The Time Cost Distance Model

To assess transit transport corridor performance

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Transit corridor performance

- The objective of the model is to propose a methodology to illustrate the cost and time components of door-to-door movement by available routes and modes as well as to illustrate the delays at borders or other inspection points up to the point of destination within a transit transport corridor.
- The cost/time methodology has been adapted from Beresford and Dubey (1990), as improved by Banomyong (2000) and later disseminated by UNESCAP.
- The model includes costs and time associated with transport by any mode and with transfers between modes. The methodology is based on the premise that the unit cost of transport varies between modes

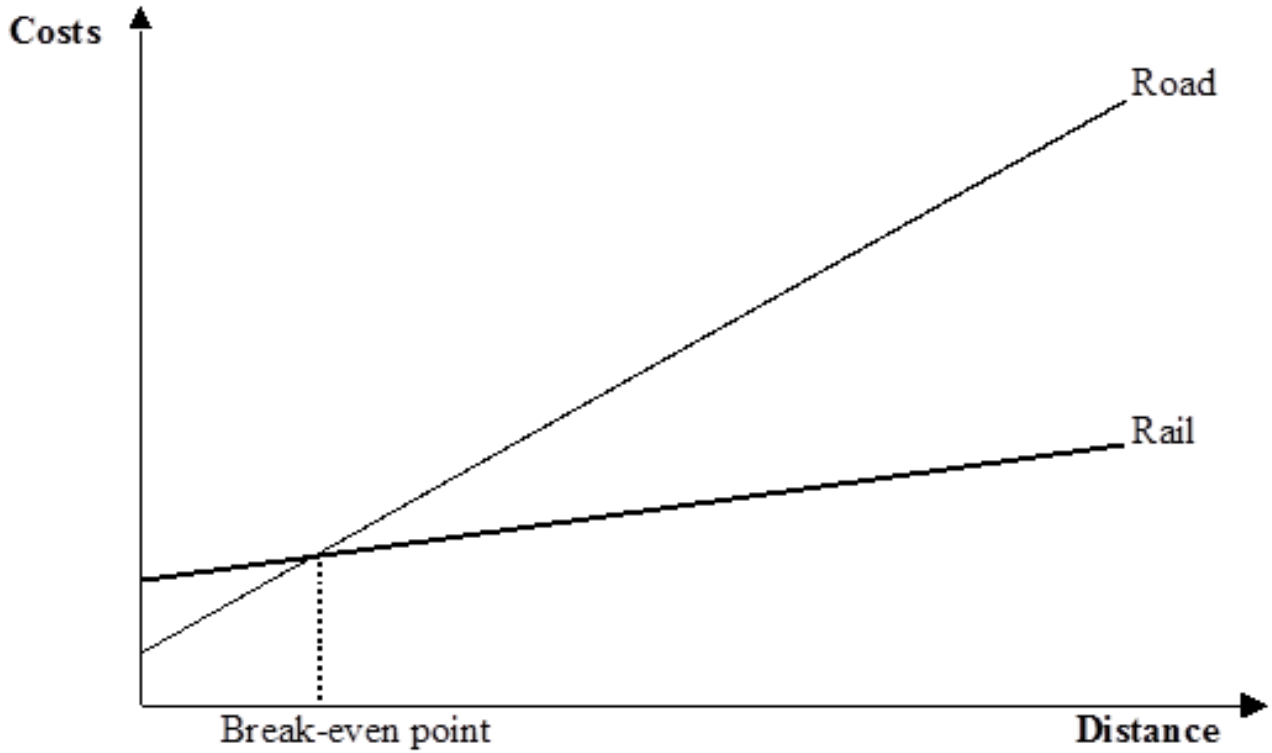
The use of the model

- This model may be used as a useful tool in the debate over the value of time in freight transport operations by analyzing transit times by mode and route.
- The longer freight takes to reach its destination (including dwell times at terminals), the greater will be the implicit interest costs of working capital.
- Total implicit costs may, however, be a good deal higher, since some goods may be needed urgently and business may be lost if goods arrive too late.
- The value of time will ultimately depend on the nature of the commodities being transported and the cost of delays must also be taken into account when appraising the risks attached to specific routes and transport modes.
- As part of the analysis of the transit corridor routeing decision, it is important to examine the trade-off between the monetary outlays for transport and the implicit costs of time.

Four developmental stages,

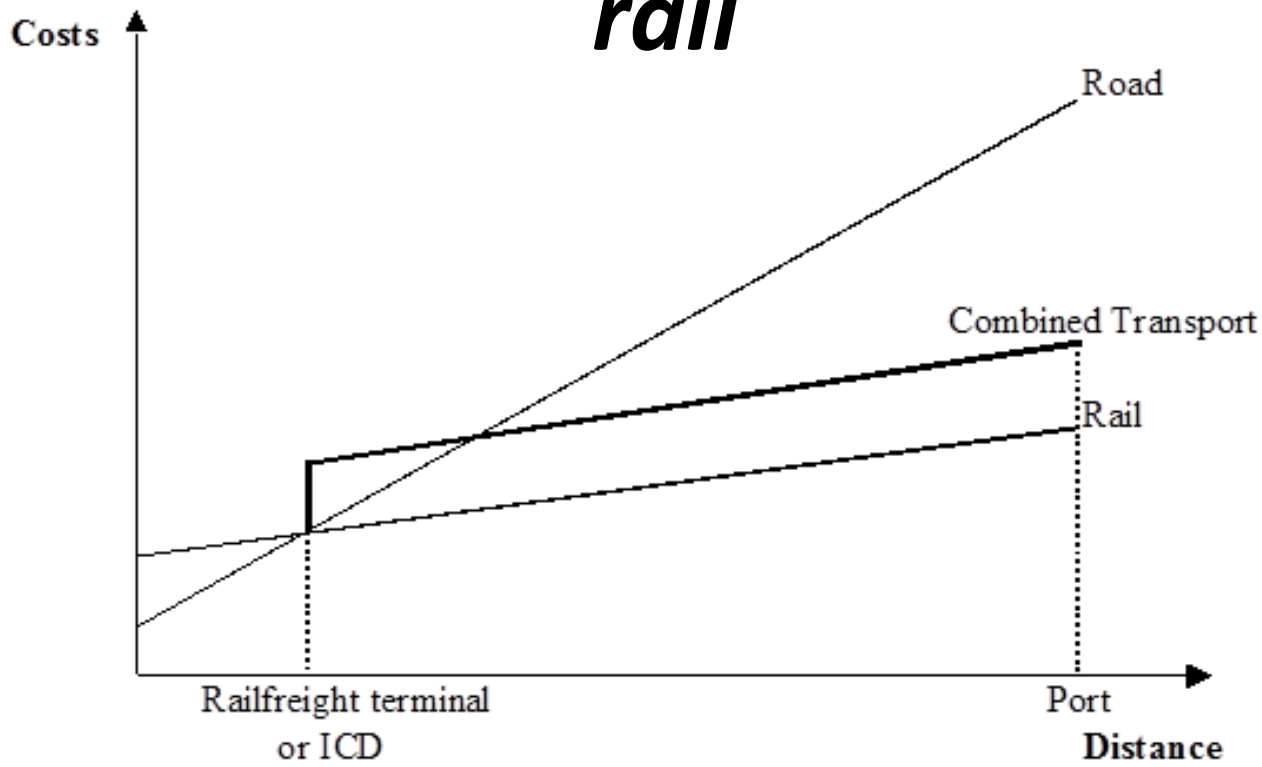
- Stage 1: Competition between just two modes of transport.
- Stage 2: a combination of transport modes, where the cost of transport by combining both modes is less expensive than just road transport and slightly more expensive than rail transport.
- Stage 3: Combined transport, road-rail-sea.
- Stage 4: Multimodal transport, from origin to destination

