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ECONOMICAL EVALUATION OF USE OF SECOND HAND MACHINERY IN PETROCHEMICAL INDUSTRY (CASE STUDY: IRANIAN PETROCHEMICAL PROJECTS)

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ABSTRACT

The high cost of purchasing high technology and severe sanctions imposed on Iran over the last decade are the reasons why economical alternatives should be assessed, such as the use of second hand technology. There is evidence to show that in Iran the use of second-hand equipment in the petrochemical industry has become commonplace in recent years. Polypropylene (PP) and Methyl Tertiary-Butyl Ether (MTBE) are produced using second hand machinery purchased from a German company and recently used machinery transferred from an Indian company was utilized in the production line of Methyl Ethyl Ketone (MEK). In this research the three above-mentioned projects were evaluated to determine whether or not the use of second-hand machinery was economically justifiable. The method of research is descriptive analysis and output data will be estimated with Comfar software. The conclusion is that PP and MTBE projects could be justified from an economic perspective, but the MEK project failed in terms of profitability in the examined years.

Keywords: Economic evaluation, Petrochemical project, Second-hand equipment

JEL classification: C80, D22, D24

INTRODUCTION

One of the crucial issues in economic development, particularly in developing countries, is to provide sufficient capital for meeting the financial needs of private businesses. Considering the fact that equipment and machinery investment is regarded as the most significant costs in fixed

investments, the purchase of used plants and equipments is one alternative way for developing countries to finance the required capital investments of heavy industries.

The foremost factors leading underdeveloped economies to use second-hand technology are varied. Relatively low costs of labor, energy and raw materials makes even the absolute energy-intensive equipment imported from developed countries to be economically acceptable. Besides, lack of infrastructure, skilled manpower, spare parts and knowledge to support the modern technology seem to reinforce the idea that used equipment could be an attractive substitute for newer technologies in these economies.

In Iranian petrochemical projects (Two examined plants in this paper), however, the main reason of using second-hand equipment has been financial constraint of private enterprises. Although, this choice has later turned out to be entirely profitable for both examined companies. The third plant using second-hand equipment, on the contrary, has proved to be an unsuccessful case of implementing second-hand equipment. The financial evaluation will back up these arguments later in the paper.

LITERATURE

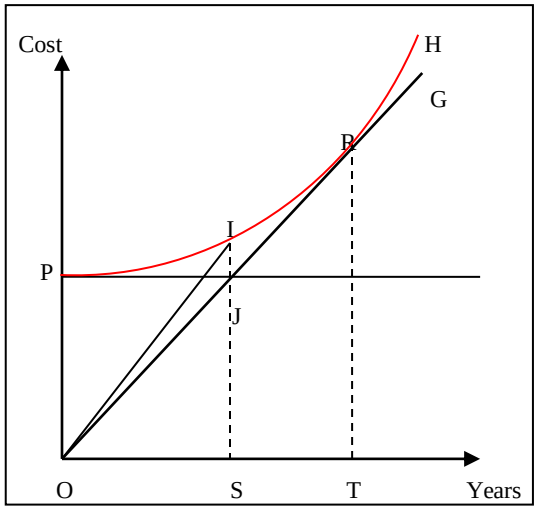
In Microeconomics, goods are categorized into durable and nondurable goods. A durable product doesn't quickly wear out, or more specifically, it yields utility over time. In other words, durable goods last for more than one period (Coase, 1972). Durable goods are usually made of durable materials such as steel, iron, aluminum and copper and their useful lifetime depends on the degree of their durability. Value of durable goods also creates service for their owners. The more the good is valuable, the more effort is made to preserve it (Ahmadian, 2001). In this study, the importance of durable goods will be examined from a different perspective. The function of durable goods will be evaluated through second-hand market. In other words, durable goods have the ability to be sold several times in the form of a second-hand good, resulting in income of its owner.

In Fox (1957) model, the original purchase of a good (point P) is added to maintenance costs to produce curve PH. This represents "Holding Cost" curve which has an increasing slope that implies the assumption that maintenance costs increase as the good gets older.

