THE IMPACT OF TRANSPORTATION PROJECTS ON JABOTABEK, INDONESIA

by

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ABSTRACT

The lack of transportation facilities has been the slackening force to the economic development of most Southeast Asian countries in recent years. A lot of transportation projects has been proposed to alleviate this pressing problem. However, each project is being appraised individually without considering its economic importance with other proposed projects. Economic evaluation is considered on a short term basis neglecting the effects of the project to the whole transportation system on the long term. There is no coordination and systematic implementation to analyze whether a project is important or will be approved first considering the limited funds and resources available. On this research, a system dynamics model is proposed which can analyze the coordination of some projects in terms of economic evaluation.

The reliability of this model is tested in Jabotabek, Indonesia which is composed of one urban area and three surrounding areas. The transportation facilities that are considered in this study area are the port which serves as an import-export terminal for products and resources, the trunk roads which provide the link between the urban area and the suburban areas, and other urban transportation facilities located within the urban area.

Comparing the trend of the socio-economic growth and development of each expected scenarios in the defined areas, the result shows the importance of coordinating the implementation of transportation facilities.

1. Introduction

The trade industry use to play a fundamental role in leading accomplishment of economic development in SouthEast Asian countries. This is particularly true in the case of foreign trade. While domestic trade is equally important, foreign trade has been considered and proven as the engine of growth for the newly industrialized countries. One of the important factors that props up the foreign trade industry is transportation facilities. Transportation Infrastructure is important in transporting either the resources or the products. However, capacity of these transportation facilities has already reached the maximum limit it can carry recently because of the rapid economic growth in this region. It has even become now a deterring factor that holds back a continuous foreign trade expansion. It is in this regard that transportation project planning plays an essential role in a sustainable economic development. Coordination and systematic implementation of a transportation project is vital in a situation where limited funds and resources are available.

During these past three decades, numerous research works have been conducted to alleviate this problem, to measure the economic impact of transportation projects on the regional development and to find out the most effective and efficient transportation project in these countries. However, several problems still remained as follows: (1) Usually, it is considered that accessibility plays an important role on the impact of transportation projects on foreign and domestic trade, and the reduction of travel time is measured as the time saving cost in monetary terms in most of the researches. However, the time value in SouthEast Asian countries is still low, therefore, relationship between the amount of available transport capacity and the existing industry must be analyzed under the framework of basic economic mechanisms. (2) There is no coordination and systematic way to analyze which project has to be approved and implemented first considering the limited funds and resources available. Economic evaluation of transportation projects is usually considered on a short term basis neglecting the effects of the project to the whole transportation system on the long run.

In view of the aforementioned problems, this paper proposes a simplified technique to coordinate the schedule of implementation of several transportation projects in a region where its transportation facilities is suffering a capacity constraint. Jabotabek, Indonesia is the case under study. Assuming that economic growth is triggered by the improvement of transportation facilities, this paper appraises the impacts of several transportation project implementation's schedule in order to find the optimal scheduling of transportation projects. System dynamics methodology is used.

2. The conception of model

Economic growth of a region largely depends on the amount of products produced in the factory situated in the region. Paul Weiner [3] noted that the most rapid economic growth has occurred in areas where both consumption and production are favorable. In case of port, as the facilities to support export and import, it indicates the importance of transportation facilities from the location of factories to the port. The lack of transportation facilities indirectly prevents the growth of the economy. On the other hand, Paul Weiner points out that the relationship between the size of the labor force and the size of the population supports the production of factories. Figure 1 is the image of multidirectional causal feedback loops on economic systems where transportation is the main component of the system.

