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Standard Railway Traffic

Costing Model

Manuals

Part I **User Manual v. 1.2**

Part II **Programmer's Manual**

designed 1990.

PULSE GROUP

Rua General Daniel de Sousa nº 136 - 138, r/c
2900 Setúbal - Portugal
Tel.: 351 65 31253
Fax: 351 65 534450
Email: pk.Service@mail.telepac.pt

The author Douglas Rasbash has had many years experience in railway economics worldwide. Specific experience of railway traffic costing both in Indonesia and Southern Africa has led to the adoption of the technique of normative costing. This has been as a result of experience of developing country railway accounting methods and a belief that normative costing methods provide a more reliable approach as well as being a useful management tool providing information on both operating and maintenance inputs and costs.

The approach using normative costing is being supported by the World Bank and is now becoming a requirement of Bank funded projects. The traffic costing model received its first application as part of a program of technical assistance to Indonesian State Railways, where it has been well received and is being implemented.

The author has subsequently developed the basic framework for wider use for all other railway organisations or appropriate government departments. Further developments which automate many of the processes within the model to assist, for example, with route by route appraisals, auditing and budgeting have been incorporated and are documented within this manual.

The data shown within this report are for example only and are only included to show the variety and types of data available to the user. All items of information including all the relationships within the model can be fully edited to suit any country or organisation.

Standard Railway Traffic Costing Model

1.0 Introduction

Standard Costs and Adjustment Factors

1.1 The model is service specific and calculates the variable costs of operation. As such the model requires service and operational information specific to the service being studied.

1.2 Unlike almost all previous Rail Traffic Costing frameworks, the costs within this model are based on standard or normalised costs. These reflect those costs that should be generated in order to conduct the business to proper standards of efficiency. It is generally found within developing country railways that there will be a significant difference between these standard costs and actual or accounting costs caused, for example, by poor working practices or inefficient stock control. Therefore the model employs a whole series of adjustment factors which allow the user of the model to convert the standard performance factors contained in the model to acceptable levels dependant on local conditions and practices.

Hardware and Software Requirements

1.3 The model is designed to be operated on a free standing personal computer. This personal computer should be equipped with 1Mb of RAM and a hard disk, which will hold the programmes and data sheets necessary to use the model, of at least 70 Mb. This is to ensure sufficient storage space to hold the results for approximately 600 services plus the programs and spreadsheets from the model itself. It is envisaged that output from the model should be in hardcopy form and to this end an appropriate printer is necessary. This hardware should of course be equipped with the appropriate operating systems and software.

1.4 The basic design of the traffic costing model is that of a series of "linked" spreadsheets, containing sections of the data required to provide cost figures. These spreadsheets have been designed and will only operate using the "Quattro Pro"[1] spreadsheet software. Many of the utilities and functions used within the model are not compatible with any other spreadsheet package.

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[1](Quattro Pro. Copyright 1989 Borland International)

Model Inputs

1.5 Because the model is line and service specific it has to be given data which defines the service to be costed. The user must specify service details such as the distance travelled and time taken by a train. The model also requires an origin and destination and service identity code, from an accounting system or operating handbook. The model will also prompt for information on average delays and service frequency. This information additionally allows the calculation of summary information for budgeting or investment appraisal.

1.6 As the model is service specific the user must also supply details of the locomotive(s) and carriages or wagons used, the train crew employed on the train and the track over which the train travels. Finally details of the terminals or stations used must be given. This data is used because the model uses unit costs for individual types of rolling stock, staff and terminal types to build up its service cost. Additionally Load Factors and commodity types which are required to allow the calculation of unit costs by passenger or km or tonne km for different classes of travel or freight types.

Model Results

1.7 The results of the model are produced in five separate spreadsheets representing the five service types:-

Inter Urban passenger
Suburban passenger
Block freight
Mixed freight
Mixed freight and passenger

The results within these spreadsheets are in 4 sections. The model produces long, medium and short term costs for a service for each commodity or class of passenger. These costs can be used to set different prices in different market segments (see Section 8). The model also produces two tables showing the breakdown of costs both in absolute and percentage terms. The final information produced by the service results spreadsheets is the total service cost which is used in the other functions of the model such as budgeting and investment appraisal.

Data Sources

1.8 Generally throughout the model two pieces of data are required, standard inputs or costs and an adjustment factor to provide an accepted input or cost.

Standard Data

1.9 The standard data required by the model can come from various sources. The first and probably most accurate would be data from a Technical Assistance Program which would produce target manning, reliability and maintenance levels and although these may not reflect a perfect situation, they will be the levels any particular railway can achieve and therefore are its standards. Data can also come from other railways, both European and Third World. This may provide a standard but this is not necessarily an attainable standard. This could be due to the equipment available to a railway or operating practices imposed upon it from outside. The other source of standards excepting the railway itself are manufacturers, contractors or suppliers who may provide maintenance schedules and inputs or expected output and reliability figures.

Adjustment Factors

1.10 These are used within the model to convert the standard data discussed above to accepted data which accurately reflects the performance of the railway. Much of the data required to calculate these factors will generally be available within the railway's management information system and will generally only require a small amount of transformation. The derivation of these adjustment factors is both an important part of the model's development and an invaluable management exercise. Since the managers of the railway must compare the performance of the railway, with the defined standard on a task by task basis, they will receive large amounts of information on the railway's performance. As the performance of the railway improves (or deteriorates) from year to year these adjustment factors will need to be adjusted, as they will when any changes occur.

1.11 Setting up and Assimilation

It is envisaged that in order to ensure the proper use and assimulation of the mode, training would be necessary for both the users of the model and railway managers and government officials. Since the model both produces and requires large amounts of data it is necessary that the costing unit members know what information to request and that railway managers are able to use effectively the model results.

1.12 To effectively use the model it will be necessary for a railway to set up a traffic costing unit possibly within a marketing or accounting section which will be staffed by experts in the use of the model. This unit will be responsible for the management of the model and its implementation and the production of traffic costs and other results

2.1 Cost Definitions

2.1.1 This model produces results based on normalised or standard costs. These being based on ideal situations or recommended inputs and schedules. The determination of these standards is both an interesting managerial exercise and a basis for efficiency or performance comparisons. However it does not provide the whole basis for determining accurate costing figures.

2.1.2 Accurate costing figures must always be related to the actual performance of a railway. However, they cannot be based on historic or accounting figures, because of the inherent inefficiencies in developing country railway accounts. This can affect, for example, locomotive maintenance where one years underspending on components is often mirrored by a resultant reduction in the next years component budget thereby making the situation worse by there being insufficient spare parts available. Therefore adjustment factors must be agreed which will alter the standard inputs or costs so that the costs within the model represent the situation on the railway in question whilst removing the effects of unproductive labour or costs which, although within operating categories remain fixed.

2.1.3 Therefore, for almost all categories of input and cost, within the model there are entries for the standard input agreed, an agreed adjustment factor and the accepted variable cost or input attached to the categories.

2.1.4 Within each of the front sheets of the model there are a number of calculations which take the disaggregate but non service specific data from the lower level spreadsheets, and apply the data entered by the user to derive the service specific traffic cost which is presented in the results page.

2.1.5 The short run costs derived from the model are those which are directly variable with the running of one train. This basically includes fuel costs, maintenance of locos, coaches, wagons and track and billing and ticketing costs.

2.1.6 In the medium term it is assumed that Labour and Terminal costs are variable with traffic. Of course all variable costs vary directly with train operation but some are subject to time lags created by legal or operational constraints.

2.1.7 In the long run all variable costs are included in the cost calculation. Even loco and rolling stock provision costs are variable in the long run since such items can be purchased or removed from stock within perhaps 1 year.

2.2 Fixed Costs

2.2.1 Identification of Fixed Costs

This model is only concerned with variable costs, so by exception fixed costs are also identified. Many costing systems go into very precise details concerning levels of variability for different cost items, for example the variable portion of signalling and communication costs may be between 1% and 5%. Such fine detail is considered inappropriate since the significance in unit costs will be negligible, but the problems and uncertainty created over the degree of variability would be large. Only track maintenance costs are considered partially variable in this exercise on research elsewhere and experience and the degree of variability can be changed.

2.2.2 Non-Productive Costs

Unfortunately many railways maintain larger levels of resources than would be commercially required for political and social reasons. Such non-productive costs are also treated as fixed in the model by requiring the railway manager to indulge only those productive resources needed to achieve certain levels of output. Such management decisions are required throughout the model so stimulating the kind decision making which is not always appropriate in many railway organisations.

2.2.3 Treatment of Fixed Costs

The treatment or allocation of fixed costs usually requires institutional changes which may include the relationship with government and the way the railway business itself is organised. Although sophisticated algorithms to allocate fixed costs do exist - based on the ability of the service to recover such costs - consideration of fixed costs is left to another exercise.

3.1 Model Inputs

When the user loads one of the front sheets of the model he will be presented with a series of tables which will require the entry of several pieces of service specific data. It will be necessary for the user of the model to collect much of this information.

3.2 Model Data Requirements

3.2.1 The consist of the trains operating the services to be costed is a most important piece of information in any costing system, but especially in this model where unit costs are calculated for each type of loco, coach and wagon. Using the types and categories set out in section 3.5 the user must enter the number of each type of locomotive, coach or wagon used.

3.2.2 Where more than one type of loco is used simultaneously the number of each should be entered. Where the type of loco used changes during a journey, the number of each used should reflect the proportion of the journey employing each loco e.g. if the loco is changed halfway then the number of each should read 0.5.

3.2.3 The timetable information required by the model consists of origin and destination, service name (where applicable), service code, start and finish time for one journey and the distance run by the service. The model also requires the service frequency in order to calculate total costs where necessary.

3.2.4 One other important piece of information is the average route delay in minutes. It is often the case that timetabled journey times are regularly exceeded. This will normally be due to speed restrictions as a result of poor or delayed track maintenance and poor operating procedures. For the purposes of this model the information on delay is applied to both loco and coach or wagon provision cost and track maintenance costs. It is assumed that average delay as a percentage of total journey time is a measure of the shortfall of expenditure on track maintenance over necessary amounts to maintain standards.

3.2.5 The crew of the train must be determined through research by the user using the categories in section 3.6, the number of crew should be entered by occupation.

3.2.6 Within the freight spreadsheets it will be necessary for the operator to enter the types of commodity in each wagon. Within a block train there will normally be only one type of wagon and one commodity with the loading of each wagon being approximately the commodities and different loads.

Load Factors

3.3 In order to calculate costs per Gross Tonne km or per Passenger km, it will be necessary to enter load factors per coach or wagon. With passenger trains the model needs information on the average number of people in each coach or each railcar.

For freight trains it is necessary to know, both for terminal and movement costs, the number of tonnes of each commodity in each wagon. It is possible that this will vary between days or even between wagons of the same type with the same commodity in the same train. An average figure will however be good enough since these differences will normally balance out.

Terminal Costs

3.4 Finally, the model also produces costs for each type of freight terminal and passenger station as listed in section 3.6. Therefore the operator must for passenger trains enter the number of each type of station called at and for freight the type of terminal used for each wagon. One other important piece of information is the ownership of each terminal. The traffic costing system ignores the terminal costs (except shunt costs) where a terminal is not owned by the railway company.

Rolling Stock Categories

3.5 Within the model it has been necessary to categorise rolling stock, track and terminals to produce a manageable number of types for these items. These are summarised in the tables below.

Locomotives

Cat	Type	Hp
1	CC200	1600
2	BB301/4	1500
3	BB202/4	1500
4	BB201/3	1425/1500
5	CC201/2	1950/2000
6	BB200	675
7	BB300	680
8	BB302/3/6	1000

Coaches

Cat	Type	Description
1	KT/K1	First Class/Executive
2	KM1/M1	1st Class Restaurant
3	K2	Second Class
4	KM2/M2	2nd Class Restaurant
5	K3	Third Class
6	KM3	3rd Class Restaurant
7	BP/B	Power/Baggage Car

Wagons

Cat	Type	Description
1	KK	Bogie Tank
2	KKB/YY/ZZ	Bogie High Side Drop
3	PP	Bogie Flat
4	GG/TT	Bogie Box
5	K/PB	2 Axle Tank
6	Y	2 Axle Low Side Drop
7	P	2 Axle Flat
8	G/T/V	2 Axle Livestock

Railcars

Cat	Type
DMU1	MCW301
DMU2	MCW302
EMU	All Electric Railcar

3.6 Other Model Categories

Track

Cat	Rail Type	Sleeper Type
1	UIC54R	Concrete
2	UIC50R	Wood
3	UIC42R	Concrete
4	UIC42R	Wood
5	UIC33R	Steel
6	UIC25R	Wood

Stations

Type	Avg Pass Through	Avg Staff
1	10000	39
2	6000	26
3	3000	10
4	1000	5
5	500	6

Freight Terminals

1 General Freight
2 Coal
3 Iron and Steel
4 Sand
5 Fertilizer
6 Oil
7 Cement
8 Container
9 [illegible]

Labour

Category	Description
1	Administrative Staff
2	Driver
3	Driver's Assistant
4	En Route Cleaning Staff
5	Wagon Manual Brake Operator
6	Senior Ticket Controller
7	Ticket Controller
8	Train Guard
9	Superintendent
10	Depot Mechanic
11	Material Storage Man
12	Large Station Master
13	Large Station Master Assistant
14	1st Class Station Master
15	2nd Class Station Master
16	3rd Class Station Master
17	4th Class Station Master
18	5th Class Station Master
19	Train Dispatcher
20	Passenger Ticket Salesman
21	Treasurer
22	Cashier
23	Station Cleaning Staff
24	Freight Billing Clerk
25	Shunter
26	Maintenance Crew
27	Machine/Equipment Operator
28	Construction Worker
29	Bridge Worker
30	Storage Guard
31	Track Inspector
32	Material Storage Clerk
33	Metal Worker
34	Cleaning Staff
35	Movement Controller
36	Freight Terminal Manager
37	Wagon Loaders/Unloaders
38	Porters
39	Restaurant Staff

3.7 Service Codes

3.7.1 In order to provide an efficient and organised method of storing and identifying costing results a series of service codes have been devised to allow the unique identification of every service.