Stage 1: Road versus rail alternative



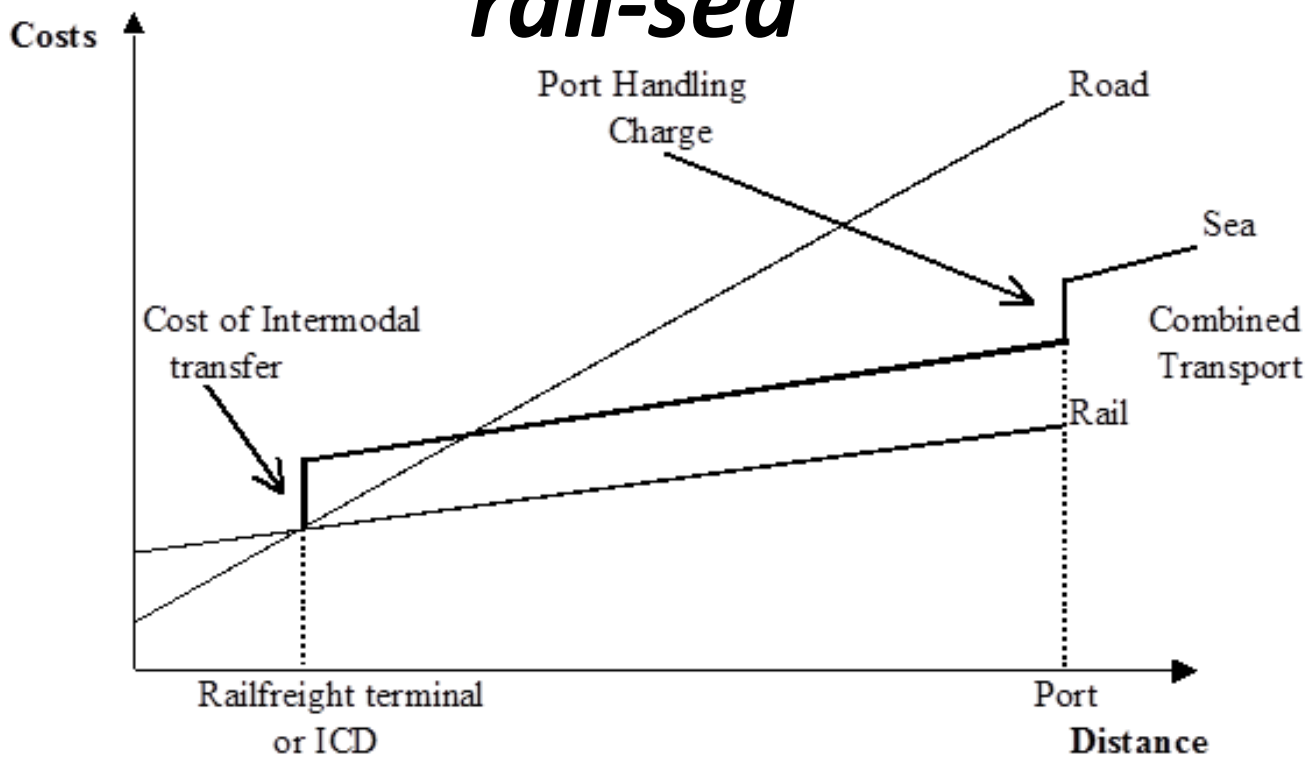
The distance and cost/time data are plotted on the x-axis and y-axis, respectively. Initially road transport may be cheaper than rail transport over shorter distances, due to the initial costs (or time) required to transport the goods to the railway station. However, as the distance increases, the two lines cross and beyond this point, rail transport has a lower per kilometre cost than road transport, as indicated by the flatter slope.

Stage 2: Combined transport, road-rail



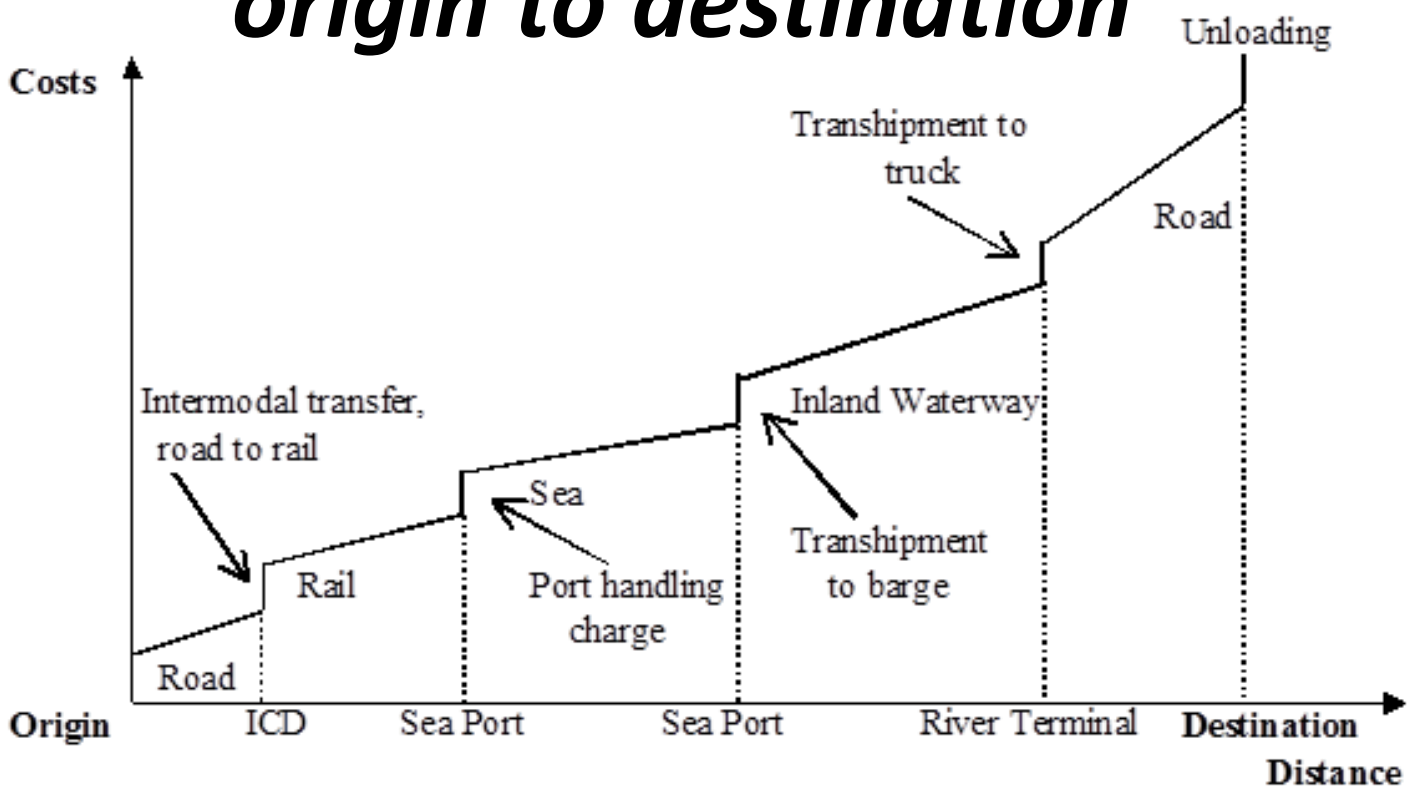
In the first part of the journey, it is cheaper to transport the goods by road rather than by rail. However, if the distance to be travelled is further than the break-even distance, transport by rail becomes more economical. An intermodal transfer can be arranged at the closest rail freight terminal or inland clearance depot (ICD). The vertical step in figure 3 represents the costs (or time) involved when goods are transshipped from road to rail at the rail freight terminal or ICD. The cost of rail transport, in reality, has not increased but the cost of the intermodal transfer is reflected in the combined transport cost from that point on.