Fox explains that point R where the line OG is tangential to the holding cost curve is the optimal point and the decision is made to scrap the good, as it is increasingly costly to continue to maintain it beyond this point.

Therefore, the original consumer must be persuaded to sell the product at some point of time away from the optimum time at T.

Figure-1. Holding Cost (Fox 1957)



If a person wished to purchase a used product from the current user at a point of time like S, they would need to compensate the current user for the move away from the optimum cost ratio line. This means distance IJ is the indicative secondhand price needed to get the user to sell their product. (Harrow, 2004)

In 1970, Akerlof's famous "lemons" model, concentrating on lemon cars, demonstrates that there is a negative correlation between the used good's quality and its volume of trade. More precisely, older goods are traded more frequently. The underlying factor for this is information asymmetry occurring in secondary markets as the seller knows more about the product than the buyer. He backs up his proposal as Gresham's law has indicated that "Bad money drives out good". Similarly, the "bad" cars tend to drive out the good and most cars traded will be the "lemons," and good cars may not be traded at all.

Although, research on second hand market has been quite dispersed and mostly focusing on a particular commodity, transfer of second hand technology has created some controversies.
Second hand equipment is not necessarily a decrepit and worn out piece of machinery, yet the physical conditions of these equipments are quite varied. Second hand equipments are regarded as an intermediate technology which had been purchased by a potential user, and resold at least once (Baxter, 1973). Second-hand equipments are categorized in one of the following forms:

- Unused: Equipment never installed for service
- Reconditioned: Used equipment repaired and not used since
- As is: Used equipment offered for sale as taken from service[1]

[1] . United Nations of export group on second-hand equipment for developing countries, 1966. Centre for industrial development.

There are several attitudes regarding transfer of second hand technology from developed nations to developing ones. Firstly, Neo-classical theoretical assumptions about factor substitutability, contends that less-developed nations should use more labor-intensive techniques. Since wage-rental ratios are relatively low in less-developed countries, more labor-intensive techniques of production would seem desirable (Todaro, 1970). Furthermore, the transfer of second hand machinery lies in the rising cost of maintenance with the age of the machine. Since underdeveloped countries have cheap labor, the cost of maintenance may be relatively lower in these economies. Similarly, a fall in the absolute productivity of the machinery with age can be more easily absorbed due to the low wage levels. A reduction in productivity that will wipe out all profits in the developed economy, may still allow a profit margin in the low-waged under-developed country (Sen, 1962). On the other hand, some argue that developing countries should import the most modern equipment. This argument suggests that by acquiring the most modern technology, developing countries could leapfrog their way into developing competitive exports (Spencer, 1970). However, there is a counter-argument which implies that even if an industry did make the decision to purchase updated equipment, they may not be able to find the replacement parts or maintenance expertise in-country to support it (Detwiler, 1997). Older machinery also may be more appropriate for firms in developing countries because the smaller optimal scale of older machines may be better suited to smaller developing-country markets and because older machines may be more flexible in their use and less specialized (Sen, 1962) (Dilmus, 1975).

Navaretti (1998) has examined data on US exports of new and used metalworking machine tools by type and by country of destination and concluded that factor prices may be less significant than technological, educational, and skill factors in determining used machinery trade. The more technologically advanced the machinery, as measured by the level of skills required to operate it, the larger the proportion of imported used machinery. Also, the higher the level of skills in the country, as measured by average years of school completed, the smaller the proportion of used equipment chosen. The common point of all studies is that developing countries would potentially benefit from the importation and use of second-hand machinery. Low wages, relatively low costs of raw materials, lack of technical infrastructure and skill constraints in developing nations are the main reasons provided in previous papers. In this study, however, the major point in the use of second hand equipment by the examined companies is financial constraints and we will expound upon this argument later in the paper.

