State-of-the-art Freight Transport Modelling

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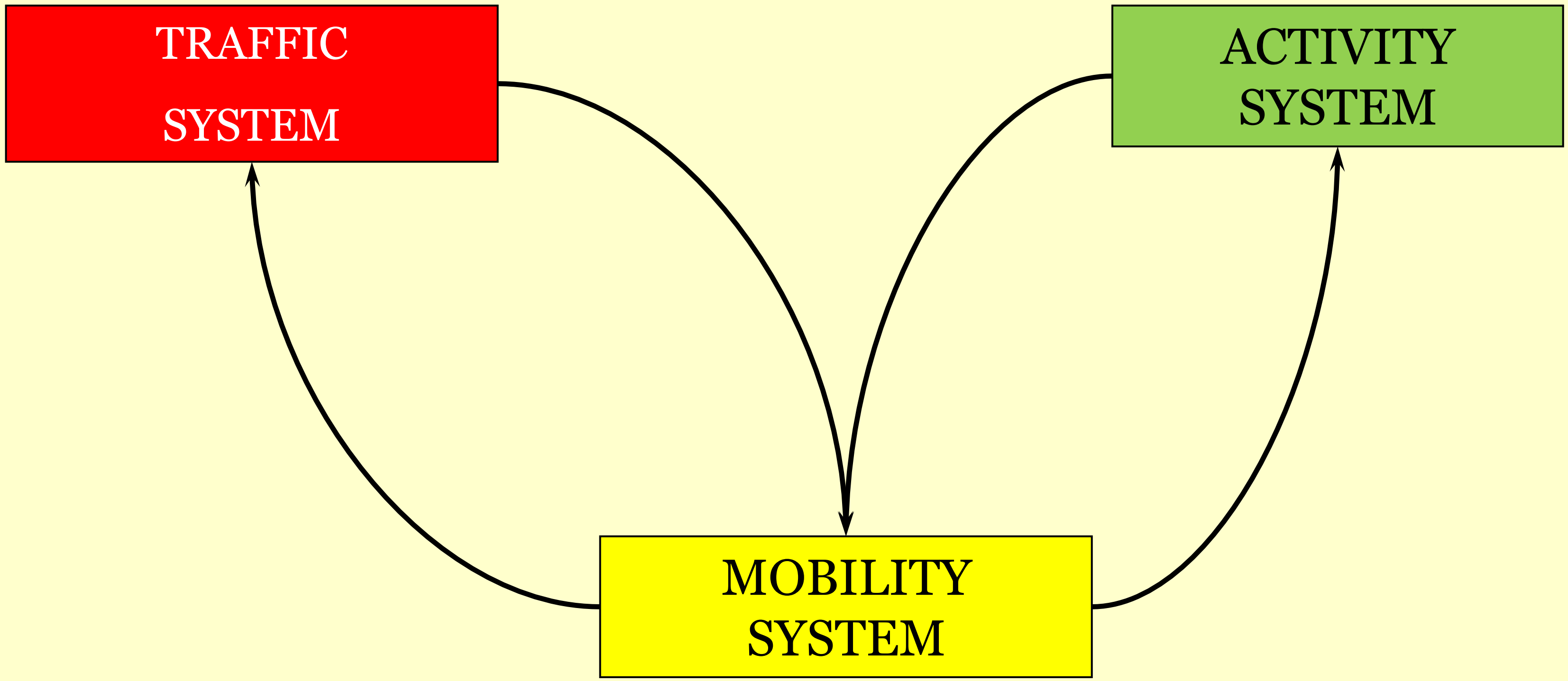
PRESENTATION OUTLINE

1. Introduction
2. The Existing Transport Model
3. The Development of Methodology
4. Model Development
5. Conclusions

LAND USE – TRANSPORT INTERACTION



INTERACTION AMONG SYSTEMS IS DYNAMIC,
NON-STABLE, NON-STRUCTURED

INTRODUCTION TO TRANSPORT PLANNING

EVERY SYSTEM HAS DIFFERENT PERSPECTIVE OF TIME AND RESOURCES:

TRAFFIC SYSTEM

DIRECT, REACTIVE, VERY SHORT TERM, LOCAL IMPACT

MOBILITY SYSTEM

INDIRECT, REACTIVE/ANTICIPATIVE LONG TERM, REGIONAL IMPACT

ACTIVITY SYSTEM

INDIRECT, ANTICIPATIVE, VERY LONG TERM, REGIONAL/MACRO IMPACT

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INTRODUCTION TO TRANSPORT PLANNING