Stage 3: Combined transport, road-rail-sea



Since the overwhelming majority of traded goods are transported by sea, the most likely destination for the freight in transit will be a seaport, where the goods will be transferred onto seagoing vessels. The additional costs (or time) incurred at the port are represented by the second vertical step. Thus, cumulative costs from the origin to the port are the sum of the cost of rail transport to the ICD plus the cost of intermodal transfer at the ICD plus the cost of rail transport from the ICD to the port plus the handling charge at the port.

Stage 4: Multimodal transport, from origin to destination



The final stage shows that numerous modes of transport may be involved for goods to be moved door-to-door. At each intermodal transfer point there will be a cost (or time) increase represented by a vertical step. Should a border crossing occur along the route, the border crossing charges (and time spent) can be represented by another vertical shift upwards in the cost curve at that point, which can then be cumulated with other costs.

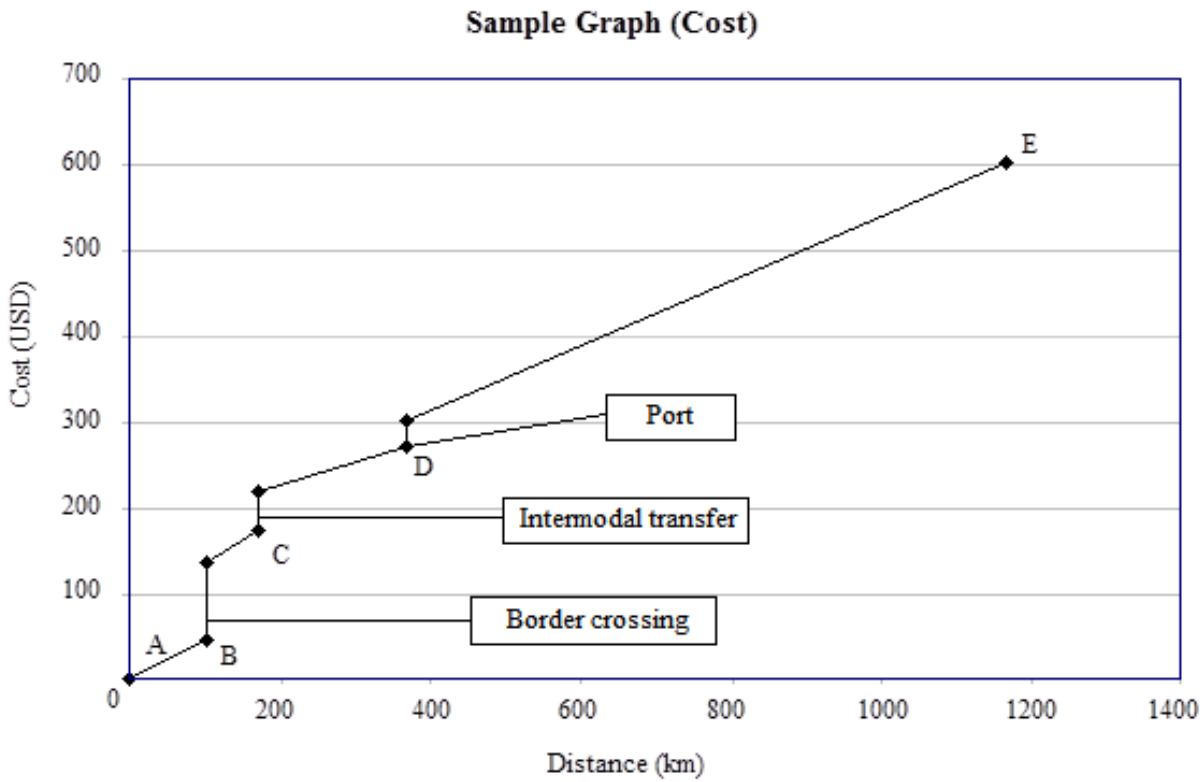
Source and Units of Information

- **Source:** The data utilised are obtained during interviews with transit and transport service providers, traders and governmental officials.
- **Units:** A unit of analysis must be agreed upon. Data such as cost or quotes should concern the shipment of one TEU on a freight-all-kind basis or for a shipment of a particular product.
- **Information needed:**
  - Origin and destination of the cargo;
  - Full route details including border crossings and modal transfers;
  - Mode of transport for each leg;
  - Distance for each leg;
  - Transit time for each leg (in hours or days); and
  - Cost or quotes for each leg.

