PROPOSED KARACHI-RASHT RAILWAY SYSTEM (KRR) AND ITS IMPACTS ON THE DEVELOPMENT OF AFGHANISTAN, IRAN AND PAKISTAN

by

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Dissertation submitted to the Graduate Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Civil Engineering

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June, 1977

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ACKNOWLEDGEMENTS

I must place on record my sincere appreciation to Dr. John W. Dickey for chartering my academic courses and for the long hours he has spent with me in providing guidance in the preparation of this dissertation. I owe to him my interest in the field of transportation planning. Over the years he has remained a constant source of encouragement and help. He aroused my interest in the topic of this dissertation and offered many valuable comments. I am also very grateful to Dr. R. D. Walker who was an invaluable professor and guide during my academic years at VPI and SU. I am also indebted to Professor D. R. Drew who offered ready and useful criticisms and much guidance. I am most grateful to Professor L. J. Simutis, Professor R. C. Stuart, and Professor J. W. Hurley for their encouragement. I am also grateful to

for typing this dissertation. Finally, I am grateful to my wife for her unstinting encouragement and emotional sustenance, and particularly to my parents, without whose interest, support, and urging my career could not have taken this shape.

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I. INTRODUCTION

This paper is concerned with multi-country ground transport links in developing areas and more specifically with the PIA (Pakistan, Iran, and Afghanistan) region, where lack of an international railway between these countries has created many problems of delay, congestion, and high transport costs. The countries in this region are commercially dependent upon each other and upon the "advanced" nations. Inefficient transportation within the region is also a major factor in the low standard of living experienced by the inhabitants. Food production, health, tourism, international trade, and political tensions are among the many things affected by the lack of transportation facilities. A third to half of the PIA population suffers from hunger or malnutrition. One-fifth to one-quarter of the children die before the age of five. The average life expectancy is about thirty years less than in the advanced nations of the world. Only sixteen percent of the population is literate.

In Afghanistan half of all trade still moves on the backs of men, camels, and donkeys. Poor transportation has increased the price of goods to as much as five times their production cost (51, p.6).

Transport difficulties have their political and social as well as economic impacts. Poor transport makes it exceedingly difficult to achieve national and international unity. In Afghanistan, communication has been so poor as to have produced a fragmented government. As a result of poor information flow, each province applies its own

techniques and procedures for tax collection. The consequence is administrative confusion (28, p.60).

Within the PIA region, there are still isolated areas that cannot be reached except by horse or foot. As a result, grains, fruits, and other farm products frequently spoil before they get to the market centers. Poor information channels have also been observed in the commercial field:

> "Market information on prices and supplies reaches producers and consumers too late or in garbled form; if commercial information were more efficient, the costly and slow means of transport would make it difficult for supply to adjust to commercial intelligence." (28, p.60)

Due to the lack of transport, the announcement of the 1964 war between India and Pakistan did not reach many villages in spite of government efforts to spread the news by newspapers dropped from airplanes, by radio, and by other means. Similarly, the 1973 overthrowing of the 800-century-old Kingdom of Afghanistan was unknown to many villagers because of the lack of communication and transportation facilities.

In other countries:

> "The great mobility provided by transport investments has played an important part in extending the benefits of education, in communicating new ideas, and in overcoming the isolation that has been a principal factor retarding economic progress. The cost of education is being reduced by good roads that make possible consolidated schools, and all-weather transport is causing a marked improvement in school attendance and enables technical personnel to cover more territory in less time." (51, p.9)

> "The contribution of transportation to domestic productive effort usually accounts for ten to fifteen percent of the gross domestic production." (80, p.143)

> "Even modest improvements in transport change the life and attitude of the people affected. Primitive roads built in

Bolivia to connect densely populated regions with hitherto inaccessible land have altered the outlook of whole communities. Ethnic groups that previously lived apart have been encouraged to join in cooperative efforts to build a better future.

"Transport is also helping to combat sickness and disease. In India, mobile hospital units move over the road to villages that have no local doctor. In Liberia, health services have been established over a wide area by flying materials, equipment, and personnel to remote airstrips for the establishment of field dispensaries. Along the Nile River, an Egyptian hospital ship brings medical care to patients along its route who would otherwise have no access to modern methods of treatment. Egyptian physicians maintain that improving transport has been a principal means of improving health." (51, pp.9-10)

"The contribution to national development that resulted from improved mobility and ease of access is demonstrated by transport advances in Colombia. Between 1938 and 1960, total freight movement increased more than seven-fold. Rail and water transport more than doubled. Truck transport expanded to thirteen times the 1938 volume, and air cargo multiplied nineteen times. Petroleum pipelines coming into use in the early 1950's soon accounted for 40 percent of the total ton-kilometers moved in Colombia. Air travel multiplied nearly 35 times to become the primary passenger carrier and the number of passenger cars and buses registered a six-fold increase. During this period of expanded transport in the 1950's, Colombia's GNP product rose 48 percent. Many rural areas that were once completely isolated are producing food and agricultural products for consumption in distant cities." (51, p.40)

Transport is not a separate sector of the economy, but a web of communications that joins other sectors together. Transportation has been regarded by some as a prime factor in causing development to occur. Gill's comments on the importance of railroads in promoting development in the United States exemplify this viewpoint.

"The railroads were often the initiating factor in the growth process. In many years they were constructed in an economic environment which could not immediately justify their existence. They were built 'ahead of demand', i.e., only the subsequent growth of these areas could provide the volume of transport which would make the roads profitable. Since the absence of adequate transportation facilities would have impeded or enormously slowed the growth of these areas, the early

> construction of the railroads ... became the spearhead of economic progress." (56, p.16)

Ullman's statements on the subject further amplify the importance of transportation as a catalyst in the development process:

> "In any case, innovations, as well as people and products, are transmitted easier. This does not mean that transport automatically develops. It is a passive force, a necessary, not a sufficient condition, but one with profound effects on spatial organization and under-development." (56, p.18)

The need for international integrated transport facilities becomes more pressing as individual countries proceed with development programs that clearly need to be related to the plans of their neighbors.

> "The Danube and Rhine Rivers have been under international administration for a hundred years. These arrangements provide for freedom of navigation to vessels of all nations, and promote uniform maintenance of waterways. The desirability of international transportation was demonstrated long ago by the Scandinavian Air Lines System, a joint enterprise of Norway, Sweden and Denmark." (51, p.147)

In recognizing the problems associated with lack of national and international transportation facilities, and in view of the importance attached to international transportation systems in enhancing the development process of Afghanistan, Pakistan, and Iran, this research is directed to six main objectives:

1. To propose an international transportation link through Afghanistan, Iran, and Pakistan (see Figure A1.1, Pocket). For purposes of this research the name Karachi-Rasht Railway System (KRR) has been assigned to the proposed link.
2. To discuss the KRR, its location, the advantages of the railway relative to other modes of transportation, and the advantages of an integrated international transport link.

3. To identify developmental events that might be affected by the impact of the KRR. Associated with this objective are two sub-objectives which are the basis for the major elements of this study.
   a. To analyze the history of the impact of an existing analogous transport link, the Suez Canal, by identifying relevant developmental events and the magnitude of their resultant changes.
   b. To study the socio-economic characteristics of the PIA region and present the identified level of development in each area expected to be affected by the KRR.
4. To discuss possible forecasting methods for estimating the developmental impact of the proposed railway system and to present the rationale for choosing the cross impact technique (CIT) as the proper method for this particular effort.
5. To apply the CIT to determine the probability of occurrence of specified events relevant to the impact of the proposed KRR.
6. To present a general summary of this paper; to make overall conclusions and recommendations concerning the proposed KRR; and to discuss future research on the further evaluation and possible improvements of the elements involved in structuring the present version of the CIT.

In the process of carrying out this project, the PIA's socio-economic characteristics will be compared with those of two other

multi-country regions linked internally by an international railway system.

The region selected in Africa is Uganda, Kenya, and Tanzania (UKT) and that in Europe is Switzerland, West Germany, and France (SGF). The UKT region has socio-economic characteristics similar to the PIA, with Uganda being land locked as is Afghanistan. Although Switzerland is likewise land locked, the SGF region obviously has different socio-economic characteristics but does represent a level to which the PIA region may eventually rise.

The purpose behind such comparisons would be to help estimate the future levels of the PIA region's identified developmental events resulting from the KRR.

Organization of the Research

The study is comprised of seven chapters. Six appendices have been added to describe technical details of the CIT and to present relevant tables, figures, and computer printouts. A systematic presentation of the steps involved in this research is presented in Figure 1.1.

Chapter I introduces the region's existing transportation problems and discusses the contribution of transportation to development, as well as the advantages of an international integrated transport link; it sets forth the objectives to be achieved by this research effort.

Chapter II presents a description of the KRR and its proposed location; it also treats of the advantages and disadvantages of

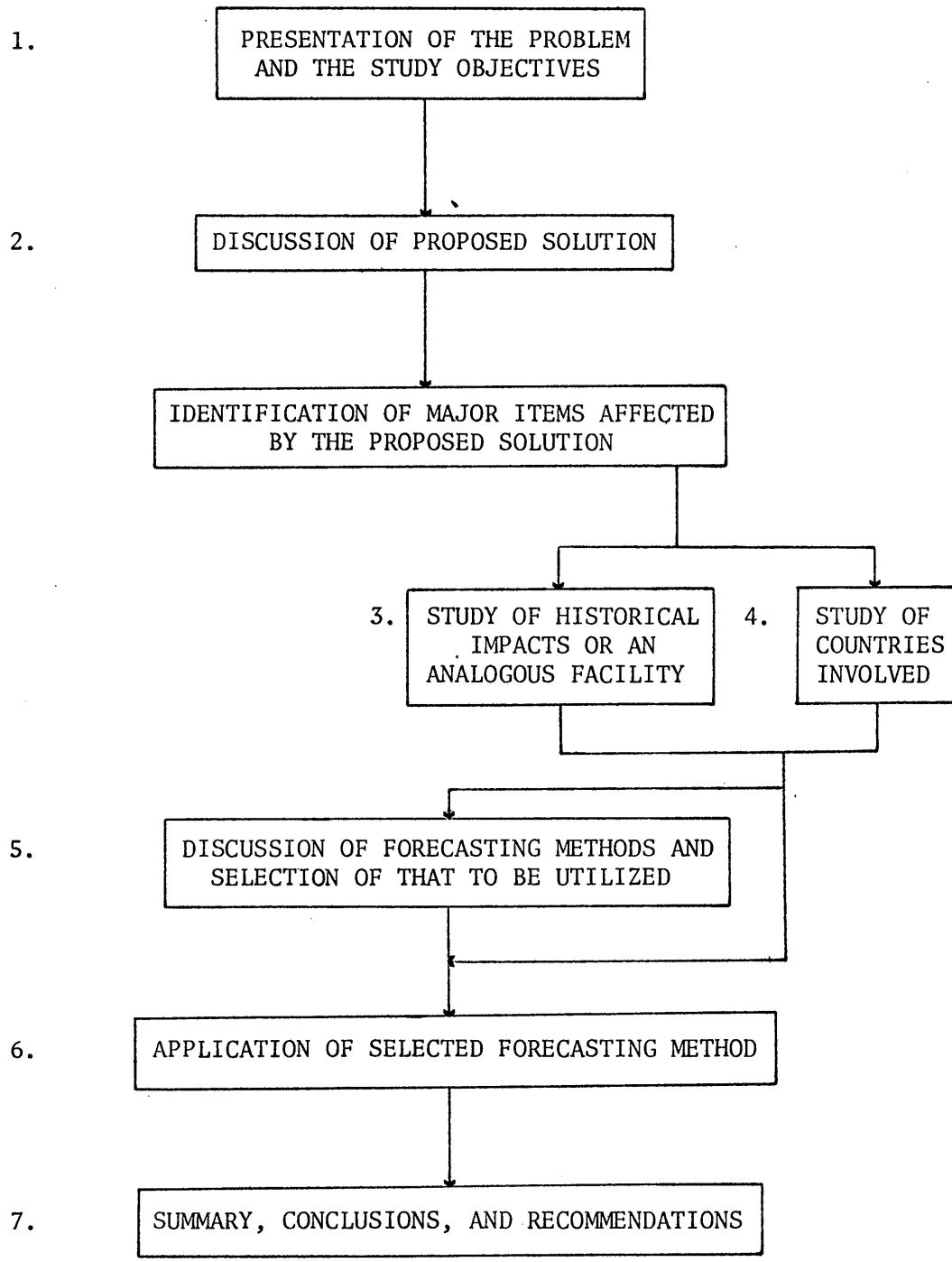

FIGURE 1.1 A SYSTEMATIC PRESENTATION OF THE MAIN STEPS INVOLVED IN DEVELOPING THIS RESEARCH.

railway, as such, and offers a justification for its selection over other modes of transportation; the chapter concludes with a discussion of the advantages of utilizing the system as a single integrated international link.

Chapter III describes the analysis used to identify developmental events relevant to the impacts of the proposed KRR. As is shown in Figure 1.1, the identification of developmental events is presented through an analysis of the history of the impact of an analogous transport link, the Suez Canal.

Chapter IV presents the background analysis of the PIA region with specific reference to present conditions most likely, in the light of Chapter III's historical analogy, to be affected by the proposed development. Furthermore, the socio-economic characteristics of the PIA region are compared with the UKT and SGF regions, which are affected by the Suez Canal and linked internally by an international railway system.

Chapter V discusses and compares various forecasting methods and presents the rationale for using the CIT as a tool for analyzing the impact of the developmental events as they interact with one another. This chapter also highlights further development of the technique and presents a method for determining the impact of an individual event.

Chapter VI discusses the CIT's input requirements and presents the results of the application of the CIT as well as its sensitivity analysis.

Chapter VII presents an overall summary of this project along with general conclusions and recommendations. Suggestions are also made toward possible future improvements of the CIT.

II. THE PROPOSED KARACHI-RASHT RAILWAY SYSTEM (KRR)

The purpose of this chapter is to describe the KRR, its proposed location, and its potential usefulness in the development of the PIA region. A further purpose is to highlight the advantages and disadvantages of railway as compared to other modes of transportation.

The proposed KRR presented in Figure 2.1 extends about 2,000 miles from Karachi on the Persian Gulf to Rasht on the Caspian Sea. Two portions of the railway are already under operation. A 674-mile section of double-track, broad-gauge line extends from Karachi to Chaman on the Afghanistan/Pakistan border. The second portion of the railway is inside Iran; it extends about 600 miles from Mashad to Qazvin near Rasht (from Qazvin the existing line, called the CENTO rail-link, connects Iran to Europe through Turkey). The proposed missing link inside Afghanistan would extend about 485 miles from Chaman to Qandahar and from Qandahar to Herat. This line would further continue to Islam Qaleh (Afghan/Iran border) and connect to the existing line in Mashad. Two portions of the proposed missing link would be inside Iran. They would cover the 120 miles from Islam Qaleh to Mashad and the 80 miles from Qazvin to Rasht, respectively. The construction of the 685 miles of double-tract, broad gauge rail is to begin at Mashad and to require 5 years at approximately $244 million. The cost estimate is based on new railway construction unit costs in Pakistan (70, p.83).

The choice of this route in preference to conceivable alternatives was based on the following considerations:

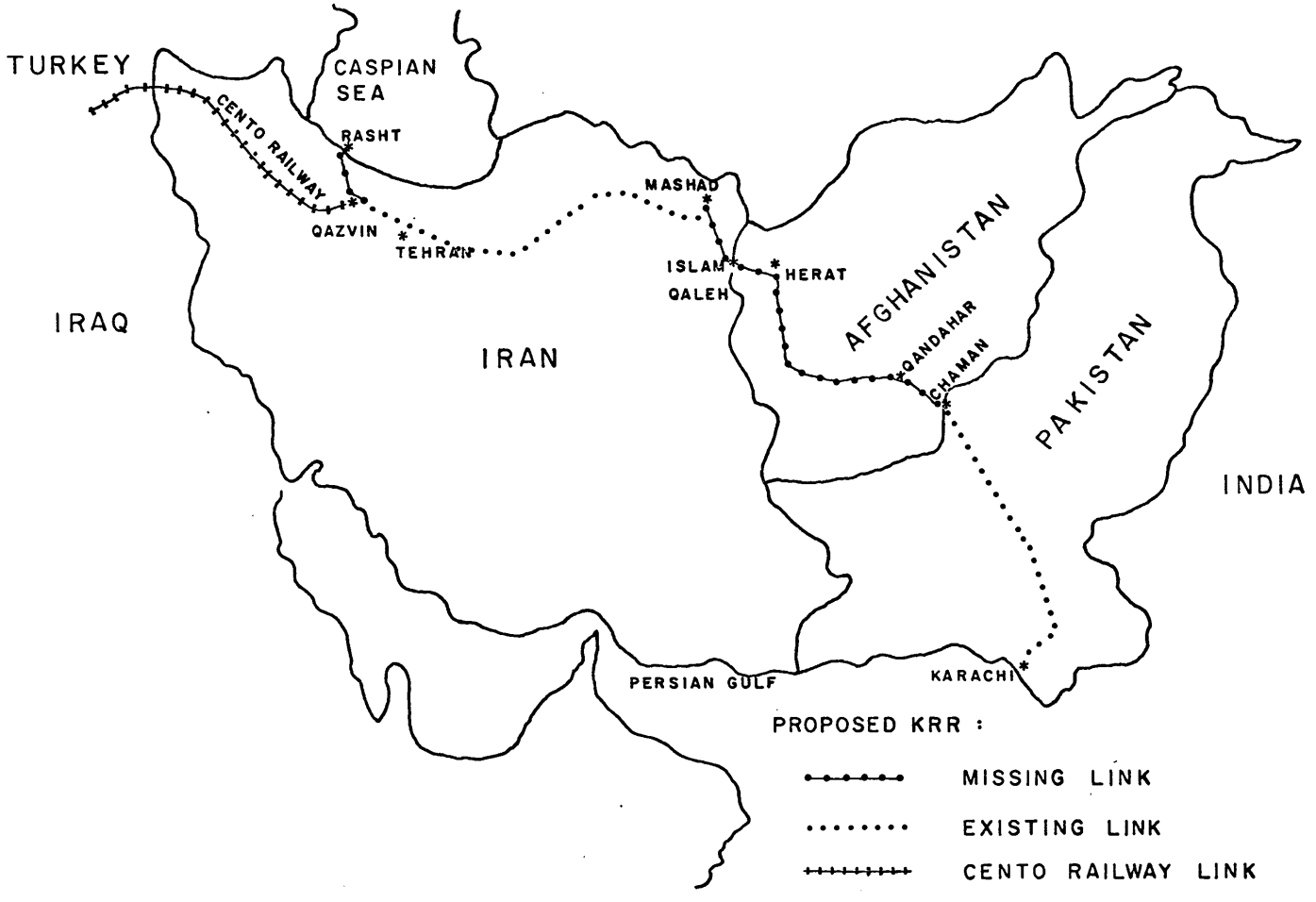

FIGURE 2.1 THE PROPOSED KARACHI RASHT RAILWAY (KRR).

1. It is the shortest possible connecting link between existing railways, and therefore could be built at the lowest possible cost.
2. It avoids to the extent possible major topographical obstacles to construction.
3. It involves optimum utilization of existing non-railway transportation, such as highways, rivers, seas, and oceans.
4. It directly links most of the major economic centers of the region (highway connections to the remaining centers already exist).

A further justification of the choice of this route is discussed in the context of the following sections.

Advantages and Disadvantages of a Railway

When regional or interregional economic activity requires long distance travel, then on a cost basis, rail services generally are favored over road (39, p.322). Arguments favoring railways as the main means for future long-distance goods movements can be reinforced by considerations arising from the source of Afghanistan/Pakistan's and even the Indian sub-continent's energy. Oil and its products account for 70 percent or more of the total energy consumption of these countries, and, with the exception of Iran, all these are net importers of energy. Rail is known to consume less energy than trucks for the same amount of diesel fuel, six times larger loads can be moved by broad gauge rail than by truck (74, p.95). Moreover, in the present state

of technical knowledge, the railway is the only transport system which can work by electricity (39, p.322). This is particularly important for the PIA region, which has favorable hydro-electric potential. There are other advantages and disadvantages of railway that can briefly be discussed.

1. Per ton-mile, manpower requirements for railway transport are less than for highway.
2. The amount of time required to inspect railway transport at borders and check-points is less than for highway transport.
3. Railways are a safer and more comfortable mode of transportation, especially on longer journeys (200-1000 km) than other modes (73, p.88).
4. Railways are a very simple mode of transportation and are considerably less pollution-prone than other transportation modes.
5. In general, railways are less affected by climate than any other major transportation mode, with the possible exception of pipe-lines.

Every transport system has certain disadvantages, and railways are no exception. For instance,

> "railways have practical limitations on the amount of curvatures and grades. In the United States maximum grades are usually kept below 2 percent. Whereas, highway facilities can be used by the general public, rail facilities are restricted to the sole use of the organization operating the service. Highways provide rapid movement of small parcels over short distances. Railway systems require large capital investments. Sixty to seventy percent of this investment is required for the right-of-way and terminal facilities. The remainder is required for carriers. The large

> investment results in fixed costs which are a large percentage of the total operating costs. Estimates of the percentage have been as high as 75%." (61, pp.5-6)

On the other hand,

> "The economy of water transport for bulk movement of commodities that do not require prompt delivery is sufficient to absorb all terminal and trans-shipment costs and still remain below rail costs." (47, p.147)

For transporting bulk products, usually liquids or gases, the unit cost of movement by pipeline is often a fifth to a third of the cost of moving comparable volumes by rail (51, p.97). The railway system requires extensive management staff for effective operation. The opposite is true for road transport, which is generally conducted at the start by an individual with a single vehicle. Railway construction may promote development at or near stations, and to a lesser degree between them, while road provides access to adjacent land for all types of users over the entire length of the route, and its area of influence can also be extended with relative ease by the construction of feeders (51, p.114).

Generally, railways have high capacity and they are extremely flexible with regard to types of freight but are somewhat inflexible with regard to route.

Identification of Transport Routes and Current Traffic of Interest Relative to the KRR Link

The KRR would create new railway connections between Afghanistan, Iran, and Pakistan, and would serve major economic centers. Furthermore, it would connect the Persian Gulf to the Caspian Sea and

subsequently, by other modes, the Black and Mediterranean Seas. In addition, it would become an alternate to the Suez Canal, connecting Asia to Europe and Africa by a revival of the old silk route used by Marco Polo to reach China. In addition it would serve as an international link connecting India, Nepal, and Bangladesh by rail to the U.S.S.R. and Europe. It would also become a future link of a Trans-Asian Railway connecting Asia to Africa and Europe. (See Figure A1.1, Pocket).

The KRR countries are economically dependent upon each other and upon the advanced nations. There are especially high demands for raw materials, petroleum products, machinery, coal, iron and steel products, fertilizers and chemicals, grain and grain products, sugar , and livestock. Afghanistan's exports of dry and fresh fruits and nuts are mainly to the Indian subcontinent. Over 30 percent of Afghanistan's foreign exchange earning is through exportation to India and Pakistan. In addition, over 20 percent of Afghanistan's imports are from India and Pakistan (78, p.T3.6).

It can be seen in Figure 2.2, that the present Indian rail line is connected from four locations: Wagah, Ferozepore, Hindu Malkot, and Munabao, near the border of India and Pakistan, to the Pakistan Railway (PR). Furthermore, the existing Russian lines at or near the northern Afghanistan borders are at Towraghondi, Keleft, and Shir Khan. When and if political considerations permit, easy construction of a branch line from Herat to the existing Soviet rail line at Towraghondi would be possible. If it should prove desirable, from

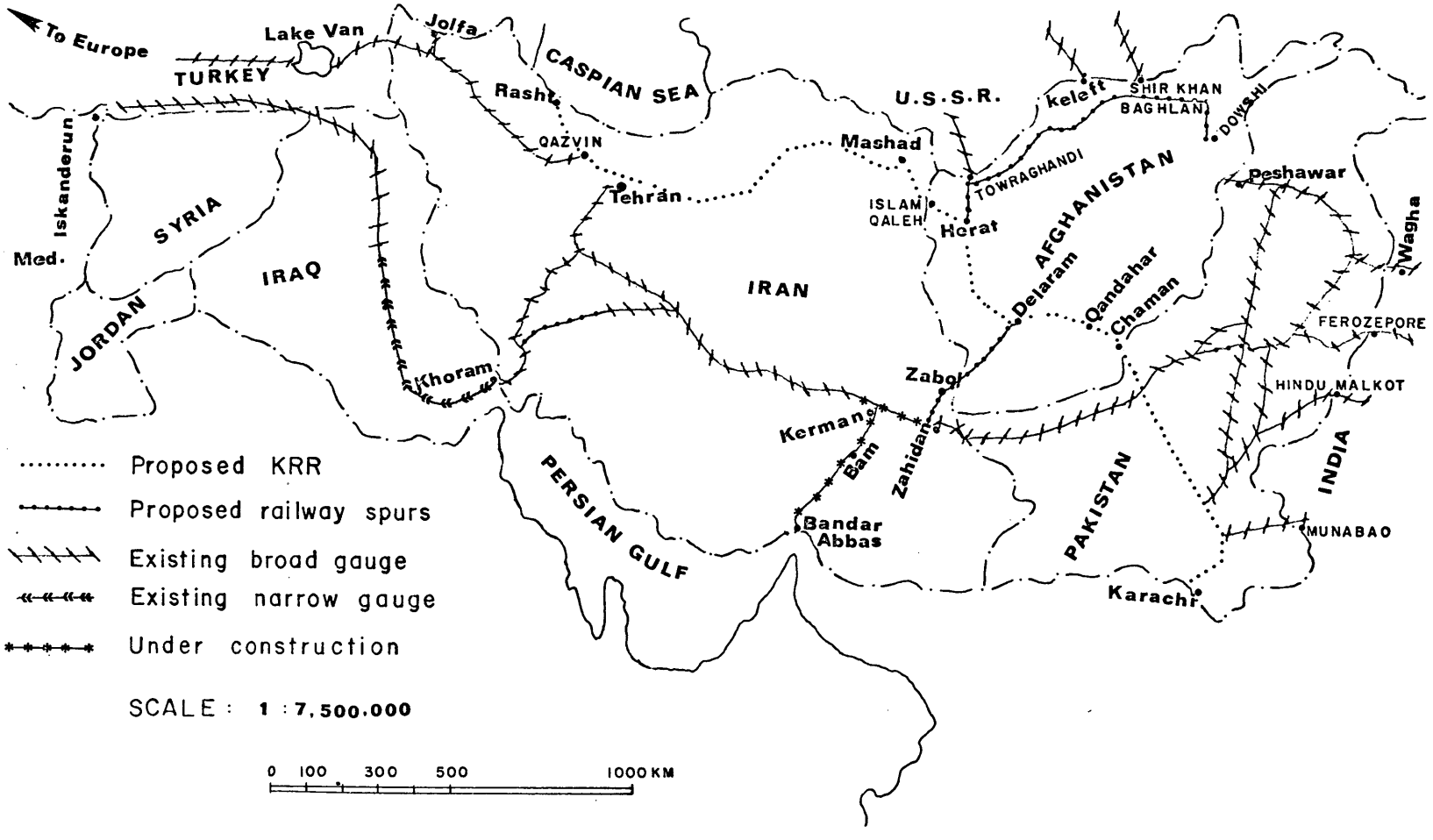

FIGURE 2.2 PROPOSED KRR, RAILWAY SPURS, AND EXISTING RAILWAY SYSTEM WITHIN AND OUTSIDE THE PIA REGION. ADOPTED FROM: (31, PP.350-700).

such a branch line another spur could be built to Khanabad, Baghlan, and Dowshi, which is about 175 miles from the PR near Peshwar close to the Afghan/Pakistan border.

While present political considerations might prevent the immediate construction of the link between Chaman and Qandahor, there is no important political barrier to construction from Mashad to Qandahar. Presence of a railhead at Qandahar might go far toward resolving existing tension between Afghanistan and Pakistan; after such resolution, there would be nothing to prohibit completion of the system. The advantages to Pakistan would be that the system would not only connect that country by rail to Europe, but it would offer the shortest possible route to the U.S.S.R. and the Caspian Sea. In addition, Pakistan would also benefit from traffic that would pass from India and South East Asia through Pakistan to the U.S.S.R. and Europe.

It can also be seen in Figure 2.2 that a short spur from Delaram inside Afghanistan through Zabol would connect the KRR to Zahiden, west of Iran, and from Bam to Bandar Abbas on the Persian Gulf. Such a link would connect Afghanistan and the U.S.S.R. through the shortest possible rail route to the Persian Gulf. The existing Iranian Railway System would connect the KRR to Europe through Iraq or through north Iran at Jolfa (Iran/U.S.S.R. border) and through Turkey (CENTO-rail link; see Figure 2.2).

Current traffic on both existing Iranian and Pakistani railways is running in reasonable capacity and making some profits. PR earnings in 1974 increased to $97.5 million, an increase of $3.1 million over

those of the previous financial year. Out of the total earnings, $33.4 million came from passenger traffic and $64.1 million from freight traffic. Operating expenses totaled to $76.1 million, an increase of $12.4 million from the previous year (100, p.389). Iran earned $91.0 million in 1973 with more than $15.0 million profit. In 1974 the earning was $105.0 million with more than $30.0 million profit (31, p.350).

The principal trading countries of the PIA region are Eastern and Western Europe, the U.K., the U.S.A., the U.S.S.R., the Middle East, India, South East Asia, Japan, Peoples Republic of China, and Australia. During 1972/73 more than 47 percent of the region's exports were to Europe, the U.K., and the U.S.A. In the same period more than 50 percent of all imports were from the same countries, and they are continually increasing (Tables 2.1 and 2.2). During that time about 20 percent of all exports and imports were interregional transit (58, pp. 9-1223).

Much trade flows by ship between Europe and the various countries of East and South Asia. Given the KRR, there is considerable probability that some of the trade would be shifted to the railway. In 1965-66, Iran shipped to Turkey nearly 20,000 tons of crude oil, plus small amounts of refined products (73, p.21). Wheat is another commodity that can be exported from Turkey to Iran and to Afghanistan by the combination of CENTO rail and the KRR. The PIA's exports to Western Europe consist largely of dry fruits, fresh fruits, and other agricultural and mineral products. The region's imports from Western

TABLE 2.1 PIA REGION EXPORT TO PRINCIPAL TRADING PARTNERS
(U.S. $ MILLION)
1972-73

	AFGHANISTAN		IRAN		PAKISTAN	
	$	% OF TOTAL	$	% OF TOTAL	$	% OF TOTAL
CZECHOSLOVAKIA	5	2	25	7		
W. GERMANY	14	7	68	20	31	6
INDIA	54	26	7	2		
JAPAN			26	8	156	31
PAKISTAN	10	5				
U.S.S.R.	65	32	119	35		
UNITED KINGDOM	36	18	17	20	63.0	13
U.S.A.	4	2	47	14	35.0	7
FRANCE			18	5	18	4
SRI LANKA					21	4

TABLE 2.1 (CONTINUED)

	AFGHANISTAN		IRAN		PAKISTAN	
	$	% OF TOTAL	$	% OF TOTAL	$	% OF TOTAL
MALAYSIA					6	.2
BELGIUM					8	.3
BAHRAIN					3	.6
HONG KONG					96	19
AUSTRALIA					7	1
CHINA REPUBLIC					19	4
ITALY			12	4	43	8
LEBNAN	7	3				
NETHERLANDS	2	1				
SWITZERLAND	9	4				
TOTAL	206	100	339	100	506	100

NOTE: OIL EXPORT FOR IRAN ARE NOT INCLUDED
SOURCE: (58,P.9-1223)

TABLE 2.2 PIA REGION IMPORTS FROM PRINCIPAL TRADING PARTNERS
(U.S. $ MILLION)
1972-73

	AFGHANISTAN		IRAN		PAKISTAN	
	$	% OF TOTAL	$	% OF TOTAL	$	% OF TOTAL
CZECHOSLOVAKIA	.70	.5	28	1		
GERMANY, FED. REPUBLIC	11.2	8	536	25	74.9	14
INDIA	18.9	14	47	2		
JAPAN	31.7	23	407	19	72.1	14
PAKISTAN	5.5	4				
U.S.S.R.	38.3	28	80	4		
UNITED KINGDOM	7.7	6	336	15	68.3	13
U.S.A.	22.0	16	483	22	209.4	40
FRANCE			137	6		

TABLE 2.2 (CONTINUED)

	AFGHANISTAN		IRAN		PAKISTAN	
	$	% OF TOTAL	$	% OF TOTAL	$	% OF TOTAL
ITALY			128	6		
SRI LANKA					29.8	6
MALAYSIA					5.8	1
BELGIUM					10.6	2
BAHRAIN					.2	.03
HONG KONG					3.2	.6
AUSTRALIA					9.9	2
CHINA, PEOPLE'S REPUBLIC					36.2	7
TOTAL	136	100	2184	100	520.4	100

SOURCE: (58,PP.9-1223)

Europe consist of a wide diversity of manufactured products.

A considerable volume of both the exports and imports moving by ship via Persian Gulf Ports or the Port of Karachi could be attracted to the KRR and CENTO-rail-link routes.

Barrite of Afghanistan was exported to the U.S.S.R. by truck for the first time in 1973 (78, p.5AC). Furthermore, the present large discovery of copper and iron ore of the Logur Valley and Hajikgak in Central Afghanistan can be utilized by the development of the KRR; this would benefit Afghanistan and other KRR countries that presently are exporting these items from Europe.

Annual average increase of mineral production in Pakistan is estimated at 86 percent (70, p.29). This large jump in mineral production would need greatly expanded transport facilities like the KRR. The significant point of importation is the railway connecting with India at Wagah Atari, West India, near the Indian and Pakistani border just east of Lahore, Pakistan. Coal traffic amounts to 350,000 tons per year imported from India (70, p.40). The utilization of KRR would create a new market for Indian coal in Afghanistan.

Nearly all of Afghanistan's trade is handled through the U.S.S.R. or Pakistan. Due to congestion, damage, and delay in Pakistan and uncertainty in the U.S.S.R., many problems are created and add to the transport cost. Transit traffic for Afghanistan passes over the government owned PR on the following routes:

1. Seaborne goods are moved by rail to Karachi and Chaman or Peshawar (see Figure A1.1, Pocket) from which points they are carried by road across the border to Afghanistan.

2. Railborne goods from India via Wagah to Chaman or Peshawar, and thereafter by road, and vice versa.

Substantial delay takes place at each transfer point. For one consignment of goods coming from abroad and destined for Afghanistan, 13 sheets of paper are required, apart from two documents required by Afghanistan (70, p.137).

Spot checks of freight cars on hand at Peshawar from June 28-July 4, 1961, indicated 236 wagons there on the former date. With new arrivals and an average release of 15 to 25 cars per day, 117 wagons still remained under load on July 4 (70, p.137). A further spot check made from August 10 to August 23, 1961 indicated that at the earlier time, 197 freight cars of general freight and 51 cars of wheat destined for Afghanistan were on hand. With new arrivals and departures, it took until August 19 to release the cars of wheat. On August 23, 163 freight cars of general merchandise were still being held (70, p.138). With the utilization of the proposed KRR, many of these problems would be eliminated.

Part of Afghanistani imports from Europe move across Iran by government-owned rail, from Persian Gulf ports or by road via Iran and Turkey. Mashad near the Afghanistan/Iran border (see Figure 2.2) is the terminal point in the east for the Iranian rail line and a trans-shipment point for Afghan imports transiting Iran. The trans-shipment time and cost is high on both sides (73, p.32). Considerable savings on both items could accrue through the utilization of the KRR.

Iran imported 1,212,500 metric tons of goods from Western Europe

in 1969-70, of which 725,200 tons were transported by ship through Persian Gulf ports. The principal origins of these imports were, in order of tonnage shipped, West Germany, the United Kingdom, Italy, France, the Netherlands, Yugoslovia, and Belgium. These countries accounted for about 90 percent of Iran's total imports from Western Europe (73, p.23).

Of the total volume of Iranian trade with Western Europe annually, approximately 14 percent of exports and 3 percent of imports are transported by truck through Bazargan near the Iran-Turkey border. Western European origins and destinations for this truck traffic are the larger countries, the first four listed above (73, p.23). The truck route roughly parallels the rail route from Iran to Western European centers. Distances and transit times are generally comparable on these two routes.

Traffic between Iran and Eastern European countries moved primarily by rail through the U.S.S.R. in 1970. About 70 percent of the total volume of Iranian imports from Poland arrived by rail through the U.S.S.R., half of the total tonnage of transit trade with Bulgaria moved by truck via Turkey; and an estimated two-thirds of the total tonnage of imports from Czechoslovakia moved via a route involving transport across the Caspian Sea.

Pakistan and Poland signed a bilateral trade agreement in February 1977 by which Pakistan will export cotton yarn, cotton textile, and other traditional goods, and will import sugar mill components, urea, transformers, coal, and road building and construction machinery (52,

p.2). These types of trade can be transported by the CENTO rail-link and KRR with reasonable time and transport cost. The railway line and road route connecting Tehran with Iskenderum (South East Turkey on the Mediterranean) are very similar in length. Moreover, transit time is only slightly greater by rail than by road.

Transit time on routes between Western Europe and Afghanistan, or, more precisely, Cologne and Kabul-Afghanistan, are shown in Table 2.3. It can be seen in this table that the time by a route involving the CENTO rail link and the KRR would be 12-14 days. On the other routes the times are substantially greater, ranging from 31 to 49 days. The most comparable road route is significantly shorter, but the time is somewhat greater - 17 days, reflecting the need for truck drivers to make more rest stops.

Table 2.4 presents the transit times and distances on principal routes between Iran and Western Europe. It can be seen that other routes, such as rail-steamer and highway-steamer, through Turkey involve trans-shipments at Iskenderun. Relative to the all-rail route, however, the combination-mode routes require 22-23 days - more than double that via rail (73, p.30).