RESEARCH METHODOLOGY

In Iran, the use of second hand equipment in the petrochemical industry[2] has become commonplace in recent years. Equipment first implanted in PVC production by Petrochemical company (PIIC) in

[2]. Petrochemical Industries Investment Company (PIIC)

1996 was not successful, because the machinery was not configured to operate in the climactic conditions of Iran. Later, Polypropylene (PP) in 2000 and Methyl Tertiary-Butyl Ether (MTBE) production in 2002 used second hand machinery purchased from HUCHEST and HUELS, German companies. In 2008 used machinery transferred from an Indian company (Edeleanu) was utilized in the production line of Methyl Ethyl Ketone (MEK) had high maintenance costs, which were not estimated before the transfer process.

Overall, technical and economical consideration in the Cost and Benefit analysis is not fully addressed in the evaluation of most projects, although machinery purchase costs are the major part of initial investment in projects. This study is mainly focused on the efficacy of use of second-hand equipments for heavy industries and economic performance of Polypropylene (PP) production by Polynar Company in the years 2000-2009 and Methyl Tertiary-Butyl Ether (MTBE) production by Chemibaft Company in the years 1999-2010 will be examined.

PP[3] Production by Polynar Company

Polynar Company was founded in 1992 with a total capital of 100m Rial[4] in Tabriz, Iran. Between 1994 and 1996, 209,625 square meters of land in the vicinity of Tabriz Petrochemical Company was purchased. Polynar took advantage of the fact that Tabriz had, and still has an infrastructure well-suited to industrial pursuits and an efficient and skilled pool of labor. Hence, the company does not have a major problem with its workforce requirements. Production line machinery was purchased from a German company (HUCHEST) with a nominal capacity of 50,000 tons annually. The nominal capacity of the plant is 55,000 tons per year and despite the serious challenge of finding a second-hand machine with the desired capacity among a narrow spectrum of available options, Polynar located and secured suitable equipment that could deliver the required capacity. Additionally, in view of the financial constraints, the outright purchase of machinery wasn't a viable option at that point in time, hence foreign currency loans totaling $5.9 million were secured in 1999 from the National Petrochemical Company ("NPC") with 3-year tenor. The main raw material in the manufacture of Polypropylene is Propylene which is provided by Tabriz Petrochemical Company under a contract specifying that 56,000 tons of Propylene per year will be provided for a maximum period of 30 years with a 30% price discount in the first 5 years. Therefore, the choice of project site in the vicinity of Tabriz Petrochemical Company was one of the key strengths of the plan, because the cost of transfer of raw materials is insignificant and the volume commitment that the Polynar Co was able to make resulted in a significant cost saving on a key raw material. In 2010, Polynar Co was sold in the private enterprise market when the scrap value of the whole factory was estimated as 644 billion Rial. For the purposes of the economic

[3] . Polypropylene (PP), is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles, stationery, and laboratory equipment.

[4] . National Iranian Currency

evaluation this residual value has been added to the last year's net income. An evaluation of the project at a discount rate of 16% produces the following results:

Investment costs

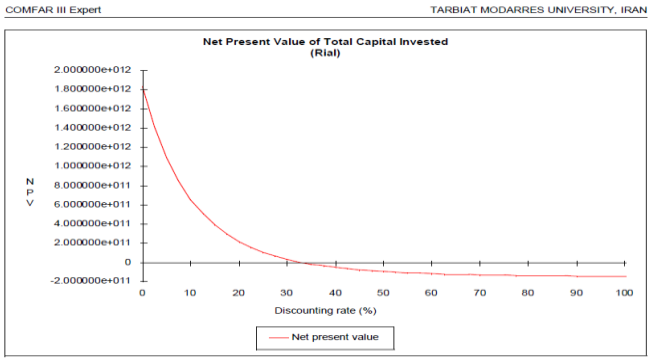
	Total construction	Total production	Total investment
Total fixed investment costs	145,123,900,769.00	0.00	145,123,900,769.00
Total pre-production expenditures	9,501,575,000.00	0.00	9,501,575,000.00
pre-production expenditures(net of interest)	5,000,000,000.00	0.00	5,000,000,000.00
Interest	4,501,575,000.00	0.00	4,501,575,000.00
Increase in net working capital	0.00	294,409,431,078,67	294,409,431,078,67
Total investment costs	154,625,475,769.00	294,409,431,078,67	449,034,906,847.67