Sample data table

Leg	*Mode*	*Distance (km)*	*Cum. distance (km)*	*Cost (US$)*	*Cum. cost (US$)*	*Transit time (hours)*	*Cum. Time (hours)*
A to B	Road	100	100	50	50	4	4
Border Crossing	-	-		100	150	6	10
B to C	Road	70	170	30	180	3	13
Intermodal transfer	-	-		40	220	3	16
C to D	Rail	200	370	60	280	18	34
Port	-	-		20	300	6	40
D to E	Sea	800	1 170	300	600	72	112
TOTAL		1 170		600		112	

Sample graph

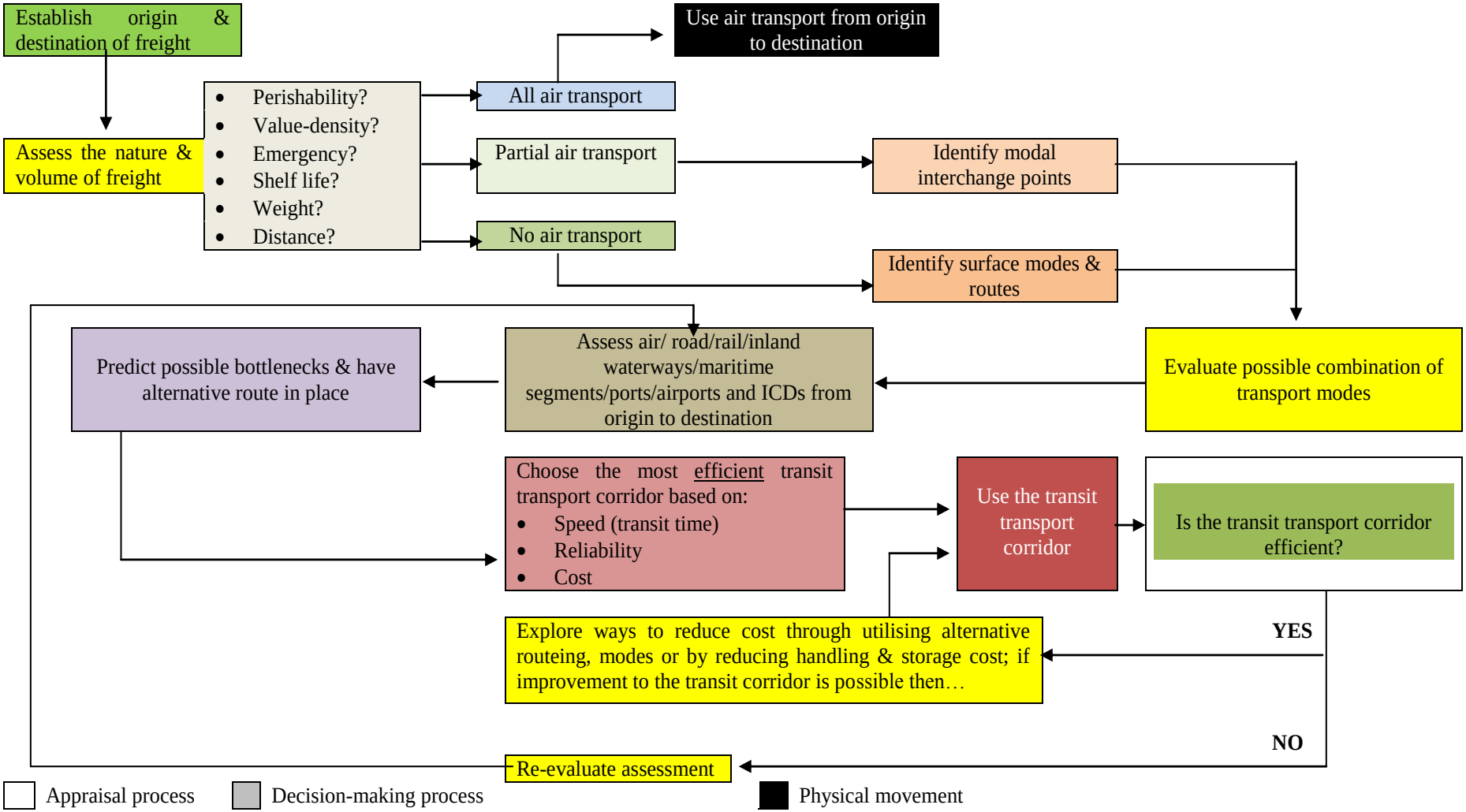


For costs or quotes, the figure shows the relative cost of each leg (or mode, where applicable), and the approximate proportion of non-transport costs in relation to transport costs.
A breakdown of costs at border crossings or ports, can highlight areas for action.
By plotting time against distance, the relative speed of transit transport for each leg (or mode) can be compared, and bottlenecks at transshipment points can be identified.
As a rule of thumb, the higher the vertical step the more likely that the border crossing or the nodal link is a bottleneck.

Dimensions not included

- In addition to transportation time and costs, traders and transit service operators must also take into consideration the reliability of the transit corridor, in terms of:
  - All year consistency of transit times;
  - Frequency and quality of services;
  - Competition between service providers
  - Balance of freight volumes; (empty returns)
  - Predictability of costs;
  - Informal controls and check points;
  - Transport safety and security, etc.

Transit transport corridor decision model



United Nations
ESCAP

Instructions on Data Collection for Route Analysis with the UNESCAP Time/Cost-Distance Methodology

- Detailed Template Version -

Version: 2.0
Prepared by: Transport Facilitation Section
Updated on: 1 August 2007

Introduction to UNESCAP Time/Cost - Distance Methodology
http://www.unescap.org/ttdw/common/TFS/ImprovingTx/VV1/All/Introduction-Time-Cost.asp

Content

What is the Time/Cost – Distance Methodology?

- The "UNESCAP Time/Cost – Distance Methodology" is the graphical representation of cost and time data associated with transport processes. The purpose of the model is to identify inefficiencies and isolate bottlenecks along a particular route by looking at the cost and time characteristics of every section along a route.

- The "UNESCAP Time/Cost – Distance Methodology" enables policy makers to:

  - compare - over a period of time - the changes of cost and/or time required for transportation on a certain route;

  - compare and evaluate competing modes of transport operating on the same route;

  - compare alternative transit routes.

Benefits of the Time/Cost – Distance Methodology

- The "UNESCAP Time/Cost – Distance Methodology" includes a detailed break-down of cost and time spent, for example, associated with border crossings. This may be particularly useful to policy makers focusing their policy approaches on the most critical issues related to transport. In addition, the inclusion of data on inventory costs for particular commodities, demurrage charges and other indirect costs may be useful to specific export/import industries in evaluating their logistics performance.

- The use of the "UNESCAP Time/Cost – Distance Methodology" allows national stakeholders to track time and cost issues along transport routes. Thereby it helps to identify bottlenecks and barriers in international transport.

- The information on time and cost involved on certain routes informs general transport facilitation policy decisions (e.g. route prioritization, allocation of funds, allocation of socio-economic development efforts).

What kind of data is collected?