It can be seen in Table 2.4 that another important route between Tehran and Cologne is the all-rail one via Jolfa through the U.S.S.R. (see Figure 2.2). This 5,460 kilometer artery requires a substantial 31 to 37 days of transit time, which is more than three times greater than that by rail through Turkey. The primary reasons for this duration are the need to transload cargo between cars at two points to

TABLE 2.3 TRANSIT TIMES AND DISTANCES ON PRINCIPAL ROUTES BETWEEN WESTERN EUROPE AND VARIOUS ASIAN COUNTRIES FOR FREIGHT.

Route		Means of Transport	Approx. Distance (kms)	Typical Transit Times (days)
1. Between Western Europe and India (Cologne-Bombay)				
a. Via U.S.S.R., Iran, and Persian Gulf		Rail-steamer	9,900	39-44
b. Via Turkey, Iran and Persian Gulf	i)	Rail-steamer	10,100	16-18
	ii)	Highway-steamer	9,550	17-19
c. Via Turkey, Iraq and Persian Gulf		Rail-steamer	9,150	15-17
d. Via Suez Canal		Steamer	14,900	26.28
e. Via Cape of Good Hope		Steamer	23,900	37-39
2. Between Western Europe and Afghanistan (Cologne-Kabul)				
a. Via U.S.S.R. (via Tashkent)		Rail-highway	6,300	38-43
b. Via Turkey and Iran	i)	KRR-highway	7,650	12-14
	ii)	Highway	6,950	15-18
c. Via Persian Gulf and Iran				
1. Via Suez Canal and Iran		Steamer-rail-highway	19,950	31-38
2. Via Cape of Good Hope		Steamer-rail-highway	29,950	42-49

Sources: 73, p.33.

TABLE 2.4 TRANSIT TIMES AND DISTANCES ON PRINCIPAL ROUTES BETWEEN IRAN AND WESTERN EUROPE FOR FREIGHT (Tehran and Cologne).

Route	Means of Transport	Approx. Distance (kms)	Typical Transit Times (days)
1. Via Turkey			
a. Via Istanbul, Balkans	i) Rail	5,630	9-11
	ii) Highway	5,000	10-14[1]
b. Via Iskenderun (trans-ship)	i) Rail-steamer	9,100	22-23
	ii) Highway-steamer	9,100	22-23
2. Via U.S.S.R.			
a. Via Jolfa	Rail	5,460	31-37
b. Via Caspian Sea (summer only)	Highway-steamer	6,000	34-40
3. Via Persian Gulf			
a. Via Suez Canal	Rail or highway-steamer	16,990	30-31
b. Via Cape of Good Hope		25,990	41-42

Sources: 50, p.30.

[1]Transit times on routes involving waterborne transport include estimated time for cargo and ship handling at ports.

accommodate changes in rail gauge and the practice of the U.S.S.R. railroad of giving priority to domestic and Eastern Europe traffic. During the summer, when boats can be used on the Caspian Sea, the Tehran-Cologne trip can be made via a 6,000 kilometer road/water route via the Don Canal and Volga River, requiring 34 to 40 days transit time (73, p.31). In both cases, however, the transit times are far greater than the 9 to 11 days via the all-rail route through Turkey.

Comparison of Routes Relevant to the KRR in Terms of Both Transit Time and Transport Costs

The area's transport data indicate that important tradeoffs between transport cost and transit times are often involved in route selection. In Figure 2.3 times and costs for shipments of electrical equipment are compared for six alternative routes between Cologne and Tehran. It can be seen in this figure that the CENTO rail and KRR offer the next to lowest cost and the lowest transit time among all six routes. Moreover, the route via Iskenderun with passage over the CENTO rail and KRR, the route of lowest cost, involves over twice as much transit time as the KRR and CENTO rail routes. The ship-highway combination via Iskenderun is nearly double the cost of the ship-rail alternative, and this applies to all commodities shipped via Iskenderun (73, p.38).

For a high-value type commodity such as electrical equipment, time savings mean important money savings (interest costs) to shippers, and slow service would therefore tend to be avoided (73, p.38). The CENTO rail and KRR would be in a strong competitive position to attract this type of traffic.

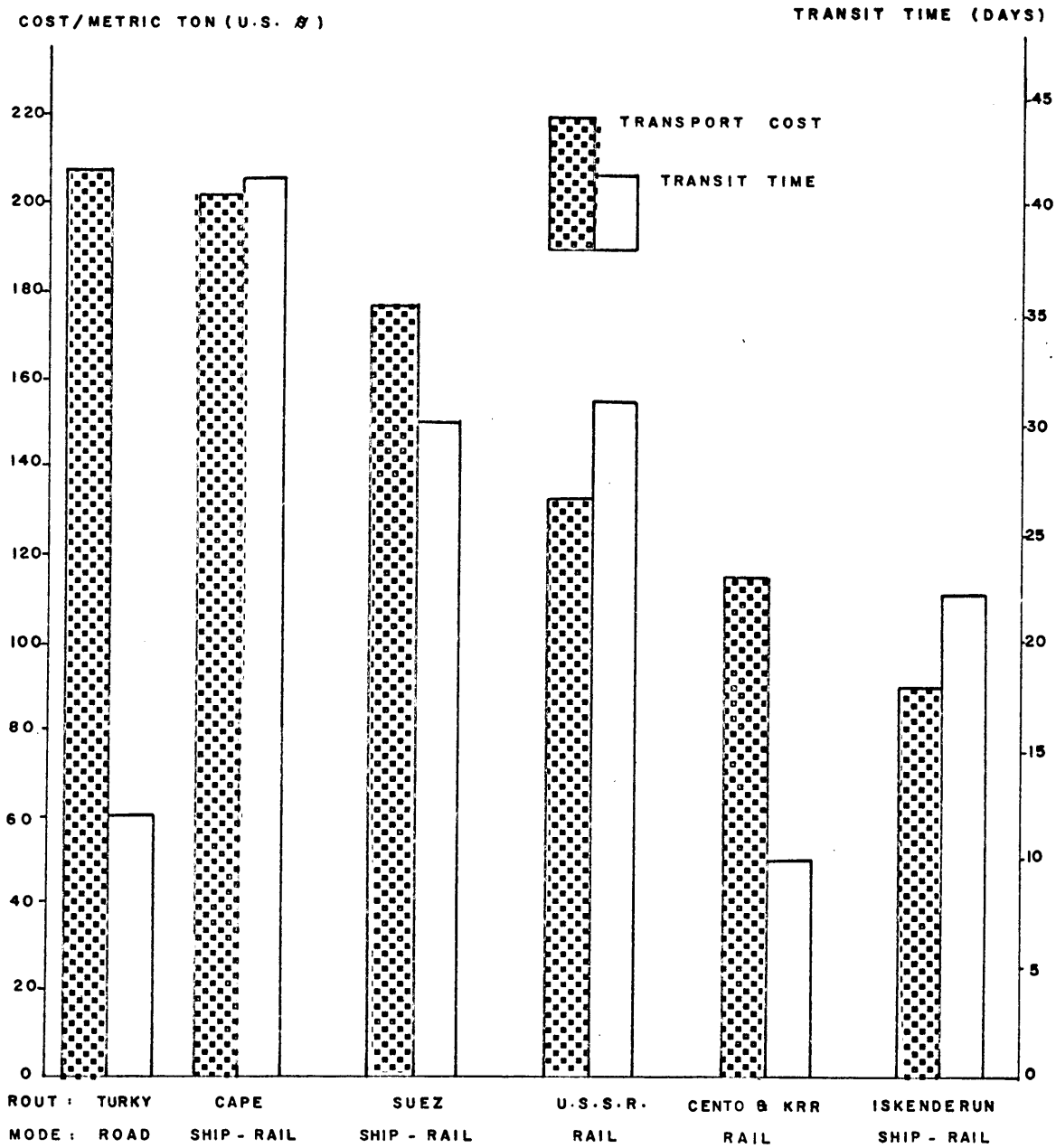

FIGURE 2.3 COMPARISON OF ROUTES IN TERMS OF TRANSPORT COSTS AND TRANSIT TIMES BASED ON ELECTRICAL EQUIPMENT SHIPMENTS (COLOGNE TO TEHRAN). ADOPTED FROM: (73, P.39).

Figure 2.4 provides a similar comparison of the above routes based on shipments of iron and steel products. In this instance the CENTO rail and KRR ranks second highest in cost among the six routes. The transit time for this route is the lowest, however, and is much less than the times required over all other routes having lower costs. A key question relates to the value of time savings to shippers of these products. Since much of the tonnage in these products is of relatively low value, the interest cost is comparatively low; time savings, therefore, are of less consequence in shipping such products than in shipping electrical equipment. Nevertheless, the CENTO rail and KRR should be able to capture some portion of Europe's iron and steel imports (particularly shipments originating in Southern Europe), especially those items within that commodity group which are of relatively high value or for which the need is urgent (73, p.38).

A third comparison of routes in terms of transport costs and transit times is the carpet shipments from Tehran to Cologne via the same six routes treated in the preceding figure. The KRR and CENTO link route are the second highest transport cost and lowest transit time among the several routes. For these relatively high-value goods, road transport offers a slight advantage over rail shipment; however, both of these routes are better able to attract carpet traffic than are the other four.

Another significant west bound traffic component is balled cotton shipments from Tehran to Cologne via the same six routes treated in the preceding figure, which the variations in transport costs between

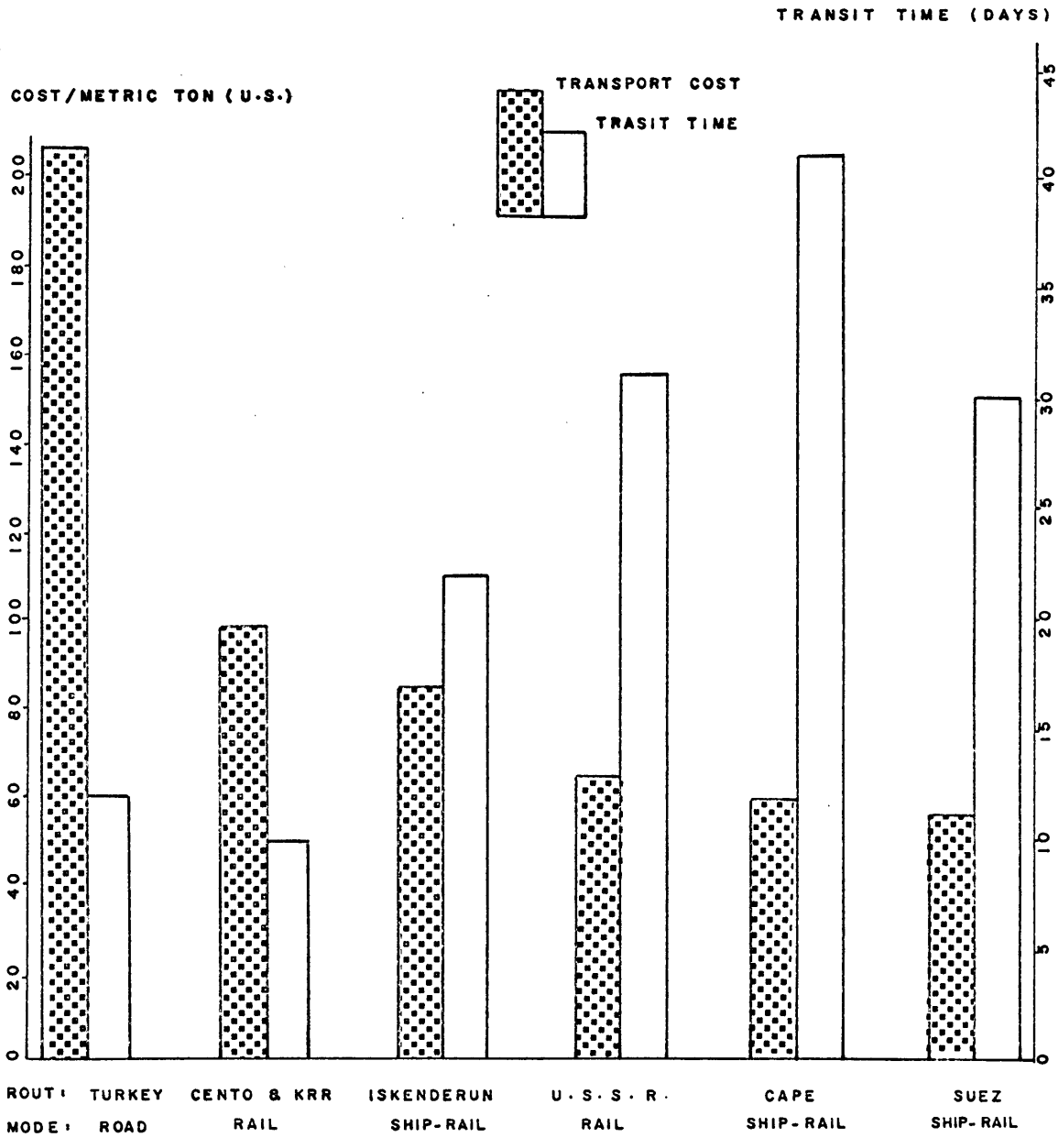

FIGURE 2.4 COMPARISON OF ROUTES IN TERMS OF TRANSPORT COSTS AND TRANSIT TIMES BASED ON IRON AND STEEL PRODUCTS SHIPMENTS (COLOGNE TO TEHRAN). ADOPTED FROM: (73, P.40).

the different routes are confined to a narrow range. Thus, the choice of route would tend to reflect mainly the wide differences in transit times. With regard to the KRR and CENTO rail and the road route, the costs are virtually the same, with transit time being slightly less by rail.

While baled cotton is a low-value commodity and transit-time savings therefore do not heavily influence route selection, the large magnitude of the time savings via the rail and road routes should be of some importance. Since all transport time and costs were estimated from Tehran to Cologne, lower transport cost and time are involved when the KRR is used from major economic centers of Pakistan, Afghanistan, and even further from India, Nepal, and Bangladesh. There thus is reason to conclude that the KRR and CENTO rail should be able to attract some traffic in baled cotton shipments and other bulk commodities.

Passenger fares and transit times provide another basis for comparing alternative routes. Figure 2.5 indicates the rail and bus fares and transit times on various short, medium, and long haul routes. In the Tehran-Tabriz case, the bus offers a substantial fare advantage. Likewise, between Elasig and Ankara the bus has a competitive advantage in terms of both time and cost. Between Tehran and Istanbul, however, the competitive positions of the rail and bus routes are seen to be fairly similar, one providing a margin in time and the other an advantage in cost. Over the great distance from Tehran to Munich, the railway provides significant advantages in both time and cost. For such

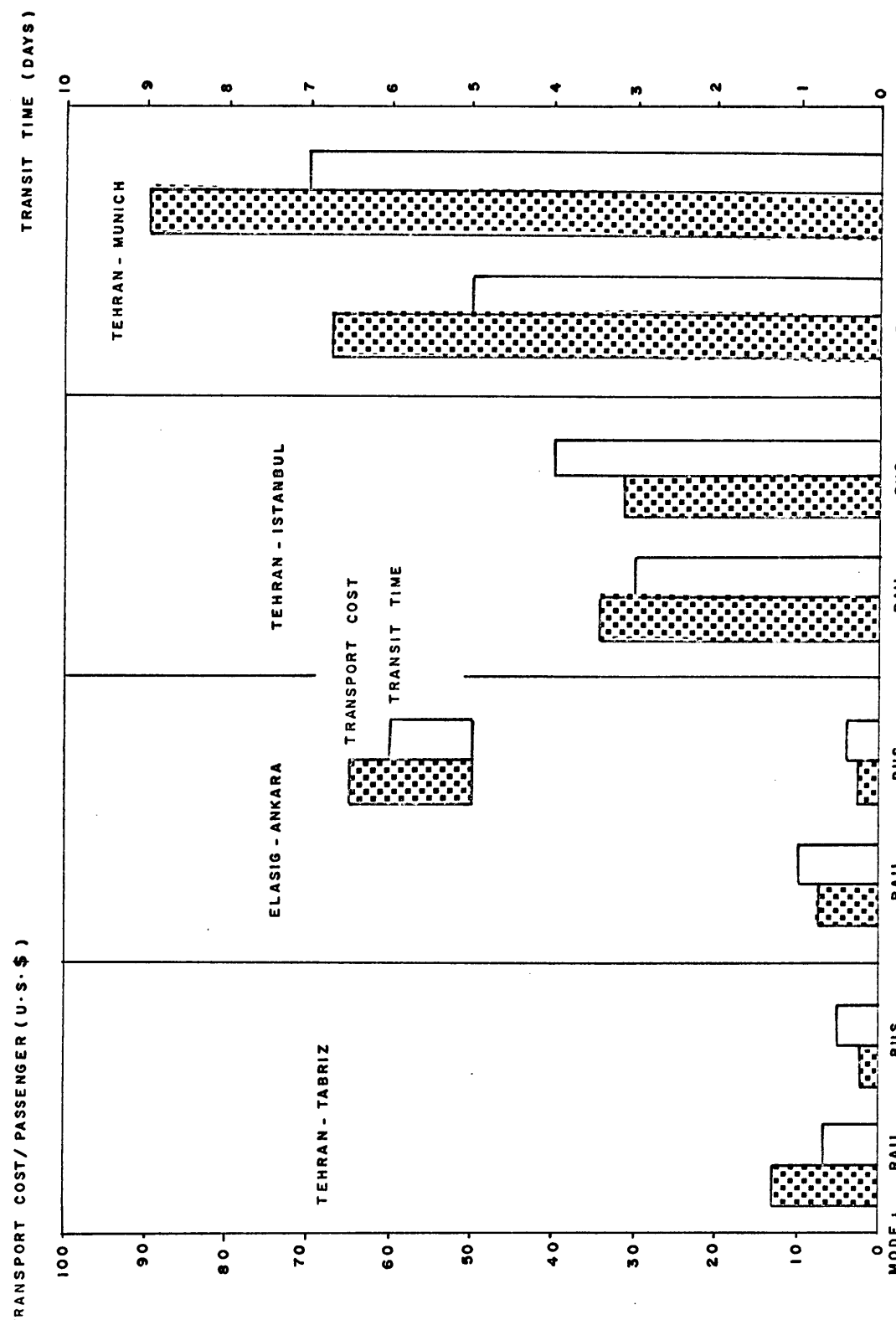

FIGURE 2·5 COMPARISON OF RAIL AND BUS ROUTES IN TERMS OF TRANSPORT COSTS AND TRANSIT TIMES FOR PASSENGERS. ADOPTED FROM : (73, P·44)

long-distance travel, of course, air transportation permits extremely large time savings over transport via surface modes, and these savings are considered by many travelers to more than offset the comparatively high air fares. In general, the railway is in its best competitive position in providing transit over the medium-distance routes.

For trucking lines operating on international routes between Europe and Iran, the outlook is such that costs are more likely to rise than to fall in the years ahead. Road improvements will tend to cause lower operating costs for truckers, but higher road user taxes will likely offset such gains. Perhaps even more significant than increased user taxes in Turkey and Iran is the prospect of greater protection of roads through strict enforcement of truck-loading limits (73, p.48).

Tourism Development

Since the PIA region has a very long history, there are many areas that could attract tourism which would provide attractive foreign exchange earnings. In 1971 Afghanistan earned $11 million from tourism, an almost $4 million increase over the previous year (58, p.10). Iran's earnings in 1974 were $58 million, an eight million dollar increase over 1973 (58, p.709). Similarly, 152,000 tourists visited Pakistan in 1974, a rise of 10,000 from the preceding year (58, p. 1224).

The completion of the Istanbul/Bosphorus bridge eliminated the bottleneck between Europe and Asia and helped increase American and Western tourists to Asia (2, p.31). It seems clear that the region through which the CENTO rail link and the proposed KRR passes should

share to some extent in the growth of tourism.

Another type of traffic that might develop along the KRR and CENTO rail-link route is the pilgrimage movement which includes Hajj[1] traffic originating in Bangladesh, India, Pakistan, and Afghanistan and moving to Mashad and Gom in Iran, Baghdad in Iraq, and onwards to Mecca.

The Advantages of Utilizing the KRR and CENTO Rail Link Routes as an International Integrated System

In the railway field, the global picture is one of chronic deficits. Many railways in developing countries barely cover their operating costs.

> "In the early sixties, the revenues of Turkish railways covered only 77 percent of total expenses. In Syria, the figure was 72 percent and in Algeria 26 percent. In some countries, the gap between costs and revenues on the railways has been so great that it has undermined the financial position of the entire national economy. Part of the reason for the deficits is historical. The rail systems in many developing countries were built when military objectives or raw material exports were the principal factors determining location. The result was typically a rail pattern that tapped the hinterlands, converged on the principal ports, and avoided connections with other countries. Today these railways often prove ill-suited to the needs of both internal and regional development." (51, p.126)

Some of the developing countries realized these historical deficits and some initiated plans for international entities.

> "In Africa, the railways of Tanzania have been operated with those of Kenya and Uganda as one system. The East African Railways and Harbours Administration, with headquarters in Kenya, provides for the administration of this unified system. The railway net is financially stronger, the utilization of the

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[1]Hajj: The pilgrimage to Mecca prescribed as a religious duty for Muslims.

> rolling stock and equipment is more efficient, staff and administration costs are lower, and tariffs are more reasonable than would have been the case if the systems had continued as separate entities. Air services of the three countries are also jointly operated by the East African Airways Corporation.
>
> "European railroads acted to reduce the effects of national boundaries three-quarters of a century ago when the Bern Conventions provided for such matters as international tariffs, interchange of equipment, procedures at frontier points, and maintenance of collective responsibility by member nations. More than a million railroad cars crossing national boundaries in Western Europe, the interchange problem has been resolved by establishing a ten-nation pool of freight cars that has greatly facilitated international movement." (51, pp.147-8)

Another international link is the Suez Canal, which played a major role in the development of the Middle East, South East Asia, Africa, and Europe (60, p.43).

The Pan American Highway, as an idea of uniting the Americas through a terrestrial communication route has had profound impacts on many Latin American countries. The 14,000-mile long highway has been an important factor in the industrial and social integration of the hemisphere and enhanced the establishment of the Latin American common market (3, p.1).

In realizing the advantages attached to an international integrated transport system, the proposed railway as an international single entity connecting the three countries of PIA might become a powerful strategy in enhancing the overall development of the region.

The following chapter will identify events that might be affected from the future impacts of the KRR.

III. IMPACT IDENTIFICATION

The main purpose of this chapter is to identify events that might be affected by the future impacts of the KRR. In line with this objective, an analysis of the general developmental impacts of an analogous transportation link, the Suez Canal, is presented. This analysis will help point to relevant impacts of the KRR.

The Suez Canal and its Developmental Impacts from 1855 Until the Present

The Suez Canal, opened in 1869, created a sea route that rivaled the old caravan routes from Europe to India and the East. It cut nearly 4,000 miles off most East-West voyages and became a symbol of progress. In 1846 a Canal company was formed with directors of several nationalities and a plan was proposed by a French diplomat, Ferdinand de Lesseps (30, p.367). Ismailia (Figure 3.1) became the headquarters of the Suez Authority and the location of a research center (23, p.369).

The construction of the Canal began in 1859 and 25,000 Egyptian workmen were employed. The work continued for ten years (30, p.367). During this time, the Canal increased the demand for speedier communication between Europe and Asia, which expedited the completion of the Indo-European telegraph and stimulated efforts to improve the overland routes by the use of developing Italian railways (25, p.3).

The Port of Suez faced the Red Sea with fewer prospects of growth than Port Said, which faced Europe. It doubled its area, trebled its houses and quadrupled its population between 1859 and 1869 (25, p.127).

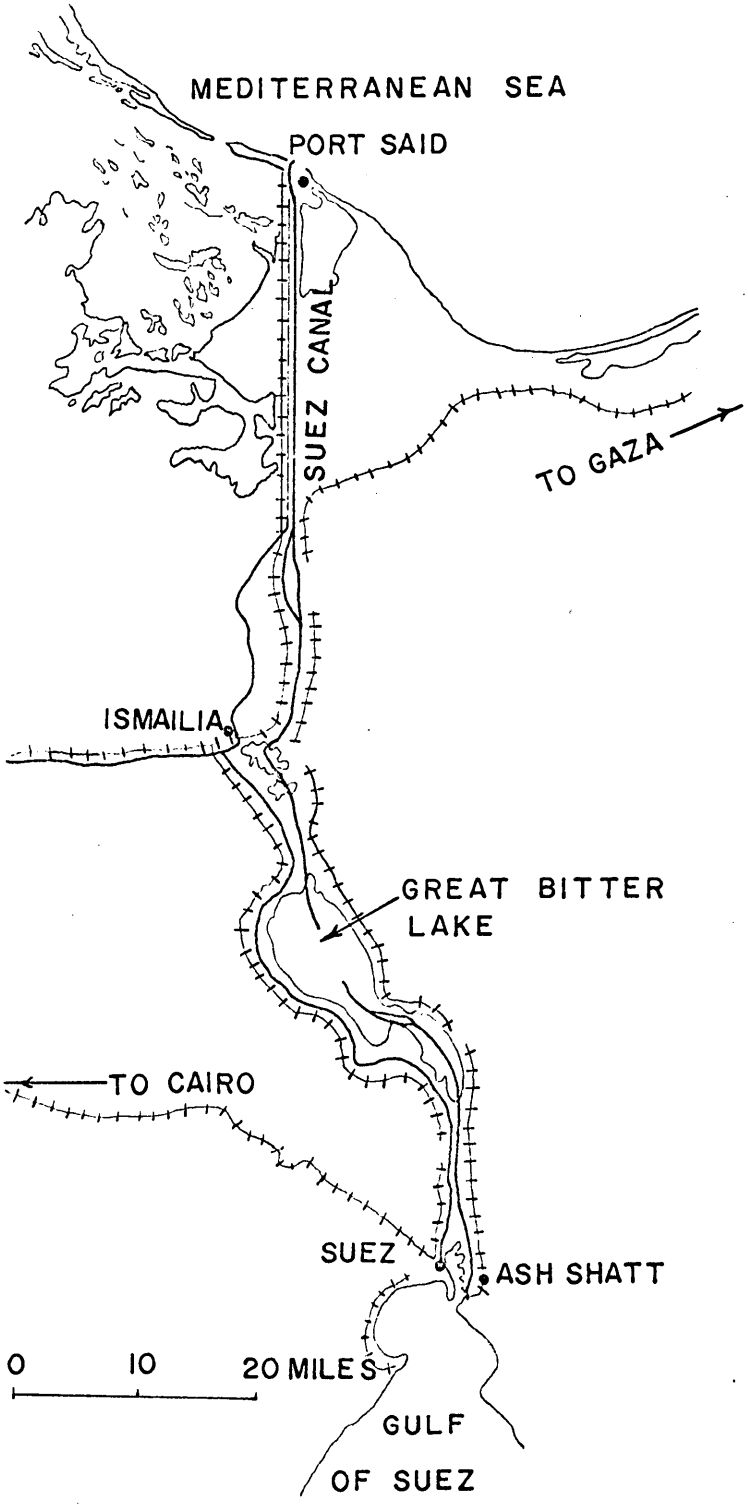

FIGURE 3.1 THE SUEZ CANAL. ADOPTED FROM: (23, P.366).

Aden (on the southeast of the Red Sea) became a center for large scale imports of cotton textiles from Europe. Its population increased by 67 percent during 1870-80 (25, p.137).

After its opening, the Canal's traffic grew from 400 ships in 1870 to 5,000 by 1913, with concomitant increases in revenue. In 1912 its income was 140 million Francs, the expenditure 48 million, for a profit of more than 90 million Francs (7, pp.43-5).

Barcelona, Marseilles, Venice, and Trieste along the northern Mediterranean and Adriatic Seas improved their harbors and increased their business (25, p.75). Damascus, on the other hand, suffered from the competition of Aleppo (west of Syria, along the Mediterranean) for the overland traffic to Baghdad and from the transfer of the North African pilgrim traffic to the sea route to Jedda (25, p.147).

The success of de Lesseps encouraged proposals from other canals throughout the world (25, pp.92-577). The opening of the Canal stimulated American interest in Middle Eastern oil (25, p.651). The rise of Arabian and Kuwaiti production transformed the oil trade of the Canal with unprecedented speed (25, p.652). The desire to compete with the Canal caused the completion of the Trans-Arabian pipeline (1951), which was extended from Kirkuk in northeast Iraq to Tripoli in the west of Syria along the Mediterranean (25, p.657).

The nationalization of the Canal in 1955 ended the English era in Egypt and began a rapid decline in effective British power in the Middle East (59, p.9). Although Britain's Indian supply routes were less important after Indian independence in 1947, British and European

reliance on Middle Eastern oil, most of it transported through the Canal, had grown enormously (7, p.44).

In 1956 two crises were created by the nationalization of the Canal Company and the invasion of Egypt by Israel, France, and Britain (25, p.718). The five month's blocking of the Canal by Egypt restored the barrier between the Mediterranean and the Red Sea, diverted traffic around the Cape, and sharply reduced the annual carrying capacity of world shipping. After its reopening in 1957, the payment of Canal dues to the Suez Canal Company ended. Nationalization also made Britain and France dependent upon American tankers (16, p.729).

For a decade after nationalization the Canal's tolls, as much as $227 million a year, provided a major part of Egypt's foreign exchange (35, p.802). The nationalization stimulated the planning of the Aswan Dam. The Aswan High Dam Authority was modeled on the Suez authority (36, p.137).

The Suez crisis marked a turning point in the history of Europe, Asia, and Africa. In 1967 the Arab-Israeli War caused the Canal to be closed for eight years. The 101 mile-long Canal remained only as a fortified ditch, and 320,000 inhabitants of Port Said left the area (35, p.802). The closing diverted traffic around the Cape of Good Hope; the result was a round trip 9,500 miles longer than via the Canal and one which consumed up to 50 percent more time per voyage. This was reflected in substantial surcharges for traffic on competing routes (7, p.46).

A United Nations study reported that the closing of the Canal has

cost the world $1.7 billion a year in lost trade and higher shipping costs (7, p.41). The closing of the Suez route increased the traffic of the Panama Canal and it gave to Japan and Australia advantages over Europe in regard to Asian trade. It raised shipping rates, enhanced the profits of shipowners, and stimulated shipbuilding, especially in Japan (25, p.738).

In assessing the negative economic impact of the Canal closure, three direct costs can be delineated:

1. higher shipping rates resulting from increased mileages;
2. higher shipping rates resulting from increased demand pressure on the limited supply of ships; and
3. higher commodity prices resulting from (1) and (2).

During the first year of the Canal's reopening (June 1975) more than 150,000 persons returned to the Port of Suez; five major factories were reopened (51, p.16). During the same period, the Canal's earning was $550 million, compared with $220 million in the year before it was closed (55, p.7).

The Canal has spurred the growth of traffic in food products between East and West, with the U.S. a major beneficiary. Transportation is cheaper and faster for U.S. grains and other products which are moving into top growth markets - Iran, Iraq, India, and the Arabian Gulf countries (55, p.10). West German's Hansa Line Company says that the Canal opening brought new life to Ethiopia and Sudan. Hansa was about the only line providing a full service to the Red Sea, but now there is a flood of competitors. The Jordanian Port of Aqaba has become

a major trans-shipment point for Iraqi cargoes, and this has won trade back for the shipping lines from the overland route. Also, other ports along the Red Sea have increased their business (55, p.12).

South African ports, which made enormous gains in traffic throughout the Canal's closure, have lost trade and the business of ship repairs (55, p.12).

In traffic and time, the Trans-Siberian Landbridge is very strong competition to Suez. The Suez Authority admits that the rail route is run on very different economics, and the Canal cannot compete against it (55, p.12). On the other hand, the World Bank is lending $45 million towards a $95 million project to improve and modernize the Port of Alexandria (55, p.23). Interestingly, the reopening of the Canal provides Russia an easy access to East Africa, as well as to the Persian Gulf and Red Sea areas. It is easier for them to ship arms to India (69, p.37).

Since 1967, when war closed the Canal, the U. S. naval presence in the Indian Ocean has been by units of the Seventh Fleet. With the Canal open, some warships of the Sixth Fleet are able to move from the Mediterranean into the Red Sea (69, p.38).

Table B3.1, Appendix B, presents brief analogies between the developmental impacts of the Canal and those that might be expected to occur from the construction of the KRR. Since the Canal impacts affected almost every aspect of world development, they are categorized in Table B3.1 under their major impact of institutional, political, social, and economic. Furthermore, they are classified as favorable,

unfavorable, or a combination of each.

In addition to the analysis of the Suez Canal, Dickey's INDEX TERMS were also reviewed. These are key words used as a means for selected information retrieval to make forecasts of gas tax revenues to complement the State of Virginia's Highway and Transportation Department's long term planning and programming efforts. The purpose was to monitor the trend of events to anticipate future divergencies from assumed directions (17, p.1).

Each key word from the alphabetic order of the INDEX TERM was analyzed to see if it was relevant to the impacts of the KRR. As a result, Table B3.2, Appendix B, was prepared, which presents a summary of each event from the analysis of the Suez Canal and from Dickey's INDEX TERM.

Under the category of institutions, the most important favorable impacts associated with the KRR include improvements in governmental operations, both within and between the individual countries, and in improvements in all modes of transportation, in employment, and in the utilization of natural resources.

Unfavorable developments included increased technological capacity for warfare and growth of bureaucracy. Predictable developments in taxation, labor organization, and the like have unfavorable as well as favorable aspects.

It is obvious that all of the above developments will have both favorable and unfavorable impacts on the environment. These are also detailed in Table B3.2, Appendix B.

Demographically, the KRR will predictably increase the mobility of the population, with consequent urbanization and dispersion of business and industry. To the extent that this involves the creation of new but limited urban centers, it can be regarded as favorable, but when it results in unwieldy enlargement of existing urban concentrations, it is unfavorable.

Perhaps the most important development to be expected from the KRR is the development of an Asian Common Market. The improvements in communication and cooperation associated with such an arrangement might fully justify the KRR by themselves.

The following chapter will describe the identified events present and future levels relevant to the impacts of the KRR.

IV. IMPACT LEVELS

The main purpose of this chapter is to identify both the present levels of developmental events expected to be impacted by the KRR and the estimated likelihood of occurrence of these events in the future. The PIA region's socio-economic characteristics are compared with those of other regions presently linked by an international railway system. The two areas used in this endeavor are Uganda, Kenya, and Tanzania (UKT) and Switzerland, West Germany, and France (SGF). The UKT region has similar socio-economic characteristics, with Uganda being landlocked as is Afghanistan. Although Switzerland is also landlocked, the SGF region has obviously different socio-economic characteristics. The purpose behind such comparative discussion is to estimate the PIA region's identified events future levels relevant to the impacts of the KRR.

As we noticed in the previous chapter, the identified events generally are categorized into human resources, health, education, agriculture, economy, religion, politics, environment, transportation, and communication. The following will provide a brief description of these developmental items.

Human Resources

In mid-1975 the PIA region's total population was an estimated 122.8 million, or 85 people per square mile. Table 4.1 presents the three regions' population and total land area figures. The existing

TABLE 4.1 POPULATION AND LAND AREA FIGURES FOR THREE REGIONS

	POPULATION, MID 1975 #1	AVERAGE ANNUAL GROWTH RATE 1960-67 #2	LAND AREA
	(MIL.)	(%)	IN SQUARE KILOMETERS
UGANDA	11.4	2.5	236,037
KENYA	13.3	2.9	582,644
TANZANIA	15.4	2.5	939,702
SWITZERLAND	6.5	1.88	41,288
WEST GERMANY	61.9	1.14	247,973
FRANCE	52.9	1.22	574,026
AFGHANISTAN	19.3	1.9	647,716
IRAN	32.9	2.84	1,648,000
PAKISTAN	70.6	2.13	945,716 #3

SOURCE:
#1: (37,PP.132-40)
#2: (26,PP.9-16)
#3: PAKISTAN INCLUDING BANGLADASH

population in the PIA region is not uniformly distributed throughout, however. While the average population density in Iran is only 45 persons per square mile, there are about 170 persons per square mile in Pakistan and 67 in Afghanistan.

The major mechanism balancing supply of and demand for labor are thus for population to migrate. The present migration pattern from rural to urban areas is attributed to three factors: employment, income, and education (21, p.63). In a developing region, mobility tends to increase urban population. This fact can be seen in Table C4.9, Appendix C. In the UKT region, which is already linked by an international railway system, the annual urban growth rate is higher than in the PIA region. It therefore is predicted that the KRR would enhance migration from rural to urban areas.

Institutional Structure

The people in the PIA region vary in race and language, but the great majority adhere to the Islamic religion. Historically, increased mobility has spread religions. In Table C4.19, Appendix C, it is predicted that diversity of religion would be increased relevant to the impacts of the KRR.

Many obstacles to regional cooperation and unity are due to historical colonialisms. Generally, international transport tends to increase regional cooperation and reduce political tensions. Examples of this are the UKT and SGF railways, which enhanced the establishment of the East African Common Market and West-European Common Market, respectively.

The need for planning and cooperation is especially important in the PIA region, since the economic, social, and natural resources in the area are so unevenly distributed that their optimum utilization can be achieved only with such efforts. The United Nations Conciliation Commission emphasized this fact:

> "Each country of the Middle East will sooner or later learn that the resources of its neighbors have an important and frequently determining influence upon the economic growth of each individual country." (42, p.175)

The development of the KRR should create a new political environment in the area to ease political tension and enhance trade activities. Perhaps tariff and taxes might be reduced and close cooperation might be created to establish combined regional economic activities.

Living Conditions

The level of income in the region is still low; however, it is not equally low in all the KRR countries. In 1973, when the SGF region had $5320 per capita gross national product, Iran's stood at $870, Afghanistan's at $90, and Pakistan's at $130 (see Table C4.15, Appendix C).

In Table C4.15 the KRR region's per capita income growth rate is predicted to increase because of the KRR, since the utilization of the new railroad would increase freight and passenger movements, which in turn would stimulate an increase in the per capita GNP.