Operation Income & Costs

	First year 2002	Reference year 2002	Last year 2010
Sales Revenue	288,559,231,200.00	288,559,231,200.00	1,437,934,053,000.00
Factory costs	182,237,918,908.00	182,237,918,908.00	70,448,589,910.00
Administrative overhead costs	5,512,521,784.00	5,512,521,784.00	6,847,076,916.00
operating costs	187,750,440,692.00	187,750,440,692.00	711,295,666,826.00
Depreciation	15,365,094,227.00	15,365,094,227.00	8,965,094,227.00
Financial costs	59,834,003,151.00	59,834,003,151.00	57,939,042,607.92
Total production costs	262,949,538,070.00	262,949,538,070.00	778,199,803,660.92
Marketing costs	0.00	0.00	267,162,441.00
Costs of products	262,949,538,070.00	262,949,538,070.00	778,466,966,101.92
Interest on short-term deposits	380,372,352.67	380,372,352.67	582,027,647.46
Gross profit from operations	25,990,065,482.67	25,990,065,482.67	660,049,114,545.54
Extraordinary income	0.00	0.00	0.00
Extraordinary loss	0.00	0.00	0.00
Depreciation allowances	0.00	0.00	0.00
Gross profit	25,990,065,482.67	25,990,065,482.67	660,049,114,545.54
Investment allowances	0.00	0.00	0.00
Taxable profit	25,990,065,482.67	25,990,065,482.67	
Income (corporate tax)	0.00	0.00	1,650,122,786.36
Net profit	25,990,065,482.67	25,990,065,482.67	658,398,991,759.18

In figure (2), Internal Rate of Return (IRR) at 33.38% is obtained from the intersection of horizontal axis and NPV curve. It can clearly be seen that IRR is more than discount rate of 16% and the plan is economically defensible.

Figure 2. Net Present Value Curve, PP Production



Source: Outputs of Estimation

MTBE[5] Production by Chemibaft Company

Chemibaft Company, the first producer of MTBE in Iran, started its activity in 2002 with an MTBE production capacity of 45,000 tons per year in the Mahshahr Special Economic Zone. The company has recently developed plans to double the capacity of MTBE production to 90,000 tons per year.

The raw materials needed for MTBE production and Raffinet II (by-product) are Methanol and Rafinet I, which are both provided from the nearby sources. The careful selection of the site has resulted in a significant reduction in raw material transfer costs. Methanol is provided by Fanavaran factory and Rafinet I is produced at the nearby Bandar Imam Factory. It is clear that the best location was selected in terms of the supply of raw materials.

Second-hand equipment for the main production line was purchased from the German company (HUELS) in 1999, using $5.2 million in foreign currency 9% loans received for this purpose from NPC. The loans were due to be repaid within 3 years by the company. According to company officials, the cost of equivalent new equipment at that time was approximately 6 times the cost of buying used equipment, therefore the purchase of second-hand machinery saved a significant amount of capital for the company. Naturally, new machinery would have lower maintenance costs and would be more energy-efficient than used machinery over its useful life. In fact, the whole costs of utility and energy in new machinery would be considerably less than its second-hand counterpart but the remarkable thing to observe is that only approximately 1% of production costs of petrochemical plants are related to energy consumption and utility (interview with Chemibaft Co). Furthermore, raw materials for petrochemical projects are accessible and profuse in Iran. In the immediate vicinity of Chemibaft Co, the Imam, Fan Avaran and Amir Kabir petrochemical companies are well placed to provide for the inexpensive transfer of raw materials, making the use of second-hand equipment interesting for a variety of petrochemical processing activities. In 2009, Chemibaft Co was sold in the private enterprise market when the scrap value of the whole factory