3.7.2 Sector Code

Each service can be identified to a particular market sector or type of traffic. These can generally be identified as:

E = Engineering Traffic
F = Freight
G = Government Traffic
I = Inter Urban Passenger
P = Parcels + Post
S = Suburban Passenger
X = Special Traffic

3.7.3 Sub Sector Code

Often it is possible to further segregate services where particular flows are easily defined. Examples of how these could be divided are:-

Freight Services (F)

FC = Coal
FF = Petroleum, Gas
FG = General Goods
FL = Livestock
FM = Minerals, Steel
FO = Foodstuffs
FS = Construction Materials
FT = Containers

Suburban Passenger (s)

SA = Suburban City A
SB = Suburban City B
SC = Suburban City C

3.7.4 Route Code

Often different trains from the same sector will use similar routes. It is therefore necessary to identify the route which a train uses in order to distinguish it from other similar services.

This could be done as:

11 = A to B
12 = B to A
13 = A to C via D
14 = C to A via D
15 = A to C via E
16 = C to A via E
17 = D to E

3.7.5 Train Number

Because trains from different sectors or even separate trains from the same sector will use the same routes it is necessary to number each service on a route separately. This also allows the separate costing of peak and off-peak services and the segregation of dated or occasional trips.

1 = A to B all stations
2 = B to A all stations
3 = A to B off peak limited stop
4 = A to B peak limited stop

4.0 Running a Costing Exercise

4.1 Start Up and Loading

4.1.1 Generally when using the costing model the user is advised to use the automatic updating procedures in section 5. However where this is not appropriate the user should follow the following procedure.

4.1.2 As already stated the model is designed to be run on a free standing personal computer. This greatly simplifies the starting procedures.

After switching on and loading the operating system of the computer the user should type

" CD/QPRO "

This should be followed by

" Q "

4.1.3 At this point the computer will load the "Quattro Pro" programmes. The user will be presented with a blank spreadsheet. To load a spreadsheet into memory the user must type

" /FR "

The computer will display a list of available files. The correct spreadsheet should then be selected by using the cursor keys. When selected the return key should be pressed.

4.1.4 When the spreadsheet is fully in memory the computer will prompt.

"Link Options"
" Load Supporting"
"Update Refs"
"None"

Always when presented with this menu the user should press "U". The computer then goes through each of the spreadsheet links reading the data from other files.

4.2 Model Front Pages

4.2.1 Generally the user will want to load one of two categories of spreadsheets.

4.2.2 For a service which is being costed for the first time the user will require a blank front page in which to load in the service specific information. These spreadsheets (Passenger, Suburban, Mixed F, Block F and Mixpass) will generally be stored in a directory on the hard disk of the computer with the other model programmes. These can be loaded in the way described in 4.1.

4.2.3 To update the results of an already costed service the user will need to access a separate directory containing the stored front pages from previous costing runs. Each file in this directory will relate to a different service and will be referenced using the coding system in section 3.2.

4.2.4 Once loaded the user will have to enter the new or edited data into the relevant part of the front pages examples of which are shown overleaf.

4.3 Results from Model

Passenger Services

4.3.1 The results from the model are split into two categories. Firstly there is the total unit variable cost of running the service. For passenger services this is given as a short, medium and long run cost for 1st, 2nd and 3rd class passengers.

Suburban rail services require a slightly different analysis. These services are characterised by heavy one way flows with corresponding light flows on the return trips. Therefore most of the costs of provision and maintenance are determined by the heaviest flow, with trips in the light flow direction being made almost in the marginal time between trips in the heaviest direction. With this in mind it seems reasonable that the passengers in the heaviest direction should pay a larger proportion of the variable cost of one full return trip.

In its extreme case this would involve the train returning completely empty, in which case the passengers in the heaviest direction would pay the full cost of a return trip. Alternatively there could be equal numbers of passengers in both directions, in which case they would pay equal proportions. To account for this the model presents a cost for passengers in the heaviest direction and a separate cost for passengers in the lighter direction

Freight Services

4.3.2 Freight services can be split into Trainload (Block) and Wagonload (Mixed). Although the cost calculations for each are the same the results are presented in different ways.

It is assumed for block freight trains that only one type of wagon and one commodity are on the train. Therefore the results can be presented in terms of short, medium and long term costs per Net Tonne km for just one commodity.

Mixed freight trains are more complicated. Because there are infinite combinations of wagon and commodity the results must be presented as short, medium and long term costs for each wagon in the consist. Within the model we have assumed that no mixed freight train will contain more than 18 wagons. Given the tractive effort of locomotives and from observation this seems a reasonable number. Therefore there are spaces for eighteen separate costs.

Terminal Costs

4.3.3 Terminal and station costs are treated separately from movement costs. Station costs are presented as an average service cost per passenger. Freight terminal costs being presented as a cost per tonne handled.

Management Information

4.3.4 The second section of results consist of a percentage breakdown of the total train variable costs by different cost headings. This is presented for the short, medium and long term and varies between type of train only in whether it includes wagon or coach costs.

Movement Costs

4.3.5 Train crew costs are simply the result of the formula:-

No of staff of type x * cost per hour * length of journey.

This is calculated for each relevant category of staff and the sum gives the total train cost for this category.

Billing and ticketing costs are simply a fixed sum per passenger or per tonne which is added to the train cost.

4.3.6 Loco Maintenance costs are calculated within the lower level spreadsheets as costs per km since PJKA use distance run to specify maintenance schedules. This cost is then placed in the formula.

No of locos type x * cost per km type x * Route Distance.

These costs are summed to derive train costs and then allocated equally between each coach or wagon of the train.

Coach and Wagon maintenance costs are calculated similarly to those of locomotives except that when the cost of each coach or wagon has been calculated this is allocated to the relevant vehicle and not to the train as a whole.

4.3.7 Within the front sheet of the model the costs of track maintenance associated with the running of the train are calculated. This is done by taking the per km cost of maintenance for each type of track multiplying by the amount of track of the type en route (perhaps zero) and then adjusting by the factors given by the operator for gradient and alignment. This cost is then multiplied by a factor which is estimated to be the share of track costs allowable to one tonne of train movement over any piece of track.

4.3.8 The average cost of collisions or derailments is calculated as a cost per km run. Within the front sheet the "accident" cost is calculated through the formula:-

Accident cost per km type x * no of type x * route distance.

This is derived for each type of loco, coach, wagon or railcar separately. The total train cost being the sum of all these.

4.3.9 Fuel consumption for train operation is generally calculated for

4.3.9 Fuel consumption for train operation is generally calculated for each type of locomotive or railcar per Gross Tonne km. Using this it is possible to multiply train weight by route distance to derive Gross Tonne km for the specified service. This is then applied to the fuel consumption figure and the delivered price of fuel to give a total train fuel cost. This is then allocated evenly between the wagons or coaches of the train.

4.3.10 The final categories of movement costs to be considered are locomotive and rolling stock provision costs. These are normally a function of time since depreciation is calculated per year. For the purposes of allocation to a train service, a cost per productive hour, is calculated which is then applied to the journey time of the train. This total locomotive provision cost is then split equally between each vehicle on the train.

Coach and wagon provision costs although calculated in the same way are distributed differently. The specific cost of each vehicle is allocated to the relevant vehicle and not to the train as a whole.

Terminal Costs

4.3.11 Terminal costs are calculated on a different basis. Although they could in practice be allocated per Gross Tonne km, this would not be logical. Within this model they are derived on the basis of per tonne throughput of a depot. This simply provides an average marginal cost to be allocated to each vehicle.

Similarly station costs are calculated on the basis of cost per passenger through a station. This is calculated in a lower level sheet for each type of station given that only the staff costs of stations are variable. For each service, the model calculates an average station cost per passenger using the station information input by the operator.

4.4. Printing and Storing Results

4.4.1 Normally the results of a costing exercise will need to be kept on a hardcopy for purposes of distribution and comparison. Therefore the operator must use the printing options within Quattro Pro to obtain this information.

Printing a spreadsheet involves the use of the "/PS" command. However this should only be used once the print block and layout commands have been set. For the output pages the columns A-H will need to be printed. Layout settings of left border 10 and right border 120 should suffice.

4.4.2 The results of a study can be stored in two ways. Either as a printing file or as a spreadsheet file. Saving to a printing file is done by altering the destination within the print menu.

Note: Printing files cannot be accessed by the spreadsheet, and so their use is limited to where several copies of the results may be needed.

4.4.3 Saving the results as a spreadsheet is much easier but will also use up more disk space. This is done by using the /FA command. This allows the operator to rename a file which should be done and also to change the directory. The /FS command should not be used because this will overwrite the spreadsheet on the hard disk.

4.4.4 The operation of the model raises several data management issues because at any one time several versions of the input or results spreadsheets could be in use. It is therefore important for the Traffic Costing Unit Manager to carefully plan the storage and editing of the model files. To ease this problem the files are initially organised in directories as follows.

C:\ COSTING	-	Costing model spreadsheets
C:\ FCRES	- -	Costing model freight coal results files One for each sector
C:\ INVAPPDS	-	Investment appraisal Do Something spreadsheets
C:\ FCINVRES	- -	Investment appraisal Do Something results One for each sector
C:\ BUDGET	-	Budgeting spreadsheets
C:\ COSTCONT	-	Cost control spreadsheets

STANDARD COSTING MODEL

PASSENGER SERVICES
(INTER-URBAN AND INTER CITY)

SERVICE DETAILS

SERVICE NAME	HARARE - BULAWAYO EXPRESS			
SERVICE CODE	IS 118			
			HOURS	MINS
FROM HARARE		DEPARTURE TIME	4	0
TO BULAWAYO		ARRIVAL TIME	18	0
DISTANCE	480	TRANSIT TIME	850	

AVERAGE SPEED 34 AVERAGE ROUTE DELAY(MINS) 10

SERVICE FREQUENCY 1 (PER DAY)

STATION DETAILS

STATION TYPE	1	2	3	4	5
NO OF STOPS ON SERVICE	4	0	0	0	0

OPERATING DETAILS

CREW

GRADE	DRIVER	ASSIST	CLEANERS	SENIOR TICKET COLLECTOR	TICKET COLLECTOR	GUARD
NO ON EACH TRAIN	1	1	2	1	1	1

GRADE	BUFFET STAFF
NO ON EACH TRAIN	0

MOTIVE POWER

TYPE OF LOCOMOTIVE	1	2	3	4
USED	0	0	0	0
	5	6	7	8
	1	0	0	0

COACHES

TYPE	1	2	3	4
NO IN CONSIST	2	0	5	1
TYPE	5	6	7	
NO IN CONSIST	0	0	1	

PERMANENT WAY

?????? ????

TYPE		1	2	3	4	5	6
DISTANCE	480	0	0	480	0	0	0
GRADIENT		0	0	4	0	0	0
ALIGNMENT		0	0	3	0	0	0

AVERAGE NO OF PASSENGERS PER COACH

TYPE OF COACH	1	2	3	4	5	6
PASSENGERS	35	0	50	15	0	0

TYPE OF COACH	7
PASSENGERS	0

PASSENGER SERVICE BETWEEN HARARE AND BULAWAYO

OUTPUT

UNIT COST/PASSENGER Km MOVEMENT	CLASS	SHORT TERM	MEDIUM TERM	LONG TERM
	1	0.01	0.01	0.08
	2	0.01	0.01	0.06
	3	0.00	0.00	0.00
UNIT COST/PASSENGER TERMINAL	0.01			
SERVICE COST/PASSENGER		6.22	6.39	36.61
		4.54	4.68	27.68
		0.00	0.02	0.02

MANAGEMENT INFORMATION

VARIABLE COST BREAKDOWN (PERCENT)	SHORT TERM	MEDIUM TERM	LONG TERM
LOCO PROVISION	0.00	0.00	59.78
LOCO MAINTENANCE	37.41	36.42	6.14
COACH PROVISION	0.00	0.00	23.36
COACH MAINTENANCE	2.83	2.75	0.46
STATION COSTS	0.00	0.05	0.01
TRAIN CREW	0.18	2.79	0.47
TRACK MAINTENANCE	0.00	0.00	0.00
FUEL COSTS	20.12	19.58	3.30
ACCIDENT COSTS	39.46	38.41	6.48
	100	100	100

VARIABLE COST BREAKDOWN	SHORT TERM	MEDIUM TERM	LONG TERM
LOCO PROVISION	0	0	6,764
LOCO MAINTENANCE	695	695	695
COACH PROVISION	0	0	2,643
COACH MAINTENANCE	53	53	53
STATION COSTS	0	1	1
TRAIN CREW	3	53	53
TRACK MAINTENANCE	0	0	0
FUEL COSTS	374	374	374
ACCIDENT COSTS	733	733	733
TOTAL TRAIN COST	1,857	1,908	11,314

ANNUAL TRAIN COST	SR	MR	LR
$ MILLIONS	0.68	0.70	4.13

STANDARD COSTING MODEL

PASSENGER SERVICES
(SUBURBAN)

SERVICE DETAILS

SERVICE NAME	HARARE-RUWA					
SERVICE CODE	SH 284			SH 284		0
			HOURS	MINS	HOURS	MINS
FROM HARARE		DEPARTURE TIME	7	45	0	0
TO RUWA		ARRIVAL TIME	8	30	0	0

DISTANCE 20 AVG.TRANSIT TIME 32.5 MINS

AVERAGE SPEED 37 AVERAGE ROUTE DELAY(MINS) 10

SERVICE FREQUENCY 39 (PER DAY)