Health and Education

The conditions of health and sanitation in the region are still

low. The number of qualified physicians in the PIA region is one for every 8,842 persons (81, p.420). Furthermore, in Table C4.12, Appendix C, it can be seen that the number of hospital beds per 1000 population in the UKT region is 1.5 and in the SGF region it is 10.2, compared to only 0.5 in the PIA region.

Life expectancy in the PIA region is 47 compared to 72 in the SGF and 48 in the UKT (see Table C4.11, Appendix C). Moreover, life expectancy in landlocked Uganda is much higher than in landlocked Afghanistan. Also, the number of deaths of children under one year of age per 1000 live births per year is 151 in the PIA region compared to only 15 in the SGF region (see Table C13.4, Appendix C).

Increased mobility should improve health. The superior levels in the UKT and SGF regions are at least partly due to their better transportation facilities. The predicted levels of life expectancy, population per hospital bed, and infant mortality are presented in Tables C4.11, C4.12, and C4.13, Appendix C.

It can be seen in Table C4.14, Appendix C, that the literacy rate in the PIA region is 16 compared to 99 in the SGF region. A possible cause of this discrepancy is that daily newspaper circulation is only 13.3 in the former compared to 352 in the latter (26, p.29). In the UKT and SGF regions the higher literacy rates are partially due to their better international transportation systems. In Table C4.14 and C4.8, Appendix C, it therefore is estimated that the literacy rate and daily newspaper circulation in the PIA region would increase with the introduction of the KRR.

Agriculture

Agriculture plays a vital role and is the principal economic activity in the PIA region. Over 60 percent of the people earn their living from the soil (68, p.176). Table 4.2 presents the relevant agricultural land use features. It can be seen that the substantial agricultural sector remains the least developed in the economy.

Livestock is moved on foot over many miles from breeding to fattening areas and from there to market because of the lack of transportation facilities. The financial cost of driving livestock for a considerable distance is heavy because of losses in weight and quality of meat.

On a related front, the United Nations Food and Agricultural Organization cites 2390 calories as the daily requirement for a normal human body. The average daily caloric intake per person in the PIA region during 1969-71 was 2147, compared to 3100 in the SGF region (see Table C4.10, Appendix C). Even the landlocked Uganda has a comparatively higher daily per capita consumption of calories than both Afghanistan and Iran. Owen states that whether agriculture, industry, power, capital, or human resources are stressed, the development of each is partly dependent for its success on mobility and accessibility (51, p.24).

The development of the KRR would enhance those factors which generally increase food production and would, consequently, be expected to increase per capita consumption of calories (see Table C4.10, Appendix C).

Industry

Except for oil production, modern industries in most parts of the

TABLE 4.2 AGRICULTURAL LAND USE

	IRAN 1967-8 #1		AFGHANISTAN 1975 #2		PAKISTAN 1972/73 #3	
	AREA (MILLION) HA	% OF TOTAL	AREA (MILLION) HA	% OF TOTAL	AREA (MILLION) HA	% OF TOTAL
TOTAL LAND UNDER CULTIVATION	19	11.5	4.8	7.6	42	32
PERMANENT PASTURES AND MEADOWS	10	6.1	40	63.5		
FORESTS AND WOODLAND	19	11.5	2	3.2	5	4
UNCULTIVATED LAND CAPABLE OF RECLAMATION	31	18.3	8	12.7	6	5
UNCULTIVATED AND NONAGRICULTURAL LAND	86	52.1	13	20.6	78	60
TOTAL LAND AREA	165	100.0	63	100.0	131	100

#1: (48,P.14); #2: (78,P.3); #3: (56,P.1217)

PIA region are still limited in size and number. Western participation in the industrialization of Iran has been significant. Iran imports iron and steel from Europe. With large deposits of iron ore and copper in central Afghanistan, Iran's growing demand can be economically met by importing these commodities from that country. The development of the KRR would have a positive impact in developing these available natural resources and thus would enhance industrial growth in the entire PIA region.

It is proper here to mention that the experts in Uganda believe that the opening of various mines was made possible by the development of the UKT railway system which in turn increased energy consumption (50, p.22). Table C4.6 and C4.7, Appendix C, present the per capita energy and electric consumption and their future levels relevant to the impacts of the KRR.

Transportation

The geography of the PIA region, with its physical configuration of vast mountain ranges, extensive deserts, and long stretches of plains and rivers, has had a decisive influence not only on the movement of people but also on the development of its travel. One old caravan route passing through the region was used by conquerors such as Alexander the Great and explorers like Marco Polo. Many of the old routes have become paths for modern highways, since they have to utilize the same mountain passes and river crossings. Today the nomads still move along the traditional trails with their grazing flocks.

Mileage statistics are only a rough indication of the extent of highway development in the PIA region. In 1969, for every 1000 square kilometers in the region, there was 16 km of road compared with 2500 in France. Furthermore, there was 0.43 km of road per thousand population in the former region compared to 30 in the latter (26, pp.180-3).

Vehicle ownership is determined in great measure by the income distribution within the region. Vehicle registration rates in Iran between 1958 and 1963 were 10.4 percent higher than in either Afghanistan or Pakistan (56, p.36). In 1964, Afghanistan, with a per capita GNP of $85 per year, had only one vehicle per thousand population and 4.3 vehicles per mile of road. In the United States, with a per capita GNP of $3300, there were 448 vehicles per 1000 population and 23.8 cars per mile of road (56, pp.30-31). In the UKT region vehicle registrations per 1000 population was 7.2 compared to 4.4 in the PIA area (80, pp.180-1).

In Tables C4.1 and C4.2, Appendix C, it is predicted that the KRR would increase road network system and car ownership.

The highway functional structure is illustrated with reference to Afghanistan because it shares common socio-economic characteristics with both Iran and Pakistan. The highway system in the former country may be classified as primary, secondary, and tertiary. The primary system provides links between important centers of population, the national and provincial capitals, and international border crossings. Secondary highways connect provincial capitals to smaller administrative and market centers within each province or region. Tertiary or

feeder roads are links between agricultural or resource extraction areas and the nearest population centers on one of the higher category road systems.

The proportionate shares of primary and secondary highways in Afghanistan are markedly different than in the United States (Figure 4.1). The U.S. road system pyramids from a broad base of low classification roads, narrowing considerably in the secondary classification, and capped by a small percentage of high classification roads. The inverse situation is found in Afghanistan, Iran, and Pakistan.

Mobility has become an accepted part of the pattern of living in the higher income countries. In the United States in 1966 there was an average of 4,650 vehicle-miles of travel per capita (56, p.46). In contrast, total travel in Pakistan in 1966 is estimated to have been an average of 9 vehicle-miles per person. Similar comparisons hold for intercity freight movements by motor vehicles on highways. Freight movements are about 1900 ton-miles per person per year in the U.S. and 105 ton-miles per person per year in Pakistan (70, p.214). The highway share of traffic in Pakistan increased from 8.1 percent in 1950-51 to 18.2 percent in 1959-60. The rate at which the traffic would have increased if the demands were fully met is an important but unknown factor. There are many cases in which available goods never moved by any means. Owen estimated that traffic equal to 15 percent of the total ton miles by both modes was available and not moved because of the slight prospect of receiving service (70, p.49). Detailed traffic data are not available in the PIA region.

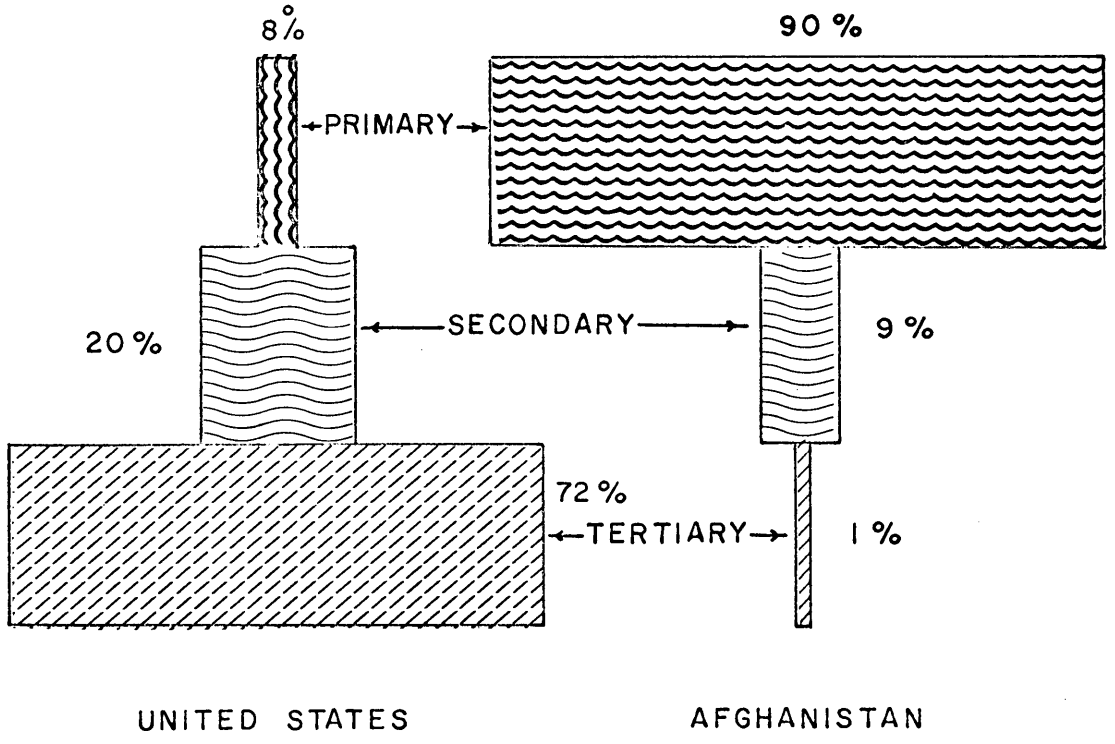

FIGURE 4.1 FUNCTIONAL ROAD CLASSIFICATION; UNITED STATES AND AFGHANISTAN. ADOPTED FROM: (56, P.44).

In both Iran and Pakistan the railroad is owned and operated by the government. Afghanistan does not have any railway system. The density, or the ratio of rail length to the total area, in the PIA region is 0.005 compared to 0.15 in the SGF region. Furthermore, in 1969 there was 0.13 km of rail per thousand population in the former region compared to 0.7 in the latter (53, p.252). Table C4.3, Appendix C, presents the PIA region's present railway length and its predicted future level resulting from the KRR.

In Pakistan, comparison of total tons moved by truck and rail with total production for the 1955-56 - 1959-60 period, indicates that a weight equal to 95 percent of the production and imports, or about 4.7 billion ton miles, was moved in intercity transport. An annual rate of increase of 7.8 percent is projected up to 1980 (70, p.49).

In 1955, the Pakistan Railway had 115,735 persons on its payroll, compared to 35,635 persons employed by the Iranian Railway. The number of employees per kilometer on the railway is 13.5 in Pakistan and 10.0 in Iran (70, p.122). In 1972 Iranian State Railways carried 1,953 million passenger-km and 3,693 million ton-km of freight (48, p.144).

In the PIA region pipelines carry a large percentage of natural gas and refined petroleum fuels. In Afghanistan 120 miles of pipeline run from the north to the U.S.S.R. (see Figure A4.1, Appendix A). During 1973-74, all the natural gas product of Afghanistan was sent to the U.S.S.R. (78, p.8.1).

In Pakistan the 1012 miles of pipeline run from Sue (see Figure A4.2, Appendix A), south to Karachi through Sukkur and Hyderabad, and

north to Multan, Lahore, Rawalpindi, and to Peshawar. In 1960 Pakistan imported 80 percent of its petroleum product; after refining, it was shipped by pipeline to large cities and industrial areas (70, p.28). Figure A4.3, Appendix A, presents the Iranian pipelines which run from Agha Jare oil fields to Tehran, Rasht, and Mashad.

In 1959 traffic on the three main carriers - road, rail, and pipeline - was at some 7.5 billion ton/kms (77, p.6). The future development of the KRR might increase exploitation of natural resources and competition between the pipeline and railway and also might enhance pipeline technology.

The PIA region's inland waterborne traffic is very small and is less developed than that of the other modes. International trade between landlocked Afghanistan and the outside world is mostly funneled through the Port of Karachi.

Since Karachi is the only port in Pakistan, its traffic is growing rapidly. In 1960-61 the total imports and exports of commodities by sea in or out of the port was 3.9 and 1.1 million tons. It is estimated that by 1980 the total imports and exports of commodity shipments through the Port of Karachi will be 6.3 and 3.2 million tons (70, p.61).

In 1961-62 the total income from the Port of Karachi was $10.5 million (70, p.61). Most of Iran's foreign trade passes through the gulf ports of Khoramshahr (see Figure A4.3, Appendix A), Bandar Shahpoor, and Bandar Abbas (77, p.6). The main rail line, the Trans-Iranian, connects the gulf ports with Tehran and also with Bandar Shah on the Caspian Sea. The utilization of the proposed KRR might relieve

some of the congested traffic at Bandar Shah and further facilitate the shipment of Bandar Pahlavy at Rasht.

Air transport has not been fully utilized since the region lacks experience and expertise in the field. For Afghanistan, the passenger-km flown in 1973-74 was 198 million and freight ton-km was 16.1 million (58, p.10). Iran's 1972 figures were 711 million and 4.3 million, respectively (58, p.719). For Pakistan in 1973-74, the passenger-km was 1.6 billion and freight ton-km was 74 million (58, p.1224).

Table C4.5, Appendix C, presents the region's earnings from tourism and it is forecast that the KRR would increase the PIA's tourist receipts.

The region has many factors that combine to limit its capability for transport development. Although manpower is abundant in these countries, there are serious shortages of trained people for technical, professional, and administrative jobs. However, the single factor that restricts transport development the most is the shortage of capital for investments. Highway expenditures in the region is presented in Table 4.3. It can be seen that these amount to about $0.50 per person, compared to $61.90 in the U.S.A. It can also be seen that highway expenditure per square mile in the PIA region is $41.2 compared to $3092.1 in the United States.

Capital and Financial

Most financial organizations of medium or large size in the region are controlled or subsidized by the relevant governments or

TABLE 4.3 HIGHWAY EXPENDITURES IN 1960 (IN U.S. $)

COUNTRY	TOTAL (IN MILLIONS)	PER MOTOR VEHICLE	PER SQUARE MILE	PER PERSON
AFGHANISTAN	3.7	369.5	14.8	0.3
IRAN	16.7	132.5	26.6	0.8
PAKISTAN	30.0	389.6	82.2	0.3
U.S.A.	11,176.0	151.3	3,092.1	61.9

SOURCE: (51,P.209)

branches of foreign institutions. In contrast with the oil-producing Iran, the financial position of Afghanistan and Pakistan is weak, and government budgets are characterized by continuous deficits. Public revenue in these two countries is limited not only by the low level of the national income but also by poorly adopted and administered taxes and other sources of revenue.

In Iran the large oil revenue obviously contributes toward reduction the budget deficit. Afghanistan and Pakistan depend largely on foreign aid and subsidies to cover part of their deficits. In 1974 the total aid from DAC and OPEC to these two countries was $115.1 million and $11,03 billion, respectively (37, p.197). During 1967-71, corresponding World Bank loans were $2.5 and $137.1 million (37, p.197).

Most foreign aid requires recipients to prepare comprehensive proposals for the developmental projects for which funding is requested. For instance, the World Bank criteria in the evaluation of transport projects are as follows:

1. Technical soundness,
2. Economic soundness,
3. Financial soundness,
4. Institutional capability of the borrowing government to administer the project, and
5. Compatibility of the project with legal and regulatory measures in the borrowing country (79, p.2).

In Tables C4.4 and C4.15, Appendix C, it is predicted that the development of the KRR would increase World Bank, DAC, and OPEC lending and

aid to the PIA.

The improvement of income in terms of trade during the 1960's added about one percent annually to the national income of Afghanistan (28, p.59). The PIA's per capita export in 1974 was $63 compared to $249 in the SGF region. Tables C4.17 and C4.18, Appendix C, indicate that the development of the KRR would be expected to increase total imports and exports.

Interactions

Generally speaking, the level of developmental impacts of the KRR depend on the interaction of factors described in this chapter. These interactions are identified in Table B3.2, Appendix B. Gross-level interactions among major impact categories are portrayed in Figure 4.2. Space does not permit a detailed description of the rationale behind the numbers employed to represent each connection. A finer level of detailed interactions among two or more impact sub-categories can be established and their future likelihoods tested by applying certain techniques. The following chapter will discuss various forecasting methods and will present reasons for choosing the Cross Impact Technique (CIT) to measure the future likelihood of identified developmental events with respect to the KRR.

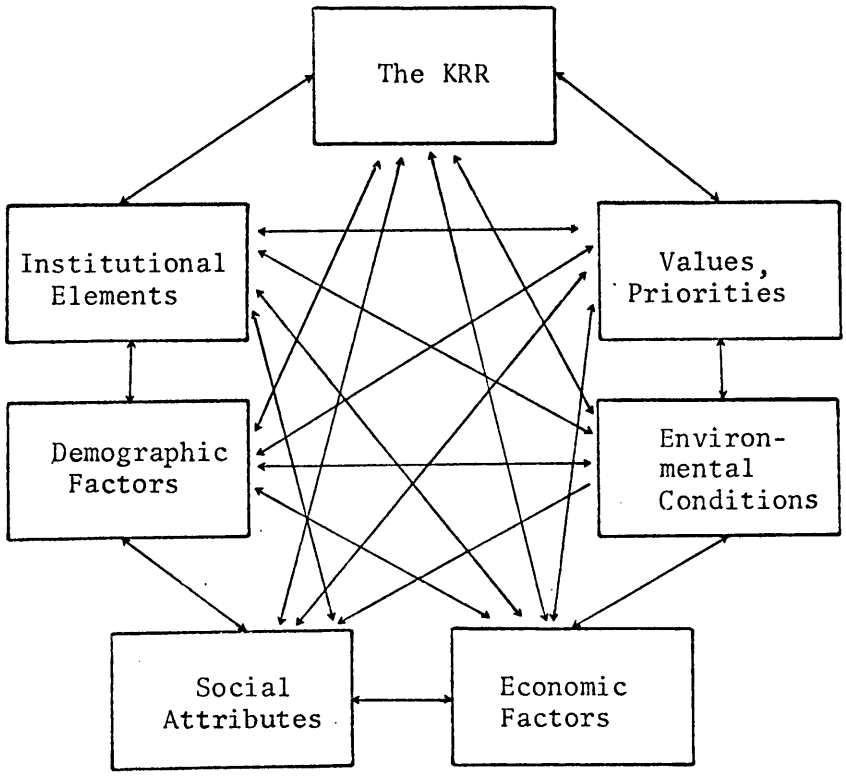

FIGURE 4.2 SOME GROSS-LEVEL INTERACTIONS.

V. A GENERAL PERSPECTIVE OF FORECASTING METHODS: FORMULATION OF THE CIT

Introduction

This chapter is directed toward the following objectives:

1. To highlight and compare a few forecasting methods, and to present the rationale for selecting the cross impact technique (CIT) to measure the developmental impacts of the KRR;
2. To discuss the CIT and present the systematic steps necessary to formulate and utilize this technique; and to further simplify and develop a general format for the mathematical relationships between the elements in the CIT; and
3. To discuss a technique for sensitivity analysis and develop sensitivity factors that can be applied to examine various probability results.

Forecasting is not new; early man doubtlessly recognized that he could live more comfortably and perhaps longer if he could predict change in his environment. In the dawn of history, many "techniques" were employed to lessen perceived uncertainties about the future.

In recent years, there has been an accelerated attempt to make forecasts more open, rational, explicit, and quantitative. Part of this attempt involves technological forecasting, which, for the purpose of this discussion, is defined as "the prediction, with a stated level of confidence, of anticipated occurrence of a technological achievement within a given time frame with a specified level of support."

A planner does not have the choice as to whether or not he will make a forecast. A forecast is implicit in planning. The only choice is whether it will be made openly, rationally, and explicitly, so it can be subjected to the review and analysis of others, or whether the forecast will be made in the musky depths of the subconscious where no one can ever know what the forecast is, let alone review or criticize it (45, p.5). The techniques associated with technological forecasting have a much wider range of applicability than technology. They currently are being employed in a very broad spectrum of economic, social, environmental, and even political contexts (18, p.2). In the next section we will highlight and compare some of the most common forecasting methods.

Common Forecasting Techniques

Regression Analysis: A statistical technique used to establish relationships between a dependent and one or more independent variables so as to minimize the error sum of squared derivations of the former (3, p.94).

"Genius" Forecasting" An intuitive forecast by an individual (genius) without interaction with any other people (18, p.2).

Committee Forecasting: That done by a typically instructured group of unrelated people (44, p.5-19).

S-Shaped Curves: Regression-based relationships in the form of S-shaped curves over time, that is, when growth is slow initially, then rapid, then tapering off quickly as a limit is reached (18, p.2).

Analogy: Prediction in which circumstances, characteristics, or events similar to that in a known entity are assumed to hold for the unknown entity (44, p.2-21).

Delphi: A method for structuring a group forecasting process so that feedback is controlled, anonymous, and statistical (43, p.3).

Gaming: Competitive situations and actions created in which the roleplayers are striving to find strategies for achieving their separate ends through either cooperation or, at the other extreme, competition (19, pp.3-22).

Morphological Analysis: A search for unique forms or combinations of events through identifying, indexing, counting, and parameterizing of all possible devices (3, p.72).

Relevance Trees: A process in which distinct levels of complexity as a hierarchy of goals and functions are identified such that the most productive (relevant) aspects for future developments are established (19, pp.1-29).

Probe: A "critical path" arrangement of future events, clarifying the sequential relations between them and subsequently eliminating many inconsistencies (19, p.1-24).

Cross-Impact: "A process for taking into account simultaneously the strength and direction of interaction between expected events" (18, p.2), and thereby determining horizon year probabilities of such events.

Factor Analysis: A statistical method to simplify and clarify by reducing the dimensionality and number of variables (factors) that

contribute to the structure of a given situation (19, p.1-12).

Discriminant Analysis: A procedure analogous to factor analysis (except that more than one group is involved) in that it provides a statistical basis for interpreting the nature of group differences in terms of dimensional characteristics (54, p.175).

Early Warning: A screening and evaluation process in which historic trends are monitored and grouped in terms of their likely implications, all this being done in time for adequate decisions to be made (19, p.1-26).

Cross-Support Matrix: A mathematical technique used to define the extent of support interrelationships, where the results can serve to rank order each item from the point of view of cross-support (38, p.253).

System Dynamics: A general methodology for analyzing a time varying (dynamic) system in which rates or policies are used in decision making to govern the variable levels in the system (21, p.32).

Trend Extrapolation: A process involving judgement modification of past-time trends based on the consideration of exogenous factors; it assumes that future advances will continue to occur at a rate which sustains the rate of growth previously shown (45, p.14).

Substitution: A process like trend extropolation, based on the rate at which one technology is substituted for another in general usage (45, p.15).

A general comparison of these techniques, presented in Table 5.1, can be made on the basis of accuracy, quality of ideas generated, cost, time and data requirements, individual knowledge, and so on. Most of

TABLE 5.1 A GENERAL COMPARISON OF TECHNOLOGICAL FORECASTING TECHNIQUES

TECHNIQUE	COMPARISON FEATURE			
	1. ACCURACY	2. QUALITY OF IDEAS	3. COST	4. TIME PERIOD REQUIRED
1. REGRESSION	HIGH IF PAST FACTORS OPERATIVE	VERY LOW	LOW	VERY LOW
2. S-SHAPED CURVES	HIGH IF PAST FACTORS OPERATIVE	VERY LOW	LOW	VERY LOW
3. GENIUS	VARIED	MEDIUM	MEDIUM	LOW
4. COMMITTEE	VARIED	MEDIUM	MEDIUM	MEDIUM LOW
5. ANALOGY	FAIR	ABOVE AVERAGE	MEDIUM	MEDIUM
6. DELPHI	FAIRLY HIGH	FAIRLY HIGH	MEDIUM	MEDIUM

TABLE 5.1 (CONTINUED)

TECHNIQUE	COMPARISON FEATURE			
	5. DATA REQUIREMENTS	6. INDIVIDUAL KNOWLEDGE NEEDED	7. GROUP KNOWLEDGE NEEDED	8. PARTICIPANT BENEFIT
1. REGRESSION	VERY LOW	HIGH	NA	NONE
2. S-SHAPED CURVES	VERY LOW	VERY HIGH	NA	NONE
3. GENIUS	LOW	VERY HIGH	NA	NONE
4. COMMITTEE	LOW	MEDIUM	HIGH	FAIRLY HIGH
5. ANALOGY	FAIRLY HIGH	MEDIUM	NA	NONE
6. DELPHI	LOW	FAILRY HIGH	HIGH	FAIRLY HIGH

TABLE 5.1 (CONTINUED)

TECHNIQUE	COMPARISON FEATURE			
	1. ACCURACY	2. QUALITY OF IDEAS	3. COST	4. TIME PERIOD REQUIRED
7. GAMING	FAIR	FAIRLY HIGH	MEDIUM	MEDIUM
8. MORPHOLOGICAL ANALYSIS	MEDIUM	MEDIUM	LOW	LOW
9. RELEVANCE TREE	VARIED	VERY HIGH	MEDIUM	MEDIUM
10. PROBE	FAIRLY HIGH IF FACTORS "DISCRETE"	BELOW AVERAGE	MEDIUM	MEDIUM
11. CROSS IMPACT	HIGH IF FACTORS "DISCRETE"	LOW	ABOVE AVERAGE	LOW

TABLE 5.1 (CONTINUED)

TECHNIQUE	COMPARISON FEATURE			
	5. DATA REQUIREMENTS	6. INDIVIDUAL KNOWLEDGE NEEDED	7. GROUP KNOWLEDGE NEEDED	8. PARTICIPANT BENEFIT
7. GAMING	MEDIUM	FAIRLY HIGH	HIGH	HIGH
8. MORPHOLOGICAL ANALYSIS	FAIRLY LOW	VERY HIGH	NA	NONE
9. RELEVANCE TREE	FAIRLY HIGH	VERY HIGH	NA	NONE
10. PROBE	MEDIUM	VERY HIGH	NA	NONE
11. CROSS IMPACT	FAIRLY HIGH	VERY HIGH	NA	NONE

TABLE 5.1 (CONTINUED)

TECHNIQUE	COMPARISON FEATURE			
	1. ACCURACY	2. QUALITY OF IDEAS	3. COST	4. TIME PERIOD REQUIRED
12. FACTOR ANALYSIS	HIGH	ABOVE AVERAGE	ABOVE AVERAGE	MEDIUM
13. DISCRIMINANT ANALYSIS	HIGH	ABOVE AVERAGE	ABOVE AVERAGE	MEDIUM
14. EARLY WARNING	HIGH	ABOVE AVERAGE	ABOVE AVERAGE	ABOVE AVERAGE
	COMPARISON FEATURE			
	5. DATA REQUIREMENTS	6. INDIVIDUAL KNOWLEDGE NEEDED	7. GROUP KNOWLEDGE NEEDED	8. PARTICIPANT BENEFIT
12. FACTOR ANALYSIS	MEDIUM	VERY HIGH	NA	NONE
13. DISCRIMINANT ANALYSIS	HIGH	VERY HIGH	NA	NONE
14. EARLY WARNING	FAIRLY HIGH	MEDIUM	NA	NONE

TABLE 5.1 (CONTINUED)

TECHNIQUE	COMPARISON FEATURE			
	1. ACCURACY	2. QUALITY OF IDEAS	3. COST	4. TIME PERIOD REQUIRED
15. SYSTEM DYNAMIC	HIGH	FAIRLY HIGH	ABOVE AVERAGE	ABOVE AVERAGE
16. CROSS-SUPPORT MATRIX	HIGH	ABOVE AVERAGE	ABOVE AVERAGE	MEDIUM
17. TREND EXTRAPOLATION	MEDIUM	LOW	LOW	LOW
18. SUBSTITUTION	LOW	MEDIUM	LOW	LOW

TABLE 5.1 (CONTINUED)

TECHNIQUE	COMPARISON FEATURE			
	5. DATA REQUIREMENTS	6. INDIVIDUAL KNOWLEDGE NEEDED	7. GROUP KNOWLEDGE NEEDED	8. PARTICIPANT BENEFIT
15. SYSTEM DYNAMIC	HIGH	VERY HIGH	NA	NONE
16. CROSS-SUPPORT MATRIX	LOW	HIGH	HIGH	FAIRLY HIGH
17. TREND EXTRAPOLATION	LOW	VERY HIGH	NA	NONE
18. SUBSTITUTION	LOW	VERY HIGH	NA	NONE

SOURCE: (18,P.20)

these methods have been developed for purposes of "man-technique dialogue" and are very sensitive to 'man' knowledge and his capacity for imaginative thinking, technical and value judgement, and synthesis. Essentially, human forecasting is not replaced, but structured and enhanced by these techniques. In particular, the human forecasting potential is extended where a large set of inputs and complex relationships are involved.

The selection of a technique depends on its characteristics, how well it fits the problem, and the object of the study. Some problems preclude certain analytical approaches, and one problem may require different approaches because of different purposes. Some of these forecasting methods suffer from a variety of problems due to their mathematical nature. For example, some tend to be readily quantified but exclude variables which, while important, are basically subjective in nature. Another shortcoming is that some are highly technical in nature and thus tend to inhibit policy makers from using them freely. Generally, simulation techniques are formulated and run by highly skilled "experts" with an elaborate and abstract language.

If anything, politicians are unlikely to read more than the abstract of the reports furnished by the experts. As a result, policymakers are denied the experience and intuition that comes with actual involvement with simulation techniques and thus tend to mistrust them. Hence a barrier is erected between those people who formulate and conceive simulation techniques and those who should ultimately use their output. It was the purpose of this research to try to use a simulation

procedure with which technically unsophisticated people could quickly become fluent. In addition, the scope of this simulation procedure should be sufficiently wide so that it would express the interaction of competing variables in a realistic and numerical fashion. Other considerations, such as the nature of the events being studied in this research, the interaction among the events, and general characteristics of the CIT were among factors which favored the use of this technique.

The Cross Impact Technique (CIT)

The CIT was selected for this research. It is one of the promising new tools that can be used to help forecast the long-range developmental impacts of facilities such as the KRR. As was discussed in Chapter IV, the future impacts of the KRR cover institutional elements, demography, social attributes, environmental conditions, values, and economical aspects. They are interrelated as a complex system. Most individuals are simply unable to follow such a system through; they assume independence of its various parts. The CIT aims to alleviate this difficulty and probe the effects of interaction among elements of the system; it deals with events without highly detailed data (especially when such are not available).

The process of combining a large number of forecasts usually involves comparison of individual events on a pairwise basis to determine if there are any significant interactions. If so, it may then be necessary to trace through several connections to determine the overall impact. For instance, two events may not interact directly, but one

of them may interact with a third, which in turn interacts with the second. Tracing all the chains of interactions can be a very tedious and time consuming process. The process can, however, be made more systematic, thus providing the usual advantages of a logical framework within which to operate and a tendency toward completeness.

The general notion of the CIT was first suggested by Helmer and Gordon with the game "Futures" created for the Kaiser Corporation (43, p.327). It was developed as a follow-up to a Delphi-type study. However, it should not be thought that the CIT is useful only with a Delphi panel. The technique can be utilized to examine interactions among events no matter how identified (even if they all come from the same source). Yet the technique is likely to be even more valuable when the events happen to come from several sources. Even if a matrix describing the interactions is available - say from estimates furnished by a panel of experts - the task of thinking through the implications rapidly gets out of hand. Some computational aid is required to take account of the large number of interdependencies.

Gordon and others at the Institute for the Future have developed two major approaches to the computational program. Both approaches involve (1) preliminary estimates of the probabilities of the individual events, (2) estimates of the interdependencies in terms of a cross-impact matrix, (3) a Monte Carlo sampling of chains of events in which the probability of an event in the chain is modified by the cross-impact of the previously occurring event in the chain, and (4) re-estimation of the probability of each event in terms of the relative

frequency of the occurrence of that event in the samples of chains (43, p.327). Figure 5.1 presents the systematic steps required to formulate and utilize the CIT in this research. The steps for identifying developmental events shown in phase 1 are presented in Chapter III.

A small scale example of three identified events relevant to the impacts of KRR is presented in Appendix D. The existing and projected developmental level of each event is displayed in Tables D5.1, D5.2, and D5.3, Appendix D. The application of the CIT is outlined and the final probability of each event is estimated both by hand and by computer. Table 5.2 presents three events which are used in this example. Columns 4 to 6 of this table show the interaction among the events. Basically, each event has been connected with each of the other events; each interaction has three characteristics: mode, strength, and predecessor. The first characteristic, mode, is indicated by a plus or minus sign, the former indicates the enhancing effect,[1] the latter an inhibiting one.

The second characteristic, indicated by the first numerical digit of columns 4 to 6 (Table 5.2) is the strength of interaction which varies from 0-0.9. The variation is used to characterize the strength of interaction of occurrence of one event on the probability of a succeeding one (0-weakest effect, 0.9-strongest effect). Clearly, some events will be strongly linked, that is, the occurrence of one

[1]Enhancing linkage: those in which the probability of the succeeding event (j) is increased by the occurrence of the preceding (i).

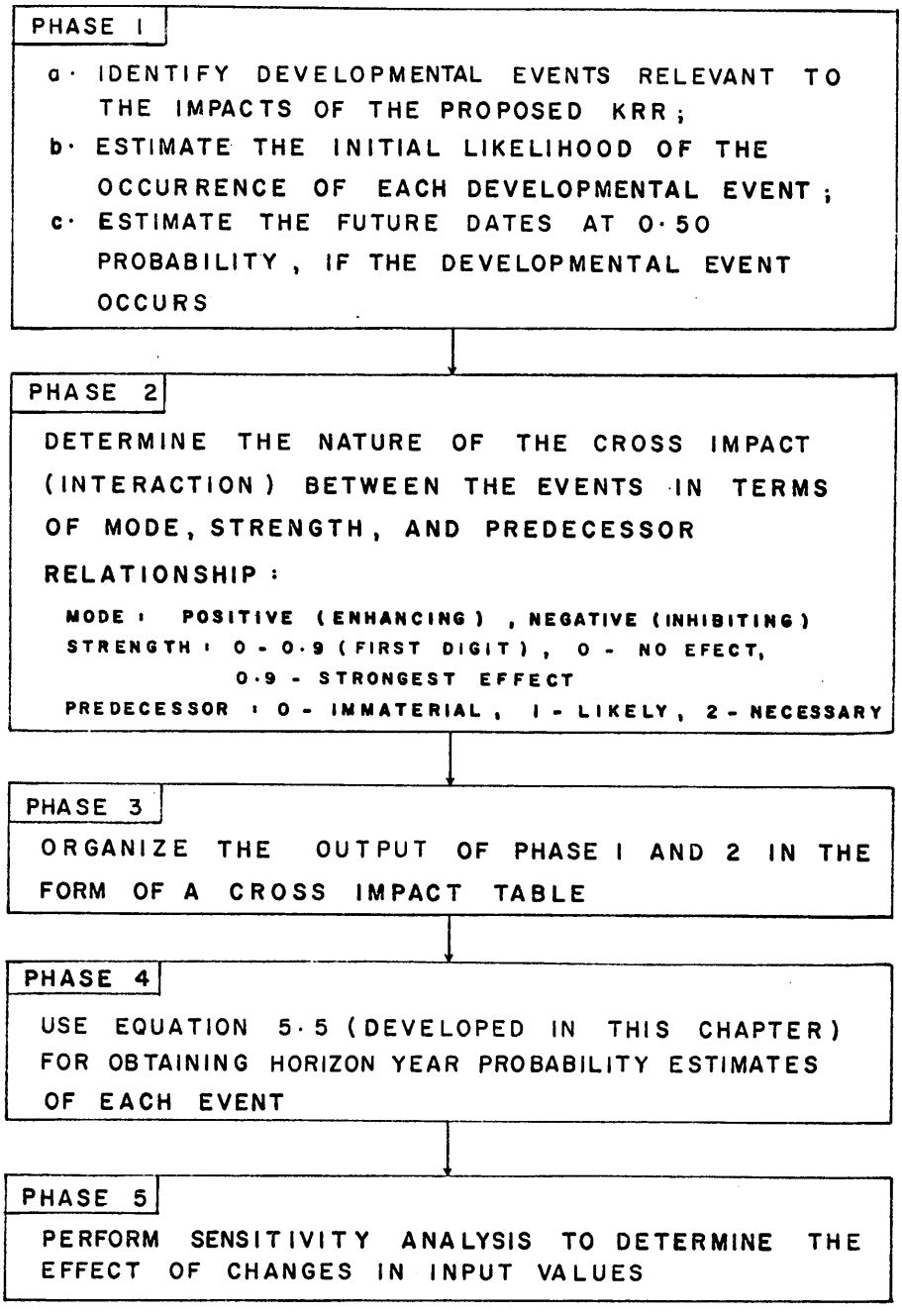

FIGURE 5.1 SYSTEMATIC PHASES REQUIRED TO FORMULATE AND UTILIZE THE CROSS IMPACT TECHNIQUE.

TABLE 5.2 CROSS IMPACT TABLE FOR A SAMPLE OF THREE DEVELOPMENTAL EVENTS RELATED TO THE KRR

	ASSUMED INITIAL PROBABILITY OF OCCURRENCE OF EVENT $Pr(E_j)$	ASSUMED DATES OF OCCURRENCE OF EVENT t_j	THEN THESE EVENTS CHANGE AS*		
IF THIS EVENT HAPPENS			E1: INCREASE IN ROAD NETWORK LENGTH	E2: INCREASE IN EXPORTS	E3: REMOVAL OF TARIFF AND TAXES
E1: INCREASE IN ROAD NETWORK LENGTH	0.50	1980		.62	.10
E2: INCREASE IN EXPORTS	0.50	1989	.62		.41
E3: REMOVAL OF TARIFFS AND TAXES	0.50	1985	.21	.41	

*ALL RELATIONS ARE POSITIVE UNLESS PROCEEDED BY MINUS SIGN
FIRST DIGIT: STRENGTH(0.0-0.9)
SECOND DIGIT: PREDECESSOR RELATIONSHIPS: 0-IMMATERIAL
1-LIKELY
2-NECESSARY

produces a large change in the probability of the second. If other events are weakly linked, then the probability of one is only slightly affected by the occurrence of the other. The second numerical digit of columns 4 to 6 is the predecessor relationship.[1] If it is 0, 1, or 2, the predecessor event is immaterial, likely, or necessary respectively for the occurrence of the particular successor event.