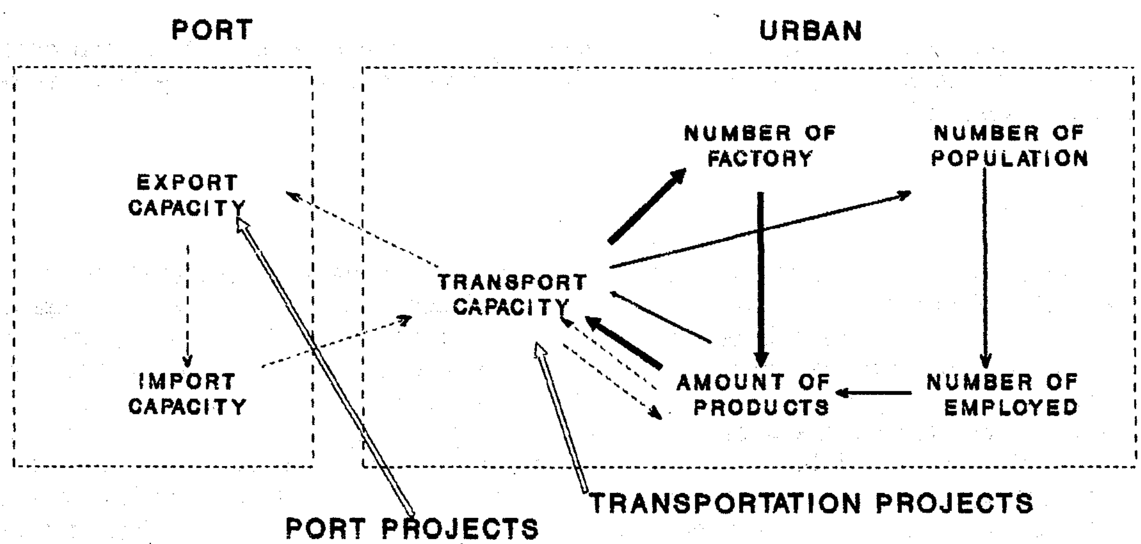

Figure 1 The image of multidirectional causal feedback loops

The thick solid line in figure 1 shows the relationship of factory, products and transport. On this relationship, it is assumed that by increasing the factory, it gives a corresponding increase of products, and furthermore changes the transport capacity. The smoothing of transport service will be given high value into attractiveness to build new or to expand the factory.

The broken line in figure 1 shows the relationship of products, transport, export and import. Export is assumed as the "products out" and import is assumed as the "material in" which is used to produce a new product. This line indicates that the better condition of transportation facilities have been contributing to the increase of export capacity on port. Of course, material import increases the production of new products in factory. To carry the material import from port to the location of factories, transport capacity will be increased again.

The thin solid line shows the relationship between transport, population, employed and products. This relationship explains that the increase of road transport capacity changes the population of urban concerned. Furthermore, the changes of population number changes the employed in the factory. The increase of road transport capacity may make the better condition in terms of productivity, however, it may also get worse in terms of urban environment. The motion of the number of employed gives the motion of products.

With this system image, the expression of the economic system has been mainly affected by transportation. On the other hand, transport capacity will change when transportation project will be done. And port project will change the export capacity in port.

The transportation sector flow diagram of these multidirectional causal feedback loops is shown in figure 2. Basically, this flow diagram is divided into 2 sectors. There is a road (truck) sector and a railway sector for industry in urban. Each sector is divided into sum by products and sum by materials as the level. The traffic jam (JMU) is indicated by changes of both total truck products (TTK1) and total truck materials (TTK2) per maximum of truck that is permitted in road concerned (TRMAX). According to the indication of traffic jam, it can find the multiply of product ship (JMM) to decide how many products go out from product stocks (PTU). The increase of product ships which has to be carried to the port, is divided into the increase of truck (TEX) and of railway (RLP). Where RCM is the capacity rate of railway to carry the products, the increase of railway can be expressed as PTU*RCM*(TTK1/TRMAX). Caused by the increase of railway, appears the decrease of truck. This expresses the equality of RLP and REX. On the equation of the increase of railway, the value of TRMAX grow larger by the road project, and the railway project changes the capacity rate of railway. The road improvement may change the condition of traffic jam, on the other hand, the railway improvement may change the railway capacity and at the same time change the condition of traffic jam too.

The indication of traffic jam arrives into population sector as the decreasing element caused by the changes of environmental factor. At the same time, the indication of traffic jam arrives into factory sector as an information to decide the accessibility multiply. Materials ship that goes out from the stock in port, is analyzed by total stock and the information of traffic jam too. For the port that is located at an urban area, the traffic capacity on urban is decided by the sum of transport from urban concerned to the port and suburban to the port.