STATION DETAILS

STATION TYPE	1	2	3	4	5
NO OF STOPS ON SERVICE	2	1	0	0	13

OPERATING DETAILS

CREW

GRADE	DRIVER	ASSIST	CLEANERS	SENIOR TICKET COLLECTOR	TICKET COLLECTOR	GUARD
NO ON EACH TRAIN	1	1	0	1	1	0

MOTIVE POWER

TYPE OF RAIL CAR USED

TYPE	DMU1	DMU2	EMU
NO OF EACH	0	0	8

PERMANENT WAY

TYPE	1	2	3	4	5	6
DISTANCE	20	0	0	0	0	0
GRADIENT	1	0	0	0	0	0
ALIGNMENT	2	0	0	0	0	0

AVERAGE NO OF PASSENGERS PER UNIT

DIRECTION OF TRAVEL	INWARD	OUTWARD
NO OF PASSENGERS/CAR	150	90

PASSENGER SERVICE BETWEEN HARARE AND RUWA

OUTPUT

	INWARD PASSENGERS	OUTWARD PASSENGERS
UNIT COST/PASSENGER Km MOVEMENT	0.02	0.01
UNIT COST/PASSENGER TERMINAL	0.02	0.01
SERVICE COST/PASSENGER	0.53	0.23

MANAGEMENT INFORMATION

VARIABLE COST BREAKDOWN
(PERCENT)

RAILCAR MAINTENANCE	8.47
RAILCAR PROVISION	56.36
TRAIN CREW	0.39
TRACK MAINTENANCE	0.24
STATION COSTS	0.43
FUEL/ENERGY COSTS	9.76
ACCIDENT COSTS	24.35
	100

VARIABLE COST BREAKDOWN

		TRAIN COST	TERMINAL COST
RAILCAR MAINTENANCE	36		
RAILCAR PROVISION	239		
TRAIN CREW	2		
TRACK MAINTENANCE	1		
STATION COSTS	2		
FUEL/ENERGY COSTS	41		
ACCIDENT COSTS	103		
TOTAL COSTS	425	423	2

STANDARD COSTING MODEL

BLOCK FREIGHT SERVICES

SERVICE DETAILS

SERVICE NAME HWANGE - BULAWAYO
SERVICE CODE FC 471

			HOURS	MINS
FROM HWANGE		DEPARTURE TIME	2	0
TO BULAWAYO		ARRIVAL TIME	22	0
DISTANCE	300	TRANSIT TIME	1210	
AVG SPEED	15			

AVG ROUTE DELAY 10

COMMODITY CODE 100
SERVICE FREQUENCY 2 (PER DAY)

TYPE OF TERMINAL 8
NUMBER OF STOP 2

OWNERSHIP OF TERMINAL

PRIVATE	0
PJKA	1
OTHER GOVERNMENT	0

OPERATING DETAILS

CREW

GRADE	DRIVER	ASSIST	BRAKE OPERATOR	GUARD
NO OF EACH	2	1	1	2

MOTIVE POWER

TYPE OF LOCO	1	2	3	4
NO OF EACH	0	0	0	0
TYPE OF LOCO	5	6	7	8
NO OF EACH	1	0	0	0

WAGONS

TYPE OF WAGON	3
NO OF EACH	13
AVERAGE LOAD(TONS)	20
% EMPTY RUNNING	0.05

PERMANENT WAY

TYPE		1	2	3	4	5	6
DISTANCE	300	0	0	200	0	0	100
GRADIENT		0	0	2	0	0	3
ALIGNMENT		0	0	1	0	0	4

BLOCK FREIGHT SERVICE BETWEEN HWANGE AND BULAWAYO

OUTPUT

UNIT COST/NET TONNE Km MOVEMENT	COMMODITY	SHORT TERM	MEDIUM TERM	LONG TERM
	100	0.02	0.02	0.15

UNIT COST/TONNE TERMINAL	COMMODITY			
	100	0.00	0.85	1.10
SERVICE COST/TONNE		5	8	46

MANAGEMENT INFORMATION

VARIABLE COST BREAKDOWN (PERCENT)

	SHORT TERM	MEDIUM TERM	LONG TERM
LOCO PROVISION	0.00	0.00	77.70
LOCO MAINTENANCE	25.13	21.59	3.50
WAGON PROVISION	0.00	0.00	5.55
WAGON MAINTENANCE	32.77	28.16	4.57
FREIGHT TERMINAL	0.00	3.92	0.64
TRACK MAINTENANCE	0.00	0.00	0.00
TRAIN CREW	0.23	3.29	0.53
FUEL COSTS	16.80	14.43	2.34
ACCIDENT COSTS	25.07	21.54	3.50
SHUNTING COSTS	0.00	7.07	1.68
	100	100	100

MANAGEMENT INFORMATION

VARIABLE COST BREAKDOWN

	SHORT TERM	MEDIUM TERM	LONG TERM
LOCO PROVISION	0	0	9,628
LOCO MAINTENANCE	434	434	434
WAGON PROVISION	0	0	687
WAGON MAINTENANCE	566	566	566
FREIGHT TERMINAL	0	79	79
TRACK MAINTENANCE	0	0	0
TRAIN CREW	4	66	66
FUEL COSTS	290	290	290
ACCIDENT COSTS	433	433	433
SHUNTING COSTS	0	142	208
TOTAL TRAIN COSTS	1,728	2,011	12,392
TRAIN COST/DAY	3,456	4,022	24,785
TRAIN COST/YEAR	1,243,980	1448069	8922448

STANDARD COSTING MODEL

MIXED FREIGHT SERVICES

SERVICE DETAILS

SERVICE NAME	HARARE - MUTARE			
SERVICE CODE	FT 283			
			HOURS	MINS
FROM HARARE		DEPARTURE TIME	8	0
TO MUTARE		ARRIVAL TIME	24	0
DISTANCE	300	TRANSIT TIME	970	
AVG SPEED	19	AVERAGE ROUTE DELAY		10
SERVICE FREQUENCY	2 (PER DAY)			

TERMINALS

TYPE	1	2	3	4
NUMBER	2	0	0	0
OWNER	1	0	0	0
TYPE	5	6	7	8
NUMBER	0	0	0	0
OWNER	0	0	0	0

OPERATING DETAILS

.CREW

GRADE	DRIVER	ASSIST	BRAKE OPERATOR	GUARD
NO OF EACH	1	1	2	1

MOTIVE POWER

TYPE OF LOCO	1	2	3	4
NO OF EACH	0	0	0.5	0
TYPE OF LOCO	5	6	7	8
NO OF EACH	0.5	0	0	0

WAGONS

WAGON NUMBER	1	2	3	4	5	6
TYPE OF WAGON	8	8	8	8	8	8
COMMODITY	5	11	3	43	1	12
AVERAGE LOAD(TONS)	10	11	15	8	10	18
EMPTY RUNNING	0.1	0.5	0.3	0	0.2	0.4
WAGON NUMBER	7	8	9	10	11	12
TYPE OF WAGON	8	8	8	8	0	0
COMMODITY	5	56	23	12	0	0
AVERAGE LOAD(TONS)	13	4	18	12	0	0
% EMPTY RUNNING	0.13	0.5	0.1	0	0	0

WAGON NUMBER	13	14	15	16	17	18
TYPE OF WAGON	0	0	0	0	0	0
COMMODITY	0	0	0	0	0	0
AVERAGE LOAD(TONS)	0	0	0	0	0	0
% EMPTY RUNNING	0	0	0	0	0	0

PERMANENT WAY

TYPE		1	2	3	4	5	6
DISTANCE	300	0	0	0	300	0	0
GRADIENT		0	0	0	4	0	0
ALIGNMENT		0	0	0	4	0	0

MIXED FREIGHT SERVICE BETWEEN HARARE AND MUTARE

OUTPUT

UNIT COST/NET TONNE Km MOVEMENT	COMMODITY	SHORT TERM	MEDIUM TERM	LONG TERM
WAGON NO				
1	5	0	0	0
2	11	0	0	0
3	3	0	0	0
4	43	0	0	1
5	1	0	0	0
6	12	0	0	0
7	5	0	0	0
8	56	0	0	1
9	23	0	0	0
10	12	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0

UNIT COST/TONNE
TERMINAL 3

MANAGEMENT INFORMATION

VARIABLE COST BREAKDOWN (PERCENT)

	SHORT TERM	MEDIUM TERM	LONG TERM
LOCO PROVISION	0.00	0.00	80.66
LOCO MAINTENANCE	29.85	22.29	2.79
WAGON PROVISION	0.00	0.00	6.43
WAGON MAINTENANCE	28.16	21.03	2.63
TERMINAL COSTS	0.00	16.29	2.04
TRACK MAINTENANCE	0.00	0.00	0.00
TRAIN CREW	0.22	2.08	0.26
FUEL COSTS	10.83	8.09	1.01
ACCIDENT COSTS	30.94	23.10	2.89
SHUNTING COSTS	0.00	7.12	1.30
	100.00	100.00	100.00

STANDARD COSTING MODEL

MIXED FREIGHT/PASSENGER SERVICES

SERVICE DETAILS

SERVICE NAME GWERU - MASRINGO
SERVICE CODE XR 811

			HOURS	MINUTES
FROM GWERU		DEPARTURE TIME	14	0
TO MASRINGO		ARRIVAL TIME	24	0
DISTANCE 150		TRANSIT TIME	610	
AVERAGE SPEED	15	AVERAGE ROUTE DELAY		10
SERVICE FREQUENCY	1	(PERDAY)		

OPERATING DETAILS

CREW

GRADE	DRIVER	ASSIST	GUARD	S TICKET COLLECTOR	TICKET COLLECTOR	BUFFET STAFF
NO OF EACH	1	1	0	1	0	0

GRADE	BRAKE OPERATORS	CLEANERS
NO OF EACH	1	1

MOTIVE POWER

LOCO TYPE	1	2	3	4
NO OF EACH	0	0	0	0

LOCO TYPE	5	6	7	8
NO OF EACH	0	0	2	0

PERMANENT WAY

TYPE	1	2	3	4	5	6
DISTANCE	0	0	0	0	0	150
GRADIENT	0	0	0	0	0	1
ALIGNMENT	0	0	0	0	0	4
MAINTENANCE TYPE	0	0	0	0	0	0

COACHES

TYPE	1	2	3	4	5
NO IN CONSIST	0	0	2	0	2
AVG NO PASSENGERS	0	0	50	0	61

TYPE	6	7
NO IN CONSIST	0	0
AVG NO PASSENGERS	0	0

WAGONS

WAGON NUMBER	1	2	3	4	5
TYPE	4	8	4	0	0
COMMODITY	28	80	12	0	0
AVERAGE LOAD(TONS)	6	13	21	0	0
%EMPTY RUNNING	0.1	0.2	0.2	0	0
TERMINAL TYPE	3	1	7	0	0
OWNERSHIP	1	1	0	0	0

TERMINALS

STATION DETAILS

TYPE	1	2	3	4	5
NO OF STOPS	1	0	0	1	3

MIXED PASSENGER/FREIGHT SERVICE BETWEEN GWERU AND MASRINGO

OUTPUT

UNIT COST/PASSENGER Km
MOVEMENT

CLASS	SHORT TERM	MEDIUM TERM	LONG TERM
1	0.00	0.00	0.00
2	0.03	0.03	0.93
3	0.02	0.02	0.61

UNIT COST/PASSENGER
TERMINAL 0.01

UNIT COST/NET TONNE Km
MOVEMENT

WAGON NUMBER	SHORT TERM	MEDIUM TERM	LONG TERM
1	0.16	0.17	4.99
2	0.08	0.08	2.23
3	0.05	0.05	1.43
4	0.00	0.00	0.00
5	0.00	0.00	0.00

UNIT COST/WAGON
TERMINAL

WAGON NUMBER	
1	0.00
2	0.00
3	0.00
4	0.00
5	0.00

MANAGEMENT INFORMATION

VARIABLE COST BREAKDOWN
(PERCENT)

	SHORT TERM	MEDIUM TERM	LONG TERM
LOCO PROVISION	0.00	0.00	93.29
LOCO MAINTENANCE	41.90	40.86	1.31
COACH PROVISION	0.00	0.00	1.95
COACH MAINTENANCE	2.37	2.32	0.07
WAGON PROVISION	0.00	0.00	1.56
WAGON MAINTENANCE	6.66	6.50	0.21
TRACK MAINTENANCE	0.33	0.32	0.01
TRAIN CREW	0.12	2.51	0.08
STATION COSTS	0.00	0.08	0.00
TERMINAL COSTS	0.00	0.00	0.00
FUEL COSTS	8.81	8.59	0.27
ACCIDENT COSTS	39.81	38.83	1.24
	100	100	100

VARIABLE COST BREAKDOWN	SHORT TERM	MEDIUM TERM	LONG TERM
LOCO PROVISION	0	0	28,917
LOCO MAINTENANCE	405	405	405
COACH PROVISION	0	0	605
COACH MAINTENANCE	23	23	23
WAGON PROVISION	0	0	484
WAGON MAINTENANCE	64	64	64
TRACK MAINTENANCE	3	3	3
TRAIN CREW	1	25	25
STATION COSTS	0	1	1
TERMINAL COSTS	0	0	0
FUEL COSTS	85	85	85
ACCIDENT COSTS	385	385	385
	967	991	30,999

5. **Automatic Updating of Costs**

Model Management

5.1 Generally the costs and inputs within the model will be constantly changing. It is however impractical to be constantly updating the results from the model each time a small change occurs. The costing model manager must therefore assess the various changes being made so that a practical interval of updating can be agreed. Generally larger changes such as wage rate increases or the introduction of new working practices will occur at six monthly intervals and since these have a greater effect on the costs than many of the small changes which may take place, it would seem that updating the full set of results every six months will be a good starting point.