In Table 5.2, the second column indicates the initial probability of occurrence of each event; this is always assumed to be 0.50. The initial probability is part of the CIT input requirement; it is combined with other variables such as mode, strength, and time to estimate the final probability of each event. The time lag characteristic refers to the time constant of the change in probability of the affected event in the presence of the occurrence of the prior one. Suppose that two events are strongly linked in the enhancing mode. Even though the linkage is strong, there is little chance that the probability of the second will significantly increase immediately after the occurrence of the prior event. Depending on the nature of the events, the time required to realize the higher probability will range from minutes to decades.

In general, the estimation of the cell entries is a matter of expert judgement. Assuming that we have a large list of n events designated as E_1, E_2, ..., E_i, ..., E_j, ..., E_n with

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[1]Predecessor: The terminology used in the cross-impact planning model logic (see Figure D5.1, Pocket) to compute the necessary predecessor group first, then the likely and finally the immaterial group.

associated probabilities $Pr(E_1)$, $Pr(E_2)$, ..., $Pr(E_i)$....., $Pr(E_j)$, ..., $Pr(E_n)$; then the question can be posed:

"If $Pr(E_i) = 1.00$ (i.e., E_i surely happens), how do $Pr(E_1)$, $Pr(E_2)$, $Pr(E_3)$, ...$Pr(E_j)$, ... and .....$Pr(E_n)$ change?"

At least three modes of connection exist between events. Assume event E_i occurs. A second event, E_j, may be completely unaffected by the occurrence of E_i or it may be enhanced or inhibited by it. We now proceed to ask how the probability of E_j might change if E_i occurs. Suppose $\hat{Pr}(E_j)$ is the probability some time after the occurrence of E_i. Then we might expect:

$$\hat{Pr}(E_j) = f(Pr(E_j), m_{ij}, s_{ij}, t_i, t) \qquad (1)$$

where,

$\hat{Pr}(E_j)$ = the "final probability of occurrence of event j, that is, the probability at the horizon year t;

$Pr(E_j)$ = the initial probability of occurrence of event j at the time t;

m_{ij} = the mode of interaction between events E_i and E_j;

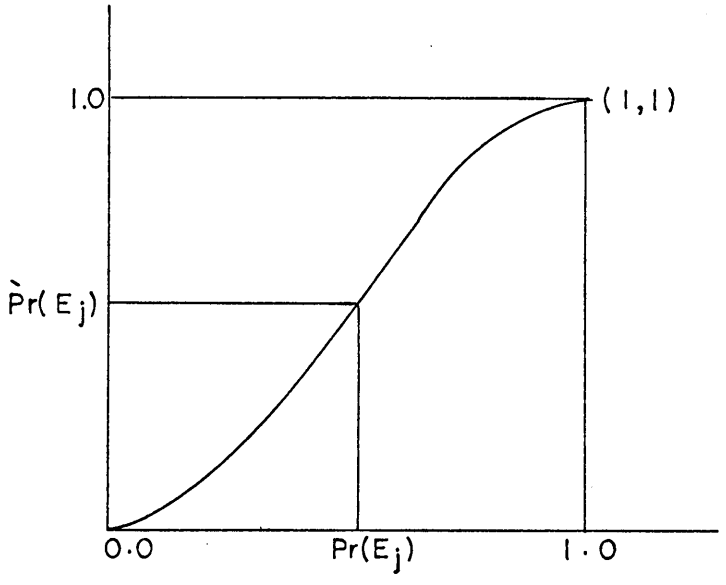
s_{ij} = a measure of strength of connection between i and j;

t_o = the origin date;

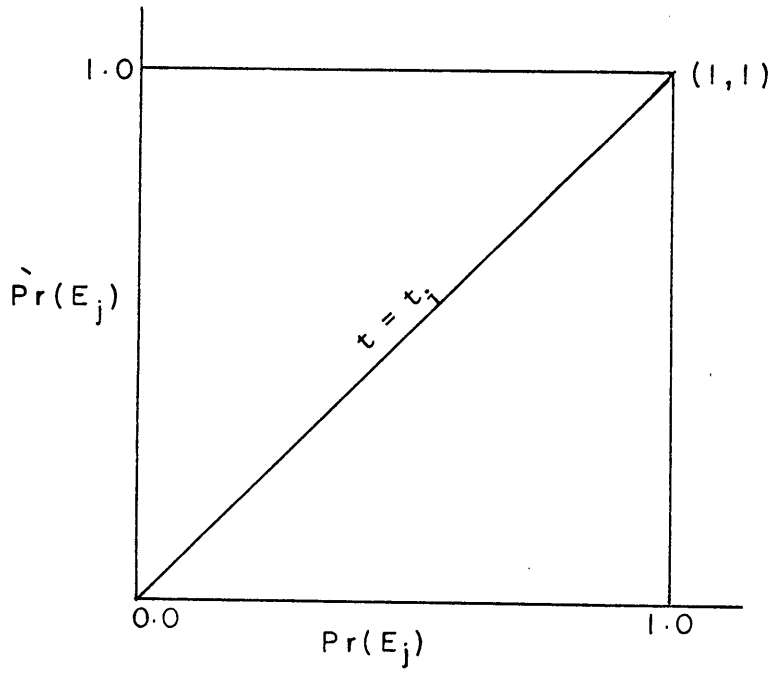
t_i = the original estimate of the time for occurrence of development i at 0.50 probability (see column 3, Table 5.2);

t = horizon year, or the specified year in the future for which the "final" probabilities are sought. Both t and t_i are measured on a time scale with origin at the present date (23, p.104).

Gordon assumed with $Pr(E_j)$ and $\grave{P}r(E_j)$ lying between zero and one that for both the inhibiting and enhancing modes when $\grave{P}r(E_j) = 0.0$, $Pr(E_j)$ must equal 0 and when $\grave{P}r(E_j) = 1.0$, $Pr(E_j)$ must also equal 1.0 (34, p.105). Therefore the relationship is something like:



When $t = t_i$, there is no time allowed for the adjustment of $Pr(E_j)$ to $\grave{P}r(E_j)$, so $\grave{P}r(E_j)$ must equal $Pr(E_j)$;



The area above the diagonal contains the enhancing mode, and the area below the inhibiting, since above the diagonal $\hat{Pr}(E_j) > Pr(E_j)$ and below $\hat{Pr}(E_j) < Pr(E_j)$ (22, p.105).

Gordon further assumed as a first approximation that within these regions the relationship between $\hat{Pr}(E_j)$ and $Pr(E_j)$ varies monotonically with time, e.g., the greater the time gap and the higher the strength, then the greater the ratio $\hat{Pr}(E_j)/Pr(E_j)$ for enhancing modes. For inhibiting modes, the greater the time and the higher the strength, the lower that ratio (23, p.105).

If the relationship is assumed to be quadratic in $Pr(E_j)$, then:

$$\hat{Pr}(E_j) = a[Pr(E_j)]^2 + b\ Pr(E_j) + c \qquad (5.2)$$

Since $\hat{Pr}(E_j) = 1.0$ when $Pr(E_j) = 1.0$ and $\hat{Pr}(E_j) = 0$ when $Pr(E_j) = 0$, we obtain $b = 1-a$, $c = 0$, and:

$$\hat{Pr}(E_j) = a[Pr(E_j)]^2 + (1-a)\ Pr(E_j) \tag{5.3}$$

For the inhibiting case, $0 < a < 1$ and for the enhancing case, $-1 < a < 0$, so:

$$a = m_{ij}\ s_{ij}\ \frac{t - t_i}{t} \tag{5.4}$$

where m_{ij} is +1 or -1, as determined by the mode:

s_{ij} is a number between 0 and 0.9, a smaller number representing weaker strength of relationship between E_i and E_j (zero designating an unrelated pair);

t and t_i are as previously defined.

Now, substituting (5.4) back into equation (5.3), we have the following equation:

$$\hat{Pr}(E_j) = m_{ij}\ s_{ij}\ \frac{t - t_i}{t}\ [Pr(E_j)]^2 + [1-m_{ij}\ s_{ij}\ \frac{t - t_i}{t}]\ Pr(E_j) \tag{5.5}$$

Equation (5.5) indicates that the sooner event i starts before the horizon year and the greater the strength of connection between events i and j, the greater the change in the revised probability, $\hat{Pr}(E_j)$. (19, p.11).

There are still some theoretical questions about equation (5.5). These are:

-The uncertain accuracy of the $\tilde{Pr}(E_j)$ vs. $Pr(E_j)$ relationship. It is not certain that the quadratic form (Equation 5.5) would generate the most accurate results;

-The accuracy of judgements on the mode, strength, and predecessor relationships is questionable. No matter how explicit the investigator is about the relationships he believes to be functioning in his field, human error still exists. Perhaps some of the interactions are not as strongly linked as he thought they were.

-It is probable that the effect of time remaining is a function of mode; that is, an inhibiting relationship might have a different action time than an enhancing one.

There are other disadvantages and advantages one can find in using the present version of the CIT. These and other details regarding future improvements of this technique are discussed at the end of this chapter and Chapter VII.

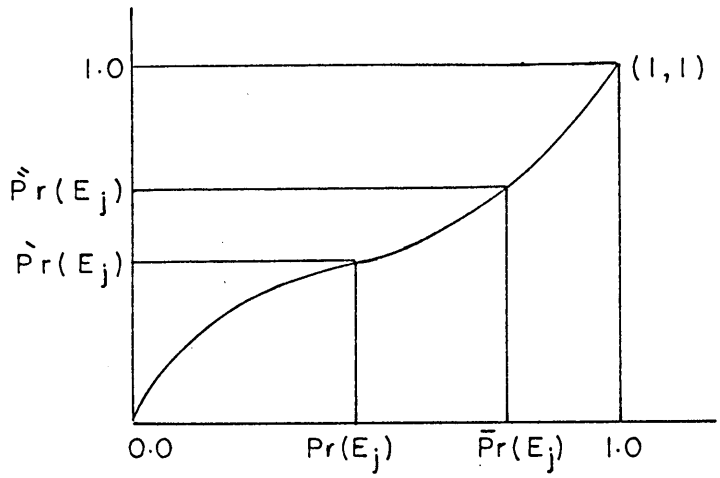
Equation (5.5) was incorporated in the theoretical example of three events (see Appendix D) and was programmed for the IBM 370/158. The modified probability of each event was calculated both by hand and computer. These results are presented in Table D5.11, Appendix D. Equation (5.5) is also used to measure the likelihood of 25 identified developmental events relevant to the impacts of the KRR. Chapter VI covers the details, and Appendix E presents the computer program and results.

Sensitivity Analysis

The effect of changing initial event probabilities, dates, and strengths of connection can be measured through sensitivity analysis. In other words, by applying sensitivity analysis one can determine how much the final results are altered in response to a change in a particular input. The magnitude of these changes can be measured by the sensitivity factor (s.f.). The mathematical relationships are established as follows:

$$s.f.(E_j) = \frac{\tilde{\tilde{P}}r(E_j) - \hat{P}r(E_j)}{\Delta Pr(E_j)} \tag{5.6}$$

$$\Delta Pr(E_j) = \bar{P}r(E_j) - Pr(E_j) \tag{5.7}$$



where $s.f.(E_j)$ = sensitivity factor of event j;

$\tilde{\tilde{P}}r(E_j)$ = the final probability of event j obtained after its initial probability was changed from 0.50 to 0.80;

$\hat{P}r(E_j)$ = the final probability of event j obtained by assuming the initial probability of 0.50.

$\bar{Pr}(E_j)$ = the initial probability of event j after it was raised from 0.50 to 0.80 for sensitivity analysis run;

$Pr(E_j)$ = the initial probability of event j before sensitivity analysis run (initial probability = 0.50).

Equation (5.6) was applied to measure the effects of change in input values of 25 identified developmental events relevant to the impacts of KRR.

The details of this analysis are presented in Chapter VI; Appendix F presents the output of sensitivity analysis.

Advantages and Disadvantages of the CIT

The CIT is a new technique and it has the following disadvantages and advantages. First the advantages:

1. So far, only pairwise interactions are taken into consideration. In reality, it is often the combined action of two or more developments that has an effect on a third. In principle, these multiple cross impacts can also be dealt with, but this requires that the number of combinations to be processed increase exponentially.

2. The quadratic form intuitively appears to have the proper shape, but the accuracy of the $\tilde{Pr}(E_j)$ versus $Pr(E_j)$ relationship and particularly the following boundary conditions are questionable:

$$\tilde{Pr}(E_j) = 0, \text{ when } Pr(E_j) = 0,$$

$$\tilde{Pr}(E_j) = 1, \text{ when } Pr(E_j) = 1.$$

The above do not necessarily hold, since the longer year probabilities are not always 0 or 1 when the initial probabilities are 0 or 1, respectively.

3. Another drawback of the CIT is that greater change in the "final" probability of E_j occurs as $\frac{t_i - t_o}{t - t_o}$ becomes greater;

4. Estimation of the "final" probability of E_j by time t, prior to the occurrence of E_i, is questionable when $t_j > t_i$;

5. The strength parameter s and time lag have not been related, which in reality they are. Such independent treatment of s and the time lag does not permit the quadratic parameter a to assume its full range of values;

6. Another difficulty is the ambiguity of defining "event", unless you attach a level to it. In our analysis we used conditions that existed at certain levels (e.g., literacy rate), and we predicted that they would change from their present level to a future one under the influence of the KRR. In this paper, such a change would be defined as an event.

7. For a matrix with N events with no precedent size restrictions, there are $N! \cdot 2^N$ possible interactions. Therefore size limitation is a factor because of large input requirements.

8. In assessing the future events the question arises: are "experts" used to develop input to the CIT, for example, is their intuitive judgement sufficient to estimate events initial probability of occurrence? Such questions are not fully investigated in the present application of the CIT, for we have not in fact

used Delphi, which relies on "expert" judgement. Furthermore, if we had used the Delphi method, organizing a panel of experts would have been extremely time consuming, which from this point of view seems rather a disadvantage of combining the CIT with Delphi.

9. In general, the major weaknesses of the CIT (as originally conceived) are that it does not account for the effect of non-occurrence of events, a situation which leads to ambiguity in defining the initial likelihoods of occurrence.

Given the acceptable data, however, the CIT poses the following advantages:

1. It provides a systematic means for combining separate forecasts of discrete events and an explicit means for examining the interactions between these events;

2. Combining two or more forecasts can be very helpful in providing decision information. Identifying the differences between the forecasts may lead to significant questions as to why the differences exist. In turn, this can lead to greater clarification of the issues and better definition of the risks and uncertainties in the subject being forecast;

3. The CIT was originally devised to permit intercomparison of the Delphi forecasts, but it can be used with forecasts from any source. Small cross impact matrices can be "played out" manually. Larger matrices can be computerized so that large numbers of future events can be "played out" in a short time. The improved estimates of event probabilities can be obtained, the proposed

policies tested, and the events which might have significant impact on subsequent ones identified;

4. The fact that the CIT includes not only technological events but also environmental, social, and political ones seems to make it particularly relevant to technology assessment studies;

5. Another advantage of the CIT is that it is easily adapted to the manner in which technological forecasting is usually carried out;

6. The CIT is compatible with other forecasting techniques such as Delphi, dynamic simulation, relevance trees, cross support matrix, etc.;

7. The technique is enlightening because it clarifies and often changes one's understanding of the importance of events;

8. The CIT can be useful in long range planning, but it is by no means an ideal technique. It must be emphasized that the CIT is new and, like any other new method, can be improved over time. A discussion on future research is presented at the end of Chapter VII.

The following chapter will describe the analysis of the application of CIT, sensitivity analysis, and results.

VI. APPLICATION OF CROSS-IMPACT TECHNIQUE AND RESULTS

This chapter is directed toward the following objectives:

1. to describe the CIT input requirements for estimating the future impacts of the KRR and carry out the resultant analysis;
2. to run selected sensitivity tests on the results.

Input Requirements

We have mentioned in the previous chapter that the CIT is utilized to predict the probability of occurrence of selected events at some horizon year. The input requirements partly include a list of the identified events selected to be tested, and would show their initially assumed probabilities and the initial date at which they might occur. The cross impact matrix itself would include characteristics that present causal relationships among the events. These characteristics are mode, strength, and predecessor (see columns 4-28, Table E6.1, Appendix E). As described in the previous chapter, the first characteristic is mode with the positive sign indicating an enhancing effect of E_i on the likelihood of occurrence of E_j (a negative sign means an inhibiting effect; no entry that E_i is unrelated to E_j).

The second characteristic, or the first numerical digit of each column 4-28, Table E6.1, Appendix E, is the strength of interaction, which varies from 0-0.9 (0-weakest effect, 0.9-strongest effect). The second numerical digit of columns 4-28 is the predecessor relationship.

If it is 0, 1, or 2, the predecessor event is immaterial, likely, or necessary respectively for the occurrence of the particular successor event.

In consideration of the above mentioned requirements, twenty-five events (see Table C.1) were chosen from Table B3.2, Appendix B, to portray the developmental impacts of the KRR. With the use of available information concerning the present level of each development, along with comparable information for the UKT and SGF regions, and with the application of some intuitive and experienced judgements, the identified developmental events' future probabilities were estimated relevant to the construction of the KRR (see Appendix C). The events, along with their initial assumed probabilities and dates at which they might occur, are presented in Table 6.1.

It is assumed that the KRR would start its initial impact in 1978; the year 2003 has been chosen as the horizon year. Referring again to Table 6.1, it can be seen that the first event is entitled "E1: increase in road network length" brought about by the KRR. It is predicted that in 1980 the PIA region's total road network length would increase from its present level of 52,487 km to 60,000 km with a probability of 0.5 (see Table C4.1, Appendix C).

Event E2 is an increase in the PIA region's number of automotive vehicles to 100,000 from its present level of 51,482.

Now we must analyze the future increase in the region's vehicle ownership, which we assume to depend on individual income, the region's GNP, agricultural and industrial output, and other factors. Increasing

TABLE 6.1 MAJOR DEVELOPMENTAL EVENTS IMPACTED BY THE KRR AND CHOSEN FOR CIT ANALYSIS

EVENT NO.	EVENT DESCRIPTION	ASSUMED INITIAL PROBABILITY OF OCCURRENCE OF EVENT $Pr(E_j)$	ASSUMED DATE OF OCCURRENCE OF EVENT (t_j)
1	INCREASE IN ROAD NETWORK LENGTHS	0.50	1980
2	INCREASE IN TOTAL NUMBER OF VEHICLES	0.50	1980
3	INCREASE IN RAIL ROUTE LENGTHS	0.50	2003
4	INCREASE IN WORLD BANK LENDING	0.50	1978
5	INCREASE IN TOURIST RECEIPTS	0.50	1985
6	INCREASE IN PER CAPITA ENERGY CONSUMPTION	0.50	1986
7	INCREASE IN ELECTRIC CONSUMPTION/CAPITA	0.50	1985

TABLE 6.1 (CONTINUED)

EVENT NO.	EVENT DESCRIPTION	ASSUMED INITIAL PROBABILITY OF OCCURRENCE OF EVENT $Pr(E_i)$	ASSUMED DATE OF OCCURRENCE OF EVENT (t_i)
8	INCREASE IN DAILY NEWSPAPER CIRCULATION	0.50	1985
9	INCREASE IN URBAN POPULATION	0.50	1984
10	INCREASE IN FOOD PRODUCTION	0.50	1982
11	INCREASE IN LIFE EXPECTANCY	0.50	1990
12	DECREASE IN POPULATION PER HOSPITAL BED	0.50	1995
13	DECREASE IN INFANT MORTALITY RATE	0.50	1980
14	INCREASE IN ADULT LITERACY RATE	0.50	1991
15	INCREASE IN PER CAPITA GROSS NATIONAL PRODUCT (GNP)	0.50	1989
16	INCREASE IN AID	0.50	1983

TABLE 6.1 (CONTINUED)

EVENT NO.	EVENT DESCRIPTION	ASSUMED INITIAL PROBABILITY OF OCCURRENCE OF EVENT $Pr(E_i)$	ASSUMED DATE OF OCCURRENCE OF EVENT (t_j)
17	INCREASE IN IMPORTS	0.50	1986
18	INCREASE IN EXPORTS	0.50	1989
19	INCREASE IN THE DIVERSITY OF RELIGIONS	0.50	1985
20	INCREASE IN POLITICAL HARMONY	0.50	1993
21	USE OF RAILWAY BY NOMADES	0.50	1980
22	REMOVAL OF TARIFF AND TAXES	0.50	1985
23	INCREASE IN ARCHEOLOGICAL DISCOVERY	0.50	1987
24	TELEVISION ESTABLISHMENT IN AFGHANISTAN	0.50	1982
25	REMOVAL OF VISA OR ENTRY FORMALITIES	0.50	1992

these factors would have a profound effect in enhancing the region's road network length, which in turn would stimulate vehicle ownership. If the increase in the former happens, it is thought to have a (0.6) enhancing (+) effect on E2, with the former being a likely predecessor to the latter.

The relationships between the remaining events were established in a similar fashion (see columns 4-28, Table E6.1, Appendix E). Equation (5.5)[1] was programmed with the mode, strength, and predecessor relationships for the 25 x 25 event pairs. An event was selected from among the predecessor group, and using random numbers, a decision was on whether the event occurred. If it did, the probabilities of the remaining events were adjusted and the "play" repeated for the next event selected. The process was repeated until all events were decided. This single run-through was repeated 1000 times to produce stable final probability estimates.

Analysis of the Results

The computer program and the output of the first trial are presented in Appendix F. The output includes listing of events considered, the probabilities initially assigned, the probability shifts when the interactions between events were correlated, and ranking according to initial and final probabilities. Table 6.2 presents the initial and final probabilities.

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[1]Equation (5.5) was derived in Chapter V, page 84.

TABLE 6.2 RESULTS OF THE FIRST RUN:
LISTING OF EVENTS BY ORDER OF FINAL PROBABILITY.

EVENT DESCRIPTION	INITIAL	DELTA	FINAL	RANK DELTA
6.INCREASE IN PER CAPITA ENERGY CONSUMPTION	0.50	0.466	0.966	1
9.INCREASE IN URBAN POPULATION	0.50	0.388	0.888	2
11.INCREASE IN LIFE EXPECTANCY	0.50	0.380	0.880	3
8.DAILY NEWSPAPER CIRCULATION	0.50	0.363	0.863	4
12.DECREASE IN POPULATION PER HOSPITAL BED	0.50	0.347	0.847	5
13.DECREASE IN INFANT MORTALITY RATE	0.50	0.341	0.841	6
4.INCREASE IN WORLD BANK LENDING	0.50	0.324	0.824	7

TABLE 6.2 (CONTINUED)

EVENT DESCRIPTION	INITIAL	DELTA	FINAL	RANK DELTA
20.INCREASE IN POLITICAL HARMONY	0.50	0.305	0.805	8
25.REMOVAL OF VISA OR ENTRY FORMALITIES	0.50	0.256	0.756	9
19.INCREASE IN THE DIVERSITY OF RELIGIONS	0.50	0.255	0.755	10
23.INCREASE IN ARCHEOLOGICAL DISCOVERY	0.50	0.234	0.734	11
3.INCREASE IN RAIL ROUTE LENGTHS	0.50	0.210	0.710	12
5.INCREASE IN TOURIST RECEIPTS	0.50	0.192	0.692	13
15.INCREASE IN PER CAPITA GROSS NATIONAL PRODUCT (GNP)	0.50	0.184	0.684	14
10.INCREASE IN FOOD PRODUCTION	0.50	0.179	0.679	15

TABLE 6.2 (CONTINUED)

EVENT DESCRIPTION	INITIAL	DELTA	FINAL	RANK DELTA
18.INCREASE IN EXPORTS	0.50	0.179	0.679	15
14.INCREASE IN ADULT LITERACY RATE	0.50	0.177	0.677	16
2.TOTAL NUMBER OF VEHICLES	0.50	0.170	0.670	17
1.INCREASE IN ROAD NETWORK LENGTHS	0.50	0.158	0.658	18
22.REMOVAL OF TARIFF AND TAXES	0.50	0.151	0.651	19
7.INCREASE IN ELECTRIC CONSUMPTION/CAPITA	0.50	0.144	0.644	20
21.USE OF RAILWAY BY NOMADES	0.50	0.135	0.635	21
17.INCREASE IN IMPORTS	0.50	0.128	0.628	22
24.TELEVISION ESTABLISHMENT IN AFGHANISTAN	0.50	0.086	0.586	23
16.INCREASE IN AID	0.50	0.018	0.518	24

The following conclusions can be drawn from this application of the CIT:

1. The judged interactions among the events significantly changed the initial probabilities. For example, the item relating to "E6: increase in energy consumption" (see Table 6.2), was initially thought to have a probability of 0.50 at 1986. Consideration of the interactions raised this to 0.966 at the horizon year, 2003. The 0.966 probability of increased energy consumption per capita from 199 kg to 299 kg suggests that by 2003, under the impacts of the KRR, travel, exports, imports, agricultural and industrial activities would significantly increase. This provides clear warning to the PIA region's policymakers concerning energy conservation measures to cope with their present and future domestic needs, especially in the context of present energy export.
2. In Table 6.2, it is indicated that the PIA's urban growth would reach 5.0 percent. This is expected to occur in 2003 with a probability of 0.888. This is a positive indication that the KRR would increase mobility, which partially would affect migration from rural to urban areas. Perhaps enlarged urban employment opportunities, higher income, and greater numbers of educational facilities would contribute to increased migration from rural to urban areas. Therefore a complementary balancing mechanism between the development of

rural and urban areas is essential to prevent undesirable population redistribution resulting from the KRR.

3. The estimated final probability of occurrence of the PIA region's increase in life expectancy is 0.880; an increase of 0.380 over the probability initially assessed. In addition, the region's population per hospital bed and infant mortality rate were predicted to decrease. The estimated final probabilities of occurrence of these events are 0.847 and 0.841. Furthermore, the final probability of increased World Bank lending is estimated at 0.824. Increased loans would add new capital that would cause the PIA government's share of health expenses to rise and might affect life expectancy and increase health levels. Furthermore, the inflow of capital (in the form of credit, grants, or loans) and technology apparently will help facilitate the process of economic growth more than is possible through local capital (42, p.50). Although the bulk of the investment needs must come from internal sources, foreign capital, particularly for Afghanistan and Pakistan, can provide a critical supplement to domestic saving.

4. The final probability of occurrence of the PIA region's increased newspaper circulation, per capita GNP, and literacy rate has shifted from 0.50 to 0.863, 0.684, and 0.677, respectively (see Table 6.2), suggesting that increased mobility provided by the KRR would help to increase the

region's schools and school enrollment. An increase in literacy rate is assumed to increase daily newspaper circulation and to decrease population, which would in turn result in higher per capita income. In addition the rise in the probability of a "television establishment in Afghanistan" suggests a substitution for mobility particularly in the isolated areas, which could receive classroom television that would increase the literacy rate.

5. With reference to the increase in political harmony in the PIA region and to removal of visa requirements, tariffs, and taxes, there was also a significant probability gain (see Table 6.2), suggesting that the KRR would increase trade and regional cooperation, thus enhancing peace and prosperity in the region and increasing tourism and cultural and religious activities.

6. Although the items relating to increased road network length, total number of vehicles, rail route length, food production, exports, use of the KRR by nomadic tribes, electric consumption per capita, and foreign aid all were originally listed at a 0.50 probability, the cross-impact analysis increased each of these to higher levels; therefore, the interactions indicate that these items should be assessed as significantly affected by the KRR.

The above list of conclusions should serve to illustrate the kinds of inferences which can be drawn from a cross impact analysis.

Sensitivity Analysis

After completion of the initial computer runs, the author then proceeded to test the sensitivity of the probability shifts in response to alterations in the original probability levels. Each event was increased in turn by 30 percent from its assumed initial probability of 0.50 to 0.80. In addition, the date of each event was altered to reduce by half the time period from the assumed inception of the KRR (1978) to the occurrence of the event. For instance, an event that was originally predicted for 1980 was now predicted for 1979; one for 1984 now for 1981, and so forth. Equation (5.6)[1] then was incorporated into the previously described CIT computer program and a run, with 1000 iterations, made for each alteration.

The detailed results of the sensitivity analysis are presented in Appendix G. In reviewing these, it is assumed that any change in the sensitivity factor for an event is significant if it is 0.10 or more. Several illustrations of interesting results from the sensitivity analysis are presented below.

1. Figure 6.1 presents one example of the sensitivity test results and shows that the increased rail route length (E3) had significant direct effect on the following events:

   E4: increase in World Bank lending;

   E2: increase in total number of vehicles;

   E5: increase in tourist receipts;

   E6: increase in per capita energy consumption;

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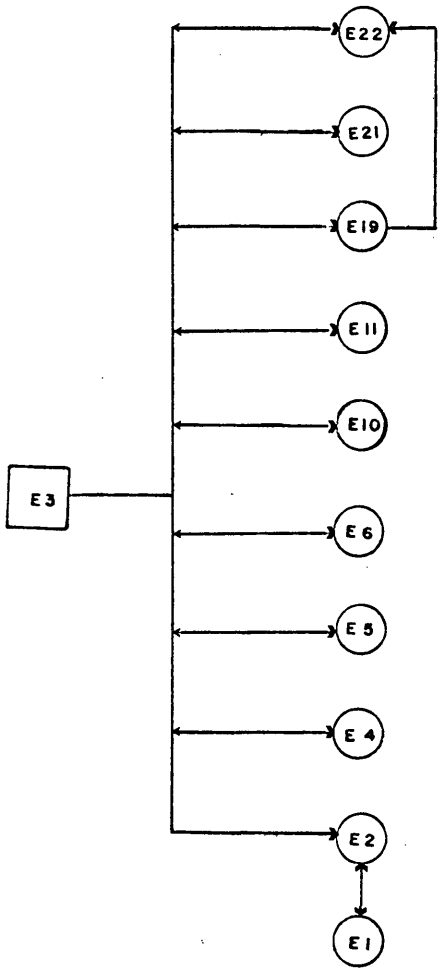
[1]Equation (5.6) was developed in Chapter V, p. 86 to estimate the sensitivity factor of each event.



E1: INCREASE IN ROAD NETWORK LENGTHS

E2 : INCREASE IN TOTAL NUMBER OF VEHICLES

E3 : INCREASE IN RAIL ROUTE LENGTHS

E4 : INCREASE IN WORLD BANK LENDING

E5 : INCREASE IN TOURIST RECEIPTS

E6 : INCREASE IN PER CAPITA ENERGY CONSUMPTION

E10 : INCREASE IN FOOD PRODUCTION

E11 : INCREASE IN LIFE EXPECTANCY

E19 : INCREASE IN THE DIVERSITY OF RELIGIONS

E21 : USE OF RAILWAY BY NOMADS

E22 : REMOVAL OF TARIFF AND TAXES

FIGURE 6.1 THE SIGNIFICANT DIRECT RELATIONS BETWEEN INCREASING RAIL-ROUTE LENGTH (E3) AND OTHER EVENTS.

E10: increase in food production;

E11: increase in life expectancy;

E19: increase in diversity of religions;

E21: increase in use of railway by nomads.

A significant direct relationship between two events means that the sensitivity factor between them is 0.10 or more (see Figure 6.1, the relationship between E3 and E2 is considered to be directly related). On the other hand, an indirect relationship between two events is one in which:

(a) An event is not directly related to a second event.

(b) The second event is directly related to a third event, which in turn is directly related to the first. For instance in Figure 6.1, EI and E3 are not directly related to each other, but they are indirectly related through their connection to E2. It can be seen in this figure that most of these developments are directly linked and that enhancing one would have a significant effect on the others. For instance, increasing rail route length has a substantial effect on lengthening the highway network. This can be interpreted as meaning that, to maximize the efficiency of any type of transportation system, other modes must also be utilized. In other words, government policies affecting transportation should not be concentrated on a single mode but on providing a balanced treatment. An example of this that comes to mind is the development of feeder roads.

E1: INCREASE IN ROAD NETWORK LENGTHS

E2 : INCREASE IN TOTAL NUMBER OF VEHICLES

E3 : INCREASE IN RAIL ROUTE LENGTHS

E4 : INCREASE IN WORLD BANK LENDING

E5 : INCREASE IN TOURIST RECEIPTS

E6 : INCREASE IN PER CAPITA ENERGY CONSUMPTION

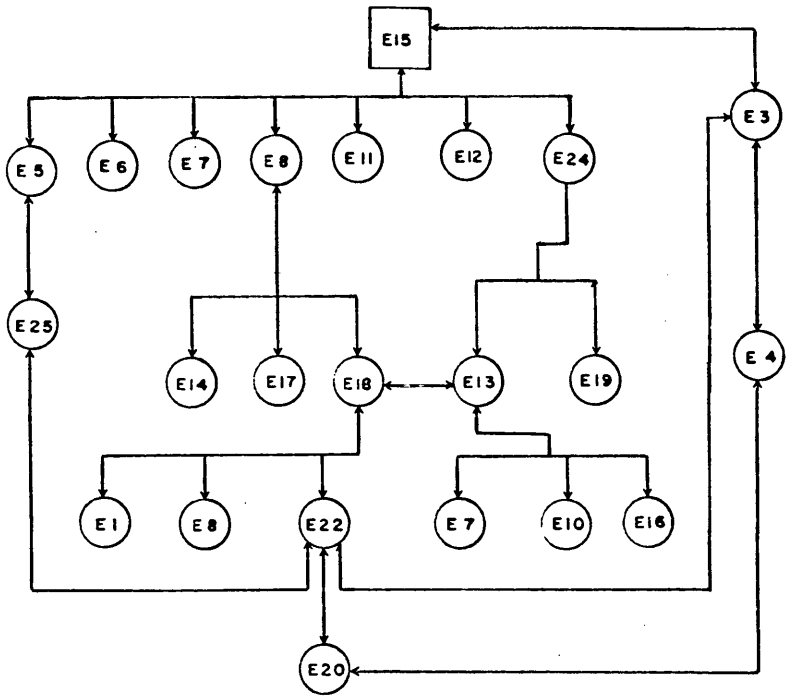
E7 : INCREASE IN ELECTRIC CONSUMPTION PER CAPITA

E8 : INCREASE IN DAILY NEWSPAPER CIRCULATION

E9 : INCREASE IN URBAN POPULATION

E10 : INCREASE IN FOOD PRODUCTION

E11 : INCREASE IN LIFE EXPECTANCY



E12 : DECREASE IN POPULATION PER HOSPITAL BED

E13 : DECREASE IN INFANT MORTALITY RATE

E14 : INCREASE IN ADULT LITERACY RATE

E15 : INCREASE IN PER CAPITA GROSS NATIONAL PRODUCT (GNP)

E16 : INCREASE IN FOREIGN AID

E17 : INCREASE IN IMPORTS

E18 : INCREASE IN EXPORT

E19 : INCREASE IN THE DIVERSITY OF RELIGIONS

E24 : TELEVISION ESTABLISHMENT IN AFGHANISTAN

E25 : REMOVAL OF VISA OR ENTRY FORMALITIES

E20 : INCREASE IN POLITICAL HARMONY

E21 : USE OF RAILWAY BY NOMADS

E22 : REMOVAL OF TARIFF AND TAXES

FIGURE 6.2 THE SIGNIFICANT DIRECT AND INDIRECT RELATIONS BETWEEN PER CAPITA GNP(E15) AND OTHER EVENTS.

such spending have a significant positive effect on the per capita income and indirectly enhance the removal of visa requirements from the region.

3. Food production is an important development that is significantly affected by the increase of rail route length and foreign aid. Figure 6.3 also shows food production's direct effect on decreasing the infant mortality rate and its substantial relations with other events. Foreign aid seems to affect electric consumption per capita and the establishment of television in Afghanistan. This seems to be rather realistic and applies mostly to Afghanistan and Pakistan since a large share of their capital expenditure comes from foreign aid. The most direct and significant effect of foreign aid is on food production. To attract foreign aid, it seems that the PIA region must initiate proper agricultural planning policies to increase food production.
4. Life expectancy is significantly affected by the number of hospital beds (see Figure 6.4). Increased literacy rate and per capita income also increase life expectancy. An increase in per capita GNP may affect life expectancy, too, but only through the ability of KRR countries to provide better food and to develop medical and sanitation facilities.
5. An increase in the literacy rate directly affects per capita energy consumption, daily newspaper circulation, life

E3 : INCREASE IN RAIL ROUTE LENGTHS

E7 : INCREASE IN ELECTRIC CONSUMPTION PER CAPITA

E10 : INCREASE IN FOOD PRODUCTION

E13 : DECREASE IN INFANT MORTALITY RATE

E16 : INCREASE IN FOREIGN AID

E24 : TELEVISION ESTABLISHMENT IN AFGHANISTAN

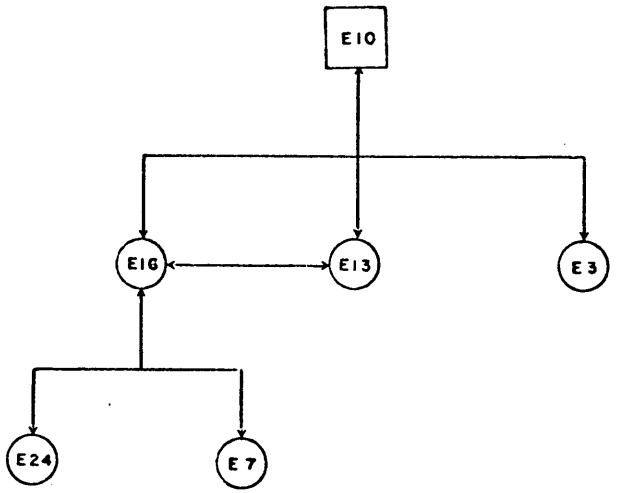


FIGURE 6.3 SIGNIFICANT DIRECT AND INDIRECT RELATIONS BETWEEN FOOD PRODUCTION (E10) AND OTHER EVENTS.