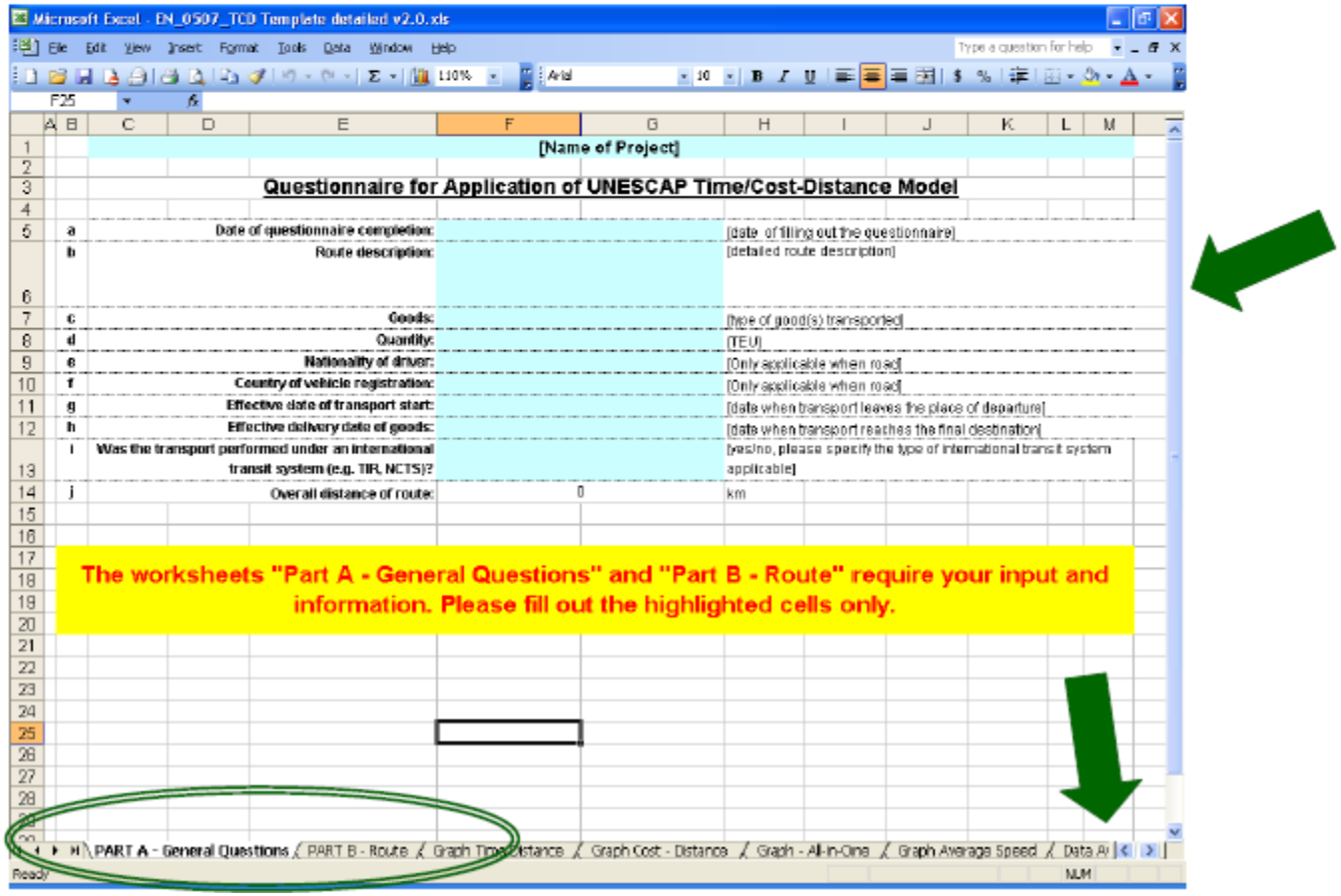
- The questionnaire for the application of the "UNESCAP Time/Cost – Distance Methodology" captures qualitative and quantitative information. On the following slides the information required for every line of the questionnaire will be explained.

- Preliminary information required:
  - Decision on a transport route including place of departure, any kind of stops (e.g. border crossings) and final destination
  - Decision on the type of goods transported (e.g. specification if only one kind or multi-packaging of goods) as well as on the quantity and/or value.

- One possibility to obtain the required data would be to directly contact transport operators and/or freight forwarders involved in cargo transport along the specified route. The national freight forwarders association may help to identify relevant transport operators or freight forwarders.

The questionnaire – All in one MS Excel file

- Please fill out <u>all</u> of the highlighted cells in Part A and Part B of the questionnaire.
- Navigate on each worksheet by moving the bars on the right side and on the lower part of the worksheet (see green arrows).
- Navigate between the worksheets by clicking on the various tabs on the bottom of the page (see green circle).



How to fill out Part A of the questionnaire?

Microsoft Excel - EN_0507_TCD Template detailed v2.0.xls

[Name of Project]

Questionnaire for Application of UNESCAP Time/Cost-Distance Model

a	Date of questionnaire completion:		[date of filling out the questionnaire]
b	Route description:		[detailed route description]
c	Goods:		[type of good(s) transported]
d	Quantity:		[TEU]
e	Nationality of driver:		[Only applicable when road]
f	Country of vehicle registration:		[Only applicable when road]
g	Effective date of transport start:		[date when transport leaves the place of departure]
h	Effective delivery date of goods:		[date when transport reaches the final destination]
i	Was the transport performed under an international transit system (e.g. TIR, NCTS)?		[yes/no, please specify the type of international transit system applicable]
j	Overall distance of route:	0	km

The worksheets "Part A - General Questions" and "Part B - Route" require your input and information. Please fill out the highlighted cells only.

PART A - General Questions / PART B - Route / Graph Time-Distance / Graph Cost - Distance / Graph - All-in-One / Graph Average Speed / Data A

Ready NUM

How to fill out Part A & B of the questionnaire? – cont'd

Part A – General Questions

- *Date of questionnaire completion:* Please insert actual date
- *Route description:* Either the route analyzed is already provided or please fill in the detailed information starting with place of departure, over main cities en route, junctions or highway numbers to place of final destination.
- *Goods:* Please enter the type of goods transported (single type of goods vs. multiple types of goods)
- *Quantity:* Please enter the quantity of goods transported. (If multiple goods then please indicate quantity by type of good.)
- *"Nationality of driver"* and "*Country of vehicle registration"* refer to transport by road only. In case of multimodal transports along the route please name nationalities of all drivers and vehicles involved.
- *"Effective date of transport start"* and *"Effective delivery date of goods"* refer to the dates, when the transport physically leaves its place of departure and when then goods physically arrive at their destination.
- *"Was the transport performed under an international transit system (e.g. TIR, NCTS)?":* Please reply with "yes" or "no". Please also specify, which international transit system has been applied.
- *Overall distance of the route:* No data entry is required, as it is automatically calculated as the sum of the length of the individual sections of the route (based on the data of Part B).

How to fill out Part B of the questionnaire?

Microsoft Excel - EN_0507_TCD Template detailed v2.0.xls

File Edit View Insert Format Tools Data Window Help

K11 Exit Border Crossing

		LEG 1	LEG 2	LEG 3
Place of departure	Name of city:		0	0
	Name of country:		0	0
Mode of Transport		road	rail	
Distance to next stop		km	km	km
Duration of travel		hrs min	hrs min	hrs 0 min
Costs per leg (while en route, in USD)		$0.00	$0.00	$0.00
Place of next stop	Name of city:			
	Name of country:			
Reason for stop		Intermediate Stop	Exit Border Crossing	
Description of stop		Type of activity / Duration / Costs	Intermediate Stop / Exit Border Crossing / Entry Border Crossing / Final Destination	Type of activity / Duration
	Activity A at stop	hrs min	hrs min $0.00	hrs min
	Activity B at stop	hrs min	hrs min $0.00	hrs min
	Activity C at stop	hrs min	hrs min $0.00	hrs min
	Activity D at stop	hrs min	hrs min $0.00	hrs min
	Activity E at stop	hrs min	hrs min $0.00	hrs min
	Activity F at stop	hrs min	hrs min $0.00	hrs min
	Activity G at stop	hrs min	hrs min $0.00	hrs min
		0 hrs 0 min $0.00	0 hrs 0 min $0.00	0 hrs min
Description of actions taken (e.g. procedures, formalities applicable to the section of the route).				

