyed according to population, per capita consumption can be determined. Table 16 shows the per capita rate of consumption of oil products in Iran during the years 1957-68.

As shown in the table, the per capita rate of consumption has always been on the increase. From 1964 onwards it rose at a faster rate.

However, per capita consumption is not a very good indicator of general consumption because it is calculated by dividing the total consumption of all products by the total population whereas some products, such as jet-fuel are not used by the general public. Moreover, in Iran not all the population are, as yet, consumers of oil products since other sources of fuel such as charcoal are still in widespread

use, particularly in the rural areas. The National Irānian Oil Company's attitude to this problem (of lack of access to oil in rural areas) is that it is a "constitutional duty" for it to expand its rural sales network but that such expansion involves economic losses. One member of the Company tells us that between Azar 1343 (Nov./Dec. 1963) and Shahrivar 1344 (Aug/Sept. 1964)) 5,975 selling-stations were created in rural areas and that oil was sold at 2.5 rials per litre, much less than its final cost in far-flung areas. The same spokesman also adds that these efforts of the NIOC are based on "operational necessity" rather than "economic necessity" and are directed to the task of raising rural living standards.

Table 16: Irān (1957-62) Per capita rate of consumption of oil products (Figures in litres)

1962	1961	1960	1959	1958	1957
190	187	173	155	132	120
1968	1967	1966	1965	1964	1963
315	288	259	259	219	195

Source: National Irānian Oil Company, Distribution Department, *Report of Distribution Activities 1967*, p.27. 1968 figure has been taken from the report of distribution activities for 1968.

The Company is, perhaps, at this point trying to define its export operations as economic and its distribution operations as something based on "operational necessity". But the simplest economic concepts would show us that the provision of the people's needs is the duty of any economy, and from this point of view NIOC's attitude creates an ambiguity. Obviously oil revenues play a crucial role in the developmental efforts of the nation but, in order to see this point in its proper perspective, the ratio of actual to potential revenue should be taken into account, and the

effects of these revenues on the economy should be measured. Only 6.7 per cent of the price of oil sold to the consumer in Western Europe accrues to producing countries such as Iran.[49] At the same time, massive investments are needed to obtain this amount. For example, the CHAM project in which about 11,470,000,000 rials was invested to renovate port installations.[50] In assessing the value of such projects one must think of the alternative benefits that would have accrued if the same amount had been spent on the equipment of domestic distribution networks and the expansion of pipelines which would lower the price of oil available to the consumer.

Table 17: Iran (1967-68) Factors contributing to the final price of oil.

Factors contributing to the final price of oil	Rial per cubic metre 1967	On average 1968
Original cost of products	305	341
Container cost	42	39
Transportation cost	529	475
Distribution cost	273	257
Total	1,149	1,112

Source: National Iranian Oil Company, Distribution Department, *Amaliat* 1968 (Operations 1968) p.4.

Transportation costs take up 50 per cent of the final cost of oil products. Therefore, since the cost of delivery by pipeline as compared with that of other means of transportation is almost zero, we can include that with the expansion and further equipment of the pipeline network, the price of products can be lowered up to 50 per cent. Thus with the expansion of the distribution network, not only can oil products reach the most distant rural areas, but even more important, they can be put at the disposal of everyone at lower cost. Since oil consumption is a considerable item in household budgets this means that the lowering of their cost will be a great contribution to household budgets.

Table 18 demonstrates the role of oil consumption in urban household budgets in 1346:

Table 18: Irān (1967-68) Average annual oil consumption costs of households according to net annual income classes in nine large cities (Rls)

Net annual income classes	Average household	Less than 30,000	From 30,000 to 39,999	From 40,000 to 49,999	From 50,000 to 74,999	From 75,000 to 99,999	From 100,000 to 149,999
Oil	1,954.3	979	1,413.1	1,594.6	1,761.1	1,932.9	2,336.5
Net annual income classes	1500,000 to 199,999	200,000 to 249,999	250,000 to 299,999	300,000 to 399,999	400,000 to 499,999	From 500,000 and more	
Oil	2813.8	3,312.4	3,641.1	4,459.7	5,750.8	7,312.6	

Source: Bank Markazi Irān. Economic Statistics Department, Household Budget Survey Section. Conclusion tables of Urban Household Budget Surveys, 1346 (1967-68) Tehran, p.3.