LAND USE MODEL

TRIP GENERATION

TRIP DISTRIBUTION

MODE CHOICE / MODE SPLIT

MODE CHOICE / MODE SPLIT

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Land Use Model

$$X_i^p = f(C_i^p)$$

Trip Generation Model

$$T_i^p = f(C_i^p)$$

Trip Distribution Model

$$T_{ij}^p = f(C_{ij}^p)$$

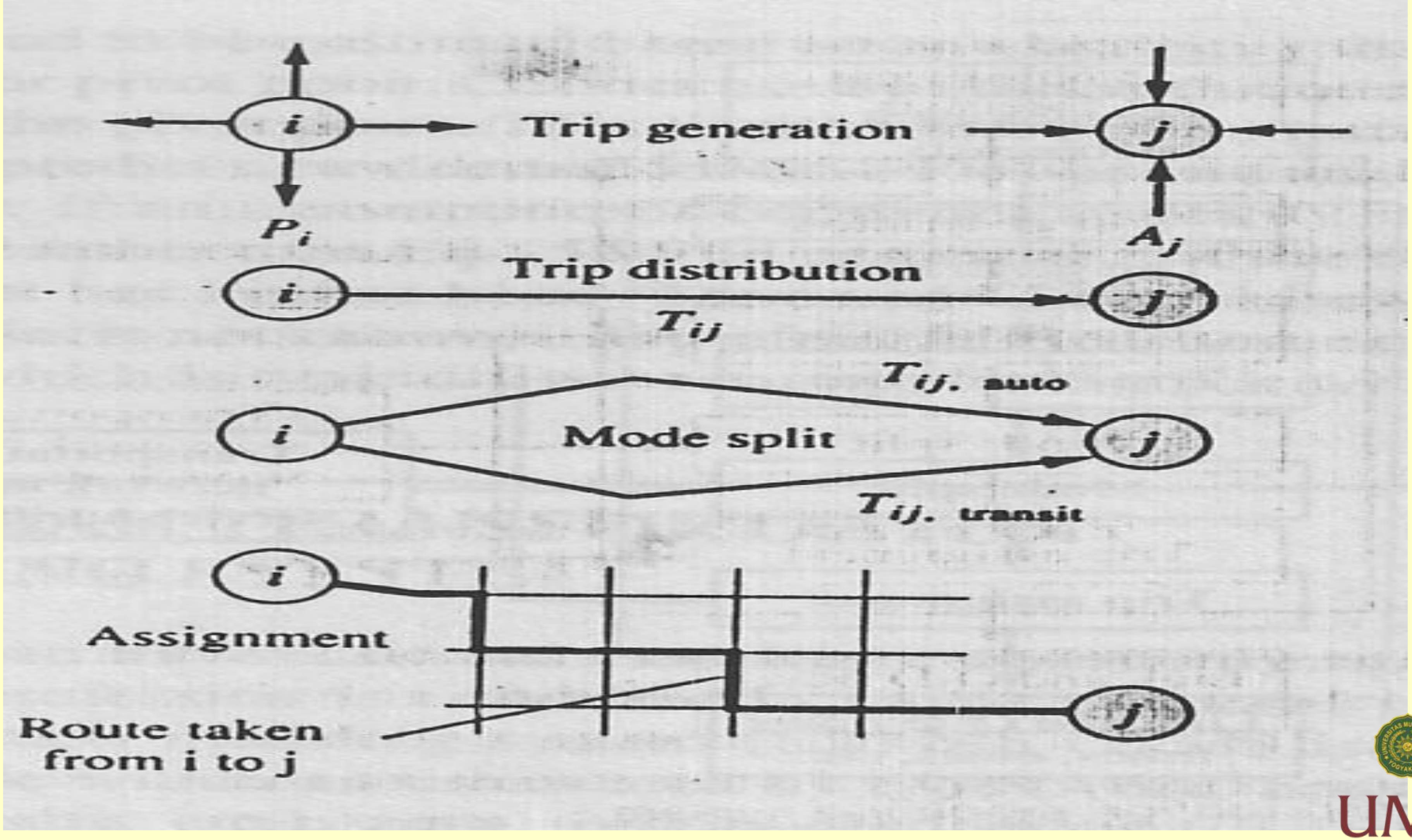
Modal Split Model

$$T_{ij}^{pm} = f(C_{ij}^{pm})$$

Network Assignment Model

$$T_{ij}^{pmr} = f(C_{ij}^{pmr})$$

TRANSPORTATION MODELING



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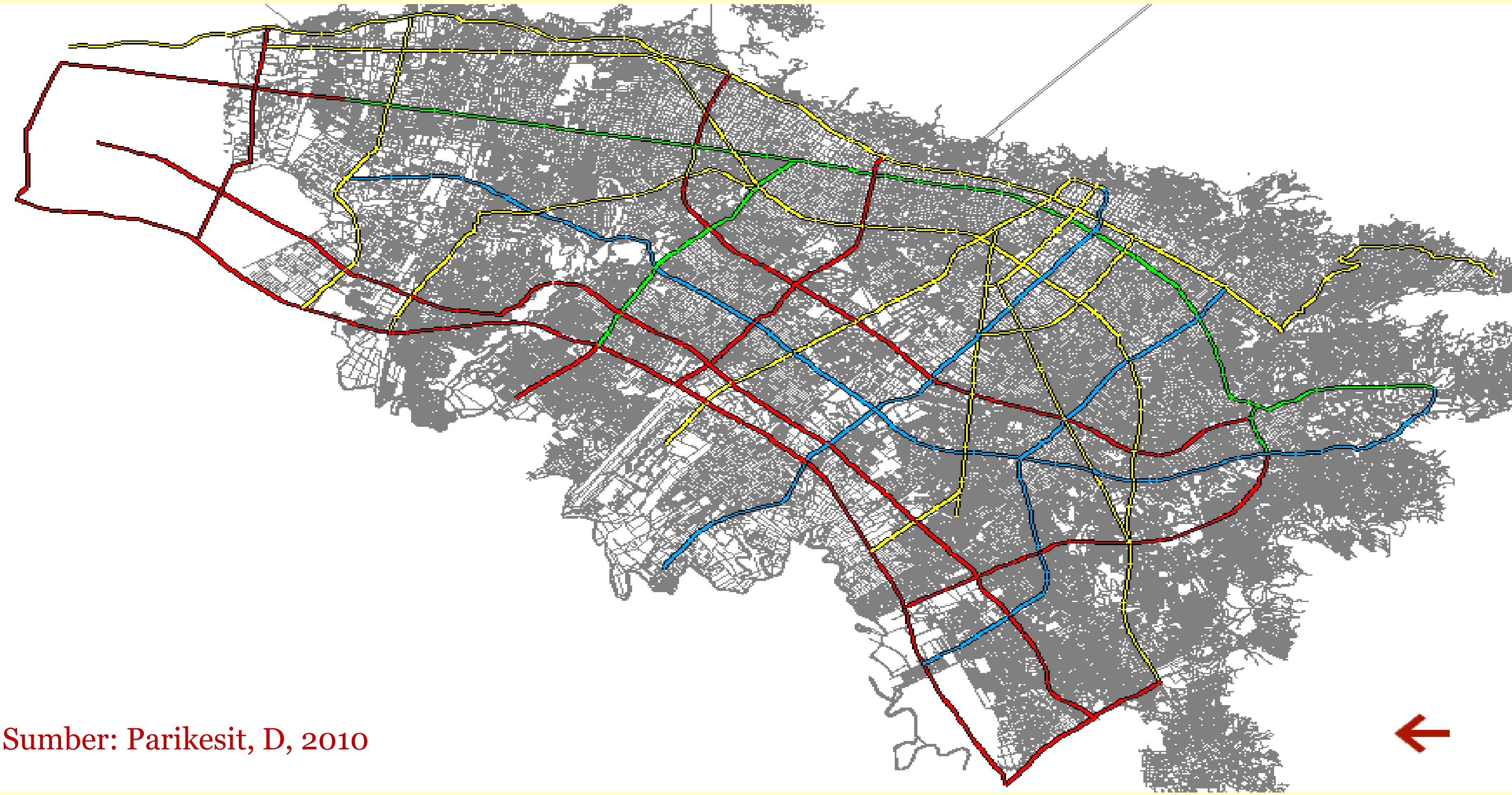
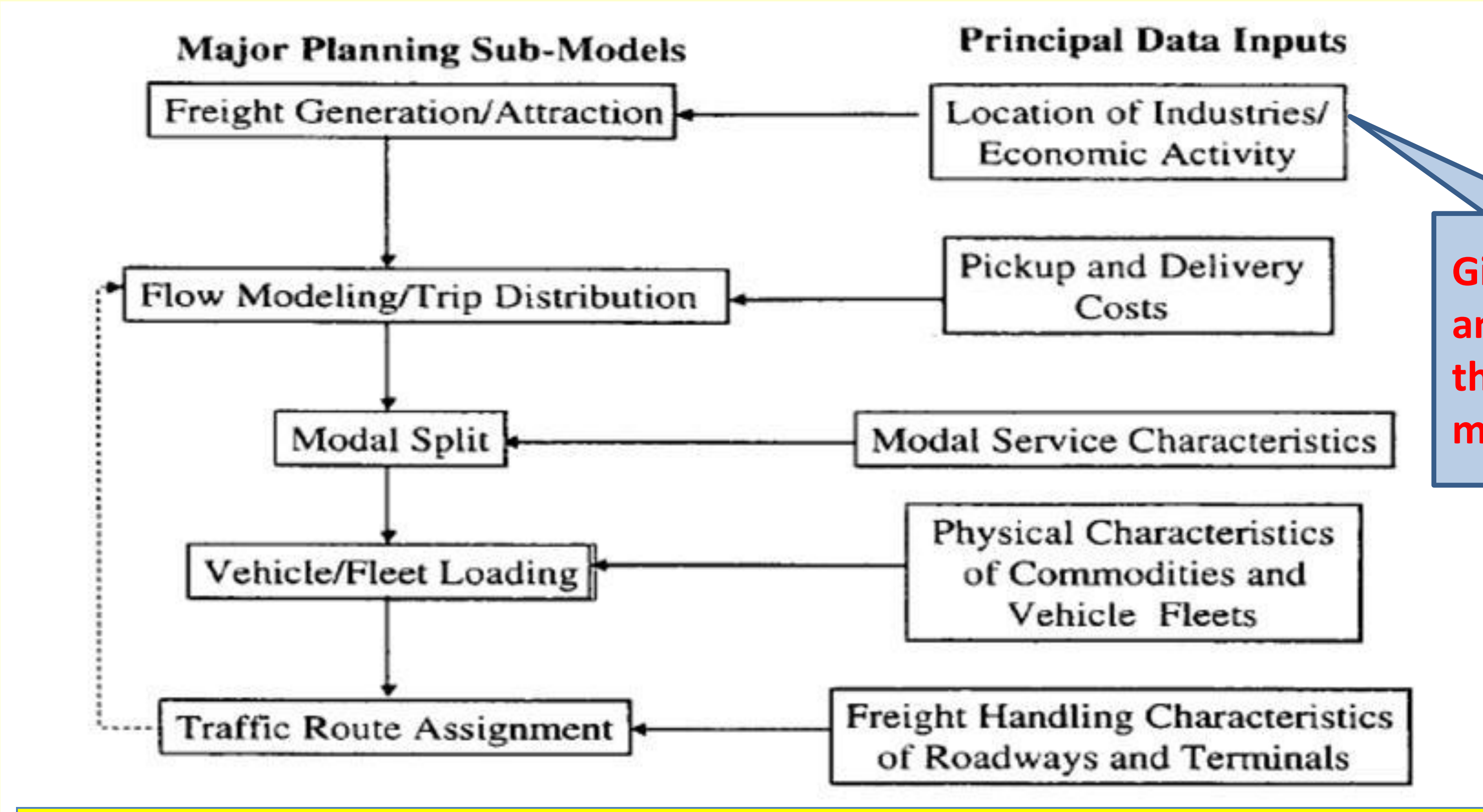
Siapa?
Kemana?
Menggunakan moda transportasi apa?
Melalui rute yang mana?



Sumber: Parikesit, D, 2010

THE EXISTING FREIGHT TRANSPORT MODEL

(Source: Southworth, 2002)



Given data and outside the transport model

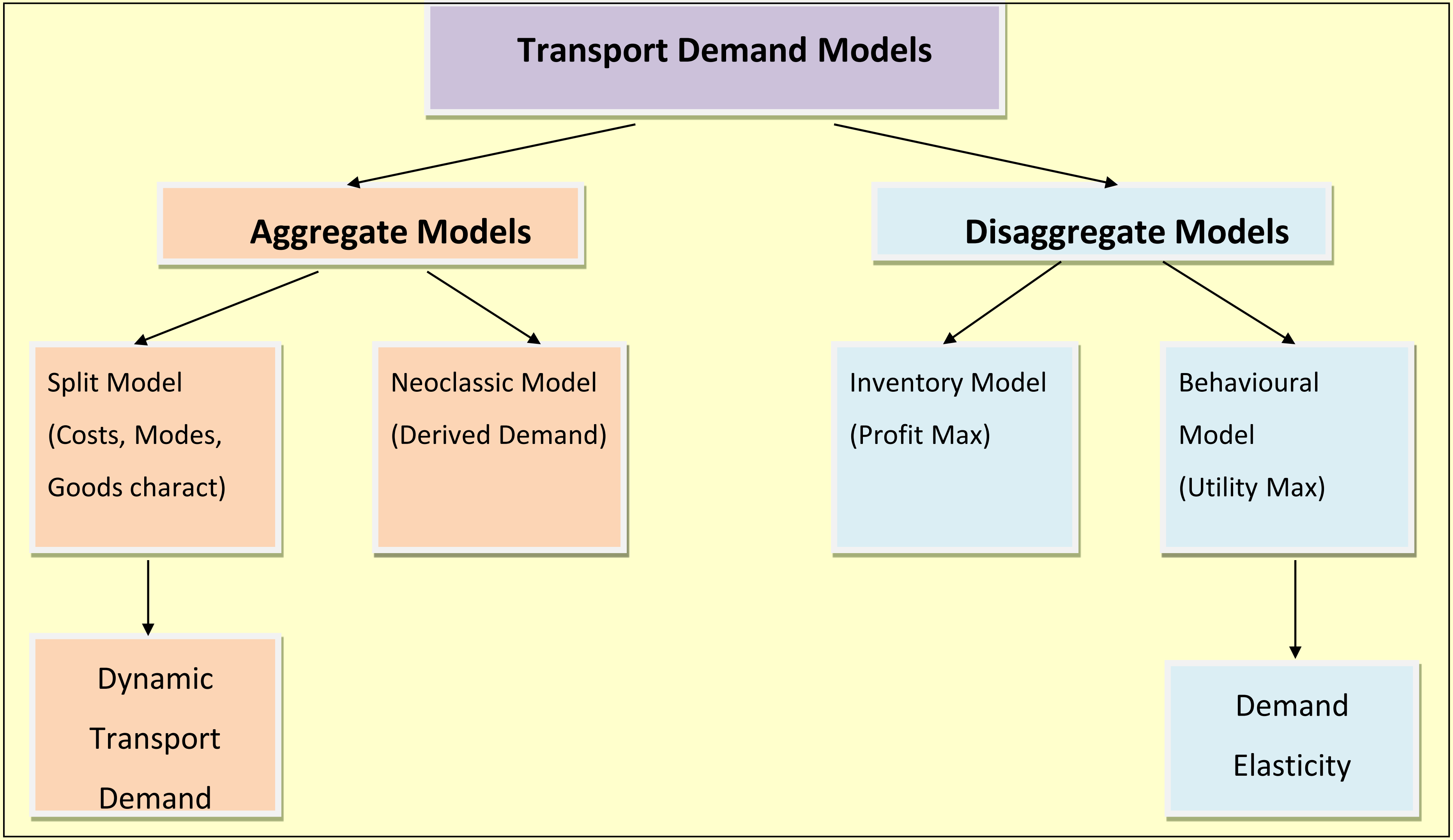
The **DEVELOPED METHODOLOGY** is attempting to:

1) Integrating (internalized) the spatial model into transportation model

2) combining the **economics activities** driving freight movement (commodity-based model) and the **vehicle movement** (trip-based model).