Updating Procedure

5.2 The model contains a macro which will allow the updating of any part of the results database automatically. This procedure uses the train code (see section 3.7) to distinguish between different types of service and will update portions of the results using these codes. To aid the user in using the model for budgeting or investment appraisal it will also be possible to make new copies of the results pages in a separate directory from the originals. This will retain the old results and can therefore be used for the comparison of the two.

5.3 **Use of the Procedure.**

5.3.1 The automatic updating procedure is called up from the operating system by typing "Q MENU". This starts up Quattro Pro in the normal way but asks the user to enter a password. Once the password has been entered the user will be presented with the table in Figure 5.1. The user should then choose the appropriate option.

5.3.2 The are four possible options for the user.

(i) Update all service files.
(ii) Update only a selection of service files.
(iii) Update a single service file.
(iv) Make new copies as above.

It is also possible that different media could be used for the storage of the service files, eg. floppy disks, hard disk. Therefore the user also has the option of updating files from either.

5.3.3 Update All Service Files

To do this the user simply needs to type "Y" in response to that question.

5.3.4 Update a Selection of Service Files.

When updating only some services the user will need to specify the services to be updated using the tables in Figure 5.3.

If the user only wants to update a particular sector's services then all that is necessary is to enter "Y" in the "Update sector (Y/N)" and then the appropriate sectors code. If a sub-sector is also required then the user should enter "N" in response to "Update Sector (Y/N)". The computer will then ask "Update Sub-Sector (Y/N)". To update a sub-sector's services the user must enter "Y" against "Update Sub-Sector (Y/N)". This should be followed by the Sub-Sectors code.

To update a route's services only the user must enter "N" against "Update sector (Y/N)", "N" against "Update sub-sector (Y/N)" and "Y" against "Update Route (Y/N)". Once the user has entered the route code the computer will automatically update all the services using a particular route.

5.3.5 As the computer updates files it automatically saves the new results, replacing the originals.

5.3.6 Update A Single Service File

It may be that the user will want to update only a single service file. To do this the user simply needs to enter the correct sub-routine and give the name of the file to be updated. When the user wants to save the file being edited he simply needs to type /FS as normal.

The service codes to be used will be defined in a separate document showing all the available options but will be in the form laid out in Section 3.7.

5.3.7 Making New Copies

If the user is carrying out an investment appraisal or producing operating budgets using "what if" analysis it may be necessary to have two sets of results, a base situation and a "do something" or future scenario. This is done simply by using the facility for making new copies of the results spreadsheets. This works in the same way as for updating except that a separate set of results are stored rather than overwriting the original.

5.3.8 When choosing "Open Service File" the user will be required to enter the name of the file to be edited or viewed. When the user has finished they will be prompted as to whether they want to save the File.

5.3.9 "Print Service Files" allows the user to produce hard copies of all updated files. When this option is chosen the user must ensure that a printer of the required type is attached to the computer.

COLQUHOUN TRANSPORTATION PLANNING

Your New Date : 02-Dec-91

AUTOMATIC SPREADSHEET UPDATING
PROCEDURES
========================
MAIN MENU

(ALT "F") UPDATE SERVICE FILES (FD)
(ALT "U") UPDATE SERVICE FILES (HD)
(ALT "S") UPDATE SINGLE SERVICE FILES
(ALT "C") CREATE NEW UPDATE SERVICE FILES
(ALT "O") OPEN SERVICE FILES
(ALT "P") PRINT SERVICE FILES
(ALT "E") EXIT

PRESS YOUR CHOICE : ☐

MENU UPDATING
===========

1. UPDATE ALL SERVICES (Y/N)
- SECTOR
- SUB SECTOR
- NUMBER
TYPE YOUR CHOICE : ☐

2. UPDATE ONLY SOME SERVICES (Y/N)
TYPE YOUR CHOICE : ☐

PRESS "ESC" TO GO BACK TO MAIN MENU

MENU SERVICES
==========

UPDATE SECTOR (Y/N) [ ]
- F = FREIGHT
- I = INTER URBAN PASSENGER
- S = SUBURBAN PASSENGER
- P = PARCEL

- G = GOVERNMENT TRAFFIC
- E = RAILWAY TRAFFIC (ENGINEERING)
- X = SPECIAL TRAFFIC
TYPE YOUR CHOICE : [ ]

UPDATE SUB SECTOR (Y/N) [ ]

- FF = FUEL
- FL = LIVESTOCK
- FS = CONSTRUCTION
- FO = FOOD-STUFFS
- FT = CONTAINERS
- FG = GENERAL
- FM = METALS

- IF = EXPRESS SERVICES (CAPITAL BASED)
- IP = EXPRESS SERVICES (OTHERS)
- IS = STOPPING SERVICES (CAPITAL BASED)
- IT = STOPPING SERVICES (OTHERS)

TYPE YOUR CHOICE : [ ]

UPDATE ROUTE (Y/N) [ ]
- 11 = BANDUNG - JAKARTA EXPRESS
- 12 = JAKARTA - BANDUNG EXPRESS
- 13 = BOGOR - JAKARTA
- 14 = JAKARTA - BOGOR
- 15 = JAKARTA - SURABAYA
- 16 = SURABAYA - JAKARTA
- 17 = BANDUNG - SOLO
- 18 = SOLO - BANDUNG
- 19 = CONTAINERS JAKARTA - GEDEBAGE
- 20 = CONTAINERS GEDEBAGE - JAKARTA
TYPE YOUR CHOICE : [ ]

6. Use of the Model for Investment Appraisal

6.1 Introduction

Investment appraisal involves the calculation of two or more total costs representing a "do nothing" and several "do something" situations. Using the automatic updating procedures (see section 5) and the investment appraisal spreadsheet it is possible to calculate total operating costs under various different sets of assumptions.

6.2 Management Issues

6.2.1 It will be necessary to keep separate copies of the model spreadsheets for use in investment analysis. It would be inappropriate to alter the costs and inputs within the model proper in order to carry out investment appraisal.

6.2.2 This leads to several management issues. Having more than one set of spreadsheets, which in the base situation at least must reflect the same position, leads to problems with updating files. A management system must be developed which ensures that all spreadsheets contain the same information and are updated simultaneously. The results of the various "do something" situations must be stored in separate directories and aggregated in the investment appraisal spreadsheet.

6.3 Calculating New Costs

6.3.1 The first stage in doing an investment analysis must be to calculate the "do nothing" costs. This is done as per sections 3, 4 and 5. To calculate the "do something" costs it is necessary to first change the relevant costs and inputs in the model spreadsheets. This may involve new track maintenance inputs, new rolling stock or reduced manning levels. The method for doing this is explained within the "programmers manual".

6.3.2 It is necessary to then update the links from the altered spreadsheet to ensure that all of the cost data reflects the new situation. Once this has been done it will then be possible to calculate the "do something" costs using the automatic updating procedure (see section 5).

6.4 Using the Investment Appraisal Spreadsheet

6.4.1 This spreadsheet presents the results from the model for each service. This data is then aggregated by sector or route or system wide for each situation. This can be done for any number of different positions. Tables 6.1 and 6.2 show the format of the Spreadsheet.

6.5 Calculation of Benefits

6.5.1 It will be possible once these various costs have been calculated to derive a benefit/cost ratio for any investment which changes the inputs and costs within the model.This is done by comparing the results from the "do something" situation with the original "do nothing" position. This total cost change calculation when compared with the cost of the investment will provide an important input to any investment appraisal.

6.5.2 Cost changes are just one of many inputs to the analysis of an investment. Where an investment, such as a track improvement, has an effect on the operating situation eg. decreased journey times, the user of the model must analyse the possible revenue and cost effects of the change.

6.5.3 For example if an investment in new track between A and B were to reduce the journey time by 20 minutes then there could be 3 effects.

(i) Better track possibly leads to lower track maintenance costs.
(ii) Higher line speeds increase track wear and also rolling stock maintenance costs.
(iii) The reduced journey time leads to an increase in demand.

6.5.4 Generally the costing model will be able to reproduce the first two effects. However it will be necessary for the user to develop a demand model to estimate any change in patronage in order to provide revenue effects of an investment.

6.5.5 Using this analysis it is possible to define the benefits of an investment as being not only any change in cost (possible negative) but also the predicted increase in revenue. Whereas the costs of the investment for simplicity should be defined as the capital costs of any improvements.

6.5.6 This allows the use of the following formulae to calculate the Net Present Value or Benefit: Cost Ratio of a Project.

$$\text{Benefit: Cost Ratio} = \frac{\text{Net Present Value}}{\text{Total Capital Outlay}}$$

$$\text{Net Present Value} = (\text{Benefit Year 0} - \text{Cost Year 0})$$

$$+ \frac{(\text{Benefit Year 1} - \text{Cost Year 1})}{((1 + \text{Rate of Interest}))}$$

$$+ \frac{(\text{Benefit Year 2} - \text{Cost Year 2})}{((1 + \text{Rate of Interest}^{2}))}$$

$$\ldots\ldots\ldots\ldots \quad + \frac{(\text{Benefit Year N} - \text{Cost Year N})}{((1 + \text{Rate of Interest}^{N}))}$$

INVESTMENT APPRAISAL SPREADSHEET

SCHEME NAME: TRACK IMPROVEMENTS

SERVICE CODE	DO NOTHING TRAIN COST	FREQ	DO NOTHING DAILY COST	NO OF DAYS PER YR	DO NOTHING ANNUAL COST	DO SOMETHING SERVICE COST	DO SOMETHING DAILY COST	DO SOMETHING ANNUAL COST
FC111	12392	2	24785	250	6196144			
FM115	12392	2	24785	50	1239229			
IC373	12392	2	24785	50	1239229			
GA116	12392	2	24785	100	2478458			
GA555	12392	2	24785	1	24785			
FC118	12392	2	24785	365	9046371			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
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FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			
FC111	12392	2	24785	250	6196144			

INVESTMENT APPRAISAL SPREADSHEET

SCHEME NAME: TRACK IMPROVEMENTS

SUMMARY TABLE

DO NOTHING

SECTOR CODE	ANNUAL COSTS
IA	0
IC	1239229
FC	15242515
FM	1239229
SA	0
GA	2503242
XX	0

DO SOMETHING

SECTOR CODE	ANNUAL COSTS
IA	0
IC	0
FC	0
FM	0
SA	0
GA	0
XX	0

INVESTMENT APPRAISAL SPREADSHEET

SCHEME NAME: TRACK IMPROVEMENTS

SUMMARY TABLE

DO NOTHING

ROUTE CODE	ANNUAL COSTS
11	16481744
19	0
37	1239229
55	24785
78	0
82	0
99	0

DO SOMETHING

ROUTE CODE	ANNUAL COSTS
11	0
19	0
37	0
55	0
78	0
82	0
99	0

7 Use of Model as a Management Tool

7.1 Budgeting

7.1.1 The costing model itself produces a service cost for each time a train runs. It is possible from this result and information on the frequency of the service to calculate a daily, monthly or annual cost for each service. Service frequency is entered by the user in the front sheet of the spreadsheet.

7.1.2 The results from the costing model for each service along with the service frequency are read into the budgeting spreadsheet where the data is aggregated and used to produce budgets for each service or route or sector.

7.2 The Budgeting Spreadsheet

7.2.1 The budgeting spreadsheet is called up by typing Q BUDGET. This starts Quattro Pro as normal but goes straight into updating the links to the results database.

7.2.2 The spreadsheet itself consists of a calculations table and summary table. The calculations table (Figure 7.1) brings data from the results spreadsheets on a service by service basis. When the information on total train cost and service frequency has been retrieved from the results database, the budgeting spreadsheet calculates a daily and an annual cost for each service.

7.2.3 These costs are then aggregated within the summary tables (Figure 7.2) to provide daily and annual budgets for each route and each sub sector defined by the user.

7.2.4 This spreadsheet can be used to provide management with varying information particularly for operating budgets and what if analysis. As the spreadsheet gives annual budgets for each sector or sub sector or route a manager when assessing operating budget requirements can simply use the tables to give these figures.It may also be that a manager contemplating a change in operating procedure or different stock utilisation will want to use this spreadsheet to produce different budget figures for 2 or more different operating situations.

7.3 Cost Breakdown

7.3.1 The costing model produces within each results sheet a cost breakdown on the basis of:

Loco provision
Loco maintenance
Rolling stoke provision
Rolling stock maintenance
Track maintenance
Train crew
Terminal costs
Fuel costs
Accident costs

7.3.2 Once this has been calculated the manager will be able to use the information both as a planning and a predictive tool. The figures given will show inter-department cash flows for a particular sector e.g. flows of costs to the personnel department to pay for train crew.

Also the information will give managers details showing whether particular sectors of operation are more or less efficient towards a particular function e.g. coal trains may have a much higher track maintenance profile than other sectors.

7.4 Cost Control

7.4.1 Within the model unit variable costs are calculated for many areas of railway operations. It is possible to produce budgets for each of these operating areas from the unit costs and information on the output of workshops, track gangs etc.

7.4.2 This module is run by typing Q COSTCONT.

7.4.3 Loco Maintenance Example

Within the model costs are calculated for eight types of locomotive and nine types of service. These costs are brought forward into the cost control spreadsheet. Within the cost control spreadsheet there will be information on the expected number of services of each type to be carried out. The combination of these two pieces of information will produce an operating budget for each class of locomotive, each workshop and depot and even each service. Tables 7.6, 7.7 and 7.8 show the layout of this spreadsheet.

7.4.4 This information will have three main uses. Firstly it will aid planning because managers will be able to better schedule resources and manpower and therefore improve throughput and efficiency. The operating budget for each class of locomotive will also enable managers to highlight where increased expenditure is necessary due to worn out equipment or ageing rolling stock and allow the analysis of remedial action. Thirdly information regarding the railways own performance will provide a basis for comparing or accessing the performance of potential alternative resources or replacement private contractors.

