

#### 4th Railway Working Group Meeting

22-24 April 2019 | Tashkent, Uzbekistan

4-е заседание Рабочей группы по железнодорожному транспорту

22-24 апреля 2019 г. | Ташкент, Узбекистан

### RAILWAY SECTOR DEVELOPMENT IN CENTRAL ASIA REGIONAL ECONOMIC COOPERATION COUNTRIES

### THE TRANSPORT MODELLING APPROACH

- Len Johnstone

- Transport Modelling Resource Person



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### **Discussion Points**

- I. AN OVERVIEW OF TRANSPORT MODELS
- II. GENERAL MODELLING APPROACH
- III. WHAT IS NEEDED FOR THE MODEL
- IV. THE MEKONG MODEL IN BRIEF
- V. RECAP



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### **Transport Model Overview**

#### Transportation refers to the movement of people and goods between different localities across different routes.

A model reproduces first the existing transportation situation and predicts the needs for future transportation.

"I always avoid prophesying beforehand because it is much better to prophesy after the event has already taken place." Famous person speaking on the future.

There is a need for a mathematical tool to address and understand the issue of demand and supply. This is what is supplied within the framework of a transport model.



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### Potential for Network Upgrading and Extension





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# **Modal Choice**

#### **Transportation decision?**

RoadTransport



- Proposed Alternative Transport Solutions
- Limited Resources
- Evaluate Best Use of Resources use numerical analysis
  - Rank Projects







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Why?

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#### The USEFULNESS of a model



Choose Best Solution with numerical Backup



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### **Structural Definition**

### WHAT IS NEEDED FOR THE MODEL DEFINITION ??







A Model is a beautiful but some times complex set of mathematical equations that attempts to propose the hypothesis of all transport movement.



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# General Modelling Approach(2)



Source: *Transport Models: TAG Unit 3.1.2*. Department for Transport, June 2005



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### **Different Types of Cargo Trips**





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# Model Needs

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### Demand

For Person and Cargo models availability of socio-economic characteristics by small area or traffic zone eg population, employment, GDP Existing Origin Destination Movement Data by Persons and Cargo Cluster Customs/Immigration datasets Supply **Inventory** Detailed data on network infrastructure Points of interest such as border crossing points Travel Cost data Operational Speed Any existing national models

The Database



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# Further detail for cargo models

- Commodity Flow Data tonnage movement to/from a zone by commodity and mode
- Population, Employment by cluster and GDP
- Details on Ports, Warehouses and Distribution Centers
- Truck, Rail, Air and Ship freight routes
- Observed Data for validation Average trip length, Vehicle Classification Counts and tonnage movement at locations by mode



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### 22-24 April 2019 | Tashkent, Uzbekistan 24 Model Outputs

### Scenario Analysis

A scenario is a group of projects acting in support of each other

An input into Economic Evaluation of Project Scenarios

An input into Financial Evaluation of Project Scenarios

- Identification of Future Infrastructure needs
  - Estimation of future traffic on network
- A tool to enable evaluation of new projects.
- A combined GIS network of all infrastructure



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### 22-24 April 2019 | Tashkent, Uzbekistan Model Needs – the next steps (A)

### Earlier TRACECA Modelling Project

- Armenia
- Azerbaijan
- 🔲 Bulgaria
- Georgia
- 🔲 Kazakhstan 🗸
- Kyrgyzstan
- Moldova
- Romania
- Tajikistan
- Turkey
- Turkmenistan
- Ukraine
- Uzbekistan
- South Russia

#### **TRACECA Zonal breakdown example – More detail needed?**

Akmola Oblast Aktobe Oblast **Almaty Oblast** Atyrau Oblast West Kazakhstan Oblast Zhambyl Oblast Karaganda Oblast Kostanai Oblast **Kyzylorda Oblast** Mangystau Oblast South Kazakhstan Oblast Pavlodar Oblast North Kazakhstan Oblast East Kazakhstan Oblast Astana city Almaty city

**Review TRACECA for CAREC** model, planning data available as well as commodity data. Possibly a good starting point, is it at an appropriate level of detail??