3. Simulation results

Jabotabek area is the object area of this study. This area is composed of one urban area and three surrounding areas as the suburban areas. The regional development planning [4] shows that the future transport network will be consisting of toll roads and railway institution. However, to construct all of the transport facilities at the same time may require enormous cost. For this reason, using the model that is explained earlier, provides an effort to prioritize each project and

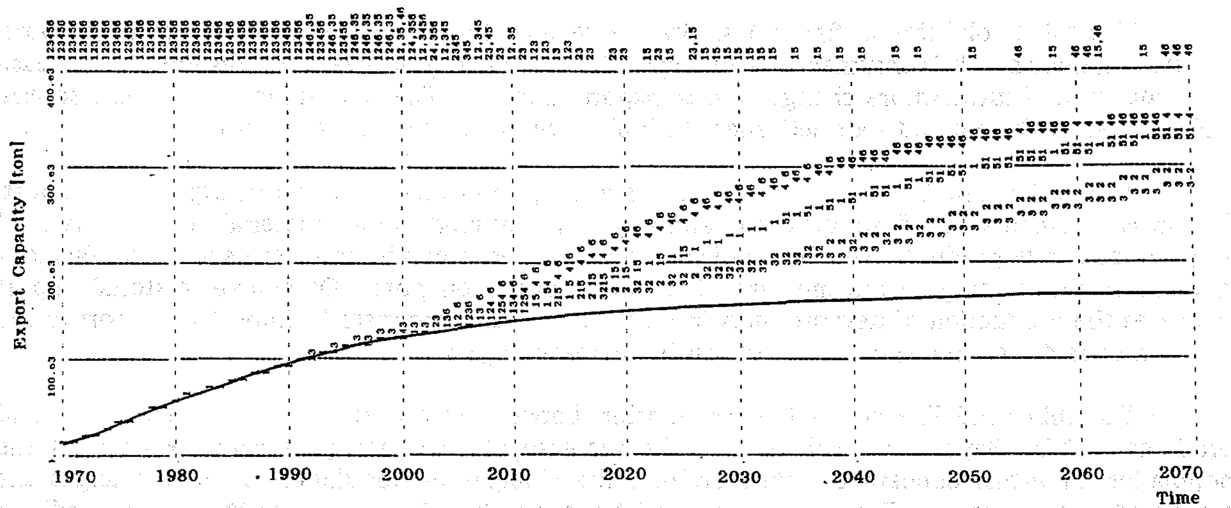

Figure 3 Export Consideration

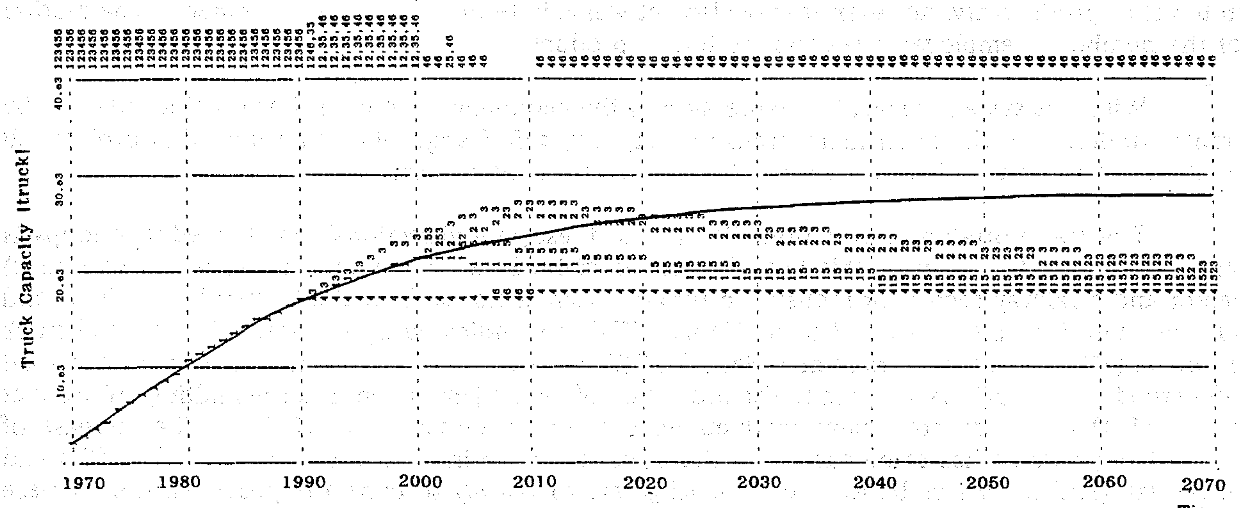

Figure 4 Transport Consideration

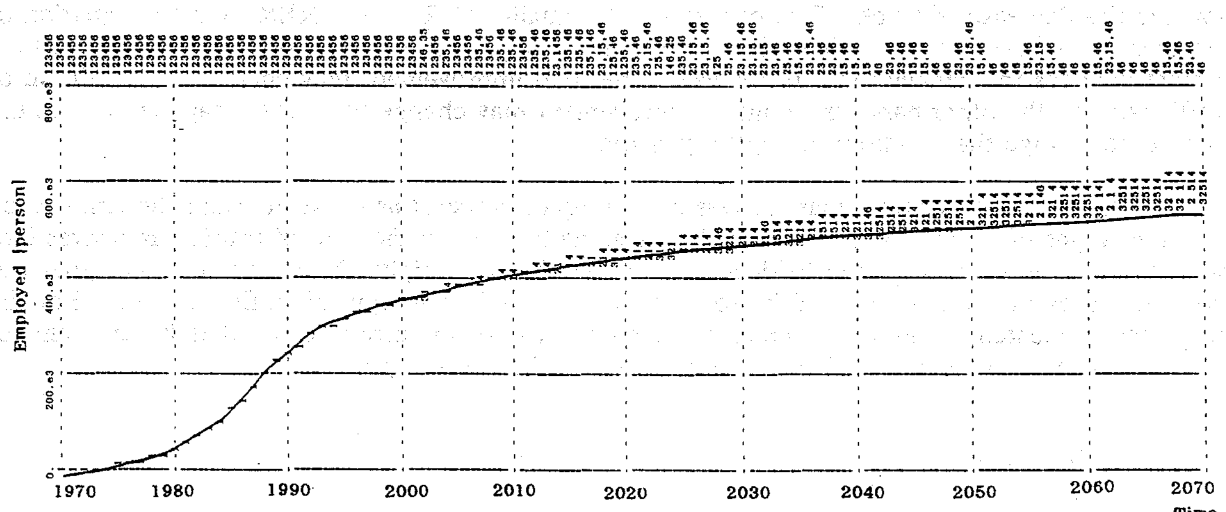

Figure 5 Employed Consideration

Legends:

1,2,3,4,5,6 = Case Number

———— = Without Projects

see what priority projects will appear to find the maximum impact for the economic growth of the object area. Both the road project and railway project are constructed as link from urban area to one of surrounding areas. Therefore, by the project, some direct impacts appear into the area concerned only.

First, the order of priority for commencement of each project is classified into six cases as shown in table 1. Each case is introduced into model for simulation from year of 1970 until year 2070. To evaluate the simulation results, three appraisal techniques are applied as the considerations. These are export consideration, truck capacity consideration and employed number consideration.

Table 1 Order of Priority Projects

Case No.	Completion Period of Project		
	1990	2000	2010
1	Port	Railway	Road
2	Port	Road	Railway
3	Road	Port	Railway
4	Railway	Port	Road
5	Road	Railway	Port
6	Railway	Road	Port

Figure 3 is the simulation results of a suburban by the export consideration. Comparing with all case simulation results, case 6 shows high value than other cases. The enforcement of railway project as the priority shows an increasing export capacity. The reason is that the friction of railway transport has only been little. The project results to an increasing railway transport. Furthermore, other project after the railway project makes the export capacity increase further.

Figure 4 shows the simulation results by consideration of truck capacity. The investigation of simulation results will be done according to the relationship that a decreasing truck capacity is environmentally better for the urban. This figure shows that case 4 have better impacts than impacts of other cases. And case 6 have bigger truck capacity than case 4. Both of case 4 and case 6 had the same character that of prioritizing the railway project. Because the little friction on railway transport had already produced higher truck capacity as the results, the later projects have not shown higher increase in truck transport.

Figure 5 shows the simulation results by consideration of employed number. The figure shows that case 6 led to a bigger number of employed than other cases, and case 4 had a bigger value than case 6. At figure 3 and figure 4, it is explained that railway project have some ability to thrive the growth impact on export capacity and urban environment. For this reason the income per capita have been raising and furthermore increases the attractiveness of urban. This also affected both housing and income. As the results, the increasing number of population shows also an increasing number of employed.