TRANSPORT DEMAND MODELS

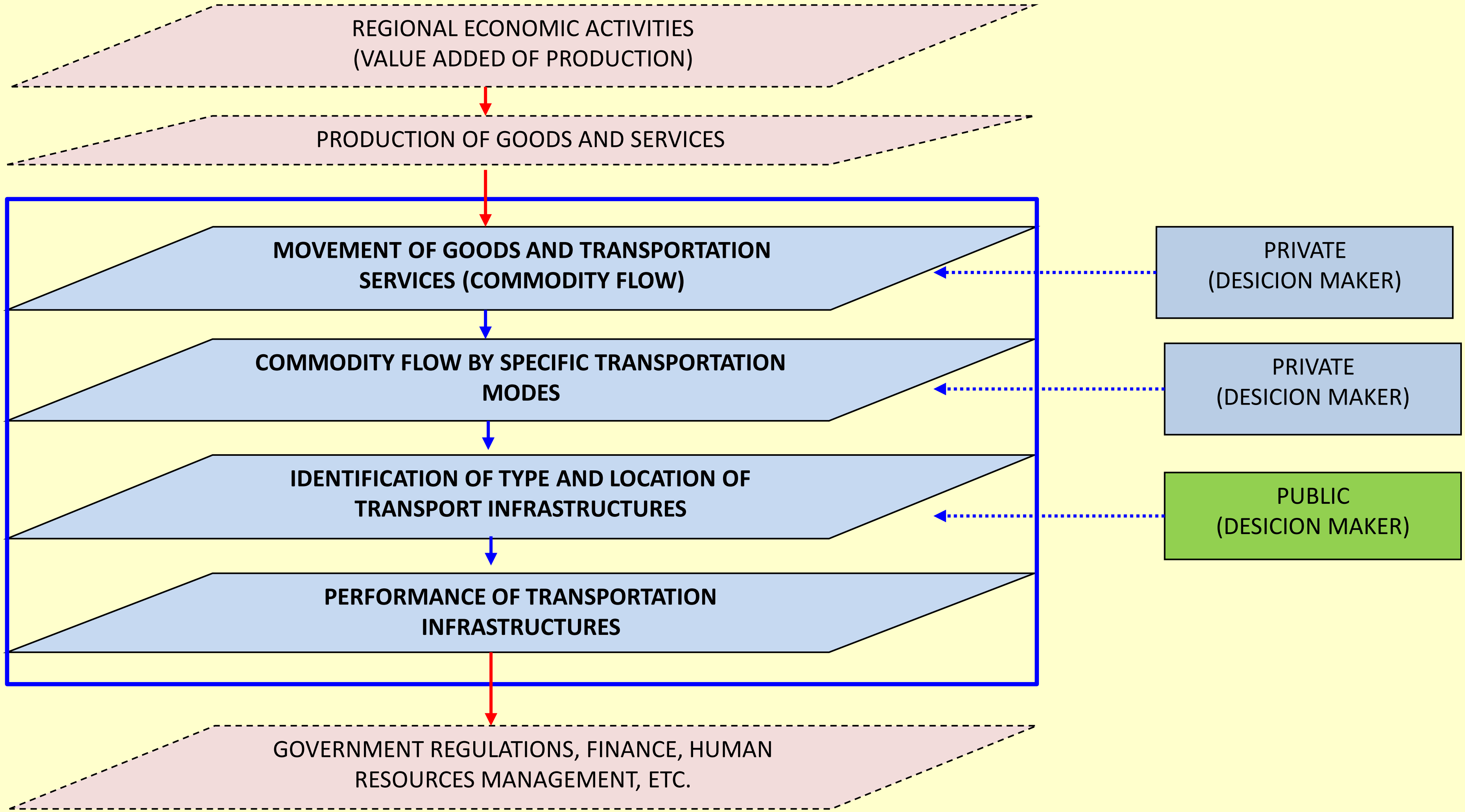
(Source: Menendez et al, 2004)



EXISTING vs PROPOSED METHODOLOGY

The existing methodology	Proposed methodology
Spatial data driving the freight transportation considered as EXOGENOUS FACTOR	Spatial data as ENDOGENOUS FACTOR
Focusing on transportation modelling only (trip-based) or only modelling the amount of freight (commodity-based)	Integration of spatial and transportation modelling
Trip generation, trip distribution, mode split, and route assignment is conducted in several stages (and sequences)	Trip distribution, mode split, and route assignment are conducted simultaneously
Only capture commodity flow (commodity-based) or capture vehicle trip only (trip-based)	Capture the flow of commodity and vehicle trip
Generally focusing on uni-modal or multimodal transportation	Possible to apply the inter-modal transportation
Unable to capture the vehicle movement (commodity-based)	Able to track the vehicle movement

STAGES OF DEVELOPING METHODOLOGY



1. The first methodology of regional transportation planning: 7 stages

(final) first research methodology.docx

2. The latest methodology of regional transportation planning : 10 stages

(final) developed methodology.docx

THE LATEST DEVELOPED METHODOLOGY

The developed methodology for regional freight transportation planning consists of **ten stages** to be considered:

I. Selection of commodity using Regional Income (RI) model;
II. Conducting observation surveys and initial data collection;
III. Conducting Revealed Preference surveys on:
   a) commodity production and distribution by interviewing shippers;
   b) commodity distribution by interviewing carriers;
   c) trip characteristics and transportation attributes b interviewing shippers and carriers;
IV. Construction of GIS geo-database by using ArcGIS;
V. Spatial modelling by simulating and mapping of geographical location of selected commodity using ArcGIS;
VI. Validation of spatial model;
VII. Transportation modelling of selected commodity using ArcGIS by considering Generalized Cost (GC) of mode/destination combination for all factory locations;
VIII. Checking of Generalized Cost (GC);
IX. Identification of issues/bottlenecks (identification of type and location of transport infrastructures);
X. Applying alternatives/scenarios into the model.

DATA COLLECTION (TYPE, METHOD, TOOLS)

DATA	TYPE	METHOD	TOOLS	REMARKS
Commodity chain	Primary	Interview	Questionnaire	Shippers
Logistics node/facs	Primary	Interview, field survey	Questionnaire	Shippers, Port Authority, Others
Area of resources and manufacturers	Primary	Interview, field survey	Questionnaire	Shippers
Vehicles characts	Primary	Interview, field survey	Questionnaire	Shippers, carriers
Travel distance and route	Primary	Interview, field survey	Questionnaire GPS, others	Shippers, carriers
Travel time	Primary	Interview, field survey	Questionnaire GPS, others	Shippers, carriers
Travel cost	Primary	Interview, field survey	Questionnaire	Shippers, carriers
Data GIS	Primary	GIS analysis	ArcGIS 9.3.1 and 10.1	RBI, field/survey
Other data	Secondary	Literature collection		National/ Province Institut.

STAGES OF DATA COLLECTION AND ANALYSIS

Secondary data collection and preparation of QS form

Training of surveyors for O-D and RP surveys

O-D (observation) surveys (road & port)

RP Surveys to carriers

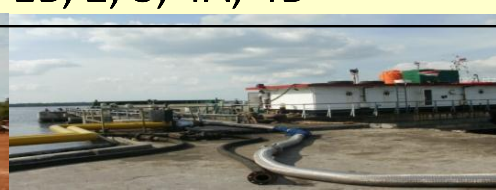
RP Surveys to shippers

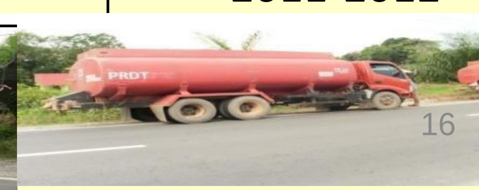
Data analysis and model development

BUILDING GIS GEO-DATABASE

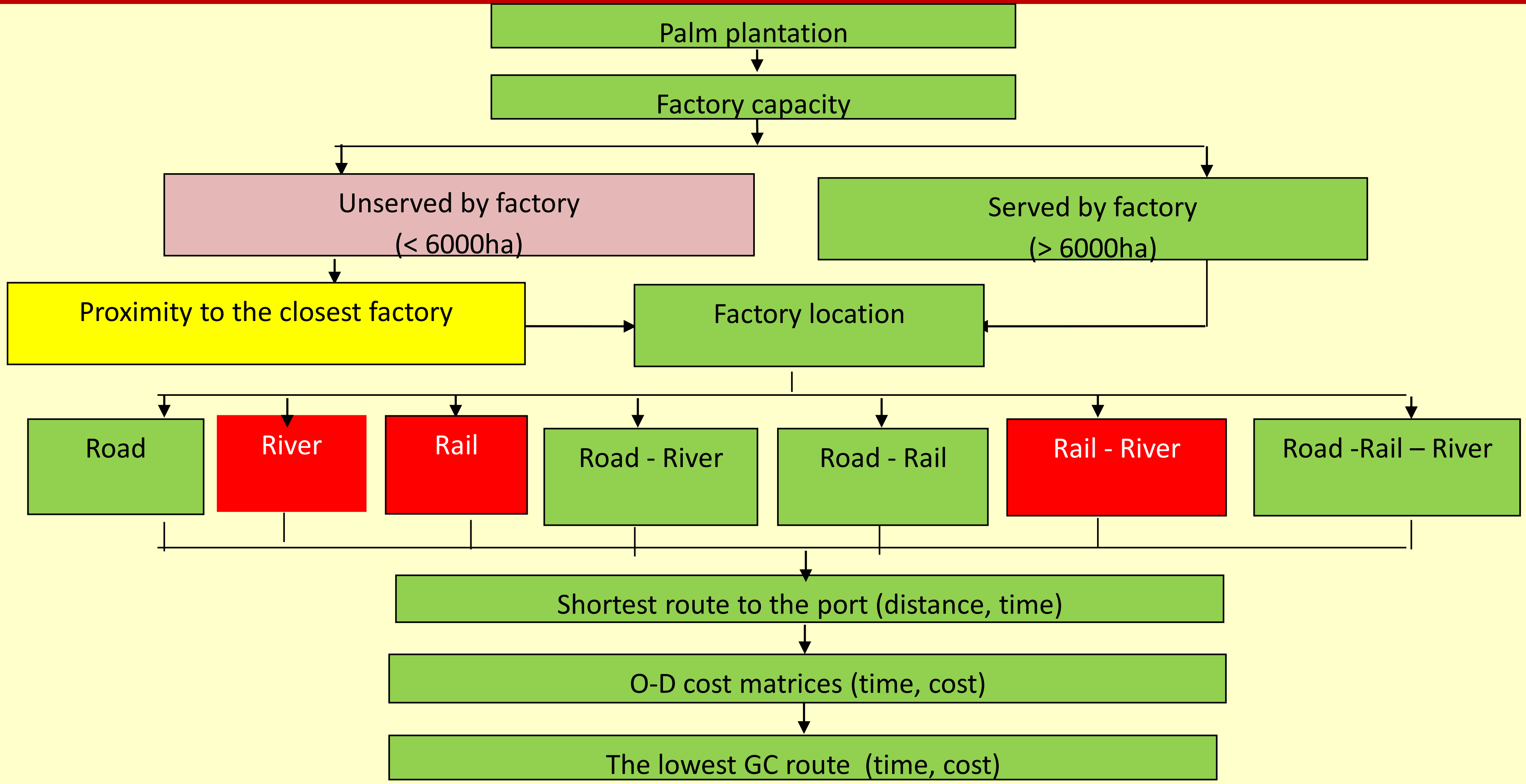
Builds the important spatial and transportation data (GIS geo-database) that can be applied directly to the program/ software of transport planning and or modeling (ArcGIS, CUBE, etc.).