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# Model Needs – the next steps – how to proceed??

### Access to any existing national/regional transport models?

- All such models, we need not only the digital files but also any documentation.
- TRACEA is a start
- Access to any existing national transport databases not only rail?
  - All such databases, we need not only the digital files but also any documentation.
- Access to any fine area national economic databases eg at provincial level
- The emphasis may be on cargo but we also need to understand people movement



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# The Mekong Model - Highlights





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### Model Framework





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4th Meeting of RWG April,2019

37,000 km

17,000 km



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# Model Extent (2)



Number of Traffic Zones: - Internal ~216 - External~ 38 Statistics in 2015 Population: 340,000,000 GDP: 1,054,000 Mil USD (constant 2010 USD)

Overall CAREC population not that dissimilar to Mekong.



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### **Generation and Distribution**

### Generation

For Person and Cargo models a function of available socioeconomic characteristics

### Distribution

- Person
  - Gamma Function
- Cargo

Fratar matrix expansion procedu





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# The Cargo Model-Trip Generation

Cargo is described using the Harmonized System (HS) of grouping

Group	Description	HS-Start	HS-End	MRTM Grouping	Description
1	Animal & Animal Products	1	5	1	Agricultural
2	Argricultural Products	6	15	1	Agricultural
3	Foodstuffs	16	24	2	Proceesed Food
4	Mineral Products	25	27	3	Chemical/Mineral
5	Chemicals & Allied Industries (Fuel)	28	38	3	Chemical/Mineral
6	Plastics / Rubbers	39	40	3	Chemical/Mineral
7	Raw Hides, Skins, Leather, & Furs	41	43	4	Wood_Skins
8	Wood & Wood Products	44	49	4	Wood_Skins
9	Textiles	50	63	3	Chemical/Mineral
10	Footwear / Headgear	64	67	4	Wood_Skins
11	Stone / Glass	68	71	5	Miscellaneous
12	Metals	72	83	5	Miscellaneous
13	Machinery / Electrical	84	85	5	Miscellaneous
14	Transportation	86	89	5	Miscellaneous
15	Miscellaneous	90	97	5	Miscellaneous



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### Mode Split Person – Hierarchical Structure





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# The Cargo Model-Mode Split





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# Model Output

#### Cargo and Person Trips estimated By Mode

- □ The specific routes or links used by trips, and at what level of intensity.
- For the road network- Combine Cargo and Person
  - Both Person and cargo are converted into vehicles and hence passenger car unit (pcu)
  - Equilibrium: all used paths have equal and minimum travel cost;
  - User equilibrium assignment
- □ Non Road network, trip are assigned onto exclusive right of ways using all or nothing assignment.
- □ Final combined network including all assigned values.

#### Network Links

- Person Travel by Mode
  - Travel on road link to access say air mode is also included
- Cargo Travel by Mode
  - Travel on road link to access say rail mode is also included



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#### MODE SPLIT OF KILOMETRES OF TRAVEL



Rail Tonne Kilometres of Travel						
Scenario	Mode Split	Modal Growth Factor				
2015	0.8	-				
2050 No Projects	1.3	1.7				
2050-Case I (All Projects)	1.6	2.1				

# **Graphical Output**

Rail Person Kilometres of Travel					
Scenario	Mode Split	Modal Growth Factor			
2015	7.8	-			
2050 No Projects	14.8	1.9			
2050-Case I (All Projects)	17.9	2.3			





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1

2

3

4

5

6

7

8

9

Total (USD)

Project

### **Projects Assessed**



Capital Cost (\$m)

633

5,431

5,500

1,933

6,468 (Lao PDR

side)

6,073

11,106

2.000

611

39,755 million



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# ReCap

MODELLING OVERVIEW
A MODELLING APPROACH
WHAT IS NEEDED?
AN EXAMPLE - MEKONG



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