[5]. Methyl Tertiary-Butyl Ether (MTBE) is a gasoline additive, used as an oxygenate to raise the octane number

was estimated 745 billion Rial. Financial data was derived from the company and final evaluations are as follows:

Investment costs

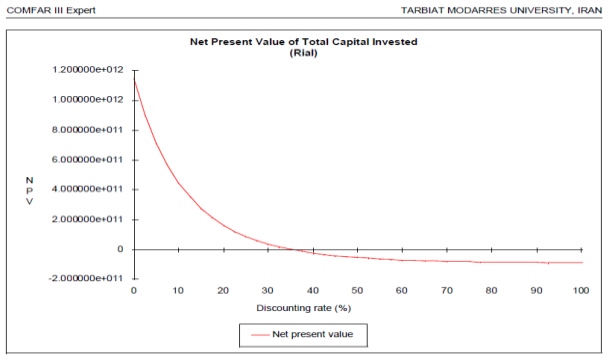
	Total construction	Total production	Total investment
Total fixed investment costs	101,940,230,960.00	0	101,940,230,960.00
Total pre-production expenditures	4,039,681,012.06	0	4,039,681,012.06
pre-production expenditures(net of interest)	1,500,000,000.00	0	1,500,000,000.00
Interest	2,539,681,012.06	0	2,539,681,012.06
Increase in net working capital	0.00	144,126,068,333.12	144,126,068,333.12
Total investment costs	105,979,911,972.06	144,126,068,333.12	250,105,980,305.18

Operation Income & Costs

	First year 2002	Reference year 2002	Last year 2009
Sales Revenue	8,381,988,047.00	8,381,988,047.00	1,209,339,000,000.00
Factory costs	11,465,314,025.00	11,465,314,025.00	356,176,000,000.00
Administrative overhead costs	0.00	0.00	2,905,000,000.00
operating costs	11,465,314,025.00	11,465,314,025.00	359,081,000,000.00
Depreciation	8,700,000,000.00	8,700,000,000.00	8,700,000,000.00
Financial costs	6,042,133,121.62	6,042,133,121.62	53,749,774,258.74
Total production costs	26,207,447,146.62	26,207,447,146.62	421,530,774,258.74
Marketing costs	18,397,477.00	18,397,477.00	120,000,000.00
Costs of products	26,225,844,623.62	26,225,844,623.62	421,650,774,258.74
Interest on short-term deposits	0.00	0.00	460,987,500.00
Gross profit from operations	-17,843,856,576.62	-17,843,856,576.62	788,149,213,241.26
Extraordinary income	0.00	0.00	0.00
Extraordinary loss	0.00	0.00	0.00
Depreciation allowances	0.00	0.00	0.00
Gross profit	-17,843,856,576.62	-17,843,856,576.62	788,149,213,241.26
Investment allowances	0.00	0.00	0.00
Taxable profit	-17,843,856,576.62	-17,843,856,576.62	788,149,213,241.26
Income (corporate tax)	0.00	0.00	0.00
Net profit	-17,843,856,576.62	-17,843,856,576.62	788,149,213,241.26

In figure (3), IRR (35.58%) is clearly more than discount rate of 16% and the plan is economically justifiable.

Figure 3. Net Present Value Curve, MTBE Production



Source: Outputs of Estimation

MEK[6] Production by Chemitex Aria Company

As mentioned above, Raffinet II is the by-product of MTBE production and it is a mainly useless and valueless by-product which was initially thrown away. However, this substance could be the main raw material of another chemical product called MEK. In 2007, feasibility research was carried out by Chemibaft Co and the MEK plant was assessed to be economically plausible and profitable. The plan had some advantages that made it immediately attractive. Firstly, the principal raw material was produced with no costs in MTBE production. Secondly, surplus civil works, structures and buildings and also factory supplies and utilities of Chemibaft Co could be used for the MEK project and this would result in a significant reduction in fixed and variable production costs.