Another type of fuel used by Iranian households is wood consumption in urban household budgets according to various income levels.

As this table shows, in low-income families wood consumption costs play a more important role in the household budget.

Besides the obsoleteness of the use of wood and coal as fuel, it also causes great damage to country's forest resources. Moreover, forests are a major national resource and a natural source of wealth and have many advantages, so that the social damages incurred by their depletion are considerable.[51]

The fuel requirements of the country can only be fulfilled through a systematic and correct expansion of the oil distribution network. Failure to implement the pipeline projects not only results in spending large sums of foreign exchange on the purchase of oil tankers (with very high capital and current costs, and low economic benefits) but in creating many problems in the area of distribution. Keeping in mind the future oil consumption estimates, it

is obvious that oil delivery by tankers in future, if not impossible, will be a very difficult task. Besides these problems, if the oil delivery projects are not executed within the next decade and oil products continue to be transported by tankers, an average annual increase of 600 million metres will occur in the consumption of fuel oil. However, this is precisely what must be avoided, since it only accentuates one of the most basic of Iran's oil problems: i.e., the incongruity between the consumption ratios of various oil products.

Table 19. Iran: Average annual expenditures of households on woold according to annual income classes in nine large cities (1967-68)amount in rials

Net annual	Average household	Less than 30,000	From 30,000 to 399,999	From 40,000 to 49,999	From 50,000 to 74,999	From 25,000 to 99,999
Wood	115	86.2	79.6	112.4	99.5	133.6
Net annual income classes	From 100,000 to 149,999	From 150,000 to 199,999	From 200,000 to 249,999	From 250,000 to 299,999	From 300,000 to 399,999	From 400,000 to 499,999
Wood	92.4	592.3	34.4	-	69.2	360

Source: Bank Markazi Iran. Economic Statistics Department. Household Budget Survey Section. *Conclusion Tables of Urban Household Budget Surveys*, 1346 [1967/68]

Finally, considering the importance of providing the requirements for all oil products throughout the country particularly in rural areas and its economic impact, emphasis must be put on oil distribution plans and projects on every level such as provision, transportation, storage and distribution. The monetary value of economic and social expansion, resulting from the provision of oil throughout the country, must be measured by new methods. And in view of what has been discussed in this paper the conclusions drawn in this way should be compared with the results of surveys of the economic effects of foreign exchange revenues from

exports of oil; and concrete conclusions drawn only after such comparisons.

The problems of oil distribution

Even though the task of distributing oil on the domestic market is one of the most difficult and least profitable operations of the National Iranian Oil Company, the needs of the country demand that the distribution network be expanded. The major difficulties involved in this task are, therefore, listed below:

The geographical distribution of consumption centres. 73 per cent of the four basic oil products are consumed in centres which lie at a great distance from the centres of production in the South.[52] The problem of distance is, moreover, exacerbated by bad physical conditions and the inadequancy of the roads.

The number of distribution centres. The number of distribution centres of various kinds increased from 554 in 1950 to 9,251 in 1968 and, in view of the consumption trends in recent years, it seems that these will multiply to even greater numbers in the future.[53] The numerous distribution centres present many complex problems to those whose duty it is to plan distribution operations.

The dependence of Iranian towns on one fuel resource. At present, kerosene is by far the most important domestic source of domestic fuel in Iran and this fact distinguishes the large Iranian city from cities in other countries where the major fuel is usually gas. Gas is distributed to homes by means of a pipeline, but the distribution of kerosene requires tankers and this creates a great many problems from the point of view of planning.