STANDARD RAILWAY TRAFFIC COSTING MODEL

BUDGETING SPREADSHEET

SERVICE CODE	TRAIN COST	FREQ	DAILY COST	NO OF DAYS PER YR	ANNUAL COST
FC111	12392	2	24785	250	6196144
FM115	12392	2	24785	50	1239229
IC373	12392	2	24785	50	1239229
GA116	12392	2	24785	100	2478458
GA555	12392	2	24785	1	24785
FC118	12392	2	24785	365	9046371
FC111	12392	2	24785	250	6196144
FC111	12392	2	24785	250	6196144
FC111	12392	2	24785	250	6196144
FC111	12392	2	24785	250	6196144
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FC111	12392	2	24785	250	6196144
FC111	12392	2	24785	250	6196144
FC111	12392	2	24785	250	6196144
FC111	12392	2	24785	250	6196144
FC111	12392	2	24785	250	6196144

BUDGETING SPREADSHEET

SUMMARY TABLE

SECTOR CODE	ANNUAL COSTS
IA	0
IC	1239229
FC	15242515
FM	1239229
SA	0
GA	2503242
XX	0

SUMMARY TABLE

ROUTE CODE	ANNUAL COSTS
11	18960202
19	0
37	1239229
55	24785
78	0
82	0
99	0

STANDARD RAILWAY TRAFFIC COSTING MODEL

COST CONTROL SPREADSHEETS

LOCOMOTIVE MAINTENANCE EXAMPLE

AVERAGE COST OF MAINTENANCE

LOCO TYPE	TYPES OF MAINTENANCE A	B	C	D	E	F	G	U1	U2
1	322	5460	7278	10928	15129	25457	44857	5460	210
2	355	6596	8788	13185	18600	31686	51785	6596	338
3	355	6185	8241	12393	17210	29222	49056	6185	338
4	355	6185	8241	12393	17210	29222	49056	6185	338
5	394	6418	8568	12846	18017	30660	50643	6418	338
6	355	6175	8228	12373	17177	29161	48987	6175	335
7	350	5864	7843	11751	16219	27404	47025	5864	338
8	350	5864	7843	11751	16219	27404	47025	5864	338

PROGRAMMED MAINTENANCE SCHEDULES

LOCO TYPE	TYPES OF MAINTENANCE A	B	C	D	E	F	G	U1	U2
1	250	50	10	5	1	0	0	20	20
2	1	1	1	1	1	1	1	1	1
3	1000	350	80	25	0	12	6	50	100
4									
5									
6									
7									
8									

PROGRAMMED MAINTENANCE COST

LOCO TYPE	TYPES OF MAINTENANCE A	B	C	D	E	F	G	U1	U2
1	80390	273009	72780	54638	15129	0	0	109203	4207
2	355	6596	8788	13185	18600	31686	51785	6596	338
3	355371	2164757	659259	309832	0	350660	294335	309251	33800
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0

TOTAL MAINTENANCE COST BY TYPE OF LOCO

LOCO TYPE	YEARLY COST	TRAIN LOCO KM YEAR	COST PER LOCO KM
1	609356	50191	12
2	137930	130833	1
3	4477264	67681	66
4	0	67681	0
5	0	103023	0
6	0	66285	0
7	0	41356	0
8	0	41356	0
OVERA	5224550		9

8.0 Use of the Model to Determine Pricing

8.1 Model Results

8.1.1 The costing model produces three different sets of costs. Short run costs are defined as those which are directly variable with the running of a single train. These basically consist of fuel, maintenance and accident costs. These are the costs which could be immediately avoided if a train did not run.

8.1.2 Medium run costs are those which would be avoided if a service were not to run at all eg. if all cement trains between A and B were withdrawn. This assumes that the actual route would still be used by other trains. Train crew costs are considered to be of this type because these costs are generally fixed in the short term.

8.1.3 In the long run it is assumed that all variable costs vary with train operation. This includes all the costs within the model.

8.1.4 For suburban passenger services a different analysis is carried out. The model produces two separate costs, one for "inward" passengers and one for "outward" passengers. These costs provide a basis for peak-load pricing (see Section 8.2). To calculate these costs the model uses the formulae:-

$$\text{Cost (Heavy Flow)} = \text{Unit Cost} \; * \frac{1}{\text{Flow Heavy}} \left(1+\left(1-\frac{\text{Flow Light}}{\text{Flow Heavy}}\right)\right)$$

$$\text{Cost (Light Flow)} = \text{Unit Cost} \; * \frac{1}{\text{Flow Heavy}} \left(1-\left(1-\frac{\text{Flow Light}}{\text{Flow Heavy}}\right)\right)$$

8.2 Application of Model Results to Pricing

8.2.1 Economic theory tells us that market segmentation and price discrimination can be justified where the aim is to equate the elasticities of demand in all market segments (social surplus maximisation). Where demand in certain segments still exceeds supply prices should be raised further (peak load pricing) in order to equate further the demand from different segments.

8.2.2 Three different sets of arguments hold for Freight/Inter Urban Passenger and Suburban Passenger services.

8.2.3 For freight services the three different costs calculated by the model can be applied to different categories of flow. Many railways carry one-off shipments which the railway would wish to encourage. Since these one off shipments could be expanded into more substantial flows and very little long run costs is normally associated with these flows the railway may wish to use the short run costs on which to base price.

8.2.4 As flows become more established and regular so the railway will incur more longer run costs particularly in relation to the provision of staff and the railway will need to recover these costs by using the medium term costs as a basis for setting price.

8.2.5 Permanent flows directly accrue further costs in connection with the provision of rolling stock to cover the service. These costs as well as those for track maintenance are classified as long run and so it would be appropriate for the railway to use the long run variable cost to calculate price.

8.2.6 Suburban Passenger services differ in their traffic patterns from other types of service in that they are heavily peaked and the majority of costs associated with operating ie. rolling stock maintenance and provision are generally led by the demand in one direction. Therefore the railway should in order to recover these costs fairly, use differential pricing to reflect the relative capacity requirements of the flows.

8.2.7 Inter urban passenger services can employ price discrimination at several levels, apart from the implicit one of by class of travel (1st, 2nd, 3rd). Generally however, pricing policy should be in the first instance be set with regard to the relative volumes of demand at different times of day or different days of the week. For example where a train is full, long run costs should be used, if it is empty then short run should be used in order to give a lower price to attract more traffic.

8.3 Fixed Costs

8.3.1 The reason for allocating fixed costs to services is to determine a pricing structure which recovers fixed and indeed total costs. While variable costs must be recovered in the long term from all services only a contribution towards fixed costs is required. The level of contribution depends entirely on the ability of the consumer to pay. On some services there may be little opportunity for fixed cost recovery because the price elasticity of demand is high and demand decreases and price increases so that actual contribution to fixed costs can remain the same. On other services, price could be increased leaving demand unchanged, so it is on price inelastic services that the scope for fixed cost recovery is greatest.

The allocation of fixed costs to services is therefore a matter of commercial judgement within each "Business Sector".

8.3.2 This relationship between price and demand can be dealt with with regard to the "Ramsey Pricing Rule" or the "Baumol-Bradford Rule" as explained below. These theories both give the amount of fixed costs which can be recovered from a service by relating the elasticities of demand to the marginal costs of the service.

8.4 Apportionment of Fixed Costs

8.4.1 The Baumol-Bradford rule requires that the users knows the relationship between fixed and variable costs. This relationship can reasonably be estimated from previous accounts. This can either be done on an overall railway basis or by splitting up the accounts into operating sectors i.e. inter urban passenger, suburban passenger etc.

8.4.2 This provides two extra levels of detail. The breaking down of costs in this way allows the comparison of the business sector's performance and also because all of the inter sector cross subsidy is removed, railway managers can better identify cases where government subsidy may be required.

8.4.3 The rule to be used in calculating price is the same regardless of which definition of fixed costs is used.

$$\text{Price (per unit km)} = \frac{\mu_1 * \text{Variable Cost (per unit km)}}{\mu_1 - \text{Scaling Factor}}$$

scaling Factor = Variable cost as a proportion of total cost e.g. where variable cost = 50% of total cost, scaling factor = 0.5

μ = price elasticity of demand for individual service

8.4.4 The price elasticity of demand must be derived from data showing the effect on demand of price changes. This should be possible using data on demand within the railway. The Formula for calculating the elasticity is:-

$$\mu_1 = \frac{dy}{dx} * \frac{x}{y} \text{ or}$$

$$\mu_1 = \frac{\text{Change in y (demand)}}{\text{change in x (price)}} * \frac{\text{Price}}{\text{Demand}}$$

8.4.5 **Examples**

a) Elasticity = 1
VC = 50% of TC

$$\text{Price} = \frac{1 * 5 \text{ c per km}}{1 - 0.5} = \frac{5}{0.5} = 10 \text{ c per km}$$

b) Elasticity = 1.3
VC = 40% of TC

$$\text{Price} = \frac{1.3 * \text{ c per km}}{1.3 - 0.4} = \frac{6.5}{0.9} = 7.2 \text{ c per km}$$

c) Elasticity = 0.8
VC = 40% of TC

$$\text{Price} = \frac{9.8 * 5\text{c per km}}{0.8 - 0.4} = \frac{4}{0.4} = 10 \text{ c per km}$$

8.4.6 As can be seen from the examples above the price that can be charged will vary greatly depending on the elasticity of demand. Where demand is relatively inelastic i.e. where price has little effect on demand the price chargeable is much higher than where demand is more elastic i.e. where price has a larger effect on demand.

8.5 Subsidy Negotiations

8.5.1 As well as providing a framework for setting prices the use of the above formula can produce information which would be helpful in subsidy negotiations.

8.5.2 Once the above process has been completed for all services it will be possible to compare the expected total income for each business sector with the predicted total cost for the relevant sector. This will allow the calculation of the amount of profit or loss being made by each sector and therefore will allow the railway managers to make a case for the subsidising of a particular sector.

8.5.3 This analysis can be done at any level of aggregation where fixed cost figures are known e.g. sub-sector, route, total operations. However it would be false to attempt this on a service basis because of difficulty of estimating the amount of fixed cost attributable to a service.

Standard Railway Traffic Costing Model

Programmer's Manual

PREFACE

The author Douglas Rasbash has many years experience in railway economics worldwide. Specific experience of railway traffic costing both in Indonesia and Southern Africa has led to the adoption of the technique of normative costing. This has been as a result of experience of developing country railway accounting methods and a belief that normative costing methods provide a more reliable approach for developing countries as well as being a useful management tool providing information on both operating and maintenance inputs and costs.

The approach using normative costing is being supported by the World Bank and is now becoming a requirement of Bank funded projects. The traffic costing model received its first application as part of a program of technical assistance to Indonesian State Railways, where it has been well received and is being implemented.

The author has subsequently developed the basic framework for wider use for all other railway organisations or appropriate government departments. Further developments which will automate many of the processes within the model to assist, for example, with route by route appraisals, auditing and budgeting are planned and will be documented as they are completed.

The data shown within this report are for example only and are only included to show the variety and types of data available to the user. All items of information can be fully edited to suit any country or organisation.

1.0 Introduction

Standard Costs and Adjustment Factors

1.1 The model is service specific and calculates the variable costs of operation. As such the model requires service and operational information specific to the service being studied.

1.2 Unlike almost all previous Rail Traffic Costing frameworks, the costs within this model are based on standard or normalised costs. These reflect those costs that should be generated in order to conduct the business to proper standards of efficiency. Generally there would be a large difference between these standard costs and actual or accounting costs. Therefore the model employs a whole series of adjustment factors which allow the user of the model to convert the standard performance factors contained in the model to acceptable levels dependant on local conditions and practices.

Hardware and Software Requirements

1.3 The model is designed to be operated on a free standing personal computer. This personal computer should be equipped with 1Mb of RAM and a hard disk, which will hold the programmes and data sheets necessary to use the model, of at least 30 Mb. It is envisaged that output from the model should be in hardcopy form and to this end an appropriate printer is necessary. This hardware should of course be equipped with the appropriate operating systems and software.

1.4 The basic design of the traffic costing model is that of a series of "linked" spreadsheets, containing sections of the data required to provide cost figures. These spreadsheets have been designed and will only operate using the "Quattro Pro"[1] spreadsheet software. Many of the utilities and functions used within the model are not compatible with any other spreadsheet package.

Model Specification

1.5 Because the model is line and service specific it has to be given data which defines the service to be costed. This information consists of three categories of data.

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[1](Quattro Pro. Copyright 1989 Borland International)

Service Details

1.6 The user must specify the distance travelled and time taken by a train. The model also requires an origin and destination and an identity code, from an accounting system or operating handbook. The model will also prompt for information on average delays and service frequency.

Consist Details

1.7 As the model is service specific the user must supply details of the locomotive(s) and carriages or wagons used, the train crew employed on the train and the track over which the train travels. Finally details of the terminals or stations used must be given.

Load Factors

1.8 The final data required are Load Factors and commodity types which are used to calculate unit costs.

Model Results

1.9 The model produces short, medium and long run unit costs for each class of passenger or each wagon. A table showing the breakdown of costs is also produced.

2 General Model Structure

2.1 Using Quattro Pro it is possible to have many small spreadsheets which act as if they were one larger sheet. Within this model there are 16 different spreadsheets which feed data from one to another through the spreadsheet linking facilities within Quattro Pro. This allows more detailed analysis of cost items because large spreadsheets of information do not need to be loaded into memory whilst running a costing exercise.