- Please note that the cells circled contain drop-down menus, which you see by clicking on the cell. Please choose your answers from the drop-down

How to fill out Part B of the questionnaire? – cont'd

- Place of departure: Please insert name of city and name of country.
- Mode of transport: Please choose from the drop-down menu, if the used mode of transport is "road", "rail" or "ship".
- Distance to next stop: Please insert the distance from the place of departure to the first stop on the route.
- Duration of travel: Please fill in the duration of the journey from the place of departure to the first stop. Please specify hours and minutes.
- Costs per leg: The costs per leg (or for each section of the overall journey) refer to the variable costs on that particular leg. Please insert all costs related to the transport while being en route on that particular section, but exclude costs at stops.

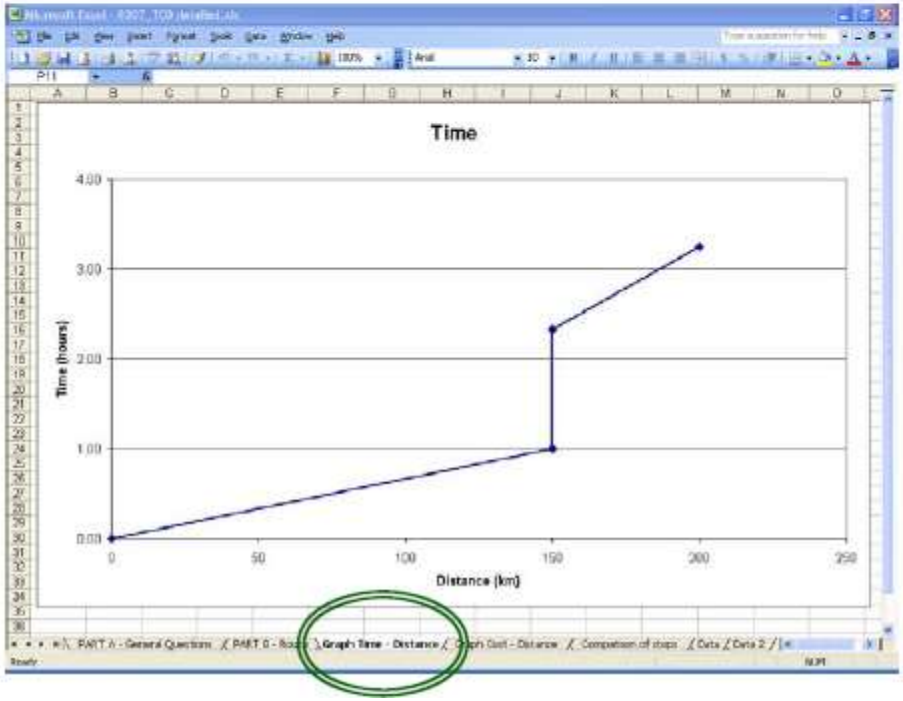
How to fill out Part B of the questionnaire? – cont'd

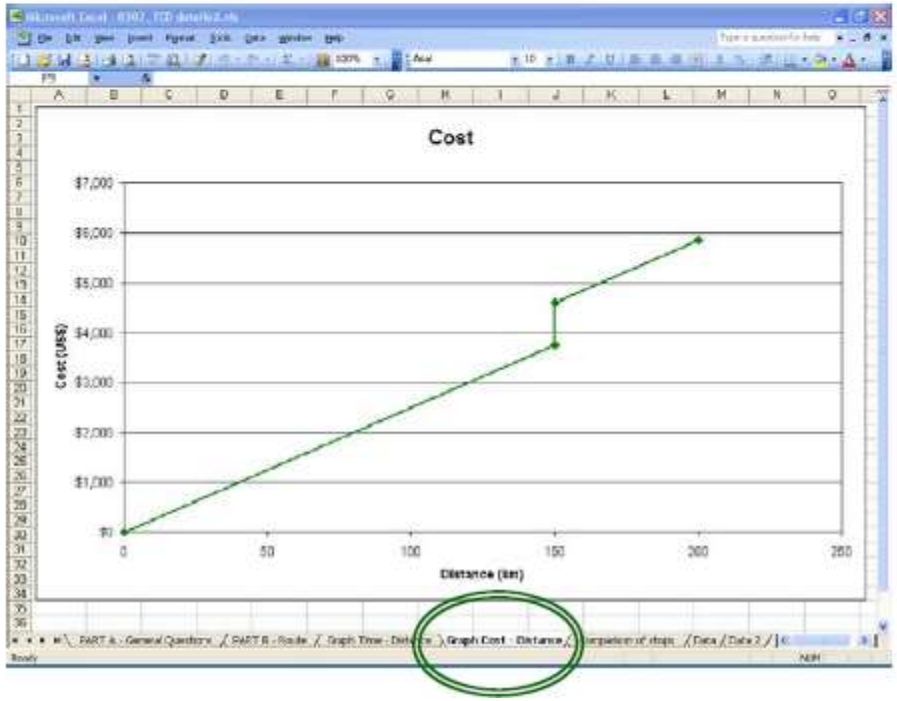
- Place of next stop: Please insert name of place (e.g. Name of city or village, junction or highway km) and of country
- Reason for stop: Please choose the most suitable reason from the drop-down menu. ("Intermediate stop" refers to all stops except place of departure, border crossings and final destination.)
- Description of stop: Please provide a short description of the individual activities undertaken at the stop, including their duration and the costs associated.
- Description of actions: Please provide additional relevant information.

How to plot the graphs?

- The individual charts “Time over Distance” and “Cost over Distance” are plotted automatically as a function of the information you entered into the highlighted cells on worksheets “Part A – General Questions” and “Part B – Route”.
- The two charts are on separate worksheets in the file:
  - The time chart is on worksheet named “Graph Time – Distance”.
  - The cost chart is on the worksheet called “Graph Cost – Distance”.

  (Please navigate between worksheets with the tabs (see circles).)