No	Data	Format	Year
1.	Kabupaten (Regency) map	Geo-database	2010-2012
2.	Kecamatan (Sub-district) map	Geo-database	2010-2012
3.	Desa (Village) map	Geo-database	2010-2012
4.	Oil palm plantation and attributes	Geo-database	2010-2012
5.	Road networks and attributes	Geo-database	2010-2012
6.	Main river network and attributes	Geo-database	2010-2012
7.	River centerline	Geo-database	2010-2012
8.	Land use data	Geo-database	2010-2012
9.	General ports	Geo-database	2010-2012
10.	Special ports	Geo-database	2011-2012
11	Railways link 1A, 1B, 2, 3, 4A, 4B	Geo-database	2011-2012

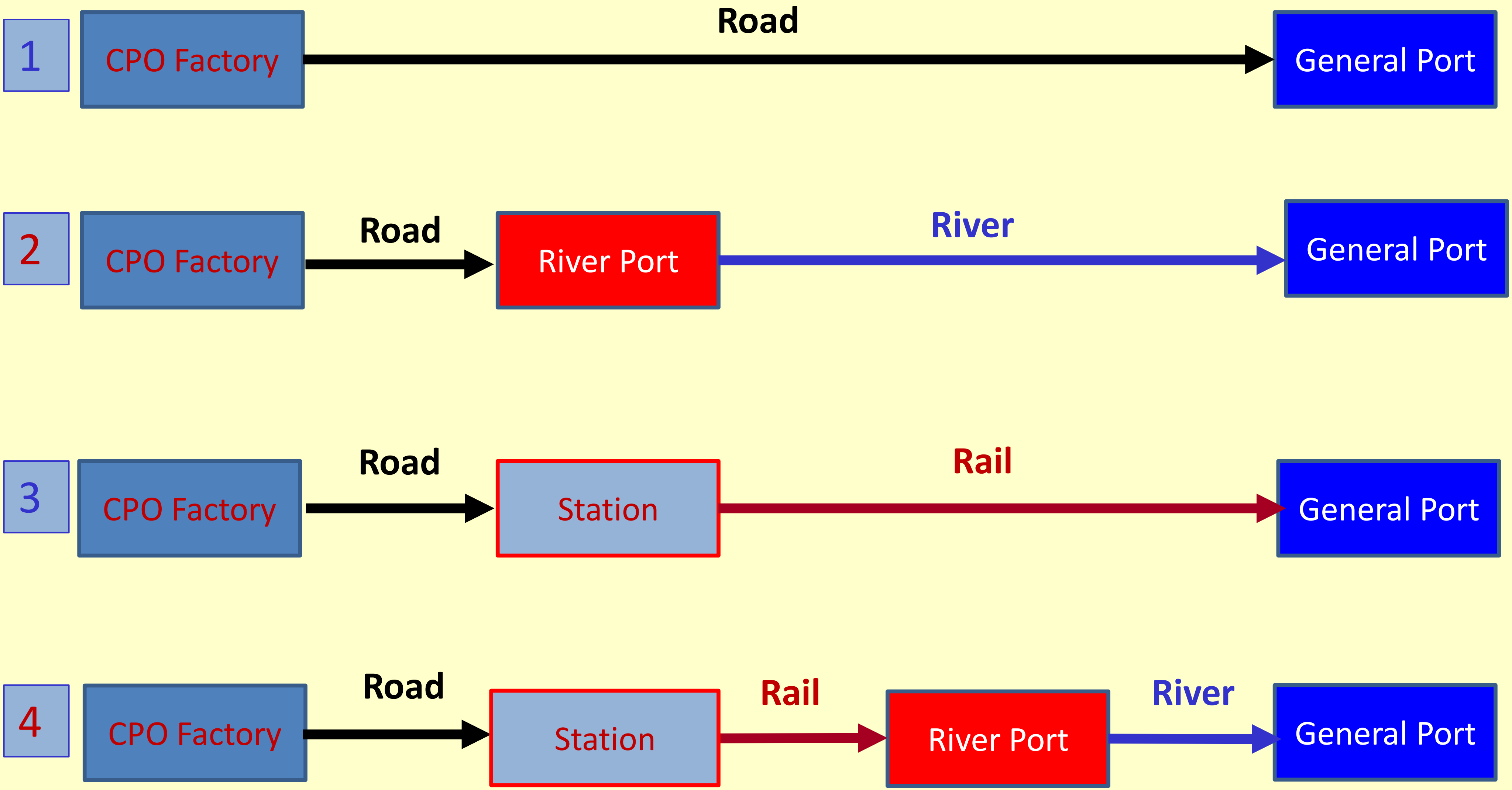


INTEGRATION OF SPATIAL AND TRANSPORTATION MODELLING



1. Model 2010: to integrate the spatial into transportation modelling
2. Model 2011 and 2012: to apply the concept of inter-modality into spatial and transportation models
3. Model 2013: to predict the likely effects of (planned) railways as an alternatives of (future) freight transportation

OPTIONS OF TRANSPORTATION NETWORKS



CASE STUDIES AND VEHICLES CONSIDERED IN THE MODELS

Year	Transportation networks	Number of general port	Number of special port	Number of CPO factories	Analysis results
2010	Road and river	2	0	113	CPO factory Shortest route
2011	Road, dry river, rainy river Intermodal road- dry river Intermodal road- rainy river	2	0	277	CPO factory Shortest route
2012	Road, dry river, rainy river Intermodal road - dry river Intermodal road- rainy river	2	11	281	CPO factory Shortest route O-D Cost, and GC
2013	Road, river, rail, Intermodal road-river, Intermodal road-rail, Intermodal rail-river, Intermodal road-rail-river	4	11	281	CPO factory Shortest route O-D Cost GC

Transport mode	Capacity (T)	Operational speed (km/hour)		Travel cost (Rp/T/km)	Time value (Rp/T/hour)
		Max	Average		
Tank-Truck	7, 8, 10, 12, and 15	45	20 - 40	1500	7700
Barge	1000, 2000, and 3000	45	30 - 35	300	7700
Rail	3000 KL	60	50	1200	7700

SPECIFICATION OF MODELLING CPO TRANSPORTATION

1. General activities of commodity considered:

PALM PLANTATION → **CPO FACTORY** → **PORT**

2. Stages of modelling:

a) Definition of CPO factories
b) Determination of the shortest route
c) Determination of O-D cost matrices
d) Calculation of modal competition
e) Calculation of generalized cost (in terms of travel cost and travel time)

3. Utility function and logit model:

$$V_m = \beta_0 + \beta_1\, Fare + \beta_2\, TTime + \beta_3\, Climate$$

$$P_{road} = \frac{exp(-V_{road})}{(exp(-V_{road}) + exp(-V_{river}) + exp(-V_{mix})}$$

$$P_{river} = \frac{exp(-V_{river})}{(exp(-V_{road}) + exp(-V_{river}) + exp(-V_{mix}))}$$

$$P_{mix} = \frac{exp(-V_{mix})}{(exp(-V_{road}) + exp(-V_{river}) + exp(-V_{mix}))}$$

ANALYSIS RESULTS FOR UTILITY AND GC FUNCTIONS

The analysis results are:

a. spatial location of origin and destination (trip generation);
b. origin-destination matrices (trip distribution);
c. the shortest routes (mode split and route assignment); and
d. utility function and probability in choosing certain transport mode.

Utility function for truck:

Utruck	= 3.383 – 0.007 Travel Cost	+ 0.021 Travel Time	+ 2.889 Climate	
t-test	= (16.758)	(57.325)	(13.866)	(13.560)
R2	= 0.618			

Utility function for barge:

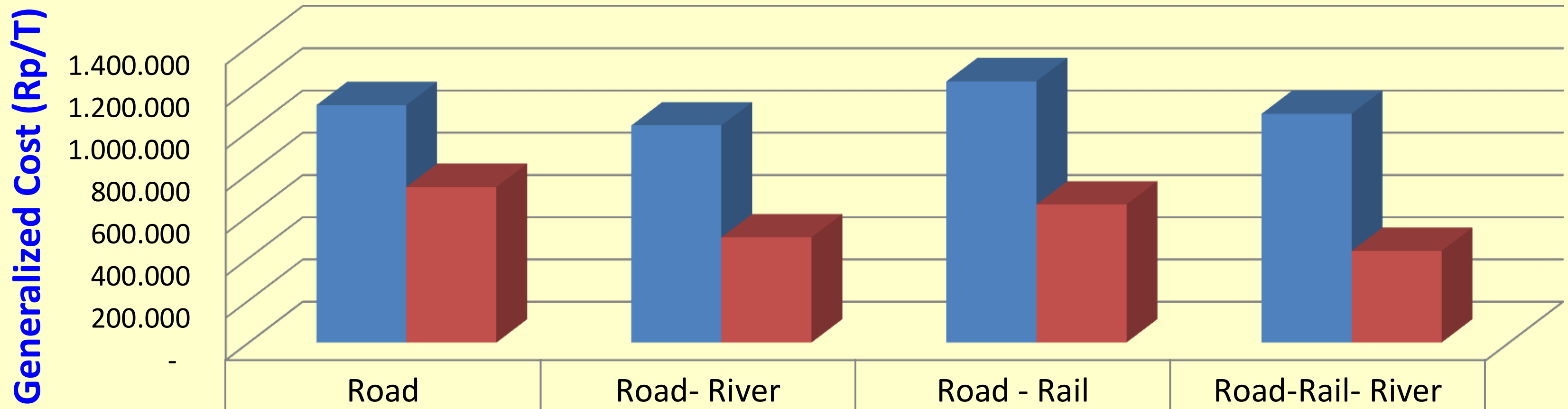
Ubarge	= 21.477 – 0.010 Travel Cost	- 0.001 Travel Time	
t-test	= (1.288)	(1.676)	(0.811)
R2	= 0.801		

The generalized cost is calculated using formula: $Cij = TC_{ij}^{m,r} + TT_{ij}^{m,r}.VoT$

C_{ij} : generalized cost (Rp/T)
$TC_{ij}^{m,r}$: fare from *i* to *j* on link *r* for mode type *m* (Rp/T)
VoT : value of time (Rp/T/hour)
$TT_{ij}^{m,r}$: total travel time spent from *i* to *j* on link *r* for mode type *m* (hour)