2.2 This transfer of data is carried out semi-automatically. Whenever a spreadsheet is retrieved from disk, Quattro Pro will prompt the user as to whether the links need to be updated. This should always be done. Because the spreadsheets within the model are separate, a change to one piece of data or one formula in a spreadsheet will not be transmitted to the other spreadsheets which use the result of the cell. Table 2.1 shows a list of the model Files

Table 2.1

List of Model Files

ACCID	-	accident costs
BLOCKF	-	front page - block freight
CSPREAD	-	carriage depreciation and maintenance
ENERGY	-	fuel and fuelling costs
LSPREAD	-	loco depreciation and maintenance
MIXEDF	-	front page - mixed freight
MIXPASS	-	front page - mixed passenger and freight
PASSENGE		-front page - inter urban passenger
RSPREAD	-	railcar depreciation and maintenance
STSTAFF	-	station staff costs
SUBURB	-	front page - suburban passenger
TRMAIN	-	track maintenance costs
WAGES	-	wage costs
WSPREAD	-	wagon depreciation and maintenance
YARDS	-	terminal costs
SHUNT	-	shunting costs

2.3 Linking of spreadsheets.

Within the model there are many flows of data from one spreadsheet to another. It is to be noted that the spreadsheets can be split into 3 layers. Table 2.2 gives details of these data flows. The importance of the wage spreadsheet can be seen by the flows of data from this to every other spreadsheet.

Table 2.2

From	To	Description	Usage
WAGES	ALL S/S's	Hourly wage rates	Calculate labour input costs
TR MAIN	FRONT SHTS	Cost per km	Calculate track costs per tonne and total train track costs
STSTAFF	FRONT SHTS	Cost per passenger	Calculate average cost per passenger
YARDS	FRONT SHTS	Costs per tonne	Calculate terminal costs per tonne handled
ENERGY	SHUNT	Cost per litre	Calculate shunt costs
ENERGY	FRONT SHTS	Cost per litre	Calculate train fuel costs
ACCID	FRONT SHTS	Cost per km	Calculated accident costs for each vehicle in train
LSPREAD	ACCID	Depn per hour	Calculate cost per day out of traffic
LSPREAD	FRONT SHTS	Depn per hour	Calculate loco provision costs
LSPREAD	FRONT SHTS	Cost per km	Calculate loco maintenance costs
CSPREAD	ACCID	Depn per hour	Calculate cost per day out of traffic
CSPREAD	FRONT SHTS	Dpn per hour	Calculate coach provision costs
CSPREAD	FRONT SHTS	Cost per km	Calculate coach maintenance costs
WSPREAD	ACCID	Depn per hour	Calculate cost per day out of traffic
WSPREAD	FRONT SHTS	Depn per hour	Calculate wagon provision cost
WSPREAD	FRONT SHTS	Cost per km	Calculate wagon maintenance costs
RSPREAD	ACCID	Depn per hour	Calculate cost per day out of traffic
RSPREAD	FRONT SHTS	Depn per hour	Calculate railcar provision cost
RSPREAD	FRONT SHTS	Cost per km	Calculate railcar maintenance cost
SHUNT	FRONT SHTS	Cost per Shunt	Calculate shunting costs

2.4 To calculate a full traffic cost for a service each of the individual costs calculated in the model spreadsheets must be transferred from spreadsheet to spreadsheet where necessary but especially to the front pages of the model. Within Quattro Pro this is made simple through the use of "spreadsheet linking". This allows data to be taken from a closed spreadsheet stored on disk and placed within the current spreadsheet.

The command structure within Quattro Pro which allows this is:

@ VALUE ([Filename : Ext] Cell)

This means take the value from cell x in file y and place it in the cell containing the command. For example

A111 : @ VALUE ([WAGES.WQ1] R45)

Take the value in cell R45 of file WAGES.WQ1 and places it in cell A111 of the current spreadsheet. As stated when a spreadsheet is retrieved from memory, all of these links can be updated automatically.

Rolling Stock Categories

2.5 Within the model it has been necessary to categorise rolling stock, track and terminals to produce a manageable number of types for these items. These are summarised in the tables below.

Locomotives

Cat	Type	Hp
1	CC200	1600
2	BB301/4	1500
3	BB202/4	1500
4	BB201/3	1425/1500
5	CC201/2	1950/2000
6	BB200	675
7	BB300	680
8	BB302/3/6	1000

Coaches

Cat	Type	Description
1	KT/K1	First Class/Executive
2	KM1/M1	1st Class Restaurant
3	K2	Second Class
4	KM2/M2	2nd Class Restaurant
5	K3	Third Class
6	KM3	3rd Class Restaurant
7	BP/B	Power/Baggage Car

Wagons

Cat	Type	Description
1	KK	Bogie Tank
2	KKB/YY/ZZ	Bogie High Side Drop
3	PP	Bogie Flat
4	GG/TT	Bogie Box
5	K/PB	2 Axle Tank
6	Y	2 Axle Low Side Drop
7	P	2 Axle Flat
8	G/T/V	2 Axle Livestock

Railcars

Cat	Type
DMU1	MCW301
DMU2	MCW302
EMU	All Electric Railcar

Locomotive Maintenance

Type	Description			Time
A	Daily	-	350 km	(3 hours)
B	500 H	-	10,500 km	(1 day)
C	1,500 H	-	31,500 km	(2 days)
D	3,000 H	-	63,000 km	(2 days)
E	6,000 H	-	126,000 km	(6 days)
F	12,000 H	-	252,000 km	(8 days)
G	24,000 H	-	504,000 km	(40 days)
U1	Repairs because of loco failure			

Coach Maintenance

Type	Description			Time
A	Daily	-	600 km	(18 mins)
B	Monthly	-	24,000 km	(1 day)
C	6 Monthly	-	60,000 km	(1 day)
D	Annual	-	120,000 km	(2 days)
E	250,000	-	Bogies	(6 days)
F	500,000	-	Overhaul	(35 days)
U1	Repairs because of in service failure			
U2	Collision/Accident repairs			

Wagon Maintenance

Type	Description			Time
A	Daily	-	50 km	(12 mins)
B	Oiling	-	1,500 km	(3 hours)
C	Overhaul	-	225,000 km	(16 days)
U1	Repairs because of in service failure			
U2	Collision/Accident repairs			

Diesel Railcar Maintenance

Type	Description			Time
A	Daily	-	350 km	(18 mins)
B		-	10,000 km	(1 day)
C		-	30,000 km	(2 days)
D		-	60,000 km	(2 days)
E		-	120,000 km	(6 days)
F		-	240,000 km	(35 days)
U1	Repairs because of in service failure			
U2	Collision/Accident repairs			

Electric Railcar Maintenance

Type	Description			Time
A	Daily	-	350 km	(18 mins)
B		-	10,000 km	(1 day)
C		-	60,000 km	(2 days)
D		-	120,000 km	(6 days)
E		-	240,000 km	(35 days)
U1	Repairs because of in service failure			
U2	Collision/Accident repairs			

2.6 Other Model Categories

Track

Cat	Rail Type	Sleeper Type
1	UIC54R	Concrete
2	UIC50R	Wood
3	UIC42R	Concrete
4	UIC42R	Wood
5	UIC33R	Steel
6	UIC25R	Wood

Stations

Type	Avg Pass Through	Avg Staff
1	10000	39
2	6000	26
3	3000	10
4	1000	5
5	500	6

Labour

Cat	Description
1	Administrative Staff
2	Driver
3	Driver's Assistant
4	En Route Cleaning Staff
5	Wagon Manual Brake Operator
6	Senior Ticket Controller
7	Ticket Controller
8	Train Guard
9	Superintendent
10	Depot Mechanic
11	Material Storage Man
12	Large Station Master
13	Large Station Master Assistant
14	1st Class Station Master
15	2nd Class Station Master
16	3rd Class Station Master
17	4th Class Station Master
18	5th Class Station Master
19	Train Dispatcher
20	Passenger Ticket Salesman

21	Treasurer
22	Cashier
23	Station Cleaning Staff
24	Freight Billing Clerk
25	Shunter
26	Maintenance Crew
27	Machine/Equipment Operator
28	Construction Worker
29	Bridge Worker
30	Storage Guard
31	Track Inspector
32	Material Storage Clerk
33	Metal Worker
34	Cleaning Staff
35	Movement Controller
36	Freight Terminal Manager
37	Wagon Loaders/Unloaders
38	Porters
39	Restaurant Staff

3.0 Management Issues

3.1 Passwords

3.1.1 In general the data within the model spreadsheets will be of a sensitive nature. To combat this problem and also to prevent any unauthorised entry to the model each file within the model will be given a password. These passwords will be held by the TCU manager and will only be available to the TCU members.

3.1.2 Within the TCU different levels of security should be given to the different model files. This will help to prevent accidental deletion or editing of spreadsheet data. This can be done by giving only the TCU manager and the TCU programmer access to certain of the model files.

3.2 File and Data Protection

3.2.1 The front sheets of the model are the most suceptible of all the model files to accidential deletion or damage. To a certain extent this has been addressed by protecting all of the data in these spreadsheets excepting that which is entered by the user. This protects all of the equations and relationships within the front sheet. When the programmer needs to change any of these it is a simple procedure to temporarily remove any protection while changes are made.

3.2.2 It is also possible to protect the model files in their entirety by using the ATTRIB + R command in DOS. This changes the files to read only files and so protects them against deletion or overwriting.

3.3 File Directories

3.3.1 The operation of the model raises several data management issues because at any one time several versions of the input or results spreadsheets could be in use. It is therefore important for the Traffic Costing Unit Manager to carefully plan the storage and editing of the model files. To ease this problem the files are initially organised in directories as follows:-

3.3.2	C:\ COSTING	-	Costing model spreadsheets
	C:\ FCRES	-	Costing model freight coal results files
		-	One for each sector
	C:\ INVAPPDS	-	Investment appraisal Do Something spreadsheets
	C:\ FCINVRES	-	Investment appraisal Do Something results
		-	One for each sector
	C:\ BUDGET	-	Budgeting spreadsheets
	C:\ COSTCONT	-	Cost control spreadsheets

4.0 Use of the Model

4.1 Start Up and Loading

4.1.1 As already stated the model is designed to be run on a free standing personal computer. This greatly simplifies the starting procedures.

After switching on and loading the operating system of the computer the user should type

" CD/QPRO "

This should be followed by

" Q "

4.1.2 At this point the computer will load the "Quattro Pro" programmes. The user will be presented with a blank spreadsheet. To load a spreadsheet into memory the user must type

" /FR "

The computer will display a list of available files. The correct spreadsheet should then be selected by using the cursor keys. When selected the return key should be pressed.

4.1.3 When the spreadsheet is fully in memory the computer will prompt.

"Link Options"
"Load Supporting"
"Update Refs"
"None"

Always when presented with this menu the user should press "U". The computer then goes through each of the spreadsheet links reading the data from other files.

4.2 Running a New Costing Exercise

4.2.1 When the user loads one of the front sheets of the model he will be presented with a series of tables which will require the entry of several pieces of service specific data. It will be necessary for the user of the model to collect much of this information.

Model Data Requirements

4.2.2 The consist of the trains operating the services to be costed is a most important piece of information in any costing system, but especially in this model where unit costs are calculated for each type of loco, coach and wagon. Using the types and categories set out in section 2.5 the user must enter the number of each type of locomotive, coach or wagon used.

Where more than one type of loco is used simultaneously the number of each should be entered. Where the type of loco used changes during a journey, the number of each used should reflect the proportion of the journey employing each loco e.g. if the loco is changed halfway then the number of each should read 0.5.

4.2.3 The timetable information required by the model consists of origin and destination, service name (where applicable), service code, start and finish time for one journey and the distance run by the service.

One other important piece of information is the average route delay in minutes. It is often the case that timetabled journey times are regularly exceeded. This will normally be due to speed restrictions as a result of poor or delayed track maintenance and poor operating procedures. For the purposes of this model the information on delay is applied to both loco and coach or wagon provision cost and track maintenance costs. It is assumed that average delay as a percentage of total journey time is a measure of the shortfall of expenditure on track maintenance over necessary amounts to maintain standards.

The model also requires the service frequency in order to calculate total costs where necessary.

4.2.4 The crew of the train must be determined through research by the user using the categories in section 2.6, the number of crew should be entered by occupation.

Within the freight spreadsheets it will be necessary for the operator to enter the types of commodity in each wagon. Within a block train there will normally be only one type of wagon and one commodity with the loading of each wagon being approximately the same. Mixed freight trains will need to be specified wagon by wagon with the wagons being of different types with different commodities and different loads.

Load Factors

4.2.5 In order to calculate costs per Gross Tonne km or per Passenger km, it will be necessary to enter load factors per coach or wagon. With passenger trains the model needs information on the average number of people in each coach or each railcar.

For freight trains it is necessary to know, both for terminal and movement costs, the number of tonnes of each commodity in each wagon. It is possible that this will vary between days or even between wagons of the same type with the same commodity in the same train. An average figure will however be good enough since these differences will normally balance out.

Terminal Costs

4.2.6 Finally, the model also produces costs for each type of freight terminal and passenger station as listed in section 2.6. Therefore the operator must for passenger trains enter the number of each type of station called at and for freight the type of terminal used for each wagon. One other important piece of information is the ownership of each terminal. The traffic costing system ignores the terminal costs (except shunt costs) where a terminal is not owned by the railway company.

4.2.7 This data is entered in the normal way using the return and cursor keys.

Examples of the front pages of the model are shown at the end of this section.

4.3. Printing and Storing Results

4.3.1 Normally the results of a costing exercise will need to be kept on a hardcopy for purposes of distribution and comparison. Therefore the operator must use the printing options within Quattro Pro to obtain this information.

4.3.2 Printing a spreadsheet involves the use of the "/PS" command. However this should only be used once the print block and layout specified wagon by wagon with the wagons being of different types with different commodities and different loads.

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4.3. Printing and Storing Results

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4.3.2 Printing a spreadsheet involves the use of the "/PS" command. However this should only be used once the print block and layout will need to be printed. Layout settings of left border 10 and right border 120 should suffice.

4.3.3 The results of a study can be stored in two ways. Either as a printing file or as a spreadsheet file. Saving to a printing file is done by altering the destination within the print menu. For the safety of the model it is best that floppy discs are used for all such operations. Where this is the case the directory used by the computer must also be changed.