E3 : INCREASE IN RAIL ROUTE LENGTHS

E5 : INCREASE IN TOURIST RECEIPTS

E6 : INCREASE IN PER CAPITA ENERGY CONSUMPTION

E8 : INCREASE IN DAILY NEWSPAPER CIRCULATION

E11 : INCREASE IN LIFE EXPECTANCY

E12 : DECREASE IN POPULATION PER HOSPITAL BED

E14 : INCREASE IN ADULT LITERACY RATE

E15 : INCREASE IN PER CAPITA GROSS NATIONAL PRODUCT (GNP)

E24 : TELEVISION ESTABLISHMENT IN AFGHANISTAN

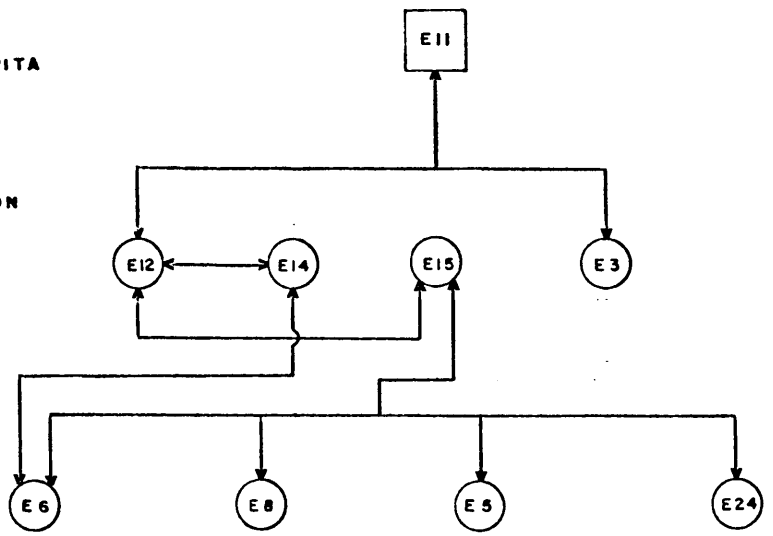


FIGURE 6.4 THE SIGNIFICANT DIRECT AND INDIRECT RELATIONS BETWEEN LIFE EXPECTANCY (E11) AND OTHER EVENTS.

the PIA region must initiate proper agricultural planning policies to increase food production.

4. Life expectancy is significantly affected by the number of hospital beds (see Figure 6.4). Increased literacy rate and per capita income also increase life expectancy. An increase in per capita GNP may affect life expectancy, too, but only through the ability of KRR countries to provide better food and to develop medical and sanitation facilities.
5. An increase in the literacy rate directly affects per capita energy consumption, daily newspaper circulation, life expectancy, and the number of hospital beds (see Figure 6.5). The literacy rate directly influenced the per capita income and indirectly influences and is affected by the increase in per capita electric consumption, imports, and exports.
6. As can be summarized in Figure 6.6, political harmony in the PIA region has a positive impact on increased World Bank lending and also enhances the removal of tariff and taxes from the region. Furthermore, it indirectly affects and is affected by the increase in exports and removal of visa formalities. It must be emphasized that due to political uncertainty, the KRR countries' large and unforeseen commitments for defense expenditures have diverted funds from many developmental projects.

Many of the existing problems in the region can be solved best through a cooperative approach among the KRR countries. In a region in

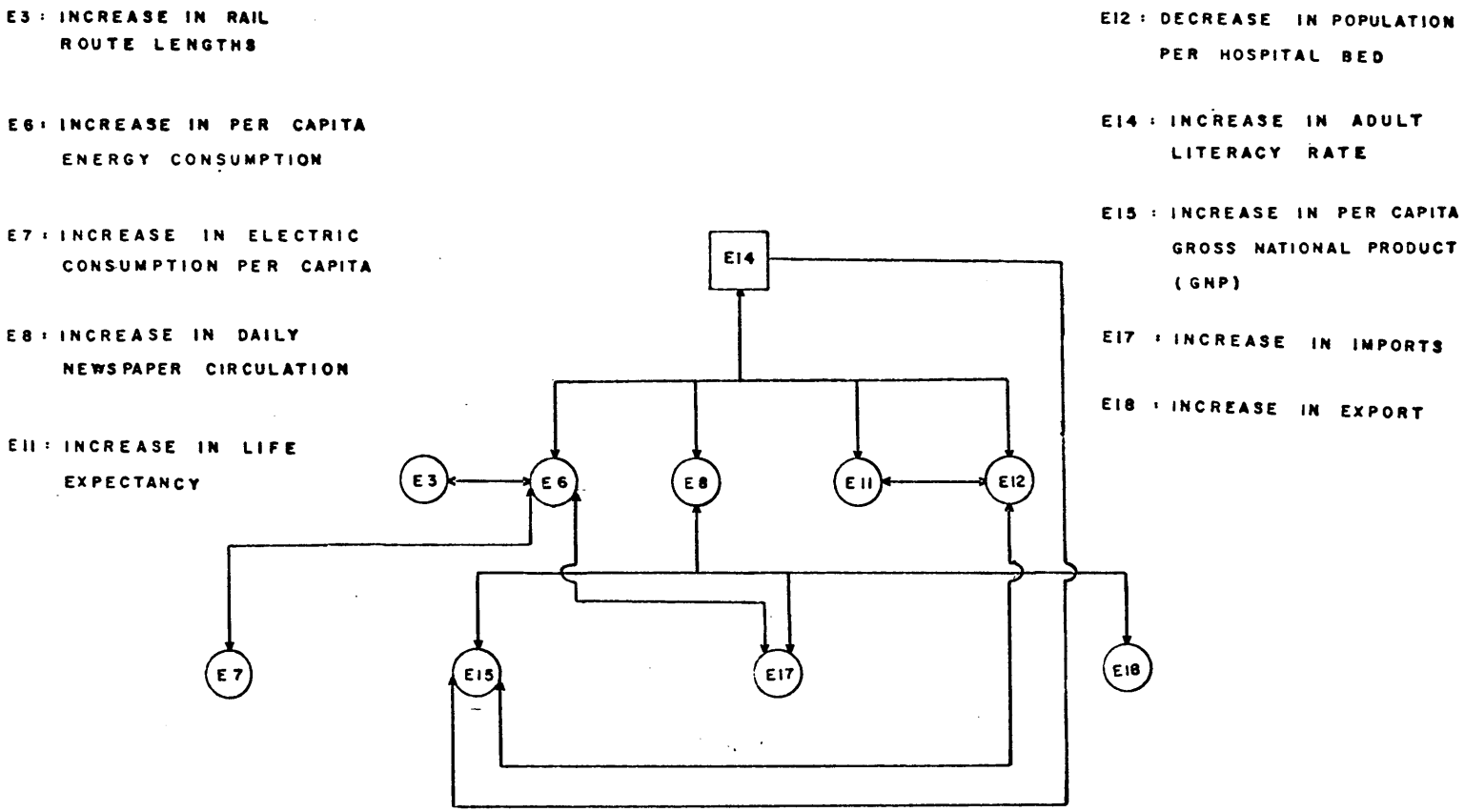


FIGURE 6.5 THE SIGNIFICANT DIRECT AND INDIRECT RELATIONS BETWEEN THE LITERACY RATE (E14) AND OTHER EVENTS.

E3 : INCREASE IN RAIL ROUTE LENGTHS

E4 : INCREASE IN WORLD BANK LENDING

E18 : INCREASE IN EXPORT

E20 : INCREASE IN POLITICAL HARMONY

E22 : REMOVAL OF TARIFF AND TAXES

E25 : REMOVAL OF VISA OR ENTRY FORMALITIES

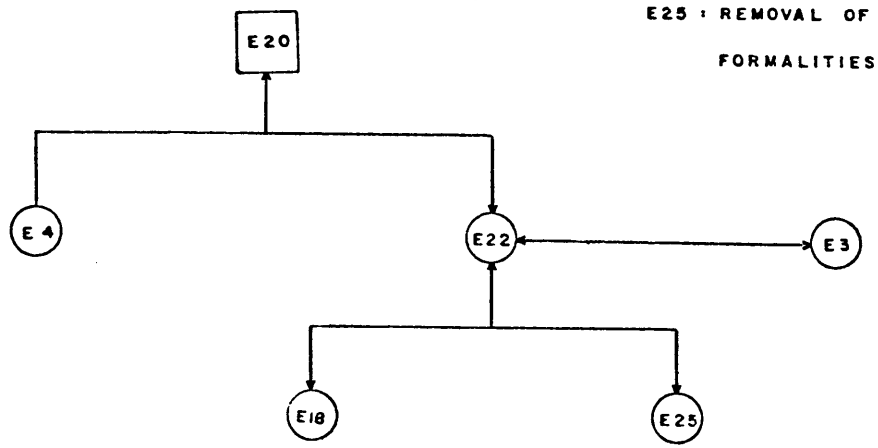


FIGURE 6.6 THE SIGNIFICANT DIRECT AND INDIRECT RELATIONS BETWEEN THE INCREASE IN POLITICAL HARMONY (E20) AND OTHER EVENTS.

which resources are unevenly distributed and the size of most national markets is restricted by inaccessibility and political problems, regional cooperation is mandatory.

Through regional unity the existing resources can be efficiently shared, markets can be widened, and programs can be more effectively implemented by coordinated efforts.

7. The most significant impacts of increased per capita energy consumption are portrayed in Figure 6.7. The main events directly affecting and affected are:

   E7: increase in electric consumption per capita;

   E14: increase in literacy rate;

   E15: increase in per capita GNP;

   E17: increase in imports;

It can be seen in Figure 6.7 that the following events indirectly impact or are impacted by per capita energy consumption:

E13: decrease in infant mortality rate;

E16: increase in foreign aid;

E8: increase in daily newspaper circulation;

E11: increase in life expectancy;

E12: decrease in population per hospital bed;

E24: establishment of television in Afghanistan;

E10: increase in food production.

It seems that the energy consumption becomes an important aspect of the PIA region's development and significantly affects and is affected by the KRR.

E3 : INCREASE IN RAIL ROUTE LENGTHS

E5 : INCREASE IN TOURIST RECEIPTS

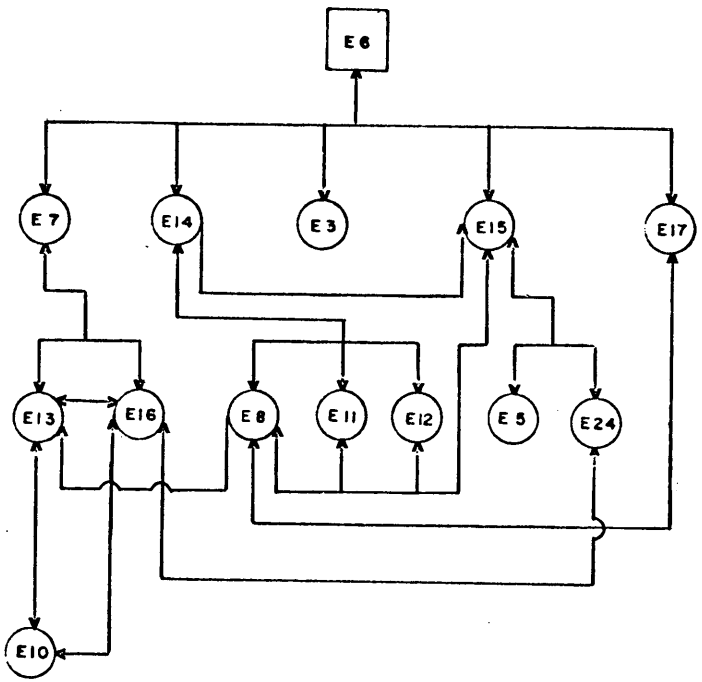
E6 : INCREASE IN PER CAPITA ENERGY CONSUMPTION

E7 : INCREASE IN ELECTRIC CONSUMPTION PER CAPITA

E8 : INCREASE IN DAILY NEWSPAPER CIRCULATION

E10 : INCREASE IN FOOD PRODUCTION

E11 : INCREASE IN LIFE EXPECTANCY



E12 : DECREASE IN POPULATION PER HOSPITAL BED

E13 : DECREASE IN INFANT MORTALITY RATE

E14 : INCREASE IN ADULT LITERACY RATE

E15 : INCREASE IN PER CAPITA GROSS NATIONAL PRODUCT (GNP)

E16 : INCREASE IN FOREIGN AID

E17 : INCREASE IN IMPORTS

E24 : TELEVISION ESTABLISHMENT IN AFGHANISTAN

FIGURE 6,7 THE SIGNIFICANT DIRECT AND INDIRECT RELATIONS BETWEEN INCREASE IN PER CAPITA ENERGY CONSUMPTION (E6) AND OTHER EVENTS.

Experiment with Uncontrolled Events

Uncontrolled events such as hurricanes, flood, drought, earthquakes, etc., cannot be controlled by the PIA's developmental policymakers. However, policies can be developed to reduce their impacts. The effect of uncontrolled events has also been gauged here to determine their likelihood of occurrence and influence on other events. For instance, a scenario in which drought (less than 5 inches rainfall over a period of one year) was imposed as an uncontrolled event was added in Table 6.1, with a 0.50 probability of occurrence by the year 1990. After determining its relations with the other events, the resulting 26 x 26 matrix was used as a basis for a single run through 1000 iterations. Table 6.3 shows the effect of the drought and compares this scenario with the basic one. The drought decreased the final probability of occurrence of the following events by 0.03 to 0.04.

E11: increase in life expectancy;

E13: decrease in infant mortality rate;

E10: increase in food production.

On the other hand the final probability of the following events increased by 0.03 to 0.04:

E22: removal of tariff and taxes;

E16: increase in foreign aid.

Sensitivity analysis was also performed to determine the most direct significant effect of the projected drought. The results of this analysis, highlighted in Figure 6.8, indicate that the significant direct negative effect of drought is to increase the population

TABLE 6.3 EFFECT OF DROUGHT ON 25 EVENTS

EVENT DESCRIPTION	INITIAL PROB	FINAL PROB BASIC SCENARIO	FINAL PROB "DROUGHT" SCENARIO	DEVIATION
6.INCREASE IN PER CAPITA ENERGY CONSUMPTION	0.50	.966	0.968	.002
9.INCREASE IN URBAN POPULATION	0.50	.888	0.899	.011
8.INCREASE IN DAILY NEWSPAPER CIRCULATION	0.50	.863	0.878	.015
11.INCREASE IN LIFE EXPECTANCY	0.50	.880	0.849	-.029
12.DECREASE IN POPULATION PER HOSPITAL BED	0.50	.847	0.824	-.018
20.INCREASE IN POLITICAL HARMONY	0.50	.805	0.819	.014
4.INCREASE IN WORLD BANK LENDING	0.50	.824	0.805	-.018
15.DECREASE IN INFANT MORTALITY RATE	0.50	.841	0.800	-.038
9.INCREASE IN THE DIVERSITY OF RELIGIONS	0.50	.755	0.775	.020

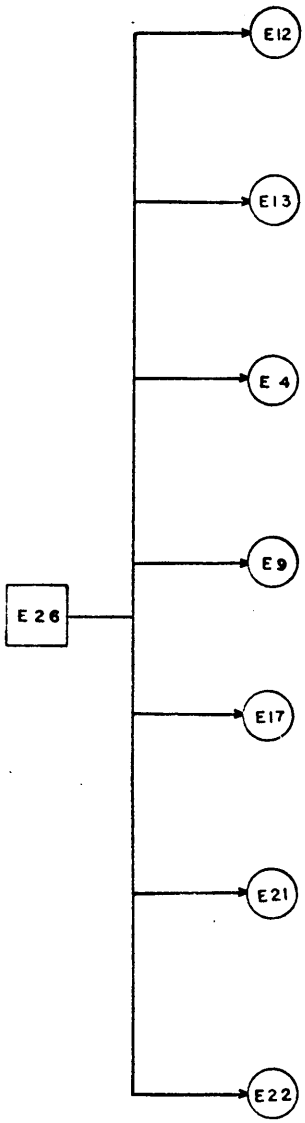
TABLE 6.3 (CONTINUED)

EVENT DESCRIPTION	INITIAL PROB	FINAL PROB BASIC SCENARIO	FINAL PROB "DROUGHT" SCENARIO	DEVIATION
25.REMOVAL OF VISA OR ENTRY FORMALITIES	0.50	.756	0.775	.019
23.INCREASE IN ARCHEOLOGICAL DISCOVERY	0.50	.734	0.733	-.001
3.INCREASE IN RAIL ROUTE LENGTHS	0.50	.710	0.695	-.015
15.INCREASE IN PER CAPITA GROSS NATIONAL PRODUCT (GNP)	0.50	.684	0.693	.009
21.REMOVAL OF TARIFF AND TAXES	0.50	.651	0.688	-.037
5.INCREASE IN TOURIST RECEIPTS	0.50	.692	0.670	-.021
1.INCREASE IN ROAD NETWORK LENGTHS	0.50	.658	0.662	.004
14.INCREASE IN ADULT LITERACY RATE	0.50	.677	0.656	-.021

TABLE 6.3 (CONTINUED)

EVENT DESCRIPTION	INITIAL PROB	FINAL PROB BASIC SCENARIO	FINAL PROB "DROUGHT" SCENARIO	DEVIATION
2.TOTAL NUMBER OF VEHICLES	0.50	.670	0.650	-.017
21.USE OF RAILWAY BY NOMADES	0.50	.635	0.647	.012
10.INCREASE IN FOOD PRODUCTION	0.50	.679	0.635	-.044
7.INCREASE IN ELECTRIC CONSUMPTION/CAPITA	0.50	.644	0.633	-.010
17.INCREASE IN IMPORTS	0.50	.628	0.626	.002
24.TELEVISION ESTABLISHMENT IN AFGHANISTAN	0.50	.586	0.567	-.018
15.INCREASE IN AID	0.50	.518	0.561	.042
26.DROUGHT	0.50		0.493	
18.INCREASE IN EXPORTS	0.50	.679	0.687	.008

SINCE DROUGHT INCREASES THE NUMBER OF PERSONS IN NEED OF HOSPITAL TREATMENT, IT HAS THE SAME EFFECT AS AN INCREASE IN POPULATION PER HOSPITAL BED; THE EFFECT WAS, THEREFORE, SUBSUMED UNDER THIS HEADING.



E4 : INCREASE IN WORLD BANK LENDING

E9 : INCREASE IN URBAN POPULATION

E12 : INCREASE IN POPULATION PER HOSPITAL BED

E13 : INCREASE IN INFANT MORTALITY RATE

E17 : INCREASE IN IMPORTS

E21 : USE OF RAILWAY BY NOMADS

E22 : REMOVAL OF TARIFF AND TAXES

E26 : DROUGHT

FIGURE 6.8. THE DIRECT POSITIVE AND NEGATIVE IMPACTS OF DROUGHT.

per hospital bed (see footnote to Table 6.3) and the infant mortality rate.

According to Figure 6.8, the positive effect of drought is to increase World Bank lending. In addition, rural and nomadic tribes would migrate from their rural communities to urban areas in order to escape starvation. This would increase the usage of the KRR. Furthermore, the imports of wheat and other agricultural products would increase.

Another positive effect of the drought might be the lifting of tariffs and taxes. A state of emergency might be declared, requiring their removal in the region. The conclusion from this analysis is that agricultural productivity and food storage capacity must be increased to cope with food shortages.

Summary

The selected developmental events tested by the application of CIT generated interesting probability results. The judged interaction among the events played a vital role in changing the horizon year probability of occurrence of each event. Particularly, the increase in per capita energy consumption, urban population, life expectancy, newspaper circulation, World Bank lending, political harmony, food production, were among events significantly affected by the interaction relevant to the impacts of the KRR. The results generated by changes in inputs (sensitivity analysis) made it possible to identify those major contingencies with which we have to cope to compare the effectiveness of alternative

policies and action programs. For instance, the increase in probability of occurrence of energy consumption provides clear warning concerning energy conservation measures. As we notice in Chapter V, oil and natural gas are the main sources of energy and the most valuable export items of Iran and Afghanistan. At this time Afghanistan does not fully utilize its natural gas and its potential for the generation of electricity. The former (which accounts for 11 percent of the country's exports) is all exported to the U.S.S.R.; in the PIA region, wood is a scarce resource used for heating homes and industries, and for cooking. Natural gas or electricity could be substituted for this purpose.

We have also noticed in the context of the results the increase in the probability of literacy rate; this depends on balancing the education system between rural and urban areas.

Increased food production was an important event with a high probability gain relevant to the KRR. In the PIA region the crucial factor in enhancing food production is the institution of policies directed toward land reforms, water resource development, livestock improvement, and inland fisheries. The KRR apparently will help in these processes.

VII. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The main objectives of this research were (1) to propose an international transportation link, the KRR through Afghanistan, Iran, and Pakistan, and (2) to demonstrate the application of the cross impact technique for forecasting the probability of occurrence of identified developmental events brought about by the construction of the proposed KRR.

In Chapter I, the region's existing transport problems of delay, cost, congestion, and other relevant matters were discussed. The transport advantages and disadvantages of the KRR were presented in the context of a general systematic portrayal of the main steps involved in the development of this research.

In Chapter II, the railway was proposed and the choice among alternative modes was based on factors favoring railway such as transit time, cost, efficiency, energy consumption (oil and its products), manpower requirements, safety and comfort, climate and environmental factors. Also discussed were the disadvantages of railway, such as grade limitations and requirements for large capital investment. The choice on the location of the railway was based on the shortest possible connecting link between the existing railways, topography, optimum utilization of existing non-railway transportation (highways, rivers, seas), and location of major economic centers.

A third objective of this research was to identify developmental

events that might be affected by the KRR. The Suez Canal and Dickey's INDEX TERMS were analyzed and consequently Tables B3.1 and B3.2, Appendix B, were prepared to show developmental events relevant to the KRR. These were organized under the major categories of institutional, political, social, and economic impacts. They were further classified as favorable, unfavorable, or a combination of each. Under the category of institutions, the most important favorable impacts associated with the KRR included improvements in governmental operations, in other modes of transportation, in employment, and in utilization of natural resources. Unfavorable developments included increased technological capacity for warfare and growth of bureaucracy. Predictable developments in taxation, labor organization, and the like were classified unfavorable as well as favorable. These were described in Chapter III.

In Chapter IV the rail-linked regions of Uganda-Kenya-Tanzania (UKT) and Switzerland-West Germany-France (SGF) were chosen to provide comparisons in helping to estimate the PIA regional impacts of the KRR. As a result, Tables C4.1 to C4.20, Appendix C, were prepared; they present the region's 25 developmental events' present levels with future probability and date of occurrence of each event relevant to the KRR.

In Chapter V various forecasting methods were compared on the basis of their accuracy, quality of ideas, cost, time period required, data requirements, and other factors. The CIT was identified as particularly suitable for this research, because of its adaptability to the nature of the events being studied, and its simplicity, low

cost, and small time period for implementation. The detailed description of the CIT is presented in Chapter V.

In Chapter VI the input requirements of the CIT were described and the results of the CIT analysis discussed. Twenty-five events were chosen and each one's future likelihood of occurrence given relevant to the impacts of the KRR. The CIT then produced probabilities of the future occurrence of each event.

The judged interaction among the events played a major role in changing the horizon year probabilities. Particularly the increases in per capita energy consumption, urban population, life expectancy, newspaper circulation, and food production were among events significantly affected by the KRR. Sensitivity analyses were performed indicating the most significant direct and indirect relations between developmental events. Increase in per capita income was among important developments directly affecting and affected by tourist receipts, energy consumption, and life expectancy. On the other hand, increase in literacy rate had direct significant effect on decreasing the population per hospital bed, increasing life expectancy, and energy consumption.

Food production was significantly affected by the increases in rail route length and foreign aid, and by decreasing infant mortality rate.

Increased political harmony had direct and indirect significant effects on increasing the World Bank lending, exports, removal of tariff and taxes, and visa formalities from the region.

Conclusions

This research reaches the following conclusions:

1. The proposed KRR would significantly reduce the present high transport costs, delay, and congestion in the PIA region. Furthermore, it would become an important means of bringing peoples of the region together and would lower the barriers which at present interfere with concerted efforts towards development. Additionally, the railway would have a profound effect on enhancing the overall development of the region. If the link were utilized as an integrated international system, it would compete with the Suez Canal and other major existing routes in connecting Asia to Europe and Africa.

2. The CIT is a suitable methodology for this type of research. The foundation on which this technique is based - cross impact relations, simulation with computer application, and policy analysis point towards its usefulness in forecasting future developments not only for the PIA, but for many other situations where a proposed single development will predictably involve many interactions not only with the existing situation, but also with secondary events provoked by the originally proposed development.

3. Generally, the results gained from simulating the identified developmental events in the PIA region show that the decision makers must know what policy changes are essential for future developmental strategy. Without such results a tradeoff is always inherent. For instance, if a trend were seen as developing and if the decision maker were to act too soon, the anticipated result might not occur, and hence

the decision probably would be incorrect. On the other hand, if the decision maker waits too long and the anticipated event does occur, he will not have enough time to react, and some negative by-products may result (or some positive by-products be missed).

4. At present, the CIT provides a reasonably good warning technique if used with care. Its real value as a forecasting method is that it can work with a limited amount of data and yet allow planners to incorporate the interaction of various events and to measure the likelihood of occurrence of each event.

5. We have found that the KRR would not only overcome the present trans-shipment problems, delay, congestion, and high transport cost, but it could stimulate the region's overall developmental events; and these long range benefits (quantifiable or non-quantifiable) would fully justify the construction of the KRR. Furthermore, we have identified relevant events such as: (a) the balanced treatment of all transportation modes (development of feeder roads, expansion of truck and bus transport for short hauls, improvement in air and water transport); (b) expansion of radio and television; (c) equal educational policy in urban and rural areas; (d) improvement in agricultural sectors and the expansion of land reform policies; (e) energy conservation measures and health improvement programs. All these projects are important and must be treated on their merits. However, the construction of the KRR should serve as a vehicle in the enhancement of these events.

Recommendations

This research recommends the following:

1. The proposed KRR should be constructed and utilized as an integrated, single system.

2. The locational analysis for the proposed KRR involves a complete field engineering investigation. Along the proposed route, a detailed physical study of the area's topography, environment and other land use features is essential. Such details would provide choice among alternatives which would prevent problems (dislocation, erosion, and so on) and high construction costs.

3. Other potentially important developmental events should also be tested to measure their likelihood of occurrence relevant to the construction of the KRR. To enhance sound economic development and to maximize the efficiency of investment, all the region's modes of transportation should be utilized.

4. In view of the poor extent and quality of data base in the region, most relationships between the identified events could not be formulated and tested statistically. The CIT output could not be checked, again due to nonexistence of past, detailed data. As and when such data become available, the parameters and other features of the CIT should be determined more precisely. The technique could then be subjected to more strenuous testing than is currently possible. This would clearly increase the degree of confidence in the technique.

Future Research

The present version of the CIT developed in this research project provides a forecasting framework for planning decisions in less

developed countries and in general for forecasting in long range planning. It is an operative technique on which experiments can be run and new improvements introduced.

There are some tactical questions of implementation that should concern users of the CIT. These questions involve certain computational aspects of the method, and may be stated as follows:

-How much inherent variability may be expected in the final probabilities which the technique yields?

-What are the guidelines for deciding the number of trials to use in evaluating the final probabilities? Is some specific number of trials necessary before a given level of statistical significance results?

Future researchers might tackle these questions; below are some suggested proposals toward this direction.

-While the technique easily accepts qualitative inputs, more precise methods of arriving at cross-impact parameters are needed. The strength parameter (s) should be calculated to permit the quadratic parameter (a) to assume its full possible range of values.

-Perhaps higher-order simulation models should be investigated. These might permit the interactions to be functions of the state of the system. Clearly A need not always be B's friend. A's attitude toward B can be conditional on the relative status of their difference A-B or perhaps depend upon the state of a third individual C.

-The effects of non-occurrence of events should be taken into consideration, perhaps by establishing their interactions and forming a non-occurrence relationship matrix.

-A Taylor Series could be applied to examine the relationship between the initial and final probabilities. In addition, the quadratic parameter (a) in equation (5.4) could also be assumed to be exponential.

Other questions arise about including events which are not of equal importance. Perhaps the construction of the matrix should be preceded by a relevance tree exercise to insure that the field under investigation has been reasonably well covered and that the events listed are of relatively equal importance. The relevance tree method would separate and identify those events that must necessarily have happened so that a certain event on the next highest level could occur. By using this approach we can identify important events. The procedure would guide the forecaster to assign higher probabilities and strengths to those important events before applying the cross impact technique (19, pp.1-26).

In general, the proposed KRR, its impact identification process, and the application of CIT to measure the overall developmental effects of the railway were perceived in a very systematic fashion that could be a guide to those gauging similar undertakings.

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APPENDICES

APPENDIX A

TRANSPORTATION FEATURES RELEVANT TO THE KRR

This appendix presents the proposed KRR in relation to the existing branches of the Trans-Asian Railway System. It also shows the transportation features in each country within the PIA region.

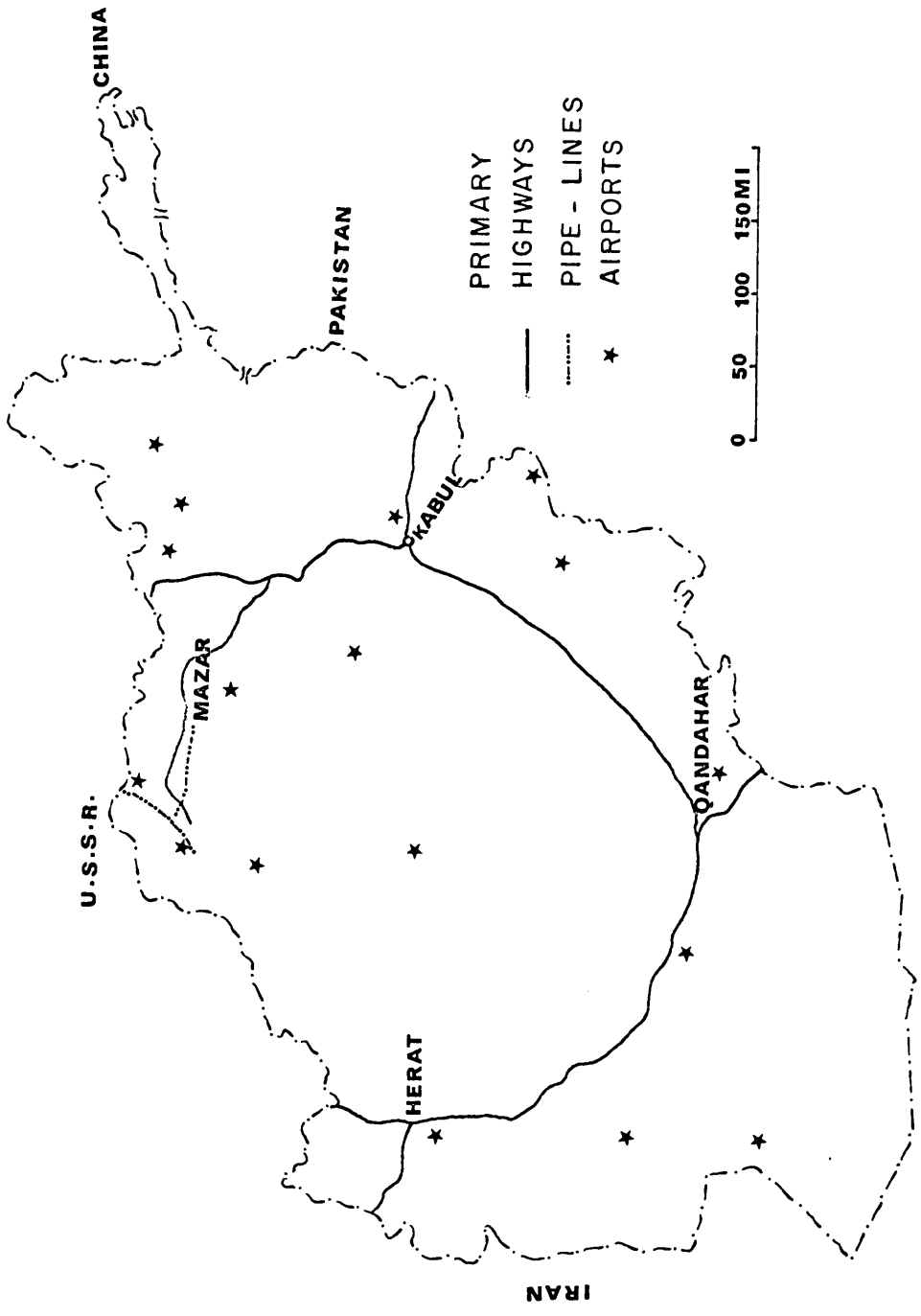


FIGURE A4.1 EXISTING TRANSPORTATION FEATURES IN AFGHANISTAN.
ADOPTED FROM: (22,P.14).

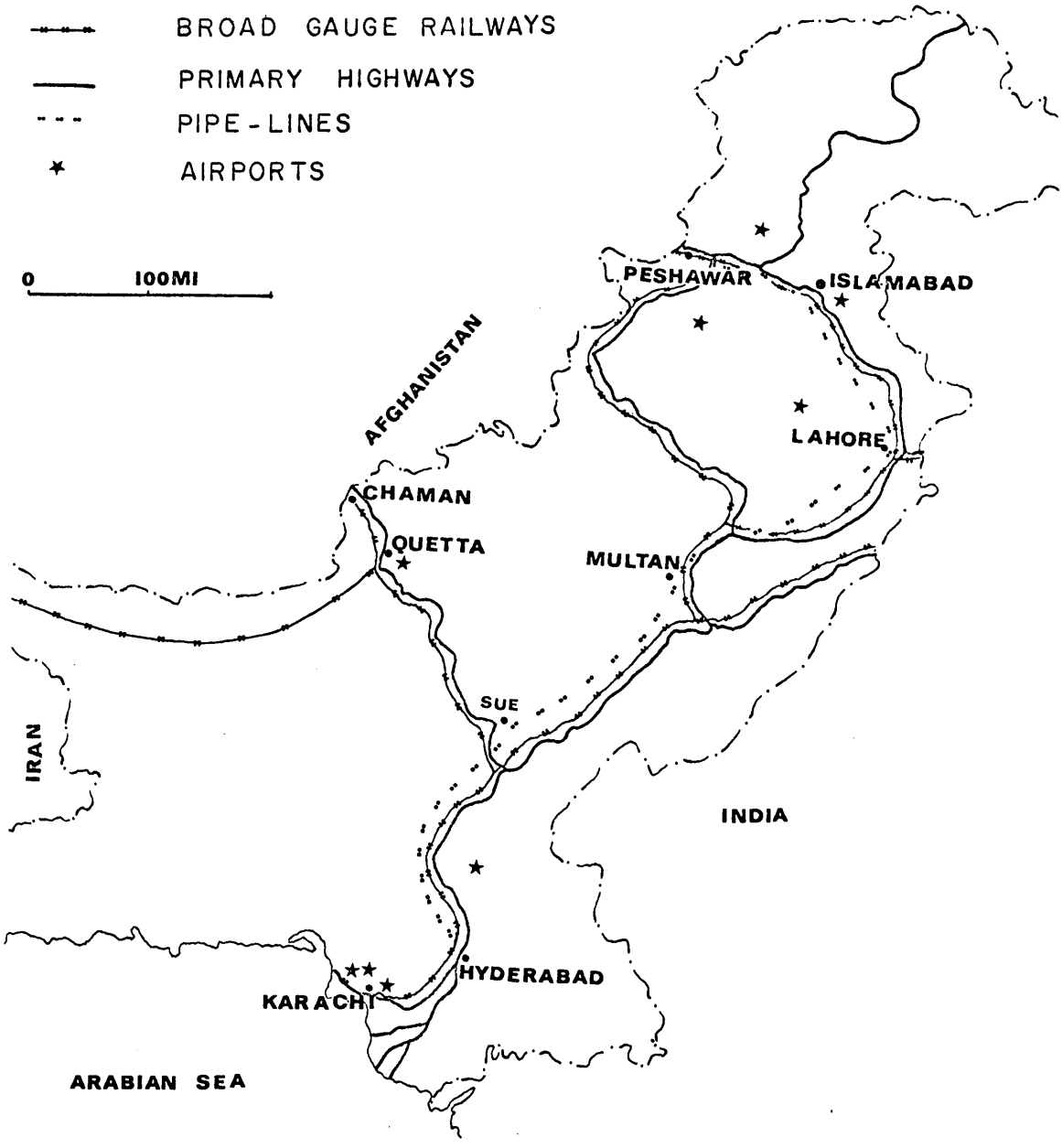


FIGURE A4.2 EXISTING TRANSPORTATION FEATURES IN PAKISTAN. ADOPTED FROM: (70, P.13).