The above mentioned discussion explains different impacts of each case under a priority order. However, to take general impact on regional development, this paper also proposes to appraise the impact of the transportation projects as presented in table 2. The appraisal is aimed to find the case that produces maximum impact for the object area. The table shows the appraisal items and rank of the results on the left and the results of each case entries on the right. Comparing results of each case, the 0 value expresses value that does not have rank, and the 1 value expresses value that have the rank. The sum of these value shows that case 6 have 2 points of rank 1 and 1 point of rank 2, and these result can propose that the case 6 is the priority order projects which have maximum impact into object areas.

4. Conclusion

From the simulation results, each priority order of transportation project produced a changing pattern of economic growth. The appraisal of the results shows that by using the simplified model that is proposed, it can find the priority order of transportation projects which have maximum impacts.

On this paper, the system dynamics approach enables one to experiment sensitiveness of the parameters. In this study not only several parameters had been developed as an initial value, but also the table function parameters. To find the desirable results, the authors proposes to compare these results with other economic model and determine the relevant parameters especially for developing countries.

Table 2 Appraisal of Priority Projects

Area No.	Consideration Item	Rank	Case					
			1	2	3	4	5	6
3	Export	1	0	0	0	0	0	1
		2	0	0	0	1	0	0
	Truck Capacity	1	0	0	0	1	0	0
		2	0	0	0	0	0	1
	Employed	1	0	0	0	0	0	1
		2	0	0	0	1	0	0
S U M		1	0	0	0	1	0	2
		2	0	0	0	2	0	1

References

1. Rothengatter, W., Scheduling of Interstate Road and Railway Investment, *Environment and Planning* A-18, 465-483(1986).

2. Leinbach, Thomas R., and Robert G. Cromley, A Goal Programming Approach to Public Investment Decisions : A Case Study of Rural Roads in Indonesia, *Socio- Econ. Plan Sci.* Vol. 17-1, 1-10(1983).

3. Weiner, Paul and Edward J. Deak, Environmental Factors in Transportation Planning, 1972.

4. Pemda DKI, Jakarta 2005,1987.

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NOTE    *********************************************************
NOTE    ********************PROGRAM LISTING**********************
NOTE    *********************************************************
NOTE    *THE IMPACT OF TRANSPORTATION PROJECTS ON JABUTABEK AREA*
NOTE    *********************************************************