Note: Printing files cannot be accessed by the spreadsheet, and so their use is limited to where several copies of the results may be needed.

4.3.4 Saving the results as a spreadsheet is much easier but will also use up more disk space. This is done by using the /FA command. This allows the operator to rename a file which should be done and also the change directory. The /FS command should not be used because this will overwrite the spreadsheet on the hard disk.

5.1 As discussed in Section 2.1 the model is made up of 16 separate spreadsheets. Each of these spreadsheets contains many different equations and relationships. These are discussed individually in the succeeding sections.

5.2 WAGES

5.2.1 It was decided that the easiest method of presenting information on salaries was to use a slightly modified version of a standard railway salary table. This is presented in Figure B1. In order to use this in a simple way an average salary for each grade was calculated by assuming an equal spread of personnel over the years of service.

5.2.2 The second stage of this spreadsheet is to identify the categories of staff to be used and then to calculate the average rank of staff in these categories. Column A then takes the relevant average salary from the firs table.

Total staff cost include various additional costs. These are calculated separately with a final hourly cost being presented

Spouse allowance is calculated as 5% of basic salary where appropriate. Column B is therefore a formula of the form AolA x 5% x 0.9. Of course not all employees are married, so the average payment is calculated from the total possible payment multiplied by the proportion of staff who get the allowance.

Child allowance is calculated in Column C as 2% of base salary per child. The average no of children per employee on PJKA is assumed to be 3. It is also assumed that only those who are married have children. The formula is therefore Col A x (3 x 2%) x 0,9.

The other allowance calculated on this percentage basis is the salary improvement allowance. This is 25% of the basic salary plus the family allowances. The formula is therefore:-

(Col A + Col B + Col C) * 0.25)

The other allowances are generally calculated per head.

5.2.3 The Rice allowance is calculated as $2.22 for each employee and his immediate family. This produces an average, payment of $10 per month.

Official occupation allowances are given as

Grade IV	20	100%
Grade III	10.5	75%
Grade II	7	20%
Grade I	0	0%

These give average payments for Grades II and III of 1.20 and 7.63 respectively.

Col G calculates housing allowances as

Grade	Payment	No received	Average Payment
IV	37.5	100%	37.5
III	25.0	90%	22.5
II	18.0	25%	4.5
I	10.0	5%	0.5

Col H gives the total salary which is not based on hours worked or kms travelled. This is the total of columns A - G.

The other component of wages is overtime payments. Average payments have been determined for maintenance, operations and administrative staff in Grades II and III. These are entered as simply the average payments for each category of staff.

The sum of cols I and H are the total employment costs per month for each grade. The other spreadsheets of the model use costs per hour and so in Col K, the costs per month are divided by the estimated number of productive hours per month.

5.2.4 The number of productive days per year per member of staff and then the number of productive hours per day, per member of staff have been estimated using experience gained from Indonesia. These calculations are included in this spreadsheet. The results are however citrate in days or hours per month.

5.3 L SPREAD, C SPREAD, W SPREAD, R SPREAD.

5.3.1 These are the largest and perhaps most important of all the spreadsheets in the model. They can be split into several separate parts.

The first of these are the statements of loco, coach, wagon, or railcar output. This is calculated for each of the classifications in section 2.5. A factor is included in this table for light or empty running. Although a locomotive covers 100,000 km per year if 10% of this is light running then its costs can only be allocated effectively over 90,000 km. This greatly increases the costs per km run.

Also there are tables which calculate availability in days per year and utilisation in terms of hours per day. This information is used to calculate depreciation and finance charges per train hour. This model uses an interest rate of 4% and a life of 25 years. Availability is calculated as the number of days per year that the loco or rolling stock is available for traffic. This is the number of days in a year minus the number of days the loco or rolling stock is set aside and the number of days it is undergoing maintenance or repair.

Utilisation of stock is calculated as the number of hours per day the item is used. This takes into account wait time and light or empty running and produces a figure of hours worked per day available. These figures in combination give a figure for train hours per year. Depreciation per hour is then calculated by simply dividing depreciation per year by the number of hours worked per year.

5.3.2 The third set of information is that of maintenance schedules. This involves taking the distance schedules for the types of maintenance listed in section 2.5. and calculating the average number of each type of service that an average vehicle of each type receives. For example where a wagon should receive maintenance every 50 km run and it runs 5000 km per year, it will receive 100 of these services each year. Using data on length of maintenance it is then possible to calculate the number of days per year that the vehicle will be undergoing maintenance. This figure is used in calculating availability.

It is important that accurate costs for each type of maintenance are determined. Firstly labour inputs by occupation need to be calculated for each type of service and for each type of vehicle. For this there is a table for standard inputs for each type of service. It is likely that the railway does not meet these standards and so there are a series of productivity adjustments which are applied to the standard costs to produce the accepted inputs.

At this point the spreadsheet uses wage costs taken from WAGES to produce total labour costs for each type of maintenance.

5.3.3 The second component of maintenance costs are materials. These are estimated for each type of maintenance, again standard and accepted figures are given. Overheads such as purchasing, storage and losses, are calculated as a percentage of materials costs. This produces a total adjusted materials cost.

Workshop equipment consists of small tools and heavy equipment such as lathes, compressors and jacks. Small tool are estimated as a percentage of labour and materials costs. Again there is a standard and accepted provision.

5.3.4 Heavy equipment within a workshop is allocated on the basis of the amount of use of each item necessary to complete a service. This is done by identifying the different types of equipment and the numbers of each in the workshop. This is used to produce a total annual cost for workshop equipment, which is allocated to each service on a daily basis given the known annual workshop output in days and the length of each service in days.

5.3.5 The final table of this sheet calculates cost per km for each type of vehicle. For each type of maintenance total costs are calculated for one service. This is then used to derive a cost per year for each type of maintenance. Finally a total maintenance cost per train km is calculated using the information on vehicle performance.

These procedures are repeated for each type of vehicle in each of the spreadsheets.

5.4 ST STAFF

5.4.1 The model is set up to allow the calculations of costs for 5 different types of station.

For each of these types of station, listed in section 2.6. calculations are made of staff costs. Daily staff inputs are listed by occupation and are given for standard and accepted scenarios. Total staff costs per day are then calculated. With information about the number of passengers using a station per day the model produces a unit cost per passenger.

5.4.2 All other station costs such as building maintenance, lighting and land charges are assumed to be fixed and are therefore precluded from these cost calculations.

5.5 ACCID

5.5.1 For the purpose of this model accident costs are calculated under 3 headings. Firstly there is the cost of lost production on the part of the vehicle. This is calculated by taking the average number of days out of service due to a collision/derailment and multiplying by the provision cost of the vehicle per day.

5.2.2 Secondly there is the cost of recovery of the vehicle from the accident site. This in turn is made up of 2 parts. Firstly there is the cost of the breakdown train itself. This includes replacement and maintenance costs and using accident figures also calculated in this sheet produces a per accident cost. There will also be a number of staff allocated to the recovery unit. These will consist of drivers, guards, supervisors, track workers and mechanics. Staff costs must be entered as the number of man days (6.3 hours) of each of the grades listed to complete a recovery. In combination with wage rates brought from that spreadsheet, this will give a total staff cost per accident.

5.5.3 The third major area of accident cost is that of the replacement of damaged track, the average length of track which is renewed and the number of accidents on each type of track per year. This will produce a different yearly cost for each type of track. The total of this divided by the total number of accidents in one year will give an average cost per accident.

5.5.4 These average costs per accident are then read into the first table in the spreadsheet, which in combination with the number of accidents and the vehicle performance figures is used to give a cost per train km.

5.6 YARDS

5.6.1 Freight terminal costs are split into three headings. The staff costs of a freight terminal are an important section of total variable costs. These costs are calculated for each type of freight terminal identified. This will automatically take into account productivity and size of terminal so no specific items for these need be included. Labour costs are calculated by occupation because different adjustments will be necessary. These inputs are quoted for standard and accepted levels, and the total cost per year is calculated using costs from the wages spreadsheet.

5.6.2 The second type of cost to be analysed is freight handling equipment. This will normally include cranes, forklifts, trolleys, conveyors and hydraulic platforms. Again for these items a yearly cost is derived using the provision costs of the equipment factored by a percentage for maintenance and fuel. An item for overheads is also included, this being a percentage of equipment costs.

A total yearly cost is then calculated which when combined with the average yearly throughout of a terminal gives a total cost per tonne.

The third section of terminal costs are the inevitable shunting movements associated with freight. This is calculated in the SHUNT spreadsheet explained overleaf.

5.6.3 One exception to these rules is a container terminal. Here different costs are calculated for full and part full containers. Although the costs for part full containers include the same costs as for full containers, they also include costs for stuffing and stripping of containers. This is the process by which extra packaging or ballast is added to a part full container to prevent movement while in transit. This is only a labour cost calculated for one container.

5.7 SHUNT

5.7.1 This sheet which has a similar structure to L SPREAD calculates the cost of shunting within freight yards. In a similar way as for main line locomotives, provision costs are calculated for each type of shunter in turn using figures on output and availability. This produces a cost per shunting hour.

Shunting Locomotive Maintenance is calculated using the same format of calculation as in L SPREAD. This again produces a cost per shunt hour.

5.8 TR MAIN

5.8.1 This spreadsheet which calculates manual and mechanised track maintenance costs is split into 7 separate tables. Thee first is there simply for information purposes and gives a breakdown of lines by type of track and sleeper. The figures are the number of km of each combination.

Manual maintenance costs are derived by first calculating the cost of a "standard maintenance gang". This would be the group of workers to maintain perhaps 54 kg rail on concrete sleepers. This is broken down by type of occupation and standard and accepted inputs. There are then a series of factors which are applied to this per km cost to produce costs for each of the track/sleeper combinations.

5.8.2 The third table takes this labour cost and add to it materials, equipment and welding costs. Materials used, are generally track fixings, ballast and other small items such as bolts etc. These inputs are estimated mseparately using standard and accepted inputs for each of the track/sleeper combinations. These tables produce a cost per gross tonne km using estimated traffic figures. Equipment for manual maintenance will be generators, jack hammers, welding equipment, spades etc. This is all estimated as a percentage of the labour cost. As with most of the model standard and accepted costs are given.

It is normally assumed that only a percentage of track costs can be considered variable and so a factor is applied within this table to produce a figure for total variable cost.

5.8.3 Mechanised maintenance is dealt with somewhat differently. For each type of track machine a cost per km is calculated using estimates for utilisation and rate of production. Next labour, materials and fuel costs associated with the operation of each machine are derived.

This then gives us costs per km for labour, materials and equipment which are entered in the final table which produces a total variable cost of mechanised maintenance per km. This is assumed to be basically similar for all types of track since machines are only used on certain types of track.

5.9 ENERGY

5.9.1 The calculation of fuel costs is an integral part of the costing of a rail service since these are probably the most variable of all costs. Although within this the delivered cost of the fuel is the mst important item, other costs are incurred in the actual fuelling of locomotives. These are calculated as labour, equipment, power and materials costs per day.

Labour inputs are listed by category with standard and accepted numbers given. Cost per day is calculated by taking the cost per hour for each of the staff from WAGES. This cost is then weighted to give figures for small, medium and large fuelling points and a cost per litre is calculated by dividing this daily cost by the average daily output of the depot.

Power and materials are estimated as a proportion of labour and again standard and accepted levels are quoted. Again costs per litre are derived.

Equipment costs only include those things which can be considered variable and so pumps and tanks are generally not included here.

5.9.2 Costs per litre are then calculated for each size of depot and a weighted average fuelling cost is derived.

5.10 SHUNT

5.10.1 This sheet which has a similar structure to L SPREAD calculates the cost of shunting within freight yards. In a similar way as for main line locomotives, provision costs are calculated for each type of shunter in turn using figures on output and availability. This produces a cost per shunting hour.

Shunting Locomotive Maintenance is calculated using the same format of calculation as in L SPREAD. This again produces a cost per shunt hour.

5.11 FRONT SHEETS

5.11.1 The front sheets of the model take the data from the spreadsheets already discussed and use service details entered by the user to calculate service specific costs. The cost calculations are in three stages. Firstly train costs are calculated for each of the categories of cost below:

Loco Maintenance
Loco Provision
Train crew
Station/Terminal
Fuel
Track Maintenance
Accidents

5.11.2 The second stage is to calculate long, medium and short run costs using this data and allocate this to each coach or wagon in a consist. To these train costs are added coach or wagon provision costs for each type of vehicle and the maintenance costs incurred in including the vehicle in the train. This cost per coach or wagon is then derived by the load of the vehicle in either passengers or tonnes, to give a cost per passenger km or gross tonne km in the long, medium and short run.

5.11.3 Thirdly a total train variable cost is calculated. This is used to produce a management information sheet giving a breakdown of costs by type.

5.12.1 PASSENGE

The first stage in calculating the cost of a passenger train is to derive the locomotive provision cost (Table 4). This is done by taking the cost per hour of each type of locomotive from LSPREAD. Multiplying this by the journey time of the train and the number of locomotives of each type used. This gives the formula:

x - 1

Cost per hr type x * journey time * No of type x

x - 8

Table B calculates the maintenance cost of locos used. A similar formula to the one above is used for this, except that km's run are used instead of journey time.

x - 1

Cost per km type x * km run * No of type x

x - 8

Next the cost of providing the coaches for the service must be derived. The formula for this is similar to that in Table A. Maintenance costs for the coaches on the train are also calculated using a similar calculation to that above.

5.12.2 The next important category of costs are those for the provision of train crew (Table E). This is simply calculated as the cost per hour for each staff member multiplied by the journey time of the train. The total train cost is simply the sum of these.

The most variable of all operating costs are those associated with the fuel consumed. In the model this is calculated by taking the average fuel consumption of each type of loco and multiplying this by the weight of the train (Table G) and the km run by the train. The fuel consumption of each type of loco is first converted in conjunction with the service details to take account of the gradients and alignments of the track used by the service.