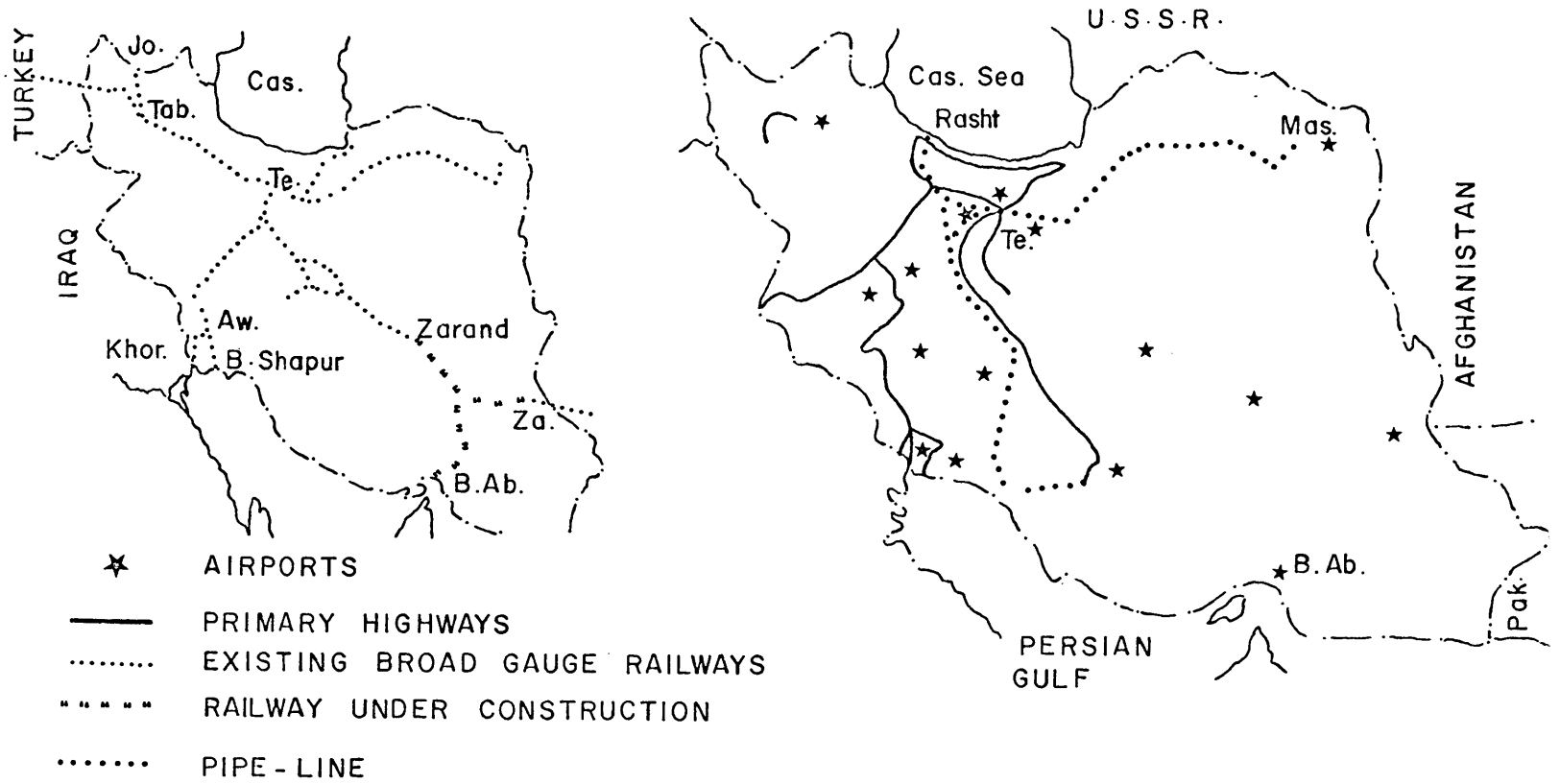


FIGURE A4.3 EXISTING TRANSPORTATION FEATURES IN IRAN.
ADOPTED FROM: (31, P.550), (77, P.101).

APPENDIX B

IDENTIFIED DEVELOPMENTAL EVENTS RELEVANT TO THE IMPACTS OF THE KRR

This appendix is divided into two sections. The first section, Table B3.1, presents the Suez Canal events and their analogies relevant to the expected impacts of the proposed KRR. The second section, Table B3.2, includes events relevant to the impacts of the KRR identified from the first section and through the analysis of Dickey's INDEX TERMS.

TABLE B3.1 CANAL'S EVENTS AS AN ANALOGY TO THE FUTURE IMPACTS OF THE KRR

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
THE CANAL CONVERTED THE RED SEA INTO A THROUGH-WAY CONNECTING ASIA TO AFRICA AND EUROPE (25,P.130);			THE KRR WOULD CONNECT ASIA TO AFRICA;		

TABLE 63.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
THE CANAL ENCHANCED THE ESTABLISHMENT OF RESEARCH CENTERS;E.G., ISMAILIA (23,P.209);			THE KRR WOULD ENHANCE THE ESTABLISHMENT OF THE PIA REGION'S RESEARCH CENTERS;		
THE CANAL ENHANCED THE PROHIBITION OF SLAVARY (25,P.20);			THE KRR WOULD ENHANCE FREEDOM AND SELF DEPENDENCY;		

TABLE 83.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
THE SUCCESS OF DE LESSEPS ENCOURAGED PROPOSALS FOR OTHER CANALS IN VARIOUS PARTS OF THE WORLD (25,P.92);			THE KRR MIGHT ENCOURAGE OTHER COUNTRIES TO BUILD SIMILAR INTERNATIONAL RAIL LINK;		

TABLE B3.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
C. COATED, AN ENGINEER ON THE SUEZ CANAL, PROPOSED A PLAN OF TRANS-ASIAN RAILWAY, WHICH WAS NEVER BUILT (25,P.182);		THE KRR MIGHT ENCOURAGE THE REVIVAL OF THE TRANS-ASIAN RAILWAY;			

TABLE B3.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
		THE FRANCO-RUSSIAN RAILWAY SCHEME WHICH ENCOURAGED THE REVIVAL OF THE EUPHRATES VALLEY RAILWAY WAS A RESULT OF THE CANAL (16,P.151);	THE KRR WOULD INCREASE THE PIA RAIL ROUTE LENGTHS;		

TABLE B3.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
AN EFFECT OF THE SUEZ CANAL WAS THE RESUMPTION OF ARCHAELOGICAL EXCAVATIONS AT NINEVEH *1 (16,P.151);			THE KRR WOULD INCREASE ARCHAELOGICAL INVESTIGATION IN THE COUNTRY SERVED;		

*1: NINEVEH: A CITY IN ANCIENT ASSYRIA

TABLE 83.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
SUEZ IS THE PORT OF DEPARTURE FOR THE PILGRIMS' SEA VOYAGE TO JEDDA (THE PORT FOR MECCA, ON THE ARABIAN COAST), THE ASH SHATT, OPPOSITE BUR TAWFIQ IS A QUARANTINE STATION FOR PILGRIMS RETURNING FROM MECCA (25,P.365);			THE KRR WOULD INCREASE TOURISTS AND PILGRIM TRAFFICS;		

TABLE 83.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVETNS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
		THE SUEZ CANAL ENHANCED THE INFLUENCE OF ENGLAND ON HINDUF AND MOSLEM. PORT SAID BECAME A CENTER OF CONTACT BETWEEN EUROPE AND ASIA (25,P.126);			THE KRR MIGHT INCREASE AND SPREAD RELIGION AND VARIOUS CITIES WITHIN THE PIA REGION MIGHT BECOME INTERNATIONAL CENTERS;

TABLE B3.1 (CONTINUED)
SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
THE ARAB VILLAGE OF ISMAILIA REMAINED DISTINCT FROM THE EUROPEAN TOWN AND WAS SITED TO THE WEST BETWEEN THE CAIRO RAILWAY AND THE SWEET WATER CANAL. ITS BLOCKS WERE SMALLER THAN THOSE OF THE FRENCH TOWN AND TEEMED WITH ACTIVITY, FOCUSING AROUND THE BAZAAR AND THE MOSQUE (25,P.195);			THE KRR WOULD ENHANCE THE PIA REGION'S NEW CITY AND TOWN PLANNING AND DEVELOPMNT;		

TABLE B3.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
MARSEILLES BECAME A WORLD PORT BECAUSE OF THE OPENING OF THE CANAL (25,P.137)			KARACHI AND RASHT MIGHT BECOME WORLD PORTS;		

TABLE B3.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KAR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
AFTER THE OPENING OF THE CANAL, GIBRALTAR'S SHIPPING INCREASED MARKEDLY IN 1871 AND IT DREDGED ITS HARBOR IN 1873. ITS COAL IMPORTS ROSE IN QUANTITY (25,P.153);			OTHER PORTS PARTICULARLY WITHIN THE PIA REGION MIGHT INCREASE THEIR SHIPMENTS;		

TABLE 83.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KPR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
THE NATIONALIZATION OF THE CANAL STIMULATED AFRICAN ENDEAVOURS TO SECURE FULL INDEPENDENCE FROM EUROPE (25,P.740).			THE KPR WOULD ENHANCE THE SOCIAL MOBILITY AND WOULD REDUCE CLASS DIFFERENCIES		

TABLE 83.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRP		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
INDIAN WHEAT, WHICH WAS UNKNOWN IN EUROPE BEFORE 1870, BECAME THE OBJECT OF A NEW TRADE AFTER THE OPENING OF THE CANAL (25,P.168);			THE KRP MIGHT ENHANCE THE ACCEPTANCE OF NEW TRADE ITEMS BY EUROPE, U.S.A., AFRICA, AND ASIAN COUNTRIES;		

TABLE 83.1 (CONTINUED)

SOCIAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
COMPETITION FROM THE CANAL CAUSED A REDUCTION IN FARES ON THE OVERLAND ROUTE (25,P.75);			THE KRR WOULD COMPETE WITH OTHER ROUTES AND FARES WOULD BE REDUCED;		
THE PASSAGE OF OIL TANKERS THROUGH THE CANAL ENCOURAGED THE SEARCH FOR OIL IN ASIA (25,P.441);			THE KRR WOULD INCREASE EXPLOITATION OF NATURAL RESOURCES;		

TABLE B3.1 (CONTINUED)

ECONOMIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
THE CANAL OPENING ENHANCED THE CONSTRUCTION OF PIPE LINES;			THE KRR MIGHT INCREASE THE CONSTRUCTION OF PIPE LINE AND OTHER TRANSPORT MODES;		

TABLE B3.1 (CONTINUED)

ECONOMIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
		THE CANAL ENHANCED PRODUCTION OF OIL IN THE MIDDLE EAST AND STIMULATED INDUSTRIAL DEVELOPMENT PARTICULARLY RISE OF AUTOMOBILE INDUSTRY (25,P.496)			THE KRR WOULD ENHANCE INDUSTRIAL DEVELOPMENT WHICH MIGHT INCREASE CAR OWNERSHIP;

TABLE 83.1 (CONTINUED)

ECONOMIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
	THE PORTS OF SYRIA LOST MUCH OF THEIR TRANSIT TRADE, ESPECIALLY TO BAGDAD, THROUGH THE DEVELOPMENT OF THE ROUTE TO THE PERSIAN GULF VIA THE CANAL (25,P.145);				SUEZ CANAL MIGHT LOSE SOME OF ITS TRANSIT DUE TO THE DEVELOPEMNT OF KRR;

TABLE B3.1 (CONTINUED)

ECONOMIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
THE CANAL ENABLED THE INDIAN MERCHANTS TO DEAL DIRECTLY WITH VISITING STEAMERS AND TO BY-PASS FOREIGN MERCHANTS (25,P.207);			THE KRR MIGHT INCREASE DIRECT TRADE THAT WOULD BY PASS FOREIGN REPRESENTATION;		

TABLE 83.1 (CONTINUED)

ECONOMIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
IN 1909-1913 INDIA SUPPLIED 45.5% OF THE CANAL'S TONNAGE, CHINA, AND JAPAN 22.2%, AUSTRALIA 9.9%, MALAYA AND THE DUTCH EAST INDIES 9.1%, EAST AFRICA 5.2%, AND THE PERSIAN GULF 1.5% (25, P.514);			INDIA, CHINA, AND SOUTH EAST ASIA MIGHT USE THE KRR;		

TABLE 83.1 (CONTINUED)

ECONOMIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
AFTER THE CANAL'S NATIONALIZATION, FOR A DECADE ITS TOLL, AS MUCH AS $227.0 MILLION A YEAR, PROVIDED A MAJOR PART OF EGYPTS' FOREIGN EXCHANGE (76,P.28);			THE KRR AS AN INTERNATIONAL INTERPRISE WOULD CONTRIBUTE TO THE REGION'S NATIONAL SAVING AND FOREIGN EXCHANGE EARNINGS;		
THE CANAL INCREASED SHIP BUILDING AND REPAIRS IN MANY PARTS (55,P.12);			THE KRR WOULD INCREASE THE PRODUCTION OF TRAIN AND TRAIN REPAIR PARTS;		

TABLE 83.1 (CONTINUED)

ECONOMIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
	THE CANAL EXPADITED THE EXPORT OF THE RAW WEALTH OF ASIA AND EAST AFRICA TO INDUSTRIAL MARKETS IN THE WEST (49,P.793)				THE KRR WOULD ENHANCE THE EXPORT OF RAW MATERIAL TO THE WEST;

TABLE B3.1 (CONTINUED)

ECONOMIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
	DEPENDENCY ON THE CANAL CAUSED MAJOR ECONOMIC DISLOCATIONS WHEN THE CANAL WAS CLOSED;			IF SIMILAR DEPENDENCY ON THE KRR DEVELOPED, ANY INTERRUPTION OF ITS SERVICES WOULD HAVE SERIOUS ECONOMIC EFFECTS;	

TABLE B3.1 (CONTINUED)
ECONOMIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
		DURING THE CANAL'S CLOSING PERIOD, PAKISTAN TOOK OVER FROM THE U.S. AS A MAJOR SUPPLIER OF RICE TO THE GULF AND AFTER THE CANAL OPENED IN 1975, THE U.S. SHARE OF MARKET PICKED UP (55,P.10);	WITH THE OPERATION OF THE KRR, THE REGION'S EXPORT OF FOOD PRODUCTS SHOULD COMPETE WITH OTHER NATIONS AND WOULD INCREASE SALES AND PRODUCTIVITY;		

TABLE 83.1 (CONTINUED)

INSTITUTIONAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
THE CANAL STIMULATED EFFORTS TO BUILD THE ASWAN DAM (36,P.27);			THE KRR MIGHT ENHANCE DAM PROJECTS AND INCREASE THE GENERATION OF ELECTRICITY;		

TABLE B3.1 (CONTINUED)

INSTITUTIONAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
NEARLY 1/3 OF THE 1870 CROP WAS CARRIED BY STEAMERS, WHILE MORE THAN 2/3 WAS CARRIED BY CLIPPER. THESE ARRANGEMENTS HAD BEEN MADE PROBABLY BY DELIBERATE CHOICE OF U.K. BETWEEN THE CAPE AND THE CANAL ROUTES SO THAT THE CANAL CARRIED ONLY 15% OF THE CROP (25,P.184);			THE KRR WOULD INCREASE TRANSPORT COORDINATION BETWEEN ALL MODES OF TRANSPORTATION;		

TABLE 83.1 (CONTINUED)

INSTITUTIONAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
		FRANCE AND ENGLAND BEGAN THE MILITARY USE OF THE CANAL WHICH REDUCED THE COST OF TROOP TRANSPORT BY 25% (25,P.171);			RUSSIA AND U.S. MIGHT USE THE KRR TO SHIP ARMS TO KRR COUNTRIES AND INDIA;

TABLE 83.1 (CONTINUED)

INSTITUTIONAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
	FOR ENGLAND THE CANAL HAD BECOME ITS HIGHWAY TO INDIA, AND THE NEED TO PROTECT IT WAS AN ARGUMENT USED TO SERVE AS AN EXCUSE FOR THE OCCUPATION OF EGYPT (25,P.292);			THE KRR COUNTRIES MIGHT BECOME A COMBINED MILITARY POWER AND A STRATEGY FOR BIG POWER;	

TABLE 83.1 (CONTINUED)

INSTITUTIONAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
		RUSSIAN EXPANSION IN ASIA WAS FOSTERED BY THE BUILDING OF THE TRANS-SIBERIAN RAILWAY AND BY ITS OIL SHIPMENTS THROUGH THE CANAL (25,P.487);			RUSSIA MIGHT CONNECT HER RAILWAY TO THE KRR AND HER SPHERE OF INFLUENCE ON THE REGION MIGHT INCREASE;

TABLE 83.1 (CONTINUED)

INSTITUTIONAL EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
	THE CANALS NATIONALIZATION BECAME A THREAT TO THE SECURITY OF ISRAEL WHICH ENHANCED THE ARAB-ISRAEL CONFLICTS (49,P.205);			THE NOMADS MIGHT THINK OF RAILWAY AS A THREAT TO THEIR CIVILIZATION WHICH MIGHT CAUSE TERRORISM;	

TABLE B3.1 (CONTINUED)

DEMOGRAPHIC EVENTS

EVENTS DEVELOPED FROM THE IMPACTS OF THE SUEZ CANAL			EVENTS RELEVANT TO THE FUTURE IMPACTS OF THE KRR		
FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS	FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	BOTH FAVORABLE AND UNFAVORABLE IMPACTS
THE CITY OF SUEZ FACED THE RED SEA WITH FEWER PROSPECTS OF GROWTH THAN PORT SAID WHICH FACED EUROPE. IT DOUBLED ITS AREA, TRIPLED ITS HOUSES AND QUADRUPLED ITS POPULATION BETWEEN 1859 AND 1869 (25,P.127);				THE KRR MIGHT CAUSE THE REPLACEMENT OF AGRICULTURAL WORKERS FROM RURAL TO URBAN AREAS;	

TABLE 83.2:IDENTIFIED EVENTS AND DEVELOPMENTS THAT MIGHT BE AFFECTED BY THE IMPACTS OF THE PROPOSED KRR

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
		INCREASE IN THE DIVERSITY OF RELIGIONS AND RELIGIOUS ORGANIZATIONS;
CREATION OF POLITICAL HARMONY WITHIN THE REGION;		
REMOVAL OF TARIFF AND TAXES ON ALL TRADE ITEMS;		
		REMOVAL OF VISA FORMALITIES;
CLOSE COOPERATION IN THE FIELD OF AIR AND WATER POLLUTION;		
ESTABLISHMENT OF KRR STATISTICAL DATA COLLECTION CENTERS;		

TABLE B3.2 (CONTINUED)

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
		ESTABLISHMENT OF NEW POLITICAL BOUNDARIES AND ANNEXATION;
CREATION OF NEW MONETARY SYSTEM;		
ESTABLISHMENT OF KRR BANK;		
		CREATION OF A COMMON LANGUAGE;
		FEDERATION (AFGHANISTAN, PAKISTAN, AND IRAN DECIDE TO COMBINE);
	LAND USAGE FOR RAILWAY - TAKES AWAY FROM RECREATION, HOUSING, ETC.;	

TABLE B3.2 (CONTINUED)

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN OPPORTUNITY FOR SELF DEVELOPMENT (TECHNICAL, SOCIAL, AND POLITICAL);		
	INCREASE IN TECHNOLOGY OF WARFARE;	
	INCREASE IN LAND VALUES;	
		INCREASE IN LAND TAXES AND COLLECTION PROCEDURES;
REDUCTION OF EXCISE TAXES ON RAIL CARS;		
INCREASE IN CITIZEN PARTICIPATION IN GOVERNMENT ELECTIONS AND GENERAL WELFARE OF THE REGION;		

TABLE B3.2 (CONTINUED)

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN COORDINATION, OPERATIONS, EFFECIENCY AND PERFORMANCE OF ALL MODES (THE KRR MIGHT JOIN INTERNATIONAL RAILWAY ORGANIZATION TO COMPLY WITH INTERNATIONAL RAILWAY STANDARDS, FINANCE, AND COMMERCE);		
CONSOLIDATION OF SCHOOL AMONG THE KRR COUNTRIES;		
ESTABLISHMENT OF CONSUMER PROTECTION AGENCIES;		
ENHANCEMENT IN THE ALLOCATION OF GARBAGE CONTAINERS, CONSTRUCTION OF LANDFILLS AND GARBAGE COLLECTION SYSTEMS;		

TABLE B3.2 (CONTINUED)

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
PROMOTION OF ADMINISTRATIVE AND SOCIAL SERVICES IN REMOTE AREAS;		
IMPROVEMENT OF COUNTY, CITY, AND DISTRICT GOVERNMENTS ORGANIZATION;		
		INCREASE IN PRICES OF CERTAIN EXPORT ITEMS (NATURAL GAS, OIL, DRY FRUITS, AND CARPETS);
		INCREASE IN DEFENSE CAPABILITIES;
INTRODUCTION OF NEW DESIGN STANDARDS FOR ALL TYPES OF CONSTRUCTION WORK;		
ESTABLISHMENT OF NEW ECONOMIC POLICIES AND MEASURES;		

TABLE B3.2 (CONTINUED)

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN DEMAND FOR ENERGY UTILIZATION, CONSERVATION MEASURES, AND POLICIES;		
INTRODUCTION OF NEW FARMING METHODS AND USE OF MACHINERY AND EQUIPMENT;		
INCREASE IN EQUITY;		
REDUCTION OF FARES AND FREIGHT RATES OF OTHER MODES;		
INCREASE IN TRAFFIC REGULATION AND SAFETY REQUIREMENTS;		
REDUCTION IN DELAYS AND SAVE TIME;		

TABLE 83.2 (CONTINUED)

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
ENHANCEMENT OF PUBLIC REFORM POLICIES;		
INCREASE IN FRANCHISE ESTABLISHMENTS;		
	INCREASE IN GOVERNMENT BEARAUCRACY OR VICE VERSA;	
INCREASE IN COMMUNITY BIRTH CONTROL CENTERS AND HOUSEHOLD PARTICIPATION;		
INCREASE IN INFORMATION ON MARKET PRICES AND DEMANDS;		
		INCREASE IN TRANSHIPMENT, EFFICIENCY, AND REDUCTION OF BORDER INSPECTIONS;

TABLE B3.2 (CONTINUED)

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
		DEVELOPMENT OF NEW LAWS AND LEGISLATIVE AGREEMENTS CONCERNING THE KRR INDEPENDENT OPERATION, ORGANIZATION, ADMINISTRATION, AND ITS UNIFICATION AS A SINGLE INTERNATIONAL ENTITY;
		INCREASE IN THE ESTABLISHMENT OF ORDINANCES;
DEVELOPMENT OF TRAFFIC DATA ON ORIGIN/DESTINATION PATTERNS;		
INCREASE IN FOOD STORAGE FACILITIES AND RESERVES;		
SUSPENSION OF MANY OLD LAWS AND REGULATIONS;		
		CREATION OF LABOR UNION;

TABLE B3.2 (CONTINUED)

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
DECENTRALIZATION OF INDUSTRIES;		
DEVELOPEMNT OF MODERN MANAGEMENT TECHNIQUES AND FARE COLLECTION PROCEDURES;		
INCREASE CONSUMER INSTALLMENT CREDITS;		
		DEVELOPMENT OF A NEW COMMERCIAL AND MILITARY POWER IN THE MIDDLE EAST;
EXPANSION AND CREATION IN THE FIELD OF INSURANCE AND REAL ESTATES (RAILROAD RETIREMENT, AND UNEMPLOYMENT INSURANCE.);		
		RISE OF ENTREPRENEURSHIP;

TABLE 83.2 (CONTINUED)

INSTITUTIONS

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
PRODUCTION OF A NEW BASES FOR AN OLIGOPOLISTIC MODEL FOR OTHER SECTORS OF THE ECONOMY OUTSIDE THE PIA REGION;		
	CREATION OF A RAILWAY LOBBY;	
CREATION OF A MODEL FOR OTHER SIMILAR UNDERTAKING;		
INCREASE IN CENTRAL GOVERNMENT AIDS TO PROVENCIAL GOVERNMENTS;		

TABLE B3.2 (CONTINUED)

ENVIRONMENT

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
	INCREASE IN NOISE, AIR POLLUTION, AND RAILSIDE LITTER; EROSION OF LAND FROM RAILWAY CONSTRUCTION; DECREASE IN WILDLIFE; INCREASE IN OPPORTUNITY FOR COMMERCIAL EXPLOITATION OF FOREST RESOURCES;	
INCREASE IN SOIL FERTILITY AND USE OF WASTELAND TO INCREASE ITS ENVIRONMENTAL VALUES, CLIMATE, AND APPEARANCE AS WELL AS TO PROVIDE FODDER FOR THE ANIMALS; INCREASE IN ENVIRONMENT PRESERVATION MEASURES.		

TABLE B3.2 (CONTINUED)

DEMOGRAPHY

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
CREATION OF NEW URBAN AREAS;		
	INCREASE IN URBAN POPULATIONS AND DENSITY;	
	DISPLACEMENT OF AGRICULTUREAL WORKERS FROM RURAL TO URBAN AREAS);	
MOVEMENT OF BUSINESS AND INDUSTRY TO SUBURBS;		
GEOGRAPHIC MOBILITY AND MIGRATION;		
CHANGE IN THE NUMBER OF FAMILIES AND EMPLOYEES;		
	MOVEMENT OF URBAN RESIDENCES TO SUBURBS;	

TABLE B3.2 (CONTINUED)

SOCIAL

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN HIGHWAY NETWORK LENGTHS;		
		INCREASE IN TOTAL NUMBERS OF VEHICLES AND OWNERS;
INCREASE IN RAIL ROUTE LENGTHS AND RAILWAY ELECTRIFICATION;		
INCREASE IN TOURIST RECEIPTS;		
INCREASE IN DAILY NEWSPAPER CIRCULATION;		
INCREASE IN FOOD PRODUCTION;		
INCREASE IN LIFE EXPECTANCY;		

TABLE 33.2 (CONTINUED)

SOCIAL

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
DECREASE IN INFANT MORTALITY RATE;		
INCREASE IN ADULT LITERACY RATE;		
INCREASE IN EQUAL DISTRIBUTION OF FOOD;		
USE OF RAILWAY BY NOMADES ;		
INCREASE IN ARCHEOLOGICAL DISCOVERY;		
TELEVISION ESTABLISHMENT IN AFGHANISTAN;		
DECREASE IN LANDLESS WORKERS;		
	INCREASE IN CONGESTION;	

TABLE B3.2 (CONTINUED)

SOCIAL

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
CREATION OF NEW CLASS OF SEMISKILLED INDUSTRIAL WORKERS;		
	INCREASE CRIME OR VICE VERSA;	
CHANGES IN EDUCATION PATTERN (STUDY ABROAD);		
	LOSS OF LIFE DUE TO TRAIN ACCIDENTS;	
	OLDER, POORER NEIGHBORHOOD DISPLACEMENT THROUGH FREEWAY CONSTRUCTION;	
INCREASE IN SOCIAL AND ECONOMIC HOMOGENEITY AMONG KRR COUNTRIES;		

TABLE B3.2 (CONTINUED)

SOCIAL

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN COMMUNICATION (MAILS, TELEPHONES, AND CABLES);		
REDUCTION OF DISASTERS;		
INCREASE IN OUT DOOR LIVING AND ENTERTAINMENTS;		
INCREASE IN CONTACT BETWEEN DIFFERENT CIVILIZATION;		
	INCREASE IN CONSUMPTION AND LUXURIES;	
	CHANGES OF CIVILIZATION;	
		DECLINE OF HORSES, CARRIAGE AND WAGON BUSINESS;

TABLE B3.2 (CONTINUED)

SOCIAL

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
ENHANCEMENT OF CONSTRUCTION OF COMMUNITY CENTERS;		
ENHANCEMENT OF MUNICIPAL SERVICES (POTABLE WATER MIGHT BECOME AVAILABLE TO RURAL VILLAGERS);		
REDUCTION OF CONGESTION ON ROADS FROM CARAVAN AND NOMADES;		
INCREASE IN COMPETITION BETWEEN ALL MODES OF TRANSPORTATION (PIPELINE, WATER, AIR, AND HIGHWAYS);		
IMPROVEMENT IN TRAINING FOR THE REGIONS ENGINEERS AND RAILWAY CONSTRUCTION CREWS;		

TABLE B3.2 (CONTINUED)

SOCIAL

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN USE OF COMPUTER TECHNOLOGY;		
INCREASE IN CAPABILITY OF CONTRACTORS TO PARTICIPATE IN THE CONSTRUCTION OF THE KRR;		
DEVELOPEMNT OF TRANSPORT SYSTEM FOR ELDERLY AND HANDICAPPED;		
INCREASE IN HOUSING AND SETTLEMENT OF NOMADIC TRIBES;		
INCREASE IN INTERSTATE AND INTRASTATE MOBILITY;		
INCREASE IN THE IMPORTANCE OF CERTAIN LOCATIONS;		

TABLE B3.2 (CONTINUED)

SOCIAL

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN MAINTENANCE OF RAILWAY AND OTHER TRANSPORT MODES;		
INCREASE IN MARITIME ACTIVITY;		
DECREASE IN EARLY AGE MARRIAGES;		
		INCREASE IN NUCLEAR ACTIVITIES;
		INCREASE IN OBSOLESCENCE OF TRADITIONS;
INCREASE IN THE SOLAR ENERGY ACTIVITY;		
INCREASE IN THE CONSTRUCTION OF PIPE LINE AND PORTS;		

TABLE 83.2 (CONTINUED)

SOCIAL

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN NATIONAL, INTERNATIONAL, AND REGIONAL COOPERATION AND UNITY;		
INCREASE IN RESEARCH IN TRANSPORTATION;		
DECREASE IN SMUGGLING OR VICE VERSA;		
INCREASE IN TOPOGRAPHICAL MAPPING AND GEOLOGICAL SURVEYING;		
DECREASE IN POPULATION PER HOSPITAL BED;		

TABLE B3.2 (CONTINUED)

ECONOMIC

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
		INCREASE IN ENERGY CONSUMPTIONS AND DEMAND (COAL AND PETROLEUM PRODUCTS);
CREATION OF EXTERNAL FINANCIAL RESOURCES AND INVESTMENT (INCREASE IN WORLD BANK FINANCING OF KRR COUNTRIES);		
INCREASE IN ECONOMIC AID TO AFGHANISTAN AND PAKISTAN BY IRAN AND OTHER OPEC COUNTRIES;		
INCREASE AID BY THE U.S.S.R., THE U.S.A., THE U.K. AND EUROPE ;		
INCREASE IN PER CAPITA ELECTRIC CONSUMPTION;		
INCREASE IN PER CAPITA GROSS NATIONAL INCOME (GNP);		

TABLE B3.2 (CONTINUED)

ECONOMIC

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN EXPORTS AND IMPORTS;		
LOWER TRANSPORT COST OF FOOD GRAIN;		
DECREASE IN RATE OF EXCHANGE;		
INCREASE IN NATIONAL SAVING AND INTERNATIONAL RESERVE;		
INCREASE IN PARTICIPATION OF FEMALE AND MINORITIES IN WORK FORCE;		
CREATION OF JOBS, LABORS, AND OCCUPANCIES;		

TABLE B3.2 (CONTINUED)

ECONOMIC

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
RISE OF SMALL BUSINESSES SUCH AS RESTAURANTS, MOTELS, AND TOURIST ACCOMODATIONS WITHIN THE PIA REGION;		
INCREASE IN INDUSTRIAL DEVELOPMENT;		
DECREASE IN INFLATION OR VICE VERSA;		
INCREASE IN EXPLORATION FOR OIL, ENERGY, AND NATURAL RESOURCES;		
		INCREASE IN LOCAL AND STATE REVENUES THROUGH TARIFF, SALES, AND TAXES;

TABLE 83.2 (CONTINUED)

ECONOMIC

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN MARKETS FOR FARM PRODUCTS;		
		INCREASE IN BUDGET AND PUBLIC EXPENDITURE;
ENHANCEMENT OF MANUFACTURING OF PARTS, MACHINERIES, AND SUPPLIES;		
	INCREASE IN COST OF LIVINGS;	
DECREASE DOMESTIC DEBT;		
INCREASE IN DEMAND FOR RAW MATERIALS;		

TABLE B3.2 (CONTINUED)

ECONOMIC

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
	CREATION OF MONOPOLY;	
INCREASE IN EQUAL INCOME DISTRIBUTION;		
		INCREASE IN INTEREST RATES AND INVESTMENTS;
		ALTERATION OF GASOLINE PRICE;
		INCREASE IN MARKET VALUE OF PRODUCTS AND GOODS;

TABLE B3.2 (CONTINUED)

ECONOMIC

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN PURCHASING POWER;		
INCREASE IN RETAIL BUSINESSES;		
INCREASE IN WAGES;		
DEVELOPMENT OF AN ASIAN COMMON MARKET;		
INCREASE IN FARM CREDIT AND AGRICULTURAL EXTENSION SERVICES (THE CONSTRUCTION OF THE RAILWAY MIGHT PROVIDE JOB FOR FARMERS. FURTHERMORE, WHEN THE REGION GETS THE KRR SERVICE, FARMERS MIGHT BE ABLE TO TAKE SEASONAL EMPLOYMENT IN URBAN AREAS AND RETURN HOME BETWEEN EMPLOYMENT);		

TABLE B3.2 (CONTINUED)

VALUES

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
EXPANSION OF PERSONAL FREEDOM AND RIGHTS;		
CREATION OF PERSONAL IDENTITY, SELF AWARENESS AND PRIDE;		
INCREASE IN SENSE OF COMMUNITY BELONGING OR VICE VERSA;		
INCREASE IN EQUAL TRAVEL OPPORTUNITY;		
INCREASE IN MATURITY;		
		CHANGES IN VALUES AND PRIORITIES;
BROADENING OF LEVELS OF THINKING;		

TABLE B3.2 (CONTINUED)

VALUES

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
REDUCTION IN DEPENDENCY AND INCREASE IN PERSONAL BELONGINGS;		
CREATION OF NEW CHALLENGES PRODUCTIVITY, AGGRESSIVENESS, AND INCENTIVES;		
CREATION OF NEW PATTERNS AND STANDARDS;		
INCREASE IN SECURITY, ORDER, SURVIVAL, AND EQUAL JUSTICE;		
DECREASE IN RELIANCE ON OUTSIDERS OR VICE VERSA;		
INCREASE IN ENVIRONMENTALISM AND APPRECIATION FOR ENVIRONMENT AS VALUES;		

TABLE B3.2 (CONTINUED)

VALUES

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN THE VALUE OF NATIONAL HISTORY AND HERITAGES;		
	INCREASE IN LEISURE;	
		CHANGES IN LIFE STYLES;
DECREASE IN RELIANCE ON SUPERSTITIONS;		
INCREASE IN THE VALUES OF PLANNING, PROJECTIONS, AND ORGANIZATIONS;		

TABLE B3.2 (CONTINUED)

VALUES

FAVORABLE IMPACTS	UNFAVORABLE IMPACTS	FAVORABLE AS WELL AS UNFAVORABLE IMPACTS
INCREASE IN PRIVACY, CONVENIENCE, AND COMFORT;		
DECREASE IN PSYCHOLOGICAL INFERIARITY;		
DECREASE IN RISKS AND UNCERTAINTIES;		
DEVELOPEMNT OF NEW SOCIOECONOMIC STATUES AND CLASSES;		

APPENDIX C

IDENTIFIED DEVELOPMENTAL EVENTS PRESENT AND FUTURE LEVELS RELEVANT TO THE KRR

This appendix presents tables showing the PIA region's developmental events present levels and compares them with the same events in the SGF and the UKT regions; the purpose is to estimate the PIA region's identified events future levels relevant to the impacts of the KRR.