MEK production finally commenced with a capacity of 8,000 tons per year in the framework of the newly established company named Chemitex Aria, which started its activity in Mahshahr, Iran in 2008. Technical knowledge and support for the installation and commissioning of the plant and equipment at the chosen site was provided by an Indian company.

As the calculated IRR indicates in table (1), the plan is not economically justified at a discount rate of 16%, returning a negative NPV whilst feasibility research by Chemibaft Co researchers had estimated an IRR of over 20% for the project. Based on interviews conducted with company officials, the high cost of maintenance and replacement parts are the main factors for the failure, while this was not the case in second-hand equipment imported from Germany (to the MTBE plant). Although equipment purchased for MEK was seemingly in a good physical condition the machinery had been dismantled and obsolete long before it was sold out to Chemitex Co and therefore required frequent replacement of parts and huge maintenance costs.

[6] . Methyl Ethyl Ketone (MEK) is an effective and a common solvent and is used in process involving gums, resins, cellulose acetate and nitrocellulose coatings

Table 1. Results of MEK production evaluation

Internal Rate of Return (IRR)	8.56%
Net Present Value (NPV)	-52,173,763,800.49

Source: Outputs of Estimation

CONCLUSION

Two plants of MTBE and PP production have shown an acceptable performance over the sampled years, while MEK didn't meet the initial aims of Co and didn't have a justifiable economic outcome which is mostly due to inappropriate selection of second-hand equipment. According to interviews with company officials, equipment used in the MEK process had not been used in the production line for years in India, while one of the most important factors when buying equipment is to test it while it is operating. Nevertheless, limited available sources of suitable machinery to Iran, due to recent stringent sanctions on Iranian industries, has been the primary reason leading officials to choose the Indian machinery. As previously mentioned, both Chemibaft and Polynar companies borrowed substantial amounts through loans for the purpose of buying second-hand equipments. This clearly shows that they couldn't have afforded to buy new machinery at that point of time. In other words, they couldn't have operated the plant if they hadn't used second-hand equipments.

All things considered, used equipments can be a potential solution for investors who are facing capital constraints. However it should be noted that the use of second-hand equipment does not guarantee profitability. The proper selection of second-hand equipment could be associated with a high rate of return, while poor choices and lack of attention at the time of purchasing can cause loss of capital and resources. Therefore, expert assessment and a full techno-economic evaluation is essential when buying second-hand machinery.

REFERENCES

Ahmadian, M., 2001. Monopoly supply of durable goods with random fluctuations in commodity price. Journal of Economic Research, 84: 50-60.

Baxter, R.W., 1973. The role of second hand equipment in developing nations. Kansas State University Manhattan Kansas.

Coase, R.H., 1972. Durability and monopoly Journal of Law and Economics, 15(1): 143-149.

Detwiler, P.K., 1997. The problem of second hand industrial equipment. In: Proceedings from the Nineteenth Industrial Energy Technology Conference. Houston, TX: pp: 23-24.

Dilmus, J., 1975. Second hand machinery in development: A comment. The journal of Development Studies, 11: 230-233.

Fox, A.H., 1957. A theory of second-hand markets. Economica, XXIV (NS): 99-115.

Harrow, B., 2004. New and secondhand goods a textbook case. Department of Economics and Finance, School of Business, Latrobe University Melbourne.

Navaretti, G.B.S., Isidro. , 1998. Bargains rejected? Developing country trade policy on used equipment. Wendy Takacs, Labour 12(2): 353-362.

Sen, A.K., 1962. On the usefulness of used machines. The Review of Economics and Statistics, 44(3): 346-348.

Spencer, D.L., 1970. Technology gap in perspective. New York: Spartan books.

Todaro, M.P., 1970. Some thoughts on the transfer of technology. Eastern Africa Economic Review: 53-64.

BIBLOGRAPHY

Akerlof, G.A., 1970. The market for "lemons: Quality uncertainty and the market mechanism". The Quarterly Journal of Economics, 84(3): 488-500.

United Nations Report of export group on second hand equipment for developing countries, 1966. Centre for industrial development.