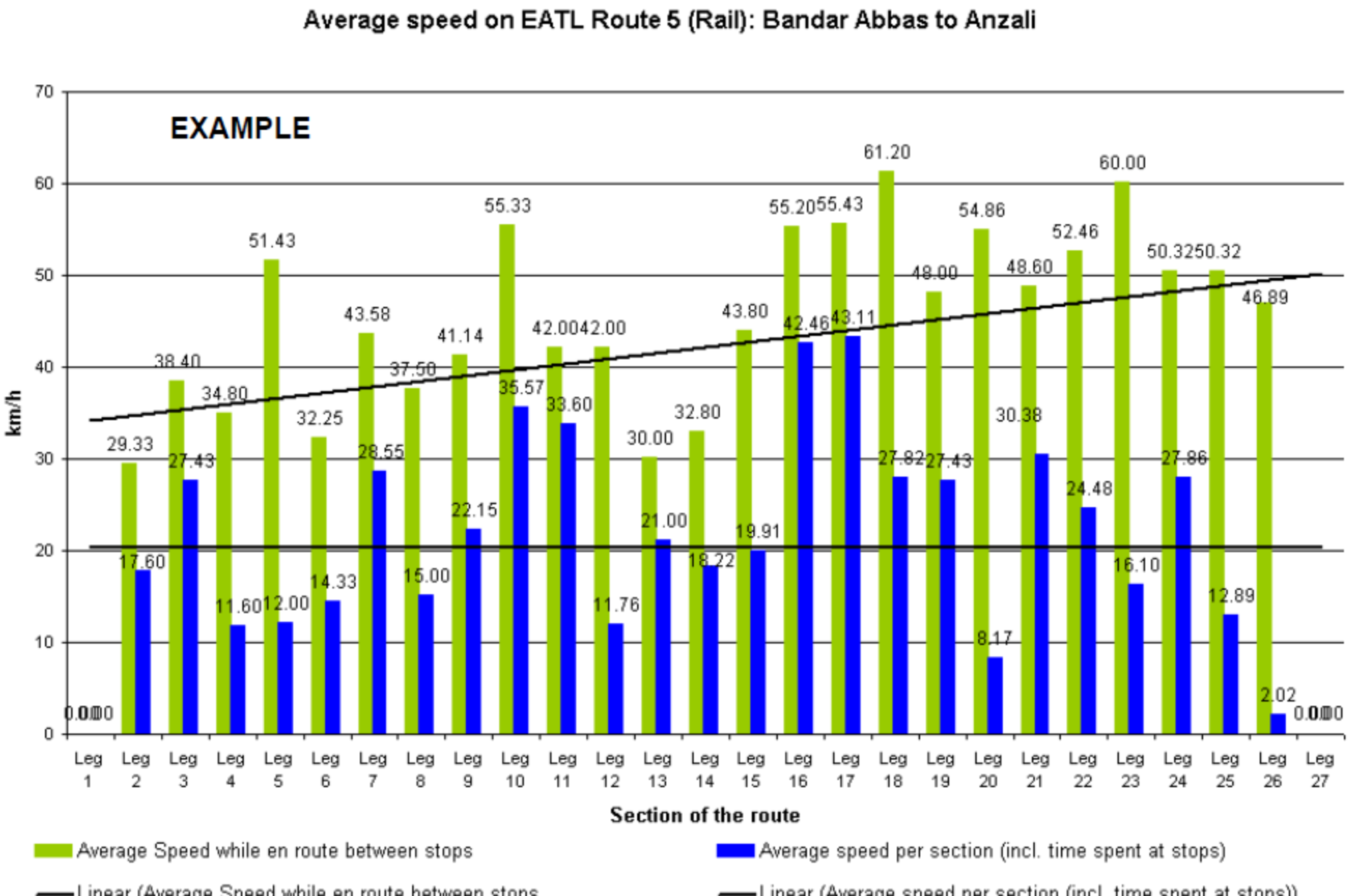
How to interpret the data and the graphs?

- The y-axis represents either the time or the cost incurred, while the x-axis represents the distance from origin to destination. It is also possible to have two y-axes, one for time and one for cost (Please see back-up slide).

- The unit costs and the time allocation of transport may vary between modes as well as over time, and the steepness of the cost/time curves reflect the costs (price) and/or time per distance.
  - The steeper the curve, the more time consuming or costly is a transport along the analyzed route.
  - Vertical steps in each curve indicate a sharp increase of time/cost without an increase in distance (i.e. without movement of the transport).
  - Vertical steps typically occur at stops (e.g. border crossings) and they indicate inefficiencies or bottlenecks on a transport route, since the larger the vertical step, the more time/cost are used for activities undergone at a stop.

Please note: The additional worksheets contain a worksheet with time and cost depicted in one graph (see back-up slide), data tables required to plot the graphs and background information for the drop-down menus.

Comparison of average speed per section of the route



Relationship between time and cost per activity at stops

Microsoft Excel - FN_0507_TCD Template detailed.xls

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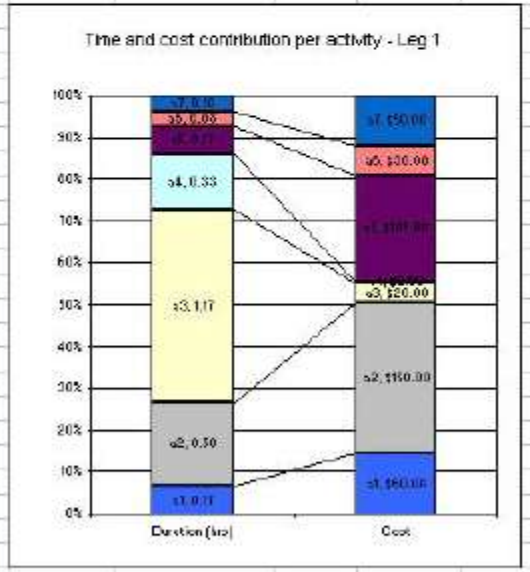
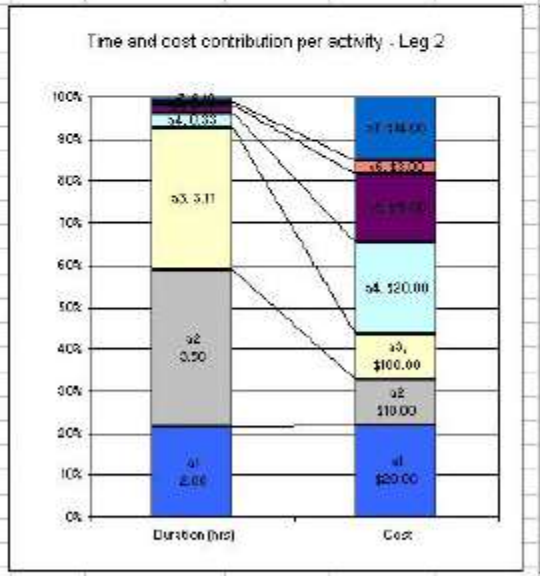
Q33