GENERALIZED COST (GC) OBTAINED FROM THE MODELS

Comparison of GC for all networks

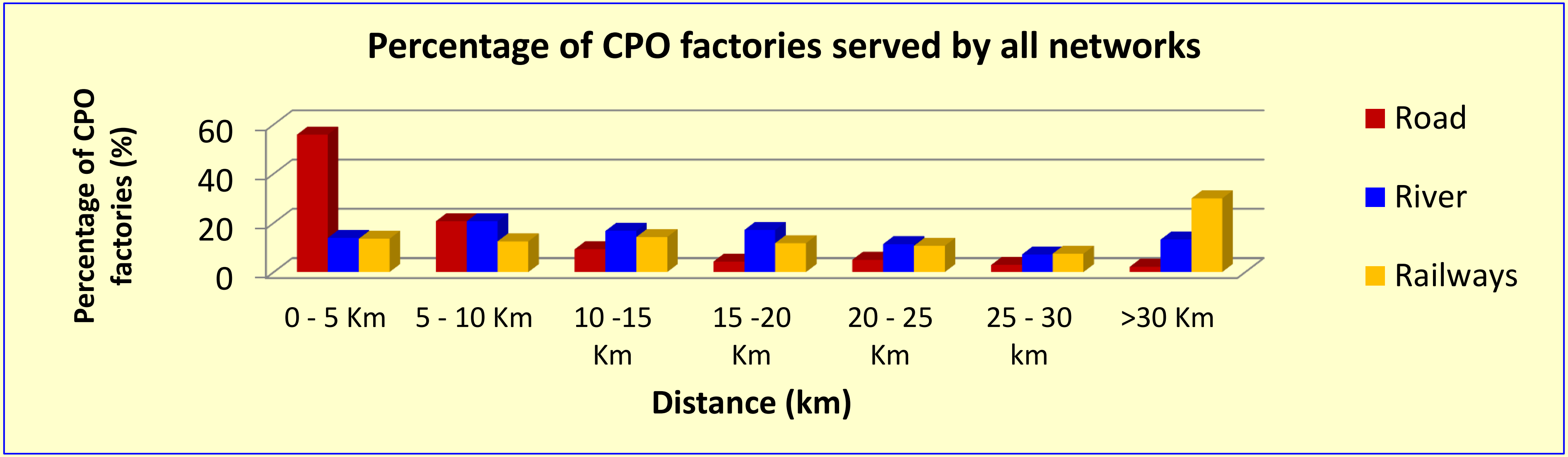


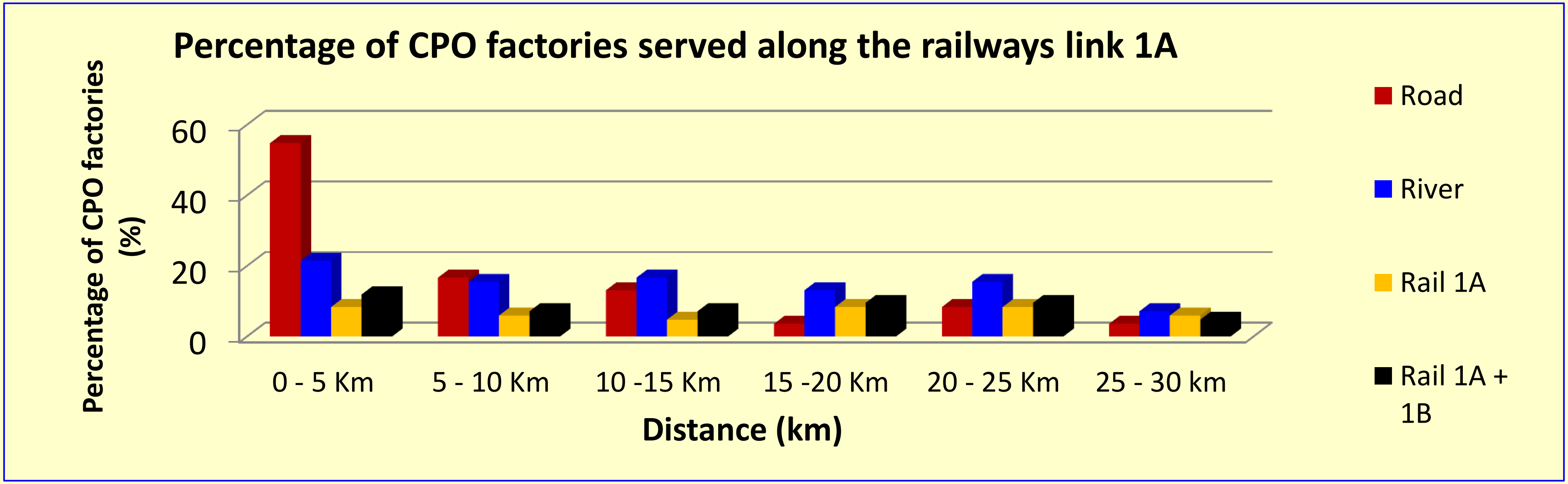
	Road	Road- River	Road - Rail	Road-Rail- River
Max	1.124.153	1.028.076	1.236.682	1.082.790
Average	736.599	497.974	653.198	433.555

Transport Networks	Road	Road- River	Road - Rail	Road-Rail- River
Average GC (Rp/T)	736,599	497,974	653,198	433,555
Efficiency	0%	32%	11%	41%

The recommended network for CPO transportation is
intermodal ROAD-RAIL-RIVER
by considering THE LOWEST AVERAGE GENERALIZED COST

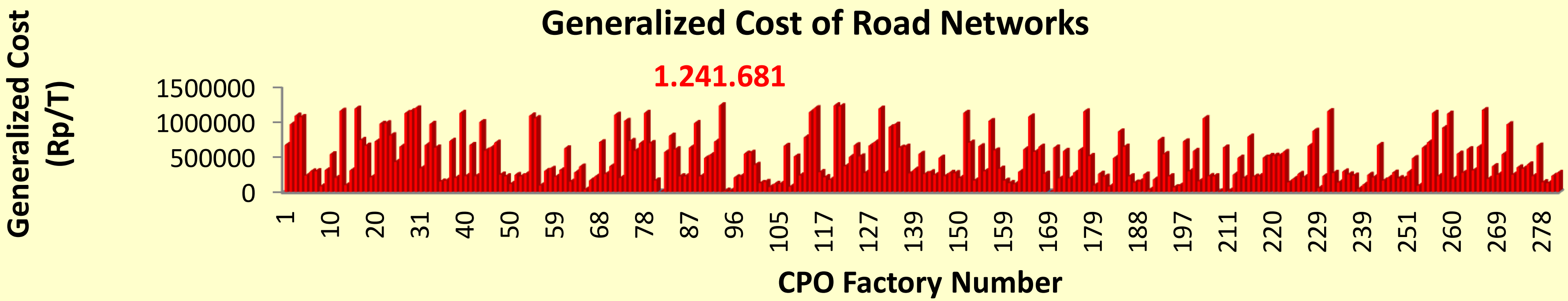
CPO FACTORIES SERVED BY THE NETWORKS

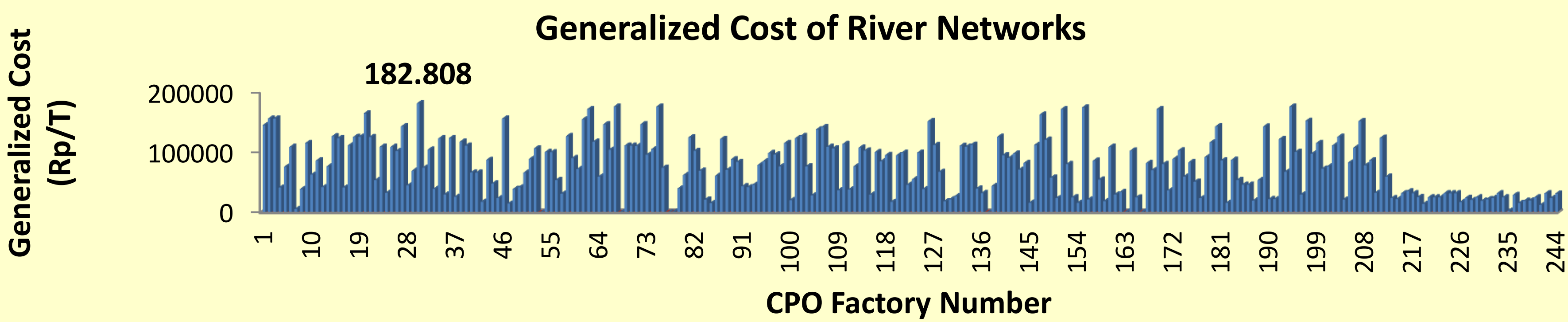


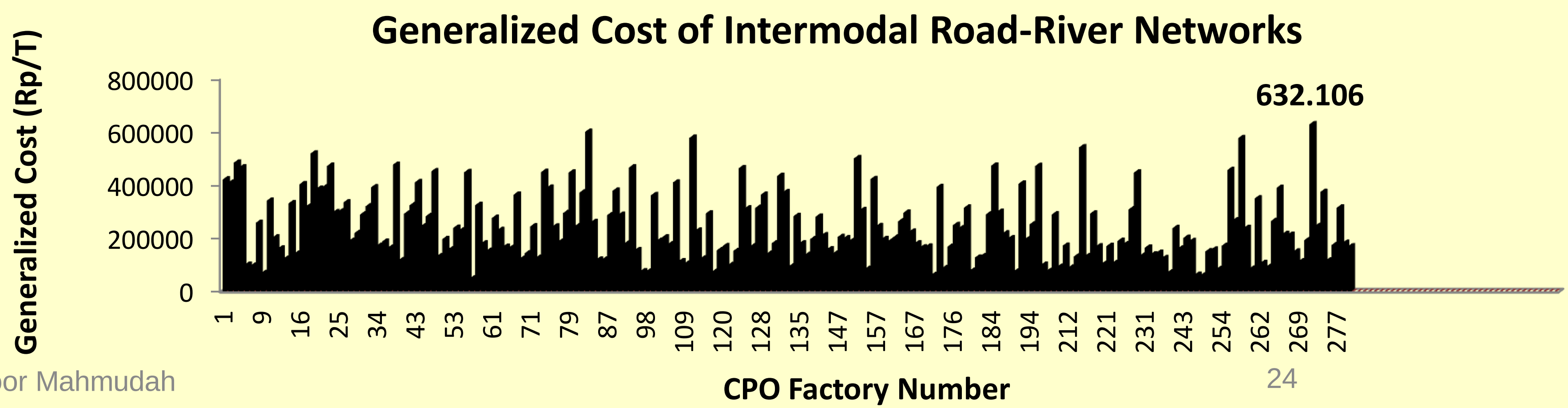


GENERALIZED COST (GC) OF THE NETWORKS(2013)