Seasonal consumption. Seasonal changes in the consumption of oil-products, particularly kerosene are so great as to create a major storage problem. Not only must adequate quantities of kerosene be reserved for the cold season, but also, the storage tanks must be located in the centres of

Table 20. Irān: Monthly sales of oil products

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Kerosene	258	234	184	142	118	111	101	101	117	141	209	274
Gas oil	189	165	176	188	214	220	226	234	228	221	205	191
Gasoline	75	62	76	71	77	81	88	88	85	86	80	74
Fuel oil	235	194	193	179	196	200	214	208	215	236	243	264
Total consumption	797.1	687.2	666.1	624.4	654.6	659.3	689.1	686	701.4	742.5	786.3	84.5

Source: National Iranian Oil Company. Distribution Department. *Amaliāt 1968* (Operations in 1968) p.14.

consumption themselves since transportation is always more difficult in the winter. The extent of seasonal fluctuations in the consumption of the four main products can be seen from Table 20.

The ratio of consumption of different oil products in Irān. Iranian oil refineries produce certain fixed quantities of oil products from the existing crudes. But these are not in proportion to the ratio of demand as between different products. Table 21 shows the ratio of demand for gasoline, kerosene, gas-oil and fuel oil; Table 22 shows the ratio of demand of these same products after the substitution of fuel oil for gas; and Table 23 shows the proportions of the major products that can be produced from crudes in three southern fields.

Table 21. Irān: The ratio of demand for different oil products

Products	1950	1955	1960	1965	1968
Gasoline	23	19	16	12	11
Kerosene	25	26	25	25	23
Gas oil	8	12	22	27	29
Fuel oil	29	40	30	29	30
Other products	5	3	7	7	7
Total	100	100	100	100	100

Source: Farxān, Hushang, *Moqayseh masraf-e mavād-e nafti dar dah sāl-e gozashteh ba pish-bini-ye ravand-e masraf dar dah sāl-e āyandeh.* (A comparison of the consumption of oil products over the past decade with a projection of the consumption trends in the next decade) National Iranian Oil Company, Public Relations Office, Tehran 1348 [1969-70] p.9.

A glance at these tables shows that there is little harmony between the existing refining possibilities and the ratio of demand for the various products. For example, while the ratio of demand for semi-distilled products is higher than the ratio of production possibilities, that of gasoline and fuel-oil is less. Moreover, the existing refinery equipment is inadequate to the production of the correct ratios. The measures we list below are, therefore, all-important steps towards correcting this situation.

Table 22. Irān: The ratio of demand for oil products when gas is replaced by fuel oil.

Product	1972	1974	1976	1978	1979
Gasoline	11	11	11	11	11
Semi-distilled products	60	63	64	65	66
Fuel oil	22	19	18	17	16
Other products	7	7	7	7	7
Total	100	100	100	100	100

Source: Aqdā'i Abbās. *Pish-bini-ye masraf-e far-āvordehāye nafti dar kesh-var va tamin-e ān* (A projection of the national consumption of oil products and their provision N.I.O.C. 1347 (1968-69) P.19.

Table 23. Irān: Proportion of major products that can be produced from crudes from three large oil fields.

Product	Ahwāz	Aqājāri	Gachsārān
Gasoline	17	19	17
Semi-distilled products	30	31	28
Fuel oil	44	41	46
Fuel burnt at refinery & waste	9	9	9
Total	100	100	100

Source: Aqdā'i,Abbās, *Pish-bini-ye masraf-e far-āvordehāye nafti dar kesh-var va tamin-e ān* (A projection of the national consumption of oil products and their provision) N.I.O.C. Public Relations Office, 1347 [1968-69] p.20.

We have already said that the proportion of gasoline that can be produced from existing crudes is higher than the proportionate consumption of this product. We are, therefore, faced with a kind of excess supply of gasoline. Keeping in

mind the fact that the raw material of gasoline is naphtha, the following measures can be suggested:

(a) The introduction of Taping equipment in the oil field itself and returning naphtha to the well.
(b) Export markets for the excess of gasoline produced should be found.
(c) Other uses for naphtha should be found perhaps in the petro-chemical industry or as the fuel of the refinery itself.