FOR A=1,4
FOR P=1,7

L      FAC.K(A,P)=FAC.J(A,P)+DT*(FCU.JK(A,P)-FDU.JK(A,P))               FACTORY
N         FAC(A,P)=DAT1(A,1)
I         DAT1(*,1)=910,115,39,18
R         FCU.KL(A,P)=FAC.K(A,P)*FCR(A)*FCC.K(A,P)
A         FCC.K(A,P)=FFF.K(A,P)*ACC.K(A,P)
P         FCR=.07,.036,.02,.015
A         FFF.K(A,P)=(FACT(A)-FAC.K(A,P))/FACT(A)
P         FACT=1500,450,1179,330
A         ACC.K(A,P)=CLIP(FIFGE(MTA(A,2),MTA(A,1),PP(P),2),
          MTA(A,1),TIME.K,TRD(P))/TTR.K(A,P)
P         MTA(*,1)=150000,25000,50000,10000
P         MTA(*,2)=160000,25000,60000,10000
P         PP=1,2,3,4,5,6,7
P         TRD=0,40,30,20,40,20,30
R         FDU.KL(A,P)=FAC.K(A,P)*.1*(ENV.K(A,P))
*
L      PIV.K(A,P)=PIV.J(A,P)+DT*(PRD.JK(A,P)-PCU.JK(A,P))     PRODUCT INVENTORY
N         PIV(A,P)=0
R         PRD.KL(A,P)=(FCU.KL(A,P)-FDU.KL(A,P))*MTC.K(A,P)*PR
A         MTC.K(A,P)=MTR.K(A,P)*MEM.K(A,P)
I         PR=400
A         MTR.K(A,P)=TABHL(TRANS,TTK2.K(A,P)/TRMIN(A),0,5,1)
P         TRMIN=39763,4905,1778,96
T         TRANS=0,1,1.01,1.02,1.03,1.04
A         MEM.K(A,P)=TABHL(MET,MEV.K(A,P),0,5,1)
T         MET=0,1,1.1,1.2,1.3,1.4
A         MEV.K(A,P)=EMP.K(A,P)/DAT10(A,1)
R         PCU.KL(A,P)=(PRD.KL(A,P))*JMM.K(A,P)
A         JMM.K(A,P)=TABHL(JMMT,JMU.K(A,P),0,2.5,.5)
A         JMU.K(A,P)=TOTTR.K(P)/TRMAX.K(A,P)
A         TRMAX.K(A,P)=CLIP(FIFGE(DAT2(A,2),DAT2(A,1),PP(P),2),^
          DAT2(A,1),TIME.K,TRD(P))
I         DAT2(*,1)=100000,100000,100000,100000
I         DAT2(*,2)=70000,100000,130000,100000
T         JMMT=1,1,.7,.4,.1,.1
*
L      TTK1.K(A,P)=TTK1.J(A,P)+DT*(TEX.JK(A,P)-REX.JK(A,P))     TRUCK TRANSPORT1
N         TTK1(A,P)=DAT3(A,1)/13
I         DAT3(*,1)=349457,44403,11560,5707
R         TEX.KL(A,P)=PCU.KL(A,P)/13
R         REX.KL(A,P)=RLP.KL(A,P)/13
*
L      RLW1.K(A,P)=RLW1.J(A,P)+DT*(RLP.JK(A,P))                        RAILWAY1
N         RLW1(A,P)=DAT4(A,1)
I         DAT4(*,1)=14543,1597,4040,1413
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R        RLP.KL(A,P)=CLIP(FIFGE(PRLW.K(A,P),0,PP(P),2),0,TIME.K,TRW(P))
A        PRLW.K(A,P)=CLIP((FIFGE(PTU.KL(A,P),0,PTU.KL(A,P),0)*RCM(A))*^
         (TTK1.K(A,P)/CLIP(MTA(A,2),MTA(A,1),PP(P),2))*FL(A),0,PP(P),2)
P        FL=1,0,1,0
P        RCM=.25,.5,.5,.5
P        TRW=0,30,40,40,20,30,20
*
L      OIV.K(A,P)=OIV.J(A,P)+DT*(PRR.JK(A,P)+PRT.JK(A,P)-EPR.JK(A,P))   EXPORT
*                                                                     INVENTORY
N        OIV(A,P)=0
R        EPR.KL(A,P)=(PRR.KL(A,P)+PRT.KL(A,P))*CLIP(FIFGE(EXRR(A),^
         EXR(A),PP(P),2),EXR(A),TIME.K,TPT(P))
P        EXR=.5,.85,.85,.85
P        EXRR=.2,.95,.95,.95
P        TPT=0,20,20,30,30,40,40
R        PRR.KL(A,P)=PTR.K(A,P)
A        PTR.K(A,P)=RLP.KL(A,P)
R        PRT.KL(A,P)=PTT.K(A,P)
A        PTT.K(A,P)=TEX.KL(A,P)*13
*
L      EPO.K(A,P)=EPO.J(A,P)+DT*(EPR.JK(A,P))                          EXPORT
N        EPO(A,P)=DAT5(A,1)