Generalized Cost $= C_{ij} = (TC_{ij}^{m,r} + TT_{ij}^{m,r} . VoT)$

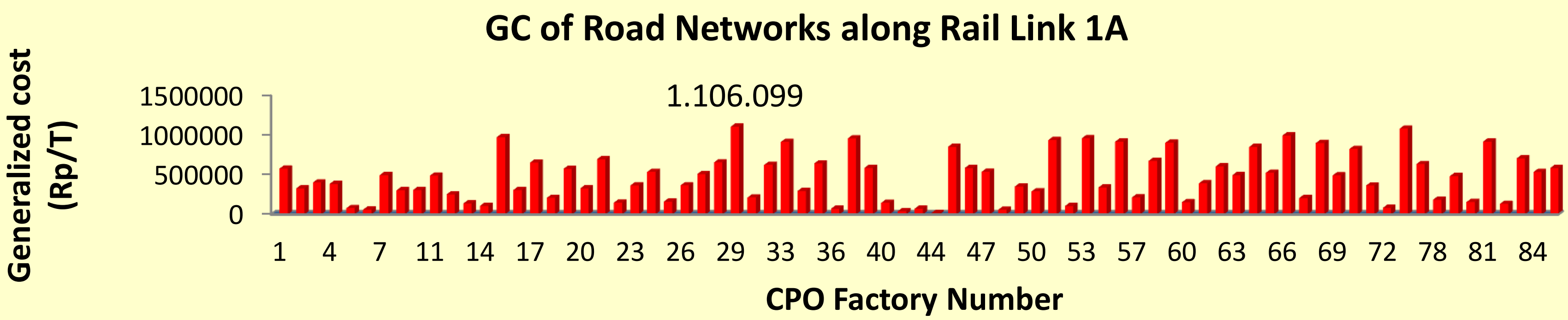


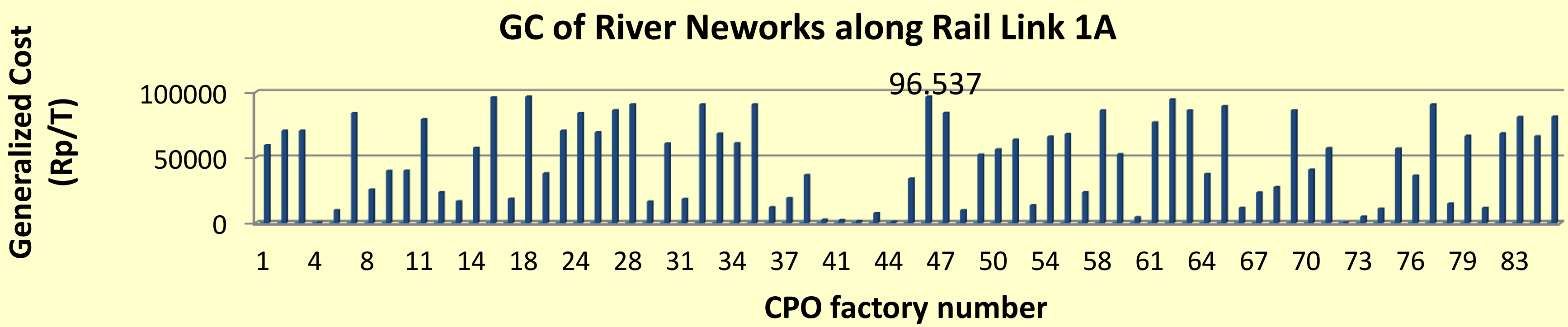


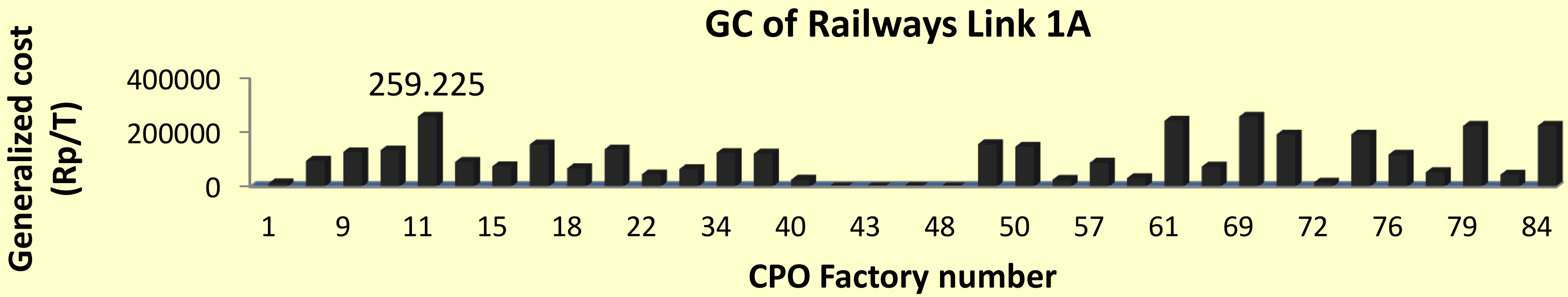


GENERALIZED COST (GC) OF THE NETWORKS (2013)

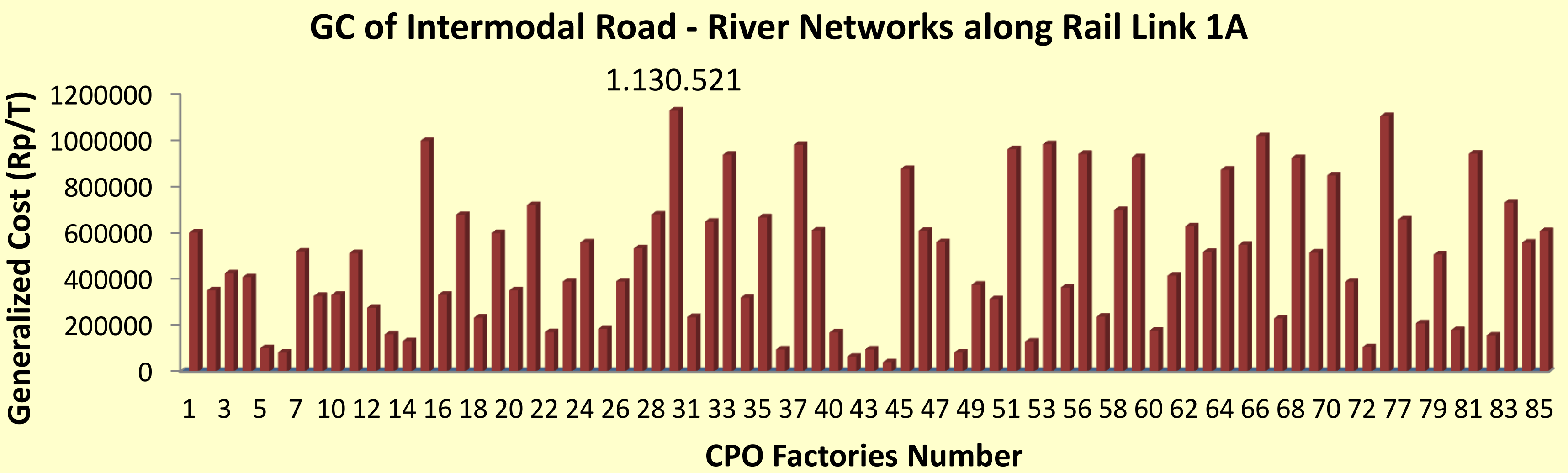
Generalized Cost = $C_{ij} = (TC_{ij}^{m,r} + TT_{ij}^{m,r} . VoT)$