Train weight (Table G) is simply calculated by taking the weight of the loco used and adding to it the unladen weights of each of the coaches on the train. No addition is made for the weight of passengers in each coach since this small increase would be difficult to derive and would not be more than perhaps 5 tonnes per train.

The total fuel consumption is then multiplied by the cost per litre of fuel to give a total fuel cost for the service. This can be written as:

((Avg fuel consumption + gradient factor + Alignment factor)
x weight of train x km run) x cost fuel.

5.12.3 Another cost calculation which uses train weight is that for track costs. Within TRMAIN costs are calculated for 1 km of each type of track for both manual and mechanised maintenance. However these costs are those for maintaining 1 km of track every 1 year and is not the cost associated with 1 tonne/km. This figure is derived by dividing the total cost for 1 km by the average number of tonnes passing over one km of track. This per tonne/km figure is then multiplied by first the weight of the train and then by the distance of each type of track used to produce a train track cost.

5.12.4 Finally, accident costs must be determined (Table H). These are calculated as an average cost per km run for each type of vehicle in ACCID. Within the front sheet this cost is multiplied by the no of km run by the train and the number of each type of coach or loco on the train.

x - 1

Cost per km type x * km run * No of type x

x - 8

5.12.5 Once these costs have been calculated they must be allocated to each coach in the train so that a per passenger km cost can be calculated. This is done for the short, medium and long term. The short term cost is defined as the fuel, maintenance and accident costs. In the medium term train crew costs are included. Whilst long term costs include all the categories of cost above.

5.12.6 The train costs are allocated to each coach on an equal basis. The total cost being simply divided by the number of coaches, including baggage and generator vans, on the train. To this average cost is added the specific costs of maintenance and provision (Long run only) of each coach.

This total cost per coach is then divided by the number of passengers in each coach, from the user information to give a cost per passenger km. This is shown in the output table as a cost by class of passenger (1, 2, 3). For this calculation it is assumed that 1st class passengers should pay for categories 1 and 2, second class for 3 and 4 and third for 5 and 6. Where there is not a coach of a particular type on a train no cost is charged.

5.12.7 Station costs are calculated by assuming that equal numbers of passengers board at each station. An average cost per passenger is then calculated using the different costs for each type of station from STSTAFF.

The third set of calculations are those which provide the data to the management information section of the results. This involves calculating a total train variable cost for the short, medium and long term which includes all the costs associated with running the train. In turn each of the categories of cost is calculated as a percentage of the total. These are the figures in the last section of results.

5.13 SUBURB

5.13.1 Suburban services are defined as those using multiple units. The cost calculations in this spreadsheet therefore do not include loco and coach costs but railcar costs instead. These are calculated on a per unit basis, but using the same relationships as for PASSENGE.

5.13.2 In this spreadsheet it is more important to provide figures for peak load pricing than for short, medium and long run costs, since this is a proxy for short and long run costs. Therefore only one set of cost calculations are used in this spreadsheet.

The model uses a formula of the form:

$$\text{Cost (Heavy Flow)} = \text{Unit Cost} * \frac{1}{\text{Flow Heavy}} \left(1 + \left(1 - \frac{\text{Flow light}}{\text{Flow heavy}}\right)\right.$$

$$\text{Cost (Light Flow)} = \text{Unit Cost} * \frac{1}{\text{Flow Heavy}} \left(1 - \left(1 - \frac{\text{Flow light}}{\text{Flow heavy}}\right)\right.$$

5.13.3 At its extremes this model says that if the flow in the light direction is zero then the heavy flow passengers pay all the costs, similar to an empty return journey for a freight wagon. Whilst if the flows are equal then both set of passengers pay equal amounts of costs.

5.14 BLOCK F

5.14.1 Block freight trains are assumed for the purpose of this model to contain only one commodity and only one type of wagon. This makes the cost calculations simpler. Loco maintenance and provision costs are calculated as before with the cost per km or per hr being multiplied by the number of each type used and the distance run or time taken by the train.

Wagon costs are similarly calculated by using the code given by the user to identify which type of wagon is being used.

5.14.2 Crew, track and fuel costs are calculated similarly to those in PASSENGE. Freight terminal costs are calculated by using the information given by the user which includes the type and number of terminals used. YARDS calculates a cost per tonne for each of eight types of terminal. (Container terminals have a cost per TEU). This cost per tonne is then multiplied by the number of terminals used (almost always 2, origin and destination) and the average load and number of wagons using the terminal. This gives a total freight handling cost. Where a terminal is not railway owned it is assumed that no handling costs are incurred, and so none should be costed.

5.14.3 The other portion of costs associated with terminals is the shunting cost. For simplicity this is calculated as a cost per shunt. An average of 3 shunts per train per terminal is taken which gives a total train shunt cost. This is divided by the number of tonnes of freight carried by the train to give a terminal cost per tonne.

5.14.4 Costs per tonne are calculated in a similar way to those per passenger except that costs are quoted in per Gross tonne km form and are given for only one commodity.

5.15 MIXED F

5.15.1 Although the theory of the calculations for the costs of mixed freight trains are similar to those for block freight, the practice is somewhat different. This stems from the problem of there being an almost endless list of different combinations of commodities and wagons. To counter this separate costs are calculated for terminals, based on commodity, and wagon maintenance and provision. These costs are then combined. The model allows for an eighteen wagon train which in theory can include each of the types of wagon and each of the types of terminal could be used.

5.15.2 When specifying the service to be costed the user must give the number and ownership of each type of terminal used. This allows an average cost per tonne to be calculated for all freight on the service. Then the user must give details of wagons used, along with the commodity carried the average load of the wagon and the percentage of empty running incurred by the vehicle.

Track, loco and crew details must also be entered.

5.15.3 The costs of loco provision and maintenance, track, fuel, accidents and train crew are calculated as before. The difference between this and the block freight calculations is in the derivation of wagon costs. For simplicity the cost for each wagon in the consist, not each type of wagon, is calculated. This is because different wagons of the same type, in the same train could be carrying different commodities and have different loadings.

5.15.4 Within the short, medium and long term cost calculations the "train" costs i.e. loco, track, crew etc. are split evenly between each of the wagons on the train. To this is added the wagon maintenance and provision cost (long run only) to give the total wagon cost.

Using the information on distance run by the train and the individual load of each wagon it is possible to calculate per tonne km costs.

5.16 MIXPASS

5.16.1 The model for mixed passenger and freight trains takes many of the characteristics of both PASSENGE and MIXED F. Within the spreadsheet the calculations are similar in nature. When total train costs have been calculated they are allocated to each vehicle in the train on an equal basis. Costs are then quoted per passenger km by class of passenger (1, 2, 3) and per tonne km for each wagon.

5.16.2 This model allows for any number of passenger coaches but for only 5 freight wagons, which must be defined in the same way as for mixed freight services.

6.0 Changing data in the Spreadsheets

6.1.1 In general much of the data in the model is designed to be of a type specific nature. However, at an early stage of the model's development much of the data will consist of system wide averages or estimates, particularly for standard costs and inputs and those items of data not collected by the railway.

6.1.2 WAGES

This data will change annually as the railway rescales its wage table to provide an annual increase. Because this spreadsheet is based on this table all that need be altered are the figures relating to each grade and length of service. In general the average grade of each occupation is unlikely to change from year to year. The other components of total wage costs are the allowances given to staff. These are set annually where an actual amount is used. The percentage based allowances will change in value each year, but this will be automatic since they are based on basic salary which already has changed.

It must be remembered that changes in this spreadsheet are reflected within all other sheets and therefore each of these must be accessed in order to update the calculations within them. It is suggested that all necessary changes to WAGES are made at one time so as to avoid confusion over which spreadsheets have been updated and which have not.

6.1.3 LSPREAD (CSPREAD, WSPREAD, RSPREAD)

Much of the data within these sheets will be estimated from what data is collected within the railway. Much work will need to be done on maintenance inputs and availability and utilisation of stock.

Maintenance inputs are split into labour, materials and equipment. Labour inputs could be estimated in the first instance using time sheets giving details of "costs" of labour used not time used. This must be divided by average wage costs to get an idea of hours input. This is unsatisfactory since the rates used by the workshop may not be the same as those used in the estimation. To improve these inputs new data must be collected on the number of man day's spent on one locomotive or coach etc.

6.1.4 Materials costs do not provide so many problems since they are only required as an average for each type of vehicle and for each type of maintenance. This is a simple task for workshops but depot or unscheduled maintenance will require more detailed study.

The usage of equipment in maintenance is at present estimated within the model in terms of the proportion of services done. This does not take into account the utilisation of equipment. Since a machine may stand idle for long periods it is not ideal to allocate costs on this basis. The best way to allocate costs is in terms of cost per hour used for each vehicle. This will again require further research.

6.1.5 Availability and utilisation directly affect the cost of providing rolling stock since, depreciation per hour is calculated as cost per year divided by number of productive hours per year, derived from the availability and utilisation of the vehicle.

As these figures change it will be necessary for them to be entered in the model. Although this, in itself is not a problem, the updating of links to other spreadsheets is. Many of the results from these spreadsheets are transferred to others, particularly maintenance costs to the front sheets, depreciation to both the front sheets and accident costs, and performance figures to ACCID. Whenever changes are made, and it must be remembered that a change at the top of the spreadsheet will cause changes further down, the relevant links should be updated. Links to the front sheet of the model are not so important, in this aspect since they are updated every time these are accessed.

6.1.6 <u>TRMAIN</u>

The track maintenance spreadsheet will be generally unaltered from year to year except for manning levels which may reduce in the long term. The efficiency of mechanised maintenance is unlikely to be greatly changed over time. As this spreadsheet is linked only to the front sheets any changes that may occur will be transferred to all the relevant spreadsheets automatically.

6.1.7 <u>STSTAFF</u>

Once the staffing information has been entered into this sheet the only changes foreseeable are where actual data will approach the standards, requiring an alteration of the adjustment factor, or where station throughputs change drastically. In the event of this the links to be updated are again only to the front sheets and so will update themselves.

6.1.8 ACCID

This spreadsheet has already been identified as a recipient of data from the other spreadsheets. This data which is liable to alteration is used to calculate costs which are read only into the front sheets of the model.

Data which will require detailed research includes the collision rate i.e. the number of kms that on average a vehicle will travel before it has a mishap. This should be derived for each of the types of vehicle identified in Section 2.6. When available this data should also be entered into LSPREAD etc.

6.1.9 YARDS

The data for staffing of the different types of terminal is a subject that requires detailed research. Although the data will be a reasonable average, specific figures for tonnes throughput per man by occupation are required to provide reliable figures for this.

The results from this spreadsheet are read only into the front sheets and so the links do not need to be specially updated.

6.1.10 ENERGY

The data in this spreadsheet is unlikely to change except where reorganisation of depot or operating systems takes place and so outputs change. The data on fuel cost is read into both TRMAIN and the front sheet. The former of these links should be updated whenever a change is made.

6.2.1 FORMULAE

Within the model there are many formulae giving relationships between costs and the factors which determine those costs e.g. track maintenance costs and gradient; overheads and labour.

Many of these are estimates or are based upon European relationships. These must be confirmed or refined in consultation with experts, engineering departments etc. As above links with other spreadsheets must be updated whenever a change is made.

One further consideration is that often these formulae are repeated many times within the model and so care must be taken to alter all similar formulae.

7.0 Changing the Number of Model Categories

7.1 Increasing the number of rolling stock categories

7.1.1 Whenever possible this procedure should be avoided since the addition of an extra category of locomotive for example involves the alteration of numerous tables and calculations in many of the spreadsheets. Where necessary however, the following procedure should be followed:

7.1.2 1. LSPREAD

All the tables for maintenance schedules, labour materials and equipment inputs, depot output and cost calculations should be copied into the space to the right of category 8. All the formulae within these tables must be checked because often they will not always act upon the correct cells after copying.

7.1.3 2. LSPREAD

Additional rows should be inserted in the tables, for availability, utilisation and depreciation. The formulae for these rows should be copied from those in the tables and again it should be checked that they operate on the correct cells.

7.1.4 3. ACCID

Additional rows must be included in the tables for costs per km and cost per accident.

7.1.5 4. FRONT SHEETS

Within the front sheets there are numerous changes which must be made so that an extra category can be included.

a) User data must be changed to include the new category.

b) Maintenance and provision costs tables must be changed. Formulae must be included to collect data from other spreadsheets.

c) Accident costs tables must be altered to accommodate new categories.

d) Fuel consumption figures and fuel costs tables must be revised.

e) Train weight calculations must be altered to include the new category of rolling stock.

7.1.6 It is unlikely that the number of categories for stations, terminals, track or staff will change and so only brief guidelines are given here.

Calculating the base data for these cost categories is simply a matter of allowing space in the relevant tables for the calculation of the costs for any new categories. As above these changes must be transferred also to the spreadsheets receiving the information especially the front sheets of the model.

7.2 Alternative approaches

The inclusion of extra categories is obviously a long process. It is therefore suggested that other methods are used. For example, maybe where a new category of rolling stock is required it will be replacing an existing category and so the same can happen within the model, e.g. category 1 for locos is CC200. These are very old. Maybe a new class CC203 becomes available to replace these. Within the model it will be simple to make category 1 CC203 and just alter the data accordingly.

7.3 Reducing the number of categories

This simply entails not using some of the calculations. It is unnecessary to alter tables to reduce the number of available categories. It is easier to just ignore the data in those categories not needed without removing them. If there are no CC200 in existence for example then just make the data in the columns and tables for category 1 zeros. In the long run this may avoid a lot of work since at a later date a new category may be required and if one is already available then the new data can just replace the zeros.

This principle also carries through to the calculations of more detailed costs. Where perhaps a type of maintenance will be eliminated or staff grade changed.