TABLE C4.1 ROAD NETWORK LENGTH

		ROAD NETWORK LENGTH (KM) #1			E1: REGION'S ROAD NETWORK LENGTH (KM)	
		PAVED	GRAVEL AND EARTH	TOTAL		
		(1969)			(1969)	
UKT REGION	UGANDA	6,382	17,791	24,173		
	KENYA	2,489	39,171	41,660	33,238	
	TANZANIA	2,234	31,647	33,881		
SGF REGION	SWITZERLAND					
	WEST GERMANY	290,271	124,402	414,673	948,706	
	FRANCE	629,593	853,146	1,482,739		
PIA REGION	AFGHANISTAN	2,000	15,000	17,000		E1 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1980
	IRAN	10,200	25,600	35,800	52,487	60,000
	PAKISTAN	27,568	77,093	104,661		

#1: (26,PP.180-3)

TABLE C4.2 TOTAL NUMBER OF VEHICLES

		VEHICLES			E2: REGION'S TOTAL VEHICLES	
		LIGHT	HEAVY	TOTAL		
		1969			1969	
UKT REGION	UGANDA	29,163	10,460	39,623#1		
	KENYA	115,000	10,300	125,300	75,799	
	TANZANIA	41,989	20,488	62,474		
SGF REGION	SWITZERLAND	1,180,500	1,007,148	2,187,648#2		
	WEST GERMANY	11,682,556	1,045,297	12,727,853#1	9,378,500	
	FRANCE	11,155,000	2,065,000	13,220,000		
PIA REGION	AFGHANISTAN	12,040	21,228#1			
	IRAN	20,000	73,000		51,482	
	PAKISTAN	137,406	38,991			

E2 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1980
100,000

#1: (80,PP.180-3); #2: (57,PP.1143)

TABLE C4.3 RAIL ROUTE LENGTH

	RAIL ROUTE LENGTH (KM) (1969)		EB: REGION'S RAIL ROUTE LENGTH (KM) (1969)	
UKT REGION	UGANDA	1,150 #1		
	KENYA	2,160	1,903	
	TANZANIA	2,400		
SGF REGION	SWITZERLAND	9,513 #2		
	WEST GERMANY	33,660	27,611	
	FRANCE	39,660		
				EB LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KBR BY: 2003
PIA REGION	AFGHANISTAN	NONE		
	IRAN	3,510 #1	4,068	20,000
	PAKISTAN	11,393		

#1: (80,PP.180-3); #2: (53,PP.252)

TABLE C4.4 WORD BANK AND IDA* LENDING FOR TRANSPORT

		TOTAL LENDING FISCAL YEARS, 1967-71 (US $ MILLION) #1	E4: WORLD BANK YEARLY LENDING FISCAL YEARS, 1967-71 (US $ MILLION)	
UKT REGION	UGANDA	16.6		
	KENYA	52.1	31.4	
	TANZANIA	25.5		
PIA REGION	AFGHANISTAN	5		E4 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1978
	IRAN	42.0	46.4	80.0
	PAKISTAN	92.2		

* IDA - INTERNATIONAL DEVELOPMENT ASSOCIATION
#1: (80,PP.185-6)

TABLE C4.5 TOURIST RECEIPTS AS PERCENT OF GROSS NATIONAL PRODUCT

		TOURIST RECEIPTS AS PERCENT OF GNP	E5: REGION'S TOURIST RECEIPTS	
		% (1968)#1	% (1968)	
UKT REGION	UGANDA	1.2		
	KENYA	4.0	2.1	
	TANZANIA	1.0		
SGF REGION	SWITZERLAND			
	WEST GERMANY	0.76	.79	
	FRANCE	0.82		
				E5 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO TEH IMPACTS OF THE KRR BY: 1985
PIA REGION	AFGHANISTAN	0.02		
	IRAN	0.56	.21	3.5
	PAKISTAN	0.04		

#1: (26,P.35);

TABLE C4.6 PER CAPITA ENERGY CONSUMPTION

		PER CAPITA ENERGY CONSUMPTION, 1973 #1 (KG. COAL EQUIV.)	E6: REGION'S PER CAPITA ENERGY CONSUMPTION 1973 (KG. COAL EQUIV.)	
UKT REGION	UGANDA	56		
	KENYA	167	101.3	
	TANZANIA	81		
SGF REGION	SWITZERLAND	5973		
	WEST GERMANY	6375	5725	
	FRANCE	5007		
				E6 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KBR BY: 1986
PIA REGION	AFGHANISTAN	71		
	IRAN	1050	435	1700
	PAKISTAN	184		

#1: (37,PP.132-40)

TABLE C4.7 PER CAPITA ELECTRIC CONSUMPTION

		ELECTRIC CONSUMPTION (KILOWATT-HOURS PER CAPITA) #1	E7: REGION'S ELECTRIC CONSUMPTION (KILOWATT-HOURS PER CAPITA)	
		(1968)	(1968)	
UKT REGION	UGANDA	66		
	KENYA	61	50.3	
	TANZANIA	24		
SGF REGION	SWITZERLAND	4,087		
	WEST GERMANY	3,495	3,324	
	FRANCE	2,389		
				E7 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KBR BY: 1985
PIA REGION	AFGHANISTAN	20		
	IRAN	185	86	300
	PAKISTAN	53		

#1: (26,PP.158-59)

TABLE C4.8 DAILY NEWSPAPER CIRCULATION

		DAILY NEWSPAPER CIRCULATION PER 1000 INHABITANTS #1 (1967)	E8: REGION'S DAILY NEWSPAPER CIRCULATION (1967)	
UKT REGION	UGANDA	6		
	KENYA	9	6	
	TANZANIA	3		
SGF REGION	SWITZERLAND	368		
	WEST GERMANY	328	352	
	FRANCE	251		
PIA REGION	AFGHANISTAN	7		E8 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KBR BY: 1983
	IRAN	15	13.3	30
	PAKISTAN	18		

#1: (26,P.29)

TABLE C4.9 POPULATION IN URBAN AREAS IN THREE REGIONS

		URBAN POPULATION 1970 (MILLION)	ANNUAL GROWTH RATE 1960-70 (%)	E9: URBAN POPULATION GROWTH RATE 1960-70 (%)	E9 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KPR BY: 1984 (%)
UKT REGION	UGANDA	0.6#1	9.2		
	KENYA	1.0	5.1	7.63	
	TANZANIA	1.0	8.6		
SGF REGION	SWITZERLAND	3.9#2	1.3		
	WEST GERMANY	43.3	1.0	1.2	
	FRANCE	31.7	1.3		
PIA REGION	AFGHANISTAN	1.1#1	2.3		
	IRAN	11.3	4.8	3.8	7.6
	PAKISTAN	18.1	4.3		

#1: (30,P.478); #2: (67,P.114)

TABLE C4.10 DAILY PER CAPITA CONSUMPTION OF CALORIES

		1969-71 AVERAGE DAILY PER CAPITA CONSUMPTION OF CALORIES #1	E10: REGION'S FOOD PRODUCTION (DAILY PER CAPITA CONSUMPTION OF CALORIES) 1969-71	
UKT REGION	UGANDA	2,160		
	KENYA	2,200	2,023	
	TANZANIA	1,700		
SGF REGION	SWITZERLAND	3,050		
	WEST GERMANY	3,050	3,100	
	FRANCE	3,200		
				E10 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KBR BY: 1982
PIA REGION	AFGHANISTAN	2,060		
	IRAN	2,030	2,147	2,650
	PAKISTAN	2,350		

#1: (67,PP.74-120)

TABLE C4.11 AVERAGE LIFE EXPECTANCY

		LIFE EXPECTANCY AT BIRTH, 1970-75 AVERAGE #1 (YRS)	E11: REGION'S LIFE EXPECTANCY (1970-75) (YRS)	
UKT REGION	UGANDA	50		
	KENYA	50	48	
	TANZANIA	44		
SGF REGION	SWITZERLAND	72		
	WEST GERMANY	71	72	
	FRANCE	73		
				E11 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KBR BY: 1990
PIA REGION	AFGHANISTAN	40		
	IRAN	51	47	55
	PAKISTAN	50		

#1: (37,PP.132-40)

TABLE C4.12 POPULATION PER HOSPITAL BED

		HOSPITAL BED PER 1000 POPULATION #1	E12: REGION'S HOSPITAL BED PER 1000 POPULATION	
		1967		
UKT REGION	UGANDA	1.1		
	KENYA	1.4	1.5	
	TANZANIA	1.9		
SGF REGION	SWITZERLAND	11.1		
	WEST GERMANY	11.1	10.2	
	FRANCE	8.4		
				E12 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1995
PIA REGION	AFGHANISTAN	0.2		
	IRAN	1.0	0.5	3.0
	PAKISTAN	0.3		

#1: (26,P.27)

TABLE C4.13 INFANT MORTALITY RATE

		INFANT MORTALITY PER 1000 LIVE BIRTHS #1	E13: REGION'S INFANT MORTALITY PER 1000 LIVE BIRTHS	
		1976	1976	
UKT REGION	UGANDA	160		
	KENYA	135	152	
	TANZANIA	162		
SGF REGION	SWITZERLAND	10		
	WEST GERMANY	18	15	
	FRANCE	16		
				E13 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KBR BY: 1982
PIA REGION	AFGHANISTAN	182		
	IRAN	139	151	140
	PAKISTAN	132		

#1: (37,PP.132-40)

TABLE C4.14 LITERACY RATE 1976

		LITERACY RATE #1 (%)	E14: REGION'S LITERACY RATE (%)	
UKT REGION	UGANDA	20		
	KENYA	20-25	20	
	TANZANIA	15-20		
SGF REGION	SWITZERLAND	99		
	WEST GERMANY	99	99	
	FRANCE	99		
PIA REGION	AFGHANISTAN	8		E14 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO TEH IMPACTS OF THE KNR BY: 1991
	IRAN	23	16	35
	PAKISTAN	16		

#1: (37,PP.132-40)

TABLE C4.15 PER CAPITA GROSS NATIONAL PRODUCT IN THREE REGIONS

		PER CAPITA GNP, 1973#1 (U.S.)	PER CAPITA GNP GROWTH RATE, 1965-73 (%)	E15: REGION'S GNP PER CAPITA GROWTH RATE, 1965-73 (%)	
UKT REGION	UGANDA	150	1.2		
	KENYA	170	3.3	2.4	
	TANZANIA	130	2.6		
SGF REGION	SWITZERLAND	6,100	3.0		
	WEST GERMANY	5,320	4.0	4	
	FRANCE	4,540	5,0		
					E15 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1989
PIA REGION	AFGHANISTAN	90	0.9		
	IRAN	870	7.4	3.6	7.2
	PAKISTAN	120	2.5		

#1: (37,PP.132-40)

TABLE C4.16 CAPITAL FLOWS-NET BILATERAL AID FROM ODA, DAC, AND OPEC COUNTRIES
* ** ***

		TOTAL CAPITAL FLOWS FROM DAC AND OPEC, 1974 (U.S. $ MIL) #1	E16: REGION'S TOTAL CAPITAL FLOWS (AID) 1974 (U.S. $ MIL)	
UKT REGION	UGANDA	25.8		
	KENYA	117.5	98.6	
	TANZANIA	152.5		
				E16 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1983
PIA REGION	AFGHANISTAN	115.1		
	IRAN		601.3	$1 BILLION
	PAKISTAN	1103.4		

* ODA (OFFICIAL DEVELOPMENT ASSISTANCE)
** DAC COUNTRIES (WESTERN EUROPE INCLUDING AUSTRALIA, JAPAN, CANADA AND U.S.A)
*** OPEC COUNTRIES (ALGERIA, INDONESIA, IRAN, IRAQ, NIGERIA, SAUDI ARABIA AND VENEZUELA)
#1: (37,PP.196-99)

TABLE C4.17 TOTAL IMPORTS

		TOTAL IMPORTS 1974	AVERAGE ANNUAL RATE OF INCREASE 1971-74	E17: REGION'S IMPORT (RATE OF INCREASE) 1971-74	
		(U.S.$MIL) #1	(U.S.$MIL)	(U.S.$MIL)	
UKT REGION	UGANDA	213	7.6 #2		
	KENYA	1026	99	63.5	
	TANZANIA	811	84		
SGF REGION	SWITZERLAND	15,813	24 #4		
	WEST GERMANY	9,646	27	30.33	
	FRANCE	6,839	40		
					E17 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1986
PIA REGION	AFGHANISTAN	226	15 #3		
	IRAN	5,672	950	389	$800MIL
	PAKISTAN	1,732	202		

#1: (37,PP.132-40); #2: (72,PP.38-9); #3: (64,P.116) ;
#4: (62,P.30)

TABLE C4.18 TOTAL EXPORTS

		TOTAL EXPORTS 1974 (U.S.$MIL)#1	AVERAGE ANNUAL RATE OF INCREASE 1971-74 (U.S.$MIL)	E18: REGION'S EXPORT (RATE OF INCREASE) 1971-74 (U.S.$MIL)	
UKT REGION	UGANDA	315	14#2		
	KENYA	603	52	31.3	
	TANZANIZ	427	28		
SGF REGION	SWITZERLAND	15,912	25#4		
	WEST GERMANY	8,748	32	28	
	FRANCE	5,512	27		
					E18 LEVEL WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KPR BY: 1989
PIA REGION	AFGHANISTAN	224	32.0 #3		
	IRAN	6,400	63.0	68	$200
	PAKISTAN	1,105	110.0		

#1: (37,PP.132-40); #2: (72,PP.38-9); #3: (64,P.116) ;
#4: (62,P.30)
NOTE: IRAN'S EXPORT OF OIL IS NOT INCLUDED WHICH WAS $17602MIL

TABLE C4.19 PERCENTAGES OF PEOPLE OF VARIOUS RELIGIOUS PREFERENCE IN THREE REGIONS

	RELIGION: 1974	MUSLEMS (%)	CHRISTIANS (%)	ANIMIST (%)	JEWISH & OTHERS (%)	
UKT REGION	UGANDA#1	6	50			
	KENYA#2	3	22	38		
	TANZANIA#3	30	30	40		
SGF REGION	SWITZERLAND#4		93		2.0	
	WEST GERMANY#5		93.5			
	FRANCE#6		90			
						E19: DIVERSITY OF RELIGIONS WOULD INCREASE WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1985 (%)
PIA REGION	AFGHANISTAN#7	99			0.001	
	IRAN#8	93			7	
	PAKISTAN#9	96			4	.5

#1: (16,P.1); #2: (12,P.1); #3: (15,P.1); #4: (14,P.1); #5: (10,P.1); #6: (9,P.1); #7: (8.P.1); #8: (11,P.1); #9: (13,P.1)

TABLE C4.20 DESCRIPTION OF DEVELOPMENTAL EVENTS RELEVANT TO THE IMPACTS OF THE KRR

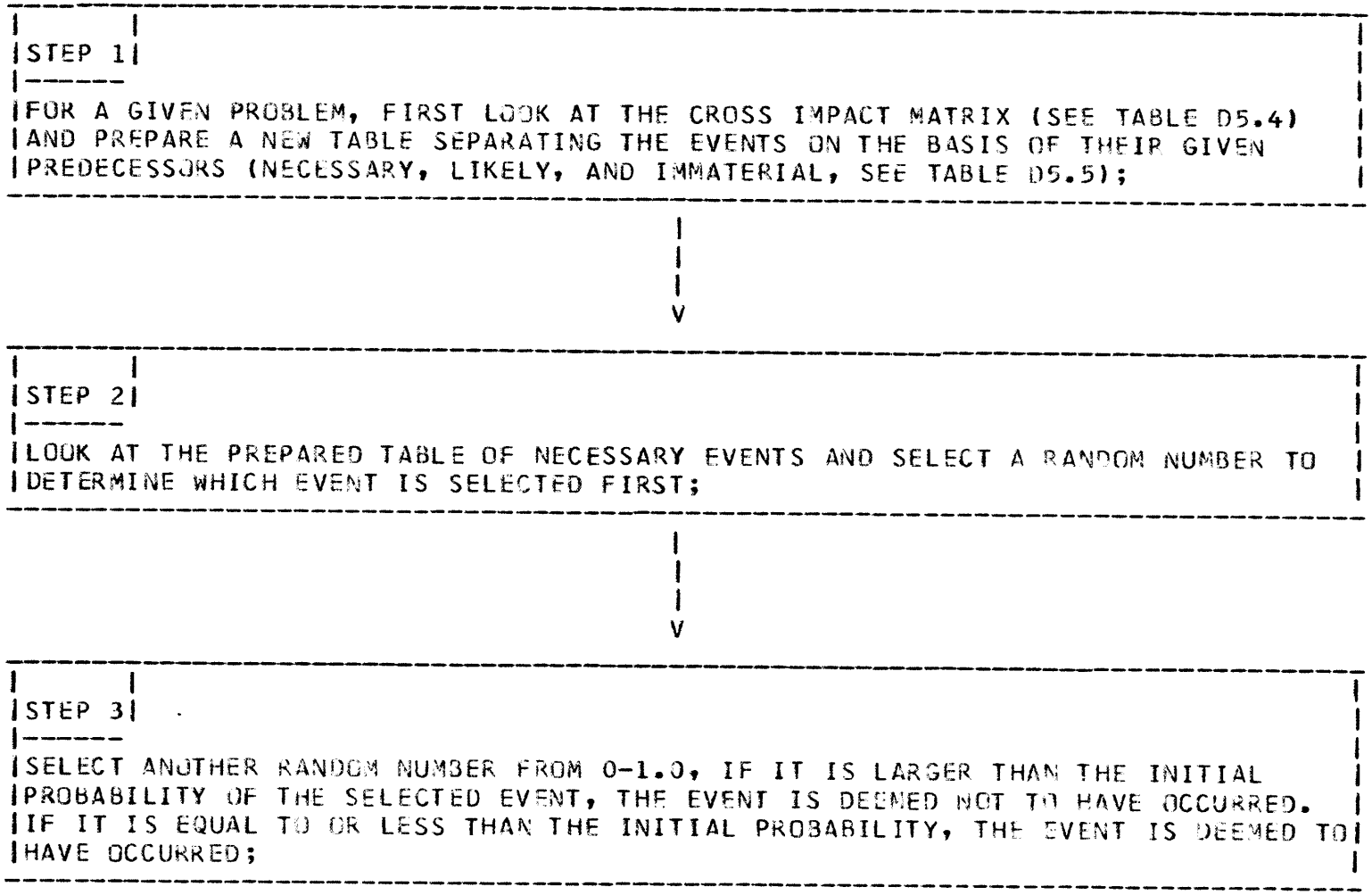
EVENT DESCRIPTION	EVENT PREDICTED DATE WITH A 0.50 PROBABILITY OF OCCURRENCE
E21: USE OF RAILWAY BY NOMADES	1985
E22: REMOVAL OF TARIFF AND TAXES ON REGION'S FREIGHT MOVEMENTS	1985
E23: ENHANCING REGION'S ARCHEOLOGICAL DISCOVERIES BY PARTICIPATION AND TOTAL FINANCIAL SUPPORT FROM U.S.A., CHINA, AND JAPAN	1987
E24: ESTABLISHMENT OF TELEVISION IN AFGHANISTAN	1982
E25: REMOVAL OF VISA FORMALITIES	1992
E19: POLITICAL HARMONY	1985

APPENDIX D

A SMALL THEORETICAL EXAMPLE OF THE CIT

This appendix presents a small theoretical example of the CIT displayed by three identified events and resultants are obtained by the hand calculation and throught the application of computer. A flow chart is included to show the CIT planning logic.

STEPS REQUIRED TO ESTIMATE THE HORIZON-YEAR PROBABILITY OCCURRENCES.



STEP 4

IF THE FIRST EVENT IS DEEMED NOT TO HAVE OCCURRED, THE INITIAL PROBABILITIES FOR THE REMAINING EVENTS ARE MAINTAINED AND THE PROCESS REPEATED FROM STEP 2. OTHERWISE THE INITIAL PROBABILITIES ARE ADJUSTED BY USING EQUATION (5.5):

$$\hat{Pr}(E_j) = -m_{ij} s_{ij} \frac{t - t_j}{t} \left[Pr(E_j) \right]^2 + \left[1 + m_{ij} s_{ij} \frac{t - t_j}{t} \right] Pr(E_j) \quad \cdots\cdots\cdots \quad (5.5)$$

STEP 5

AFTER COMPUTING THE NEW PROBABILITIES, REPEAT THE PROCESS FROM STEP 2 (BUT NOT USING THE SAME NECESSARY PREDECESSOR WHICH WAS ALREADY TESTED). A RANDOM NUMBER AGAIN IS COMPARED WITH THE NEW PROBABILITY AND IF THE FORMER IS LARGER, THE EVENT IS DEEMED NOT TO HAVE OCCURRED (OR ALTERNATELY IF SMALLER);

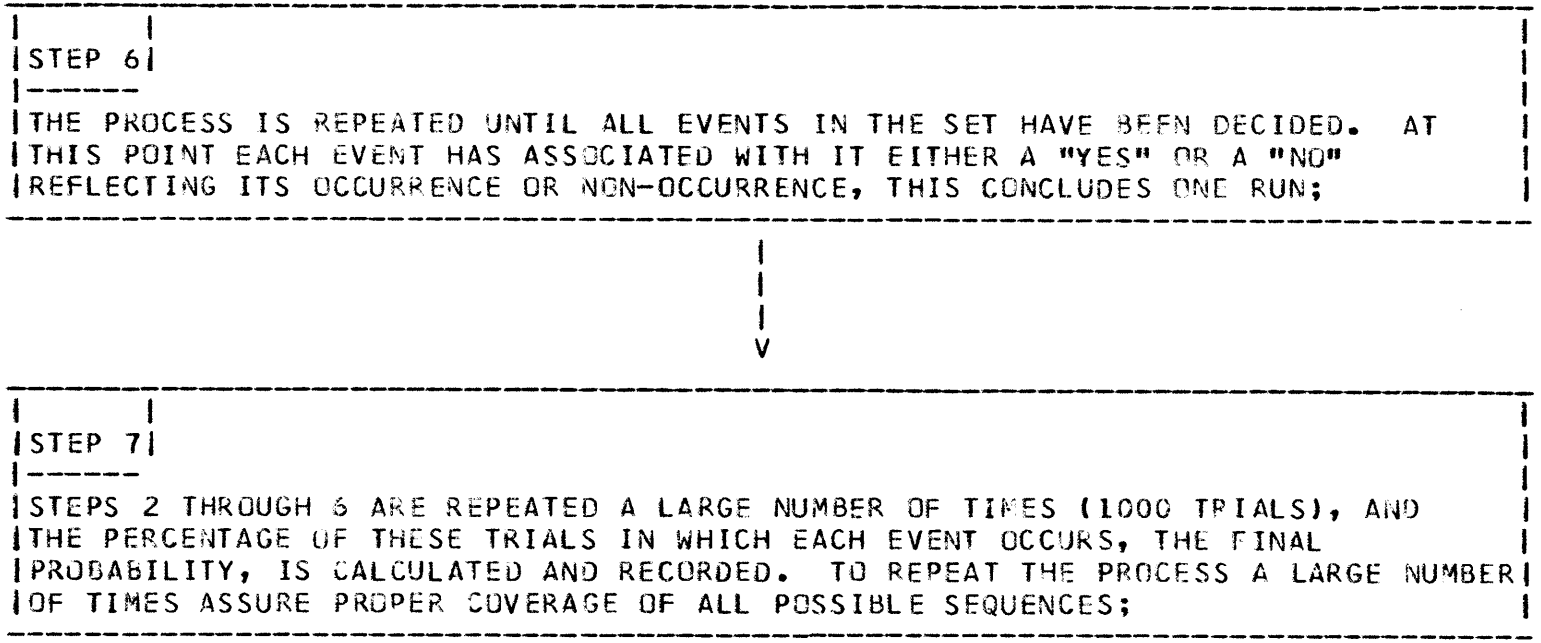


FIGURE D5.1 A PORTRAYAL OF STEPS NECESSARY TO CALCULATE THE FINAL PROBABILITY OF OCCURRENCE OF AN EVENT.

A Small Theoretical Example

This example involves three developmental events that might be affected by the KRR. Tables D5.1-D5.3 show the events' present and future levels. The relationships between these events are established and presented in Table D5.4. The second and third column in this table are the events' initial probabilities and dates at which there is a 50 percent likelihood of occurrence. The first digit in each number in columns 4 to 6 is strength or force of interaction (S_{ij}) between event i and j. The S_{ij} values vary from 0.0-0.9 (0 - weakest effect, 0.9 - strongest effect). The negative entries indicate an inhibiting effect and the positive an enhancing one. The entries along the diagonal are undefined. The second digit of the number in the right sill of the matrix (Table D5.4), represents the predecessor grouping; if the digit is 0, 1, or 2, the predecessor event is immaterial, likely, or necessary, respectively, for the successor.

The matrix is used as follows:

1. We separated the necessary, likely, and immaterial events into their respective groups (see Table D5.5);
2. We looked at Table D5.5 of which both event 1 and 2 is grouped as necessary predecessors. By selecting a random number, we found that event 2 should be tried first;
3. We selected another random number (from 0-1.0), which was 0.2. Since $0.2 \leq 0.5$ (the initial probability of event 2), that event is occur. A "1" then is added to column 3 of Table D5.6 which accounts for one occurrence of event 2 in

TABLE D5.1: ROAD NETWORK LENGTH

	ROAD NETWORK LENGTH (KM) #1			E1: REGION'S TOTAL ROAD NETWORK LENGTH (KM)	E1 WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1980
	PAVED	GRAVEL AND EARTH	TOTAL		
		(1969)		(1969)	
AFGHANISTAN	2,000	15,000	17,000		
IRAN	10,200	25,600	35,800	52,487	60,000
PAKISTAN	27,568	77,093	104,661		

#1: (80,P.1803)

TABLE D5.2 TOTAL EXPORTS

	TOTAL EXPORT 1974	AVERAGE ANNUAL RATE OF INCREASE 1971-74	E2: REGION'S EXPORT (RATE OF INCREASE) 1971-74	E2 WITH A 0.50 PROBABILITY OF OCCURRENCE RELEVANT TO THE IMPACTS OF THE KRR BY: 1989
	(U.S. $MIL.)#1	(U.S. $MIL.)#2	(U.S. $MIL.)	
AFGHANISTAN	226	32.0		
IRAN	6,400	63.0	68	$200
PAKISTAN	1,105	110.0		

#1: (37,PP.132-40); #2: (64,P.116)

TABLE D5.3 DESCRIPTION OF DEVELOPMENTAL EVENT RELEVANT TO THE IMPACTS OF THE KRR

	EVENT DESCRIPTION	EVENT PREDICTED DATE WITH 0.50 PROBABILITY OF OCCURRENCE
E3:	REMOVAL OF TARRIFF AND TAXES ON REGION'S FREIGHT MOVEMENT	1985

TABLE D5.4 CROSS IMPACT TABLE FOR A SAMPLE OF THREE DEVELOPMENTAL EVENTS RELATED TO THE KRR

			THEN THESE EVENTS CHANGE AS*		
IF THIS EVENT HAPPENS	ASSUMED INITIAL PROBABILITY OF OCCURRENCE OF EVENT $Pr(E_i)$	ASSUMED DATES OF OCCURRENCE OF EVENT t_i	E1: INCREASE IN ROAD NETWORK LENGTH	E2: INCREASE IN EXPORTS	E3: REMOVAL OF TARIFF AND TAXES
E1: INCREASE IN ROAD NETWORK LENGTH	0.50	1980		.62	.10
E2: INCREASE IN EXPORTS	0.50	1989	.62		.41
E3: REMOVAL OF TARIFFS AND TAXES	0.50	1985	.21	.41	

*ALL RELATIONS ARE POSITIVE UNLESS PROCEEDED BY MINUS SIGN
FIRST DIGIT: STRENGTH(0.0-0.9)
SECOND DIGIT: PREDECESSOR RELATIONSHIPS: 0-IMMATERIAL
1-LIKELY
2-NECESSARY

TABLE D5.5 EVENTS ORDERED ON THE BASIS OF THEIR VARIOUS PREDECESSOR VALUES

EVENTS FROM NECESSARY PREDECESSOR GROUP	EVENTS FORM LIKELY PREDECESSOR GROUP	EVENTS WITH IMMAMATERIAL DESIGNATION
1	3	
2		

TABLE D5.6 ANALYSIS OF FINAL PROBABILITIES OBTAINED FROM THE APPLICATION OF THE CROSS IMPACT TECHNIQUE BY HAND CALCULATION

EVENT DESCRIPTION	ASSUMED EVENT INITIAL LIKELIHOOD OF OCCURRENCE	PROBABILITY COUNT TRIALS										FINAL PROB (NUMBER OF TIMES EVENT HAD HAPPENED/ 10)	DELTA PROB.= INITIAL PROB.- FINAL PROB.	RANK FINAL PROB.
		1	2	3	4	5	6	7	8	9	10			
E1: INCREASE IN ROAD NETWORK LENGTH	.50	0	0	1	0	1	0	1	0	1	0	4 TIMES OUT OF 10 TRIALS = 4/10 = .4	.10	3
E2: INCREASE IN EXPORTS	.50	1	1	0	0	1	0	1	0	0	1	5 TIMES OUT OF 10 TRIALS = 5/10 = .5	.00	2
E3: REMOVAL OF TARIFF & TAXES	.50	1	1	1	1	0	0	1	1	0	1	7 TIMES OUT OF 10 TRIALS = 7/10 = .7	.20	1

the first trial. Equation (5.5) subsequently is employed to calculate the adjusted probability of E1 and E3, with E1 first:

$$\acute{Pr}(E_j) = m_{ij}s_{ij}\frac{t-t_i}{t}[Pr(E_j)]^2 + [1 + m_{ij}s_{ij}\frac{t-t_i}{t}]\,Pr(E_j) \qquad (5.5)$$

$\acute{Pr}(E1) = ?$

$m_{ij} = 1$ (E2 enhances E1, see Table D5.4)

$s_{21} = 0.6$ (see Table D5.4)

t = horizon year - origin year = 2003 - 1978 (the origin year at which all probabilities are predicted from this date)

$t_i = t_i' - t_o$; $t_i' = t_2' = 1989$ (Table D5.4); $t_2 = 1989 - 1978$

$$\acute{Pr}(E1) = (-1)(.6)\left[\frac{25-(1989-1978)}{25}\right](.5)^2+[1+(1)(.6)\frac{25-(1989-1978)}{25}](.5)$$

$$\acute{Pr}(E1) = (-1)(.6)(.56)(.25) + [1+(.336)](.5) = -0.084 + .668$$
$$= 0.584$$

Therefore $\acute{Pr}(E1) = 0.584$.

$Pr(E3) = ?$

$m_{ij} = 1$ (E2 enhances E3, see Table D5.4)

$s_{23} = .4$

$t = 25$ years

$t_i' = t_2' = 1989$

$t_o = 1978$

We used equation (5.5):

$$\hat{Pr}(E3) = (-1)(.4)\left[\frac{25-(1989-1978)}{25}\right](.5)^2 +$$

$$+ 1 + (.4)\left[\frac{25-(1989-1978)}{25}\right](.5)$$

$$= (-1)(.4)\left[\frac{25-11}{25}\right](.25) + 1 + .224\ (.5)$$

$$= (-1)(.224)(.25) + (.612)$$

$$= -0.056 + .612 = .556$$

$\hat{Pr}(E3) = .556$

$\grave{Pr}(E1) = .584$ and $\grave{Pr}(E3) = .556$

4. We selected a random number which was 0.8, since 0.8 > 0.584 (the adjusted probability of E1); therefore, E1 did not occur;
5. We referred to Table D5.6 and added zero on column 3 which indicated non-occurrence for E1 under the first trial;
6. We selected a random number which was 0.3, since 0.3 < .556 (the adjusted probability of E3); therefore, E3 had occurred;
7. We referred to Table D5.6 and added "1" for E3 which had occurred.

The first trial was over and all three events had been tested. The results of the 10 trials are shown in Table D5.6.

There are many possible scenarios implicit in a single matrix, the total is thus given by 2^n, where n is the number of events in the matrix. For a small matrix, it is possible to investigate the outcome of all possible combinations. For a large matrix, without computer aid, the process is very time consuming. Equation (5.5) was programmed for the VPI and SU Computing Center IBM 370/158. The computer selected an event from among the predecessor group, and using random numbers, decided whether the event occurred. If it did, the probabilities of the remaining events were adjusted and the process repeated for the next events selected. These steps were repeated until all events were decided.

The planning logic and flow chart of the computer program is presented in Figure D5.2 (see Pocket). Tables D5.7 to D5.10 present the results of the 10 trials by computer. Table D5.11 shows a comparison of final probabilities estimated by hand and with the computer. It can be seen that these final probabilities are fairly close, but to obtain comparable results, it would be necessary to repeat the process a large number of times by both methods to assure proper coverage of all possible sequences.

TABLE D5.7 LISTING OF EVENTS BY ORDER OF INITIAL PROBABILITY

EVENT	INITIAL	DELTA	FINAL
1 ROAD NETWORK LENGTH	0.500	0.000	0.500
2 EXPORTS	0.500	0.100	0.600
3 REMOVAL OF TARIFF AND TAXES	0.500	0.300	0.800

TABLE D5.8 LISTING OF EVENTS BY ORDER OF DELTA PROBABALITY

EVENT	INITIAL	DELTA	FINAL	RANK
3 REMOVAL OF TARIFFS AND TAXES	0.500	0.300	0.800	1
2 EXPORTS	0.500	0.100	0.600	2
1 ROAD NETWORK LENGTHS	0.500	0.000	0.500	3

TABLE C5.9 LISTING OF EVENTS BY ORDER OF FINAL PROBABILITY

EVENT	INITIAL	DELTA	FINAL	RANK
3 REMOVAL OF TARIFFS AND TAXES	0.500	0.300	0.800	1
2 EXPORTS	0.500	0.100	0.600	2
1 ROAD NETWORK LENGTHS	0.500	0.000	0.500	3

TABLE D5.10 LISTING OF EVENTS IN ORDER PRESENTED 10 GAMES 3 EVENTS

	EVENT	INITIAL PROB	DELTA PROB	FINAL PROB	DELTA PROB	FINAL PROB
1	ROAD NETWORK LENGTHS	0.500	0.000	0.500	3	3
2	EXPORTS	0.500	0.100	0.600	2	2
3	REMOVAL OF TARIFF AND TAXES	0.500	0.300	0.800	1	1

TABLE D5.11 FINAL PROBABILITIES CALCULATED BY HAND AND COMPUTER

	FINAL PROBABILITY ESTIMATED BY HAND CALCULATION	FINAL PROBABILITY ESTIMATED BY THE COMPUTER
INCREASE IN ROAD NETWORK LENGTHS AS PREDICTED IN TABLE D5.1	.4	.5
INCREASE IN EXPORTS AS PREDICTED IN TABLE D5.1	.5	.6
REMOVAL OF TARIFFS & TAXES	.7	.8

APPENDIX E

INPUT DATA FOR THE CROSS IMPACT TECHNIQUE

This appendix presents the input data for the CIT application, which include the cross impact relationships for the 25 selected events, the initial probability of each event, and its expected date of occurrence.

TABLE E6.1 THE CROSS IMPACT RELATIONSHIPS FOR THE 25 SELECTED EVENTS

EVENT	DATE	INITIAL	IF THE VERTICAL EVENTS HAPPENED, THE HORIZONTAL EVENTS CHANGE PROBABILITY FIRST DIGIT = STRENGTH 0.0 – 0.9 SECOND DIGIT = PREDECESSOR, 0 – IMMATERIAL, 1 – LIKELY, 2 – NECESSARY									
			1	2	3	4	5	6	7	8	9	10
1	1980.	5	0.00	0.61	0.51	0.51	0.82	0.71	0.20	0.31	0.61	0.51
2	1980.	5	0.41	0.00	0.51	0.20	0.51	0.72	0.20	0.31	0.51	0.31
3	2003.	5	0.51	0.61	0.00	0.51	0.72	0.82	0.20	0.20	0.51	0.51
4	1978.	5	0.61	0.41	0.61	0.00	0.51	0.51	0.41	0.31	0.20	0.61
5	1985.	5	0.61	0.71	0.61	-0.20	0.00	0.51	0.30	0.20	0.20	0.31
6	1986.	5	0.41	0.31	0.61	0.20	0.20	0.00	0.51	0.20	0.21	0.21
7	1985.	5	0.20	0.10	0.10	0.20	0.20	0.72	0.00	0.10	-0.20	0.31
8	1983.	5	0.20	0.20	0.10	0.31	0.41	0.51	0.10	0.00	0.20	0.10
9	1984.	5	0.61	0.51	0.41	0.20	0.20	0.61	0.30	0.41	0.00	-0.31
10	1982.	5	0.31	0.31	0.41	-0.10	0.20	0.41	0.20	0.10	-0.20	0.00
11	1990.	5	0.31	0.21	0.31	-0.21	0.41	0.41	0.21	0.20	0.21	0.41
12	1995.	5	0.20	0.20	0.20	-0.10	0.21	0.31	0.31	0.20	0.30	0.31
13	1982.	5	0.10	0.10	0.10	0.31	0.20	0.41	0.10	0.10	0.31	0.31
14	1991.	5	0.31	0.31	0.31	0.21	0.31	0.41	0.31	0.41	0.31	0.41
15	1989.	5	0.51	0.72	0.51	-0.31	0.51	0.62	0.52	0.51	0.61	0.61
16	1983.	5	0.62	0.21	0.62	-0.31	0.41	0.41	0.41	0.21	0.21	0.62
17	1986.	5	0.31	0.31	0.31	0.21	0.51	0.41	0.31	0.31	0.41	0.31
18	1989.	5	0.62	0.62	0.62	0.21	0.31	0.52	0.41	0.41	0.31	0.51
19	1985.	5	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.20	0.10	0.00
20	1993.	5	0.31	0.21	0.31	4.10	0.51	0.21	0.11	0.11	0.41	0.21
21	1980.	5	0.00	0.00	0.21	0.00	0.00	-0.11	0.00	0.00	0.11	0.11
22	1985.	5	0.21	0.31	0.21	0.21	0.31	0.21	0.11	0.10	0.11	0.11
23	1987.	5	0.10	0.10	0.10	0.21	0.41	0.21	0.00	0.10	0.00	0.10
24	1982.	5	0.11	0.21	0.21	0.10	0.31	0.41	0.41	0.31	0.51	0.31
25	1992.	5	0.21	0.31	0.31	0.11	0.41	0.21	0.11	0.31	0.51	0.31

TABLE E6.1 (CONTINUED)

IF THE VERTICAL EVENTS HAPPENED, THE HORIZONTAL EVENTS CHANGE PROBABILITY
FIRST DIGIT = STRENGTH 0.0 - 0.9
SECOND DIGIT = PREDECESSOR, 0 - IMMATERIAL, 1 - LIKELY, 2 - NECESSARY

EVENT	DATE	INITIAL	1	2	3	4	5	6	7	8	9	10
1	1980.	5	0.00	0.61	0.51	0.51	0.82	0.71	0.20	0.31	0.61	0.51
2	1980.	5	0.41	0.00	0.51	0.20	0.51	0.72	0.20	0.31	0.51	0.31
3	2003.	5	0.51	0.61	0.00	0.51	0.72	0.82	0.20	0.20	0.51	0.51
4	1978.	5	0.61	0.41	0.61	0.00	0.51	0.51	0.41	0.31	0.20	0.61
5	1985.	5	0.61	0.71	0.61	-0.20	0.00	0.51	0.30	0.20	0.20	0.31
6	1986.	5	0.41	0.31	0.61	0.20	0.20	0.00	0.51	0.20	0.21	0.21
7	1985.	5	0.20	0.10	0.10	0.20	0.20	0.72	0.00	0.10	-0.20	0.31
8	1983.	5	0.20	0.20	0.10	0.31	0.41	0.51	0.10	0.00	0.20	0.10
9	1984.	5	0.61	0.51	0.41	0.20	0.20	0.61	0.30	0.41	0.00	-0.31
10	1982.	5	0.31	0.31	0.41	-0.10	0.20	0.41	0.20	0.10	-0.20	0.00
11	1990.	5	0.31	0.21	0.31	-0.21	0.41	0.41	0.21	0.20	0.21	0.41
12	1995.	5	0.20	0.20	0.20	-0.10	0.21	0.31	0.31	0.20	0.30	0.31
13	1982.	5	0.10	0.10	0.10	0.31	0.20	0.41	0.10	0.10	0.31	0.31
14	1991.	5	0.31	0.31	0.31	0.21	0.31	0.41	0.31	0.41	0.31	0.41
15	1989.	5	0.51	0.72	0.51	-0.31	0.51	0.62	0.52	0.51	0.61	0.61
16	1983.	5	0.62	0.21	0.62	-0.31	0.41	0.41	0.41	0.21	0.21	0.62
17	1986.	5	0.31	0.31	0.31	0.21	0.51	0.41	0.31	0.31	0.41	0.31
18	1989.	5	0.62	0.62	0.62	0.21	0.31	0.52	0.41	0.41	0.31	0.51
19	1985.	5	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.20	0.10	0.00
20	1993.	5	0.31	0.21	0.31	4.10	0.51	0.21	0.11	0.11	0.41	0.21
21	1980.	5	0.00	0.00	0.21	0.00	0.00	-0.11	0.00	0.00	0.11	0.11
22	1985.	5	0.21	0.31	0.21	0.21	0.31	0.21	0.11	0.10	0.11	0.11
23	1987.	5	0.10	0.10	0.10	0.21	0.41	0.21	0.00	0.10	0.00	0.10
24	1982.	5	0.11	0.21	0.21	0.10	0.31	0.41	0.41	0.31	0.51	0.31
25	1992.	5	0.21	0.31	0.31	0.11	0.41	0.21	0.11	0.31	0.51	0.31

TABLE E6.1 (CONTINUED)

EVENT	DATE	INITIAL	IF THE VERTICAL EVENTS HAPPENED, THE HORIZONTAL EVENTS CHANGE PROBABILITY FIRST DIGIT = STRENGTH 0.0 - 0.9 SECOND DIGIT = PREDECESSOR, 0 - IMMATERIAL, 1 - LIKELY, 2 - NECESSARY				
			21	22	23	24	25
1	1980.	5	0.00	0.10	0.21	0.11	0.11
2	1980.	5	0.00	0.00	0.11	0.21	0.11
3	2003.	5	0.21	0.21	0.21	0.31	0.21
4	1978.	5	0.00	0.11	0.21	0.21	0.11
5	1985.	5	0.00	0.00	0.52	0.10	0.41
6	1986.	5	0.00	0.00	0.00	0.00	0.00
7	1985.	5	0.00	0.00	0.00	0.11	0.00
8	1983.	5	0.10	0.00	0.10	0.10	0.10
9	1984.	5	0.10	-0.21	0.10	-0.21	-0.21
10	1982.	5	0.11	0.10	0.10	0.11	0.11
11	1990.	5	0.11	0.00	0.10	0.10	0.00
12	1995.	5	0.00	0.00	0.00	0.00	0.00
13	1982.	5	0.11	0.00	0.00	0.00	0.00
14	1991.	5	0.11	0.10	0.11	0.31	0.31
15	1989.	5	0.10	0.10	0.21	0.31	0.11
16	1983.	5	0.11	0.10	0.31	0.31	0.11
17	1986.	5	0.11	0.21	0.00	0.11	0.41
18	1989.	5	0.00	0.41	0.10	0.11	0.51
19	1985.	5	0.00	0.10	0.00	-0.10	0.41
20	1993.	5	0.41	0.31	0.41	0.51	0.00
21	1980.	5	0.00	0.10	0.00	0.10	0.11
22	1985.	5	0.11	0.00	0.10	0.11	0.51
23	1987.	5	0.00	0.10	0.00	0.00	0.10
24	1982.	5	0.11	0.11	0.11	0.00	0.00
25	1992.	5	0.31	0.51	0.41	0.21	0.00

APPENDIX F

THE CROSS IMPACT TECHNIQUE COMPUTER PROGRAM AND RESULTS

This appendix presents the computer program and the CIT results with respect to the 25 developmental events identified as major impacts of KRR.