I        DAT5(*,1)=364000,46000,15600,7200
*
L      IIV.K(A,P)=IIV.J(A,P)+DT*(IMP.JK(A,P)-IMT.JK(A,P))      IMPORT INVENTORY
N        IIV(A,P)=0
R        IMP.KL(A,P)=IER.K(A,P)
A        IER.K(A,P)=EPR.KL(A,P)*1.5
*
L      IMO.K(A,P)=IMO.J(A,P)+DT*(IMP.JK(A,P))                          IMPORT
N        IMO(A,P)=DAT6(A,1)
I        DAT6(*,1)=546000,69000,23400,10800
R        IMT.KL(A,P)=(IMP.KL(A,P))*JMM.K(A,P)
*
L      TTK2.K(A,P)=TTK2.J(A,P)+DT*(TIM.JK(A,P)-RIM.JK(A,P))    TRUCK TRANSPORT2
N        TTK2(A,P)=DAT7(A,1)/13
I        DAT7(*,1)=516914,63765,23118,1253
R        TIM.KL(A,P)=MTU.K(A,P)/13
R        RIM.KL(A,P)=RLM.KL(A,P)/13
*
L      RLW2.K(A,P)=RLW2.J(A,P)+DT*(RLM.JK(A,P))                      RAILWAY2
N        RLW2(A,P)=DAT8(A,1)
I        DAT8(*,1)=29086,5235,282,9547
R        RLM.KL(A,P)=CLIP(FIFGE(MRLW.K(A,P),0,PP(P),2),0,TIME.K,TRW(P))
A        MRLW.K(A,P)=CLIP((CLIP(MTU.K(A,P),0,MTU.K(A,P),0)*RCM(A))*^
         (TTK2.K(A,P)/CLIP(MTA(A,2),MTA(A,1),PP(P),2))*FL(A),0,PP(P),2)
*
A        TTR.K(A,P)=TTK1.K(A,P)+TTK2.K(A,P)            TOTAL TRUCK TRANSPORT
A        TOTTR.K(P)=SUMV(TTR.K(*,P),1,4)
*
L      POP.K(A,P)=POP.J(A,P)+DT*(PIN.JK(A,P)+PBT.JK(A,P)-POT.JK(A,P)-POPULATION
*        PDT.JK(A,P))
N        POP(A,P)=DAT9(A,1)
I        DAT9(*,1)=4546000,1863000,1067000,831000
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R       PIN.KL(A,P)=POP.K(A,P)*PIR(A)*ATT.K(A,P)
P       PIR=.023,.014,.019,.016
A       ATT.K(A,P)=CLIP(HOM.K(A),.01,HOM.K(A),.01)*INC.K(A,P)
A       HOM.K(A)=(HOST(A)-HOK.K(A))/HOST(A)
P       HOST=1.6E6,3.5E5,9E5,9E5
*
L     HOK.K(A)=HOK.J(A)+DT*(HOG.JK(A))                              HOUSING
N       HOK(A)=0
R       HOG.KL(A)=HOST(A)*HOR.K(A)
A       HOR.K(A)=TABHL(HORT,HOK.K(A)/LIM(A),0,1.6,.8)
P       LIM=1E6,21E4,56E4,56E4
T       HORT=.028,.028,0
A       INC.K(A,P)=TABXT(INCT,EPO.K(A,P)/POP.K(A,P),0,.2,.05)
T       INCT=2.05,2.12,2.19,2.26,2.33
R       PBT.KL(A,P)=POP.K(A,P)*PBR(A)
P       PBR=.02,.043,.03,.02
R       POT.KL(A,P)=POP.K(A,P)*POR(A)*ENV.K(A,P)
P       POR=.011,.039,.028,.004
A       ENV.K(A,P)=CLIP(TTR.K(A,P),TOTTR.K(P),URB(A),2)/TENV(A)
P       URB=1,2,3,4
P       TENV=250000,70000,150000,30000
R       PDT.KL(A,P)=PDR(A)*POP.K(A,P)
P       PDR=.019,.02,.023,.013
*
L     EMP.K(A,P)=EMP.J(A,P)+DT*(EIN.JK(A,P)-EOT.JK(A,P))         EMPLOYMENT
N       EMP(A,P)=DAT10(A,1)
I       DAT10(*,1)=110214,16696,6850,2718
R       EIN.KL(A,P)=EMP.K(A,P)*PER.K(A,P)*EIR(A)
P       EIR=.0192,.038,.118,.14
A       PER.K(A,P)=(INC.K(A,P))*(POP.K(A,P)/1E6)
R       EOT.KL(A,P)=(EMP.K(A,P)*PEM.K(A,P))+BDR.K(A,P)
A       PEM.K(A,P)=TABXT(EMTB,POEM.K(A,P),0,5,1)
T       EMTB=.08,.09,.1,.11,.12,.13
A       POEM.K(A,P)=(EMP.K(A,P)/DAT10(A,1))
A       BDR.K(A,P)=FDU.KL(A,P)*75
*
SAVE  FAC,PIV,OIT,IIV,POP,EMP,TTR,TOTTR,EPO,IMO,HOK,RLW1,RLW2,TTK1,TTK2,OIV
SPEC  DT=1/LENGTH=100/SAVPER=1
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