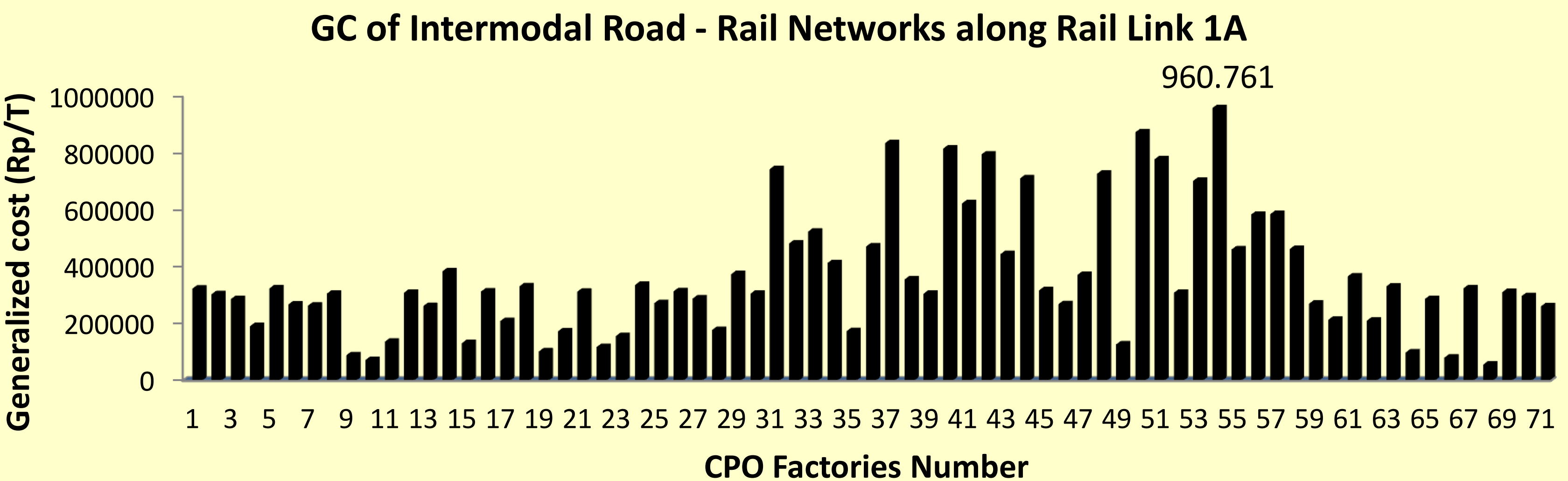




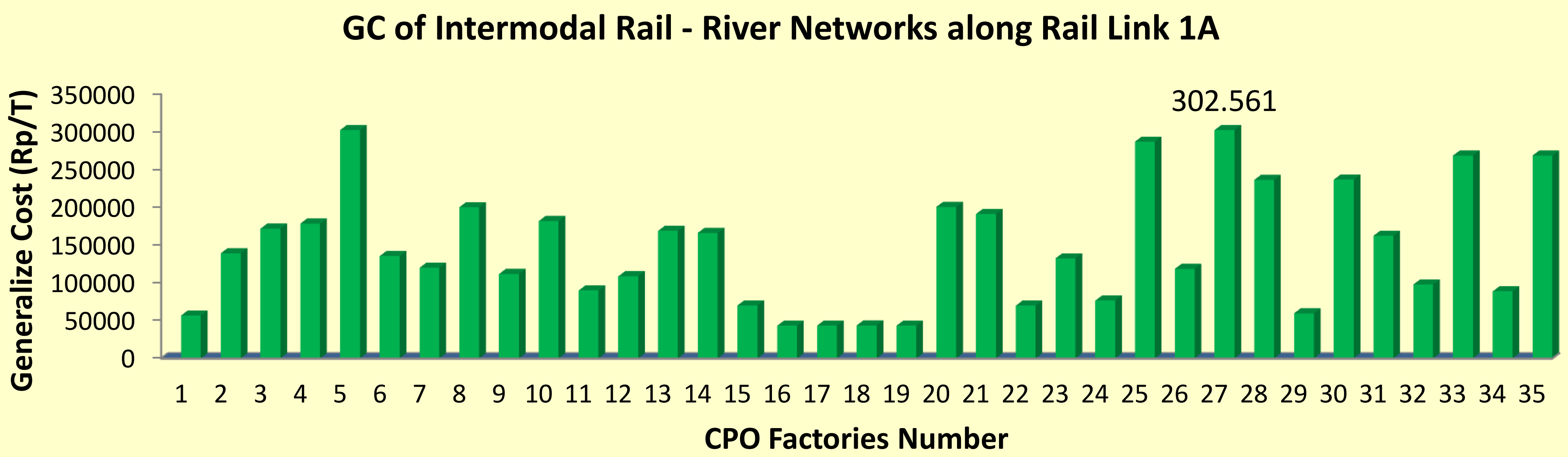


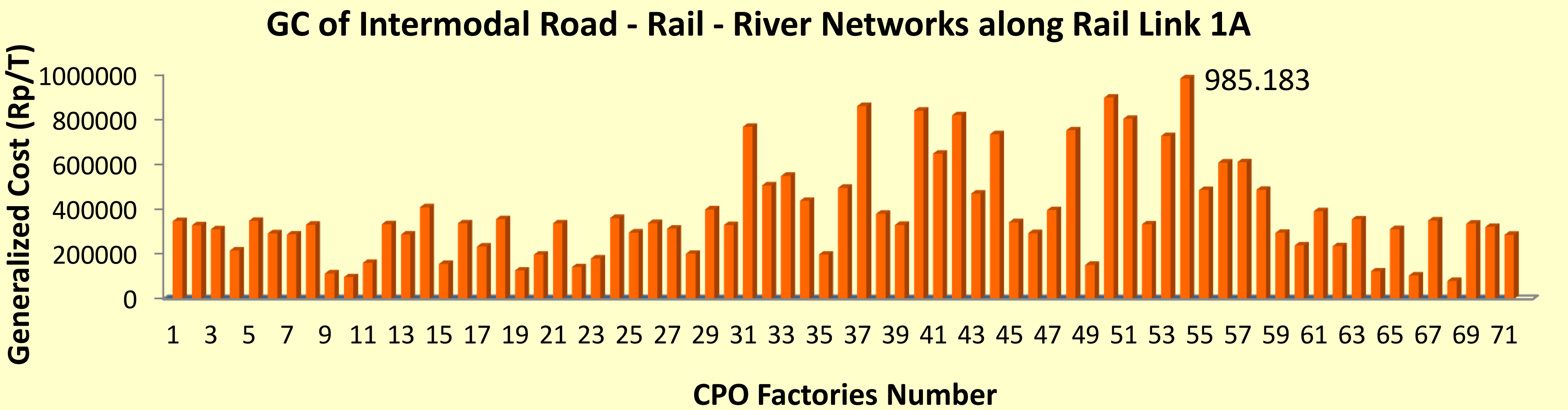
GENERALIZED COST (GC) OF THE NETWORKS (2013)



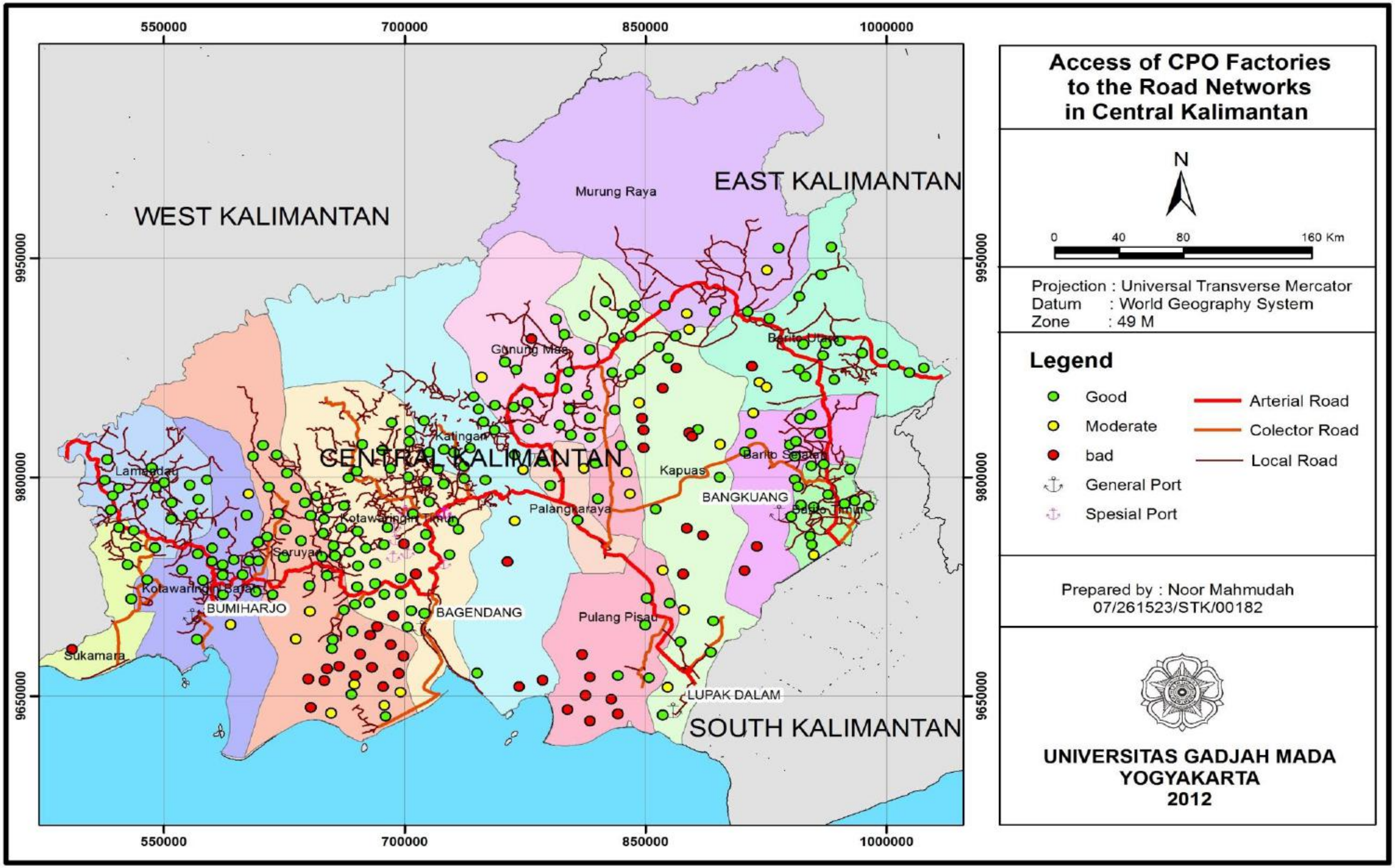


GENERALIZED COST (GC) OF THE NETWORKS (2013)