THE CIT COMPUTER PROGRAM FOR THE 25 DEVELOPMENTAL EVENTS RELEVANT TO THE KRR

```
      INTEGER P(200,200),LIK(200),EO(200),EH(200),PN(200),DELTA(200)
     DIMENSION PNP(200),DATE(200),S(200,200),NAME( 7,200)
      COMMON/SELECT/ NS, Z, J, ITEST(200), I, NP(3), IFIN, LIK
      COMMON/SELECT/ NEO(200), IMM(200),IT
      DATA IX / 65539 /
      DATA EH / 200 * 0 /
      DATA NE, NT, BY, PY / 25,1000, 1978.0, 2003.0 /
     DO704I=1,5
     WRITE(6,700)
 700 FORMAT(' <<<<<',33X,'*****    TOP LINE OF PAGE    *****',33X,
    1'>>>>>')
     DO702J=1,64
     WRITE(6,701)
 701 FORMAT(' <<<<<',45X,'ALIGNMENT',46X,'>>>>>')
 702 CONTINUE
     WRITE(6,703)
 703 FORMAT(' <<<<<',33X,'*****  BOTTOM LINE OF PAGE    *****',33X,
    1'>>>>>')
 704 CONTINUE
999    CONTINUE
       T = PY - BY
       DO 1 K=1,NE
   1 READ(5,2) EO(K),(NAME(N,EO(K)),N=1, 7),PN(EO(K)),DATE(EO(K)),
    1(S(EO(K),L),P(EO(K),L),L=1,NE)
   2 FORMAT(I3,2X,7A4,41X,I1,1X,F4.0/10(4X,19(F3.1,I1)/),4X,10(F3.1,I1)
    1)
       M = 1
       N = 10
199    IF(N.GT.NE) N=NE
       WRITE(6,202) ((L), L=M,N)
 202 FORMAT(1H1,12(/), 27X,'I',2X,'IF THE VERTICAL EVENTS HAPPENED, THE
    1 HORIZONTAL EVENTS CHANGE'/1H ,26X,'N',2X,'PROBABILITY'/1H ,16X,'E
```

```
     2',9X,'I',2X,'FIRST DIGIT = STRENGTH  0.0 - 0.9'/1H ,16X,'V',4X,'O'
     3,4X,'T',2X,'SECOND DIGIT = PREDECESSOR, 0 - IMMATERIAL, 1 - LIKELY
     4,'/1H ,16X,'E',4X,'A',4X,'I',2X,'2 - NECESSARY'/1H ,16X,'N',4X,'T'
     5,4X,'A'/1H ,16X,'T',4X,'E',4X,'L',2016/)
       DO 201 K=1,NE
       IF(N.GT.NE) N = NE
       WRITE(6,200) EO(K), DATE(EO(K)), PN(EO(K)), (S(EO(K),L),
     1  P(EO(K),L), L=M,N)
200    FORMAT(1H ,15X,I3,F6.0,I3,20(F5.1,I1))
201    CONTINUE
       IF(N.EQ.NE) GO TO 203
       M = N + 1
       N = N + 10
       GO TO 199
203    CONTINUE
       DO 3 I=1,3
   3   NP(I) = 0
       DO 6 M=1,NE
       DO 4 L=1,NE
       IF(P(M,L).EQ.2) GO TO 17
   4   CONTINUE
       DO 5 L=1,NE
       IF(P(M,L).EQ.1) GO TO 18
   5   CONTINUE
       NP(3) = NP(3) +1
       IMM(NP(3)) = EO(M)
   6   CONTINUE
       DO 14 IT = 1,NT
       I = 0
       NS = 0
       IFIN = 0
       DO 10 L=1,NE
```

```
      PNP(L) = FLOAT(PN(L)) / 10.0
 10   ITEST(L) = 0
 11   CALL RANDU(IX,IY,Z)
      IX = IY
      CALL EVENT
      IF(IFIN.EQ.1) GO TO 14
     CALL RANDU(IX,IY,Z)
     IX=IY
      IF(Z.LE.PNP(J)) GO TO 100
      GO TO 11
100   EH(J) = EH(J) +1
      DO 12 K=1,NE
      IF(S(J,K).NE.0.0) GO TO 13
 12   CONTINUE
      GO TO 11
 13   TM = DATE(J)  - DY
      TF = (T-TM) / T
      IF(DATE(J).EQ.0.0) TF = 1.0
      IF(T.LE.TM) GO TO 12
      A = S(J,K) * TF * (-1.0)
      PNP(K) = (A * PNP(K)**2) + ((1.0 - A) * PNP(K))
      GO TO 12
 14   CONTINUE
      DO 16 L=1,NE
      PN(L) = PN(L) * 100
      EH(L) = (EH(L) * 1000) / NT
      DELTA(L) = EH(L) - PN(L)
     WRITE(1,15) L,PN(L),DELTA(L),EH(L),(NAME(M,L),M=1, 7)
 15  FORMAT(4I5, 7A4)
 16   CONTINUE
      GO TO 19
 17   NP(1) = NP(1) + 1
```

```
      NEC(NP(1)) = ED(M)
      GO TO 6
18    NP(2) = NP(2) + 1
      LIK(NP(2)) = ED(M)
      GO TO 6
19    STOP
      DEBUG UNIT(6), SUBCHK
      AT 999
      END
```

```
      SUBROUTINE EVENT
      INTEGER LIK(200)
      DIMENSION NA(200)
      COMMON/SELECT/ NS, Z, J, ITEST(200), I, NP(3), IFIN, LIK
      COMMON/SELECT/ NEC(200), IMM(200),IT
    1 CONTINUE
      IF(NS.EQ.0) GO TO 4
      K = (Z * NS) + 1.0
      IF(K.GT.NS) K = K + 1
      J = NA(K)
      NS = NS - 1
      IF(K.EQ.(NS+1)) GO TO 3
      DO 2 M=K,NS
    2 NA(M) = NA(M+1)
    3 ITEST(J) = 1
      GO TO 12
    4 I = I + 1
      IF(I.GT.3) GO TO 11
      IF(NP(I).EQ.0) GO TO 4
      IF(I-2) 9,5,7
    5 NS = NP(2)
      DO 6 M=1,NS
    6 NA(M) = LIK(M)
      GO TO 1
    7 NS = NP(3)
      DO 8 M=1,NS
    8 NA(M) = IMM(M)
      GO TO 1
    9 NS = NP(1)
      DO 10 M=1,NS
   10 NA(M) = NEC(M)
      GO TO 1
```

```
11    IFIN = 1
12    CONTINUE
      RETURN
      END
```

```
      INTEGER E(200), EN(200)
      DIMENSION IR(200), P(200), DELTA(200), EH(200), IDR(200),
     1  IFR(200), NAME( 7,200)
      DATA NT / 1000/
999   CONTINUE
  1   IC = 1
  2   NE = 1
  3   READ(2,4) E(NE), P(E(NE)), DELTA(E(NE)), EH(E(NE)),
     1(NAME(M,E(NE)),M=1, 7)
  4   FORMAT(I5, 3F5.3, 7A4)
      EB = P(E(NE))
      IR(E(NE)) = IC
  5   NE = NE + 1
      READ(2,4,END=7) E(NE), P(E(NE)), DELTA(E(NE)), EH(E(NE)),
     1(NAME(M,E(NE)),M=1, 7)
      IF(EB.EQ.P(E(NE))) GO TO 6
      IC = IC + 1
  6   IR(E(NE)) = IC
      EB = P(E(NE))
      GO TO 5
  7   NE = NE - 1
      WRITE(6,9)
  9   FORMAT(1H1,12(/),
     *              30X,  'LISTING OF EVENTS BY ORDER OF INITIAL PROBABIL
     1ITY'/1H , 89X, 'RANK'  / 1H , 18X, 'EVENT', 31X, 'INITIAL', 5X,
     2  'DELTA',  5X, 'FINAL', 5X, 'INITIAL'/)
      WRITE(6,10) (E(I), (NAME(K,E(I)),K=1, 7),P(E(I)), DELTA(E(I)),
     1  EH(E(I)), IR(E(I)), I=1,NE)
 10 FORMAT(1H ,15X,I3,1X,7A4,2F12.3,F11.3,I10)
      IC = 1
      NE = 1
      READ(3,4) E(NE)
```

```
      EB = DELTA(E(NE))
      IDR(E(NE)) = IC
11    NE = NE + 1
      READ(3,4,END=13) E(NE)
      IF(EB.EQ.DELTA(E(NE))) GO TO 12
      IC = IC + 1
12    IDR(E(NE)) = IC
      EB = DELTA(E(NE))
      GO TO 11
13    NE = NE - 1
      WRITE(6,14)
14    FORMAT(1H1,12(/),
     *              31X, 'LISTING OF EVENTS BY ORDER OF DELTA PROBABILITY
     1'/ 1H0, 39X, 'RANK' / 1H0, 28X, 'EVENT', 20X, 'INITIAL', 6X,  'DEL
     2TA',  6X, 'FINAL', 7X, 'DELTA'/)
      WRITE(6,10) (E(I), (NAME(K,E(I)),K=1, 7),P(E(I)), DELTA(E(I)),
     1  EH(E(I)), IDR(E(I)), I=1,NE)
      IC = 1
      NE = 1
      READ(4,4) E(NE)
      EB = EH(E(NE))
      IFR(E(NE)) = IC
15    NE = NE + 1
      READ(4,4,END=17) E(NE)
      IF(EB.EQ.EH(E(NE))) GO TO 16
      IC = IC + 1
16    IFR(E(NE)) = IC
      EB = EH(E(NE))
      GO TO 15
17    NE = NE - 1
      WRITE(6,18)
18    FORMAT(1H1,12(/),
```

```
     *            31X, 'LISTING OF EVENTS BY ORDER OF FINAL PROBABILITY'
     1  / 1H , 89X, 'RANK' / 1H , 28X, 'EVENT',20X, 'INITIAL',6X,
     2  'DELTA',  6X, 'FINAL', 7X, 'FINAL'/)
19    WRITE(6,10) (E(I), (NAME(K,E(I)),K=1, 7),P(E(I)), DELTA(E(I)),
     1  EH(E(I)), IFR(E(I)), I=1,NE)
      WRITE(6,20) NT, NE
20    FORMAT(1H1,12(/),
     *             23X, 'LISTING OF EVENTS IN ORDER PRESENTED', 2X, I6,
     1 ' GAMES', I7, ' EVENTS'/ 1H ,  82X,'RANK'
     2 / 1H , 28X, 'EVENT', 18X, 'INITIAL', 2X,  'DELTA', 2X,  'FINAL',
     3  2X, 'INITIAL', 2X, 'DELTA', 2X, 'FINAL'/1H , 52X, 'PROB',
     4  4X, 'PROB',        3X, 'PROB',       4X, 'PROB', 4X, 'PROB',
     5  3X, 'PROB'/)
      WRITE(6,21) (I, (NAME(K,I), K=1, 7),P(I), DELTA(I), EH(I), IR(I),
     1  IDR(I), IFR(I), I=1,NE)
21    FORMAT(1H ,15X,I3,1X,7A4,F10.3,1X,2F7.3,I6,I8,I7)
      STOP
      DEBUG UNIT(6), SUBCHK
      AT 999
      END
```

TABLE F6.1 LISTING OF EVENTS BY ORDER OF INITIAL PROBABILITY

EVENT	INITIAL	DELTA	FINAL	RANK INITIAL
1 ROAD NETWORK LENGTHS	0.500	0.158	0.658	1
2 TOTAL NUMBER OF VEHICLES	0.500	0.170	0.670	1
3 RAIL ROUTE LENGTHS	0.500	0.210	0.710	1
4 WORLD BANK LENDING	0.500	0.324	0.824	1
5 TOURIST RECEIPTS	0.500	0.192	0.692	1
6 ENERGY CONSUMPTION/CAPITA	0.500	0.466	0.966	1
7 ELECTRIC CONSUMPTION/CAPITA	0.500	0.144	0.644	1
8 DAILY NEWS PAPER CIRCULATION	0.500	0.363	0.863	1
9 URBAN POPULATION	0.500	0.388	0.888	1
10 FOOD PRODUCTION	0.500	0.179	0.679	1
11 LIFE EXPECTANCY	0.500	0.380	0.880	1
12 POPULATION PER HOSPITAL BED	0.500	0.347	0.847	1
13 INFANT MORTALITY RATE	0.500	0.341	0.841	1
14 ADULT LITERACY RATE	0.500	0.177	0.677	1
15 GROSS NATIONAL PRODUCT (GNP)	0.500	0.184	0.684	1
16 AID	0.500	0.018	0.518	1
17 IMPORTS	0.500	0.128	0.628	1
18 EXPORTS	0.500	0.179	0.679	1
19 RELIGION	0.500	0.255	0.755	1
20 POLITICAL HARMONY	0.500	0.305	0.805	1
21 USE OF RAILWAY BY NOMADES	0.500	0.135	0.635	1
22 REMOVAL OF TARIFF AND TAXES	0.500	0.151	0.651	1
23 ARCHEOLOGICAL DISCOVERY	0.500	0.234	0.734	1
24 TELEVISION ESTABLISHMENT	0.500	0.086	0.586	1
25 REMOVAL OF VISA	0.500	0.256	0.756	1

TABLE F6.2 LISTING OF EVENTS BY ORDER OF DELTA PROBABILITY

	EVENT	INITIAL	DELTA	FINAL	RANK DELTA
6	ENERGY CONSUMPTION/CAPITA	0.500	0.466	0.966	1
9	URBAN POPULATION	0.500	0.388	0.888	2
11	LIFE EXPECTANCY	0.500	0.380	0.880	3
8	DAILY NEWS PAPER CIRCULATION	0.500	0.363	0.863	4
12	POPULATION PER HOSPITAL BED	0.500	0.347	0.847	5
13	INFANT MORTALITY RATE	0.500	0.341	0.841	6
4	WORLD BANK LENDING	0.500	0.324	0.824	7
20	POLITICAL HARMONY	0.500	0.305	0.805	8
25	REMOVAL OF VISA	0.500	0.256	0.756	9
19	RELIGION	0.500	0.255	0.755	10
23	ARCHEOLOGICAL DISCOVERY	0.500	0.234	0.734	11
3	RAIL ROUTE LENGTHS	0.500	0.210	0.710	12
5	TOURIST RECEIPTS	0.500	0.192	0.692	13
15	GROSS NATIONAL PRODUCT (GNP)	0.500	0.184	0.684	14
10	FOOD PRODUCTION	0.500	0.179	0.679	15
18	EXPORTS	0.500	0.179	0.679	15
14	ADULT LITERACY RATE	0.500	0.177	0.677	16
2	TOTAL NUMBER OF VEHICLES	0.500	0.170	0.670	17
1	ROAD NETWORK LENGTHS	0.500	0.158	0.658	18
22	REMOVAL OF TARIFF AND TAXES	0.500	0.151	0.651	19
7	ELECTRIC CONSUMPTION/CAPITA	0.500	0.144	0.644	20
21	USE OF RAILWAY BY NOMADES	0.500	0.135	0.635	21
17	IMPORTS	0.500	0.128	0.628	22
24	TELEVISION ESTABLISHMENT	0.500	0.086	0.586	23
16	AID	0.500	0.018	0.518	24

TABLE F6.3 LISTING OF EVENTS BY ORDER OF FINAL PROBABILITY

	EVENT	INITIAL	DELTA	FINAL	RANK FINAL
6	ENERGY CONSUMPTION/CAPITA	0.500	0.466	0.966	1
9	URBAN POPULATION	0.500	0.388	0.888	2
11	LIFE EXPECTANCY	0.500	0.380	0.880	3
8	DAILY NEWS PAPER CIRCULATION	0.500	0.363	0.863	4
12	POPULATION PER HOSPITAL BED	0.500	0.347	0.847	5
13	INFANT MORTALITY RATE	0.500	0.341	0.841	6
4	WORLD BANK LENDING	0.500	0.324	0.824	7
20	POLITICAL HARMONY	0.500	0.305	0.805	8
25	REMOVAL OF VISA	0.500	0.256	0.756	9
19	RELIGION	0.500	0.255	0.755	10
23	ARCHEOLOGICAL DISCOVERY	0.500	0.234	0.734	11
3	RAIL ROUTE LENGTHS	0.500	0.210	0.710	12
5	TOURIST RECEIPTS	0.500	0.192	0.692	13
15	GROSS NATIONAL PRODUCT (GNP)	0.500	0.184	0.684	14
10	FOOD PRODUCTION	0.500	0.179	0.679	15
18	EXPORTS	0.500	0.179	0.679	15
14	ADULT LITERACY RATE	0.500	0.177	0.677	16
2	TOTAL NUMBER OF VEHICLES	0.500	0.170	0.670	17
1	ROAD NETWORK LENGTHS	0.500	0.158	0.658	18
22	REMOVAL OF TARIFF AND TAXES	0.500	0.151	0.651	19
7	ELECTRIC CONSUMPTION/CAPITA	0.500	0.144	0.644	20
21	USE OF RAILWAY BY NOMADES	0.500	0.135	0.635	21
17	IMPORTS	0.500	0.128	0.628	22
24	TELEVISION ESTABLISHMENT	0.500	0.086	0.586	23
16	AID	0.500	0.018	0.518	24

TABLE F6.4 LISTING OF EVENTS IN ORDER PRESENTED 1000 GAMES 25 EVENTS

	EVENT	INITIAL PROB	DELTA PROB	FINAL PROB	RANK INITIAL PROB	RANK DELTA PROB	RANK FINAL PROB
1	ROAD NETWORK LENGTHS	0.500	0.158	0.658	1	18	18
2	TOTAL NUMBER OF VEHICLES	0.500	0.170	0.670	1	17	17
3	RAIL ROUTE LENGTHS	0.500	0.210	0.710	1	12	12
4	WORLD BANK LENDING	0.500	0.324	0.824	1	7	7
5	TOURIST RECEIPTS	0.500	0.192	0.692	1	13	13
6	ENERGY CONSUMPTION/CAPITA	0.500	0.466	0.966	1	1	1
7	ELECTRIC CONSUMPTION/CAPITA	0.500	0.144	0.644	1	20	20
8	DAILY NEWS PAPER CIRCULATION	0.500	0.363	0.863	1	4	4
9	URBAN POPULATION	0.500	0.388	0.888	1	2	2
10	FOOD PRODUCTION	0.500	0.179	0.679	1	15	15
11	LIFE EXPECTANCY	0.500	0.380	0.880	1	3	3
12	POPULATION PER HOSPITAL BED	0.500	0.347	0.847	1	5	5
13	INFANT MORTALITY RATE	0.500	0.341	0.841	1	6	6
14	ADULT LITERACY RATE	0.500	0.177	0.677	1	16	16
15	GROSS NATIONAL PRODUCT (GNP)	0.500	0.184	0.684	1	14	14
16	AID	0.500	0.018	0.518	1	24	24
17	IMPORTS	0.500	0.128	0.628	1	22	22
18	EXPORTS	0.500	0.179	0.679	1	15	15
19	RELIGION	0.500	0.255	0.755	1	10	10
20	POLITICAL HARMONY	0.500	0.305	0.805	1	8	8
21	USE OF RAILWAY BY NOMADES	0.500	0.135	0.635	1	21	21
22	REMOVAL OF TARIFF AND TAXES	0.500	0.151	0.651	1	19	19
23	ARCHEOLOGICAL DISCOVERY	0.500	0.234	0.734	1	11	11
24	TELEVISION ESTABLISHMENT	0.500	0.086	0.586	1	23	23
25	REMOVAL OF VISA	0.500	0.256	0.756	1	9	9

APPENDIX G

RESULTS OF THE SENSITIVITY ANALYSIS

This appendix presents the CIT results of the sensitivity analysis run; the results were obtained after changing the initial probability and date of occurrence of each event. The purpose was to examine the most direct and indirect effects of one event on another relevant to the impacts of the KRR.

TABLE G6.1 THE RESULT OF THE SENSITIVITY ANALYSIS RUN

SENSITIVITY FACTORS

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.63	0.10	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.13	0.63	0.10	0.0	0.03	0.0	0.0	0.0	0.0	0.03	0.0	0.0	0.0
3	0.03	0.0	0.63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.07	0.10	0.27	-0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.03	0.07	0.13	0.0	0.43	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0
6	0.03	0.07	0.13	0.03	0.03	0.17	0.13	0.03	0.0	0.03	0.0	0.03	0.03
7	0.0	0.03	0.03	0.0	0.0	0.0	0.03	0.0	0.0	0.07	0.0	0.0	0.0
8	0.07	0.03	0.07	0.0	0.0	0.0	0.0	0.37	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.0	0.0	0.0	0.0
10	0.0	0.0	0.10	0.0	0.0	0.0	0.03	0.0	0.0	0.67	0.0	0.0	0.0
11	0.07	0.03	0.10	0.0	-0.03	0.0	0.03	0.0	0.0	0.03	0.37	0.03	0.03
12	0.03	0.03	0.07	0.0	0.03	0.0	0.07	0.0	0.0	0.07	0.10	0.43	0.03
13	0.13	0.0	0.07	0.0	-0.03	0.0	0.10	0.0	-0.03	0.10	0.0	0.03	0.47

TABLE G6.1 (CONTINUED) SENSITIVITY FACTORS

	1	2	3	4	5	6	7	8	9	10	11	12	13
14	0.0	0.03	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.07	0.0	0.07	0.0	0.10	0.0	0.03	0.0	0.0	0.07	0.0	0.0	0.0
16	0.03	-0.03	0.03	0.0	-0.07	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0
17	0.03	0.0	0.07	0.0	0.03	0.0	0.03	0.0	0.0	-0.07	0.0	0.0	0.0
18	0.03	0.0	0.03	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.07	0.03	0.13	0.0	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.03	0.0	0.07	0.0	0.07	0.0	0.03	0.03	0.0	0.03	0.0	0.0	0.03
21	0.0	0.0	0.13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.03	0.0	0.10	0.0	0.0	0.0	0.0	0.0	-0.03	0.03	0.0	0.0	0.0
23	0.10	0.03	0.0	0.0	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.07	0.07	0.07	0.0	0.0	0.0	0.03	0.0	0.0	0.03	0.0	0.0	0.0
25	0.0	0.03	0.07	0.0	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE G6.1 (CONTINUED)

	SENSITIVITY FACTORS											
	14	15	16	17	18	19	20	21	22	23	24	25
1	0.0	0.03	0.07	0.0	0.13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.03	0.07	0.07	0.03	0.03	0.0	0.0	0.0	0.0	0.0	0.07	0.0
3	0.03	0.03	0.03	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.03	0.0
4	0.0	-0.03	0.0	0.0	0.0	0.0	0.20	0.0	0.0	0.03	0.0	0.0
5	0.03	0.10	0.03	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.0
6	0.10	0.13	0.03	0.10	0.07	0.0	0.07	0.0	0.0	0.0	0.07	0.0
7	0.03	0.03	0.10	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.03	0.0
8	0.13	0.17	0.03	0.10	0.13	0.0	0.0	0.0	0.0	0.0	0.03	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.07	0.03	0.13	0.03	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.10	0.10	0.03	0.0	0.03	0.0	0.0	0.03	0.0	0.0	0.07	0.0
12	0.10	0.10	0.03	0.0	0.07	0.0	0.0	0.0	0.0	0.0	0.13	0.03
13	0.07	0.07	0.13	0.07	0.10	0.0	0.03	0.0	0.0	0.0	0.10	0.03

TABLE G6.1 (CONTINUED)

SENSITIVITY FACTORS

	14	15	16	17	18	19	20	21	22	23	24	25
14	0.57	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	0.03	-0.03	1.07	0.0	0.03	0.0	0.0	0.0	0.0	0.0	0.03	0.0
17	0.03	0.03	0.0	0.67	0.07	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
18	0.03	0.07	0.0	0.03	0.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.03	0.03	0.0	0.0	0.0	0.33	0.0	0.03	0.0	0.0	0.10	0.03
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.67	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	0.0	0.0	0.03	0.0	0.03	0.0	0.07	0.80	0.0	0.0	0.0	0.03
22	0.07	0.07	0.07	0.07	0.13	0.07	0.10	0.03	0.83	0.07	0.07	0.20
23	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	0.43	0.03	0.0
24	0.07	0.13	0.10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.17	0.0
25	0.03	0.03	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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PROPOSED KARACHI-RASHT RAILWAY SYSTEM (KRR) AND ITS IMPACTS ON THE DEVELOPMENT OF AFGHANISTAN, IRAN, AND PAKISTAN

by

Fazil Tawab Najafi

(ABSTRACT)

This research represents an analysis of the developmental impacts of a proposed international railway system. The proposed railway extends an approximate length of 2000 miles from Karachi on the Persian Gulf, through Pakistan, Iran, and Afghanistan (the PIA Region), to Rasht on the Caspian Sea. The proposed link, named the Karachi-Rasht Railway (KRR), as a single integrated system is expected to have profound effects in enhancing the overall development of the PIA region.

The KRR's developmental impacts were partially identified through the study of an existing, analogous international transportation link, the "Suez Canal." Furthermore, the present levels of selected developmental factors were gauged in relation to the socio-economic characteristics of the PIA region; their future levels were projected in the context of the impacts of the KRR. In the process of this analysis, the PIA region was compared with two other areas: (1) Uganda, Kenya, and Tanzania (UKT) and (2) Switzerland, West Germany, and France (SGF). The UKT region has similar socio-economic characteristics to the PIA region, but the SGF region is radically different. Yet both are similar in that they were affected by the Suez Canal and each is linked internally by an international railway system. These facts helped provide comparative data for estimating the future levels of the identified

developmental events relevant to the impacts of the KRR.

The KRR is expected to enhance developments such as energy consumption, urban population, food production, life expectancy, existing highway and railway systems, the literacy rate, exports, imports, political harmony, foreign aid, per capita income, tourist receipts, and so on. To measure the likelihood of occurrence of each of these types of developmental events, various forecasting methods were analyzed. The cross impact technique (CIT) was selected for this purpose because of its simplicity, reliability, accuracy, flexibility in utilizing available data, and its role in measuring the long-range impacts of the KRR.

As a first step in the CIT, relationships between the identified 25 developmental events were established and an initial probability, with an occurrence date, assigned to each event. The CIT, programmed in FORTRAN for the IBM 370/158, then was employed to generate final (horizon year) probability estimates, which are believed to be adequate indicators of how various events might be affected by the KRR. With three minutes of computer time, the CIT incorporated the interaction among the events and estimated the likelihood of occurrence of each event. Because of the judged interactions among the events, there was an increase in the final probability of occurrence of energy consumption, urban population, World Bank lending, tourist receipts, food production, per capita income, exports, life expectancy, and literacy rate. In addition, sensitivity analyses were performed by changing certain input values indicating the most direct significant effects

of increased rail route length on increasing World Bank lending, road network lengths, tourist receipts, per capita energy consumption, food production, life expectancy, diversity of religions, and removal of tariffs and taxes.

It is believed that the proposed KRR would significantly reduce the present trans-shipment problems, costs, congestion, and delay in the PIA region and would help lower the barrier which at present interferes with concerted efforts towards development.

The CIT was found to be a suitable methodology for this research and possibly for similar situations where a proposed single development will predictably involve many interactions, not only with the existing situation, but also with secondary events provoked by the originally proposed development.

Generally speaking, the systematic steps used in this research could be used as a guide for gauging similar undertakings. The study should be updated with changing conditions, reorientated objectives, better data, and improvements in understanding of the technique's parameters and of computational capabilities.

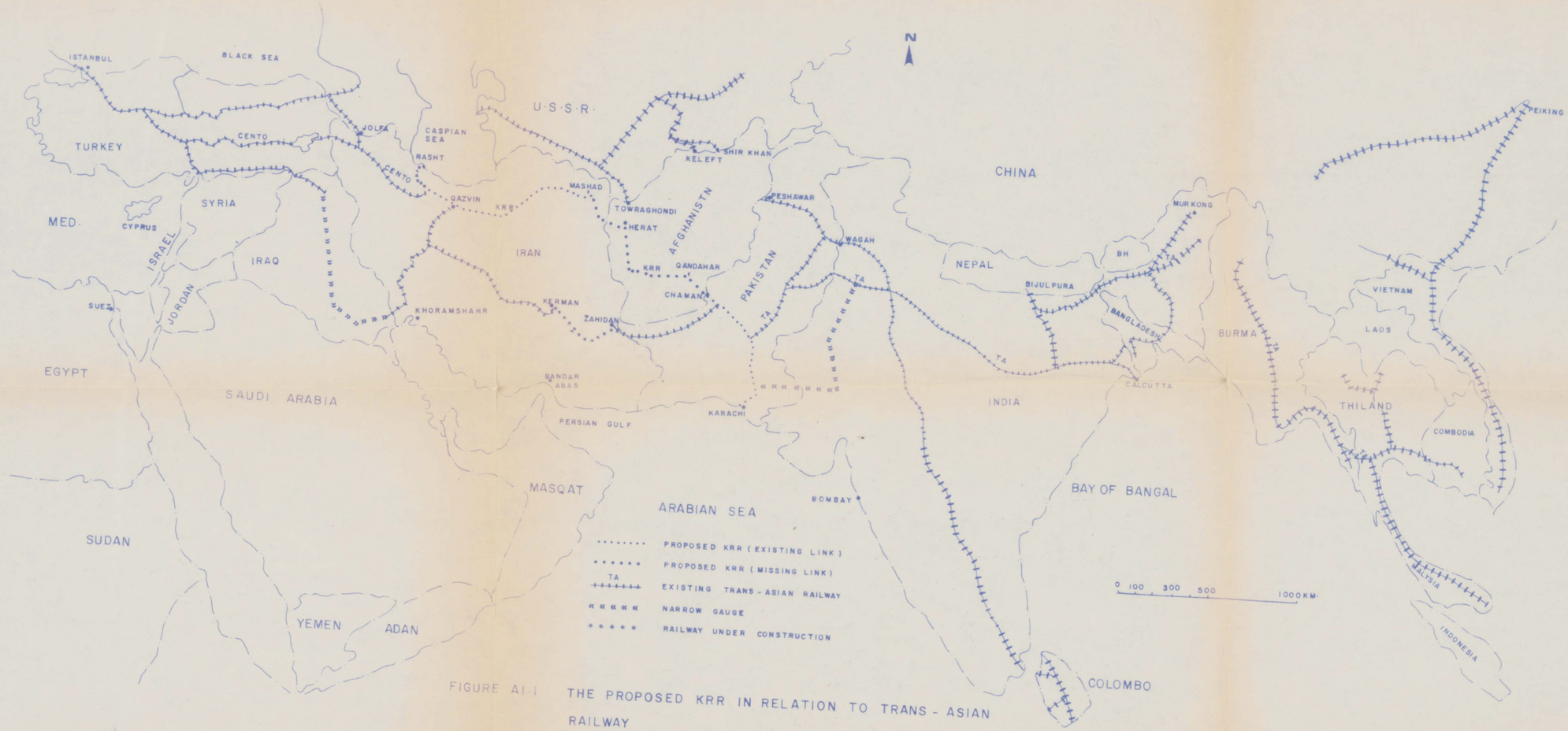

FIGURE A1.1 THE PROPOSED KRR IN RELATION TO TRANS-ASIAN RAILWAY

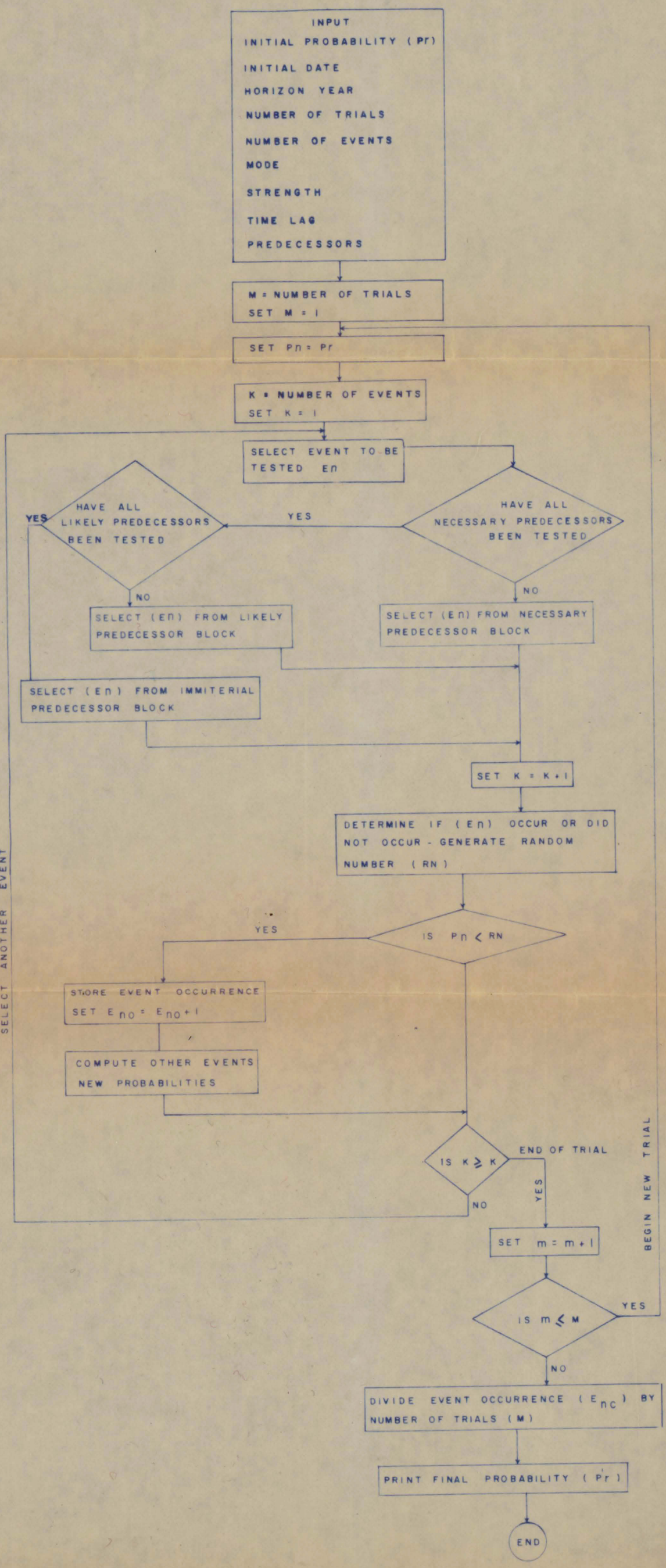

FIGURE D5-1 CROSS IMPACT PLANNING LOGIC AND COMPUTER FLOW CHART