With respect to semi-distilled products (kerosene and gas-oil) the production ratio is lower than the consumption ratio. However, there is a solution to this problem. The development of a method for refining heavy crudes into semi-distilled products (Hydrocracking) offers the possibility of turning 80 per cent of the refined-product of heavy crudes into kerosene and gas-oil. ISOMAX,equipment designed to do just this, has already been installed at the Tehrān refinery and this offers a production capacity of 1,4000 barrels per day. At present it produces 84 per cent kerosene and gas-oil and 16 per cent lighter products. A similar piece of equipment but with a lower production capacity is to be installed at the Shirāz refinery. Other similar methods such as Deep Cracking are also being developed.

We must now consider what the results of production by means of the expensive equipment noted in the table will be. The production of one barrel of semi-distilled products by means of ISOMAX is one dollar more expensive than production by more conventional means and production by the Deep Cracking method is 1.5 dollars more expensive.[55] Therefore, the introduction of new methods will raise the costs of production considerably. But, more important, the production of gas oil will be greater than the market can absorb since using this methods to produce more semi-distilled products Means that the production of gas oil must necessarily be raised.[56] Therefore the use of new equipment will exacerbate existing contradictions even more.

Among the factors that may upset the ratios of production and consumption even more is the pending substitution of natural gas for fuel oil in industry.

Lack of co-ordination between economic planning and NIOC's Operations. **This is particularly true in the** field of transport **where lack of co-ordination has, on many** occasions, prevented considerable savings. Many examples of such difficulties can be found.

Notes

1. This refinery was the first of its kind in Irān. Production began in 1913, and at first was primarily for export, and only a minor part of it was distributed among the workers in the refinery area. After a few years, that is in 1925-26, its products were distributed domestically, but mainly in the south and areas surrounding plant. Later on, with the improvement of the highways and new means of transportation, Ābādān's oil products were distributed throughout the nation.
2. Notes taken from a lecture by Mr. Hassan Āgahi on "An economic survey of, and the production of major oil products at the Abadan Refinery" delivered at a seminar on the Production and Consumption of Oil Products in Irān, Farvardin 1349 (March-April 1970).
3. Iranian Oil Operating Companies, *Nokāte chand dar bāre ye-Ābādān*. (Notes on Abadan). Azar 1346 (March - April 1970).
4. Aqdā'i, Abbās, *Pish-bini-ye masraf-e far āvordeh- hā-ye naft dar keshvar va tamin-e ān* ("A projection of the national consumption of oil products and their provision.") N.I.O.C. Public Relations Office, 1347[1968-69] P.9.
5. Rowhāni, Ahmed. "Barnameh rizi-ye xati va haml naql-e mavād-e xati" (Linear programming and transportion of materials) *Majalleh-e Anjuman-e Naft* No.29 Tehrān, Azar 1346 [Nov./Dec. 1967] pp.95-96.
6. Ne'mati, Qolāmhossein, *Barresi-ye eqtesādi va ejtemā'i towzi'-ye mavād-e nafti dar Iran* (A social and economic survey of the distribution of oil products in Irān) University of Tehrān, Faculty of Economics.
7. Aqdā'i, Abbās, *Op.cit.* p.10.
8. *Ibid.* pp.17-18.
9. *Ibid.* p.9&10.
10. *Ibid.*