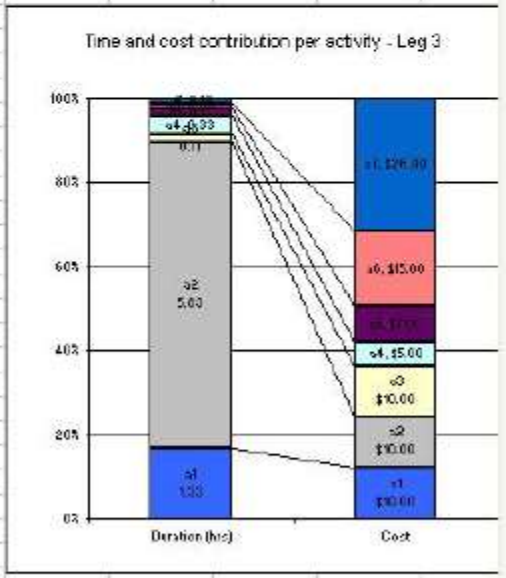
LEG 1	Duration (hrs)	Cost
a1	0.17	$60.00
a2	0.50	$150.00
a3	1.17	$20.00
a4	0.33	$2.00
a5	0.17	$105.00
a6	0.08	$30.00
a7	0.10	$50.00

LEG 2	Duration (hrs)	Cost
a1	2.00	$20.00
a2	3.50	$10.00
a3	3.17	$10.00
a4	0.33	$20.00
a5	0.17	$15.00
a6	0.08	$3.00
a7	0.10	$14.00

LEG 3	Duration (hrs	Cost
a1	1.33	$10.00
a2	5.83	$10.00
a3	0.17	$10.00
a4	0.33	$5.00
a5	0.17	$7.00
a6	0.08	$15.00
a7	0.10	$26.00







LEG 4	Duration (hrs)	Cost
a1	0.00	$0.00
a2	0.00	$0.00

LEG 5	Duration (hrs)	Cost
a1	0.00	$0.00
a2	0.00	$0.00

LEG 6	Duration (hrs	Cost
a1	0.00	$0.00
a2	0.00	$0.00

Graph Time-Distance / Graph Cost - Distance / Graph - All-in-One / Comparison of stops / Data / Data 2

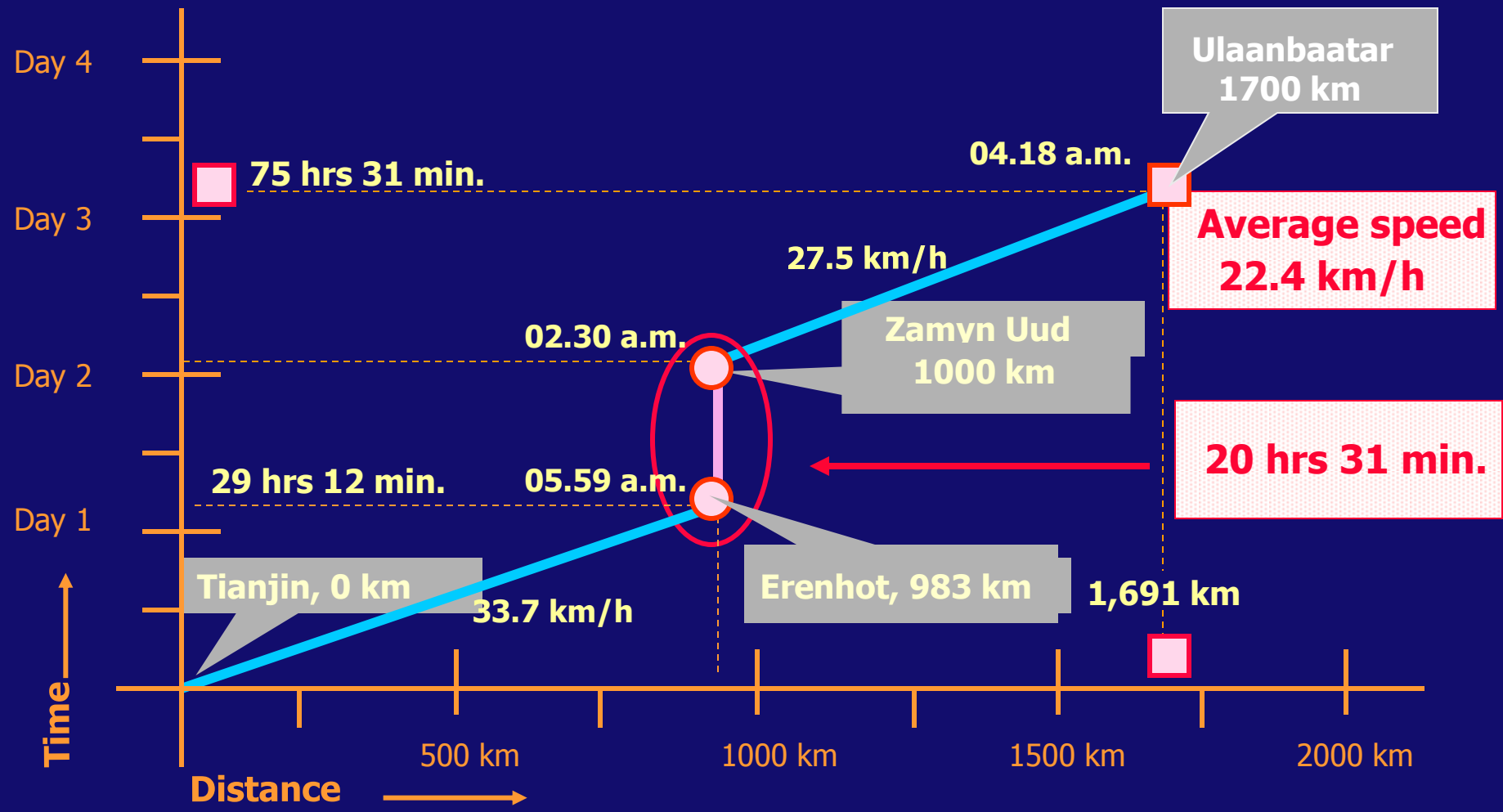
Ready NUM

How to interpret the data and the graphs?

- Each graphs illustrates with two individual bars the time (duration) and the costs allocated to the activities undertaken at a stop.
- The bar for time/duration (in hrs) shows how much (in per cent) each activity contributes to the overall time of the stop (sections of the bar), which is represented as 100%.
- The bar for the costs depicts the amount each activity (sections of the bar) contributes to the overall costs of the stop.
- The lines connecting the two corresponding sections of the bars facilitate the comparison between the percentage of time and the percentage of costs attributed to one activity.

Facilitation: UNESCAP Analysis Methodology

Results of Demo Run Tianjin - Ulaanbaatar



- Transshipment:	3 hrs. 20 min. *(3.5 min. per box)*	- Customs:	China,	3 hrs. 00 min.
Shunting + train formation:	3 hrs. 35 min.		Mongolia,	4 hrs. 50 min.

Next steps 2012-13

- Combine the TC/D model with UNCTAD corridor cluster development methodology.
- Develop the “Cross-border and Transit Transport Process Management Toolkit” or CTPM Toolkit. (English, French and Russian)
- Train corridor stakeholders in Central Asia and Eastern Africa in the use of CTPM Toolkit.

Thank you for your attention

The Time Cost Distance Model

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