11. *Ibid.* p.10.
12. National Iranian Oil Company, Public Relations Office, *Seiri dar Sən'at-e naft-e Irān* (Series on the Iranian oil industry), Tehrān, Xordad 1348 [May / June 1969] P.15.
13. Ne'mati Qolāmhossein *Op.cit.*, p.183.
14. *Ibid.*, p.183.
15. National Iranian Oil Company, Distribution Department, *Amaliāt 1967* (Operations in 1967) Tehran, 1967, pp.2& 3.
16. National Iranian Oil Company, Distribution Department, *Op.cit.*, p.2.
17. Qanāt-Ābadi, Mahmud, *Fa'āliat-e Sherkat-e melli-e naft dar zamine-ye xotut-e luleh va asarāt-e an* (Activities of the NIOC with respect to the pipeline and their effects) Tehrān, NIOC, Public Relations Office, 1967, p. 10.
18. Refer to Engineer Naficy's lecture notes on "Means of Transportation". Faculty of Economics, University of Tehrān.
19. Rowhāni, Ahmed. *"Xat-e luleh dovom"* (The second pipeline) *Majalleh-e Anjuman-e Naft* No.24. Tehran, 1344.
20. Qanāt-Ābadi, Mahmud, *Op.cit.* p.15.
21. Rowhani, Ahmed *"Behtarin qatar-e xat-e luleh"*(The best dimension for a pipeline) *Majalleh-e Anjuman-e Naft,* Tehrān,Āzar 1344 [Nov./Dec. 1965].
22. Ne'mati, Qolāmhossein. *Op.cit.* p.p. 87-88.
23. Qanāt-Ābadi, Mahmud, *Op.cit.* p.13.
24. *Ibid.*
25. Rowhāni, Ahmed. *"Barnāmeh rizi xati va haml o naql-e mavād-e xati"* (Linear programming and the transportation of materials) *Majalleh-e Anjuman-e naft,* No.29, Tehrān, Āzar 1346 [Nov./Dec.1967] pp.94-95.
26. Rowhāni, Ahmed. *Op.cit.*
27. Qanāt-Ābadi, Mahmud, *Op.cit.* PP.51-55.
28. *Ibid.*, pp.34-35.
29. National Iranian Oil Company, Public Relations Office, *Op.cit.*
30. NIOC, Distribution Department, *Operations 1968.* P.19.
31. *Ibid.*, p.20.
32. Qanāt-Ābadi, Mahmud, *Op.cit*, pp.15-17.
33. From Engineer Rowhani's notes. I am grateful to Engineer Rowhani for his help in compiling this section.
34. That is, the dimension of the pipeline at point B does

not change.

35. NIOC, Distribution Department, *Operations 1968* p.3.
36. Notes taken from an oil seminar held in Farvardin 1349 [March/April 1970].
37. *Ibid.*
38. *Ibid.*
39. *Ibid.*
40. Pākdaman, Nasser *Jamiat-shenāsi omumi* (General demography) lecture notes mimeographed by the Faculty of Economics, University of Tehran.
41. Plan Organization of Iran, Statistics Centre, *Natāyej-e sar shomāri* 1345, vol. 168, (The 1345 Census) Tehrān, Esfand 1346 [Feb/March 1968].
42. Pākdaman, Nasser *Eqtesād-e Irān* (The Iranian economy) Lecture notes mimeographed by the Faculty of Economics, University of Tehran.
43. Bank Markazi Irān (The Central Bank of Irān) *Gozāresh-e sāliāneh va taraznāmeh-e Bānk-e Markazi-e Irān dar Pāyān-e Esfand 1347* (Annual Report and Balance sheet at March 1968) Tehrān, Bank-Markazi Iran.
44. Notes taken from the oil seminar help in Farvardin in 1349 [March/April 1970].
45. *Ibid.*
46. *Ibid.*
47. *Ibid.*
48. *Ibid.*
49. Farxān, Hushang *Moqayseh masraf-e mavād-e nafti dar dah sāl-e gozashteh bā pish-bini-e ravand-e masraf dar dah sāl-e āyandeh va masā'el marbut be ān* (A comparison of the consumption of oil products over the past decade with a projection of the consumption trends in the next decade and related problems). National Iranian Oil Company, Public Relations Office, Tehrān 1348 [1969-70]. P.8.
50. National Iranian Oil Company, Oil Consortium, *'CHAM'*, *Projet-e now dar sana't-e naft-e Irān* (CHAM, A New Project in Irān's Oil Industry) Tehran, p.1.
51. Pākdaman, Nasser. *Op.Cit.*
52. Farxān, Hushang, *Op.Cit.* p.10.
53. *Ibid.*
54. Aqdā'i Abbas, *Op.cit.*

55&56 Notes taken from the oil seminar held in Farvardin 1349 [March/April 1970] at the Faculty of Economics, University of Tehran.