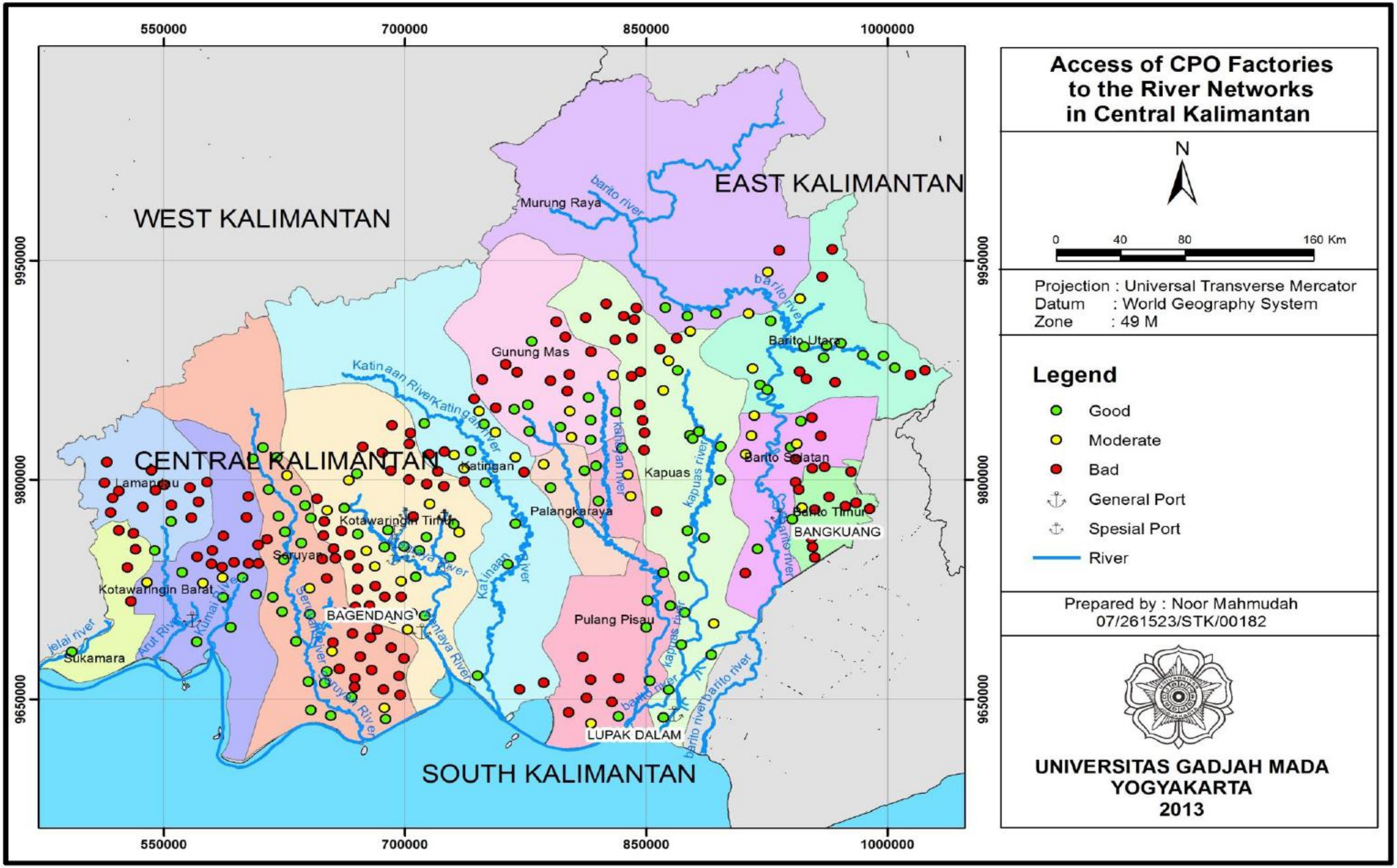




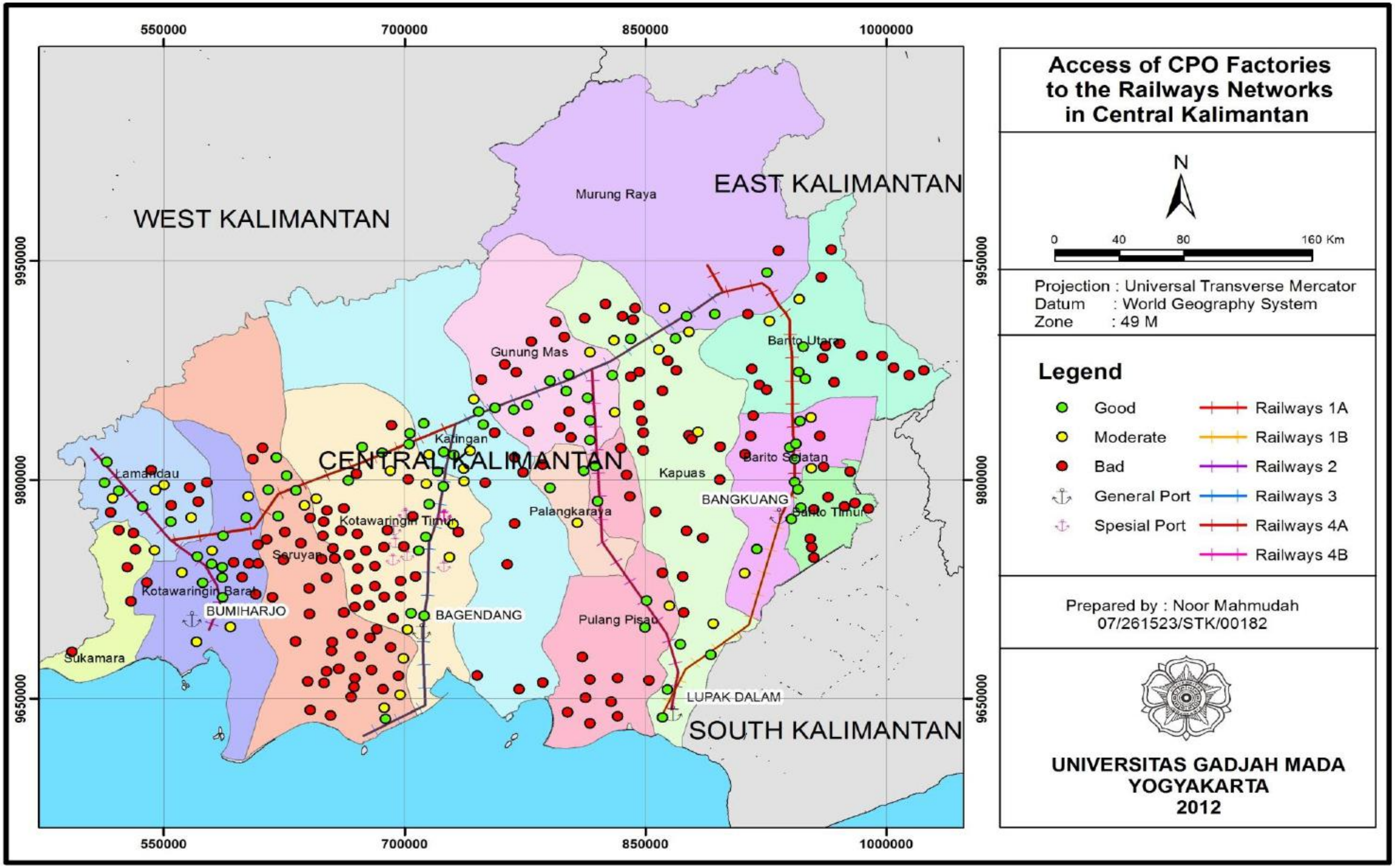
ACCESS OF CPO FACTORIES TO ROAD NETWORKS



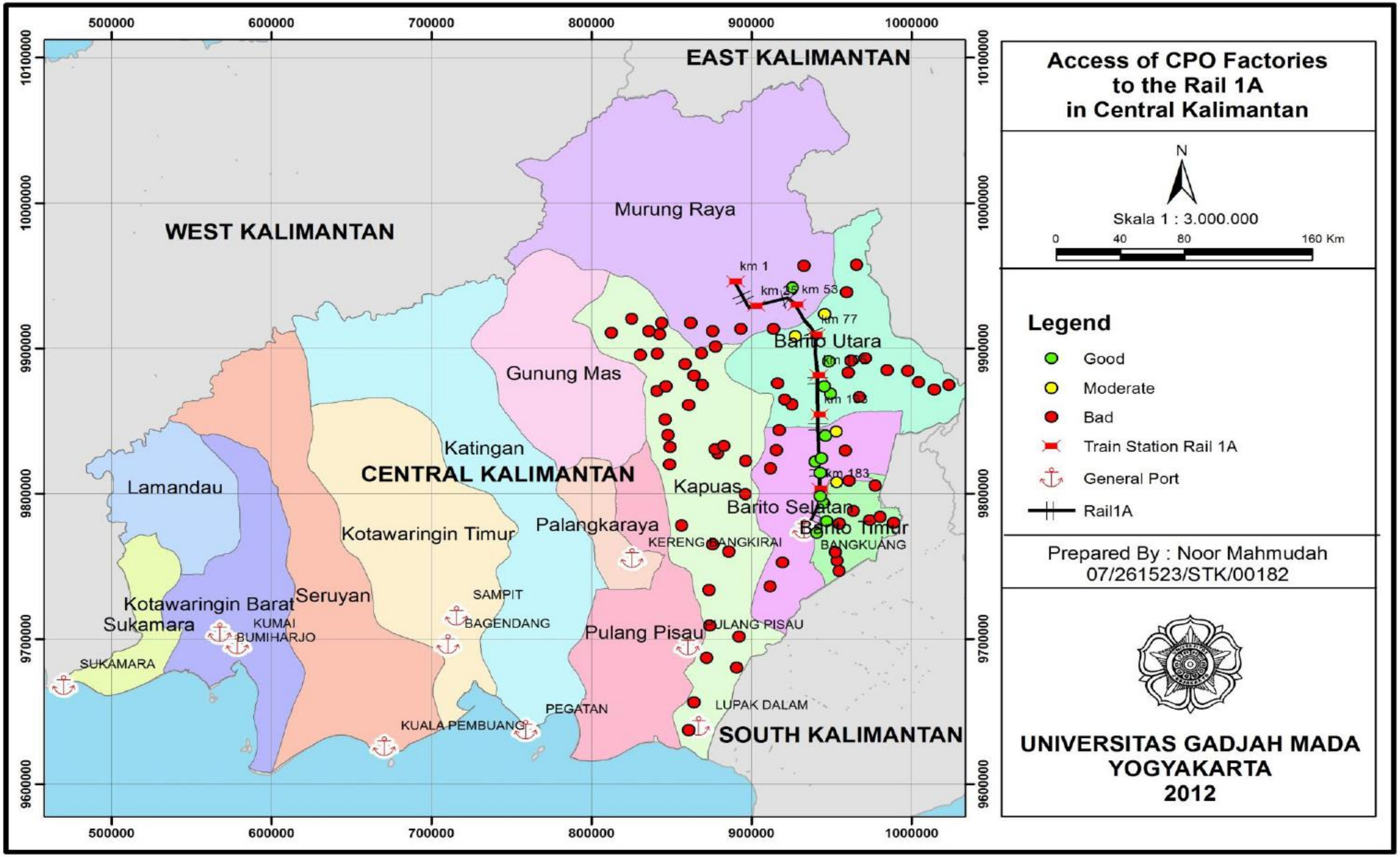
ACCESS OF CPO FACTORIES TO RIVER NETWORKS



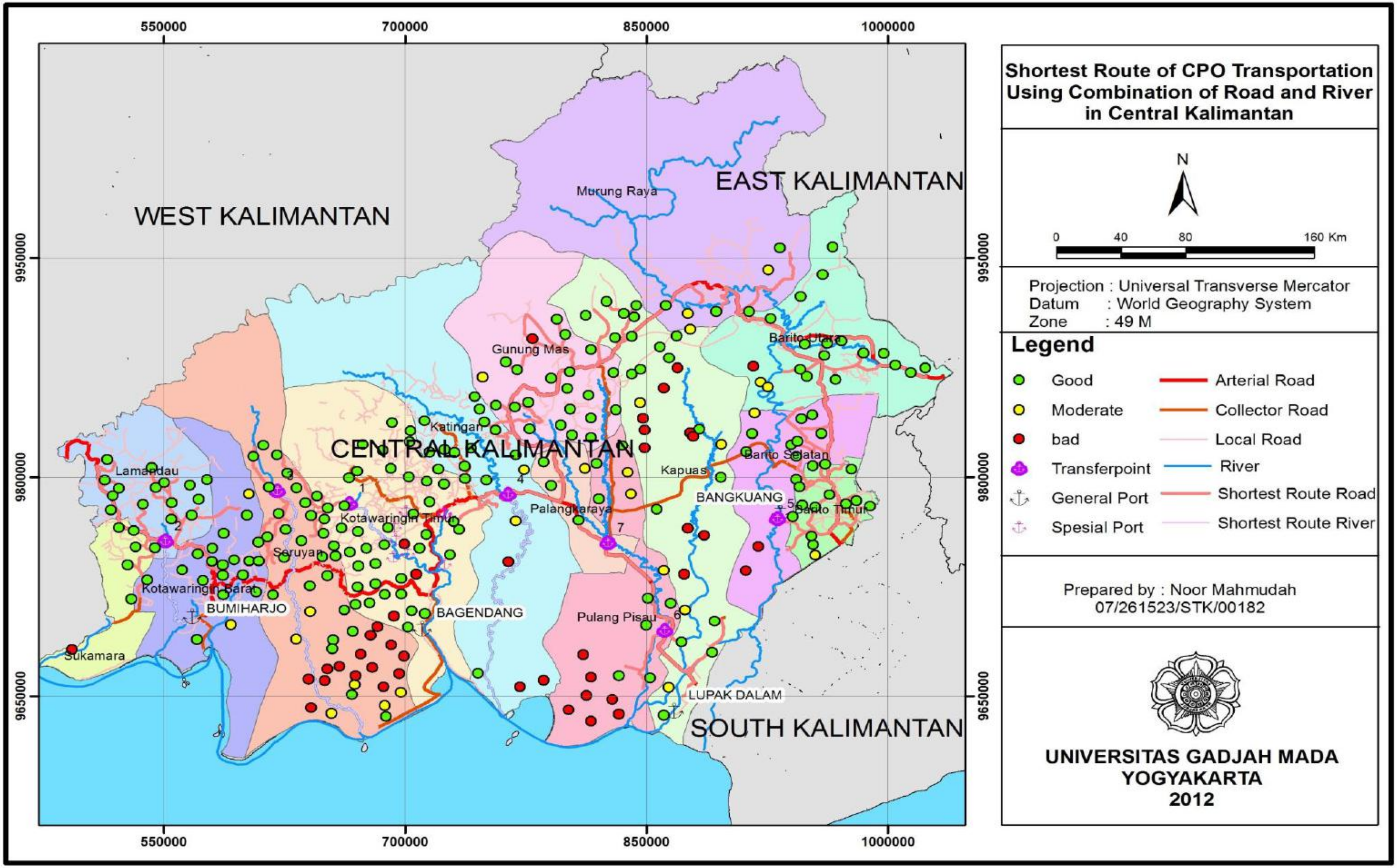
ACCESS OF CPO FACTORIES TO RAILWAYS



ACCESS OF CPO FACTORIES TO THE RAIL LINK 1A



SHORTEST ROUTE OF INTERMODAL ROAD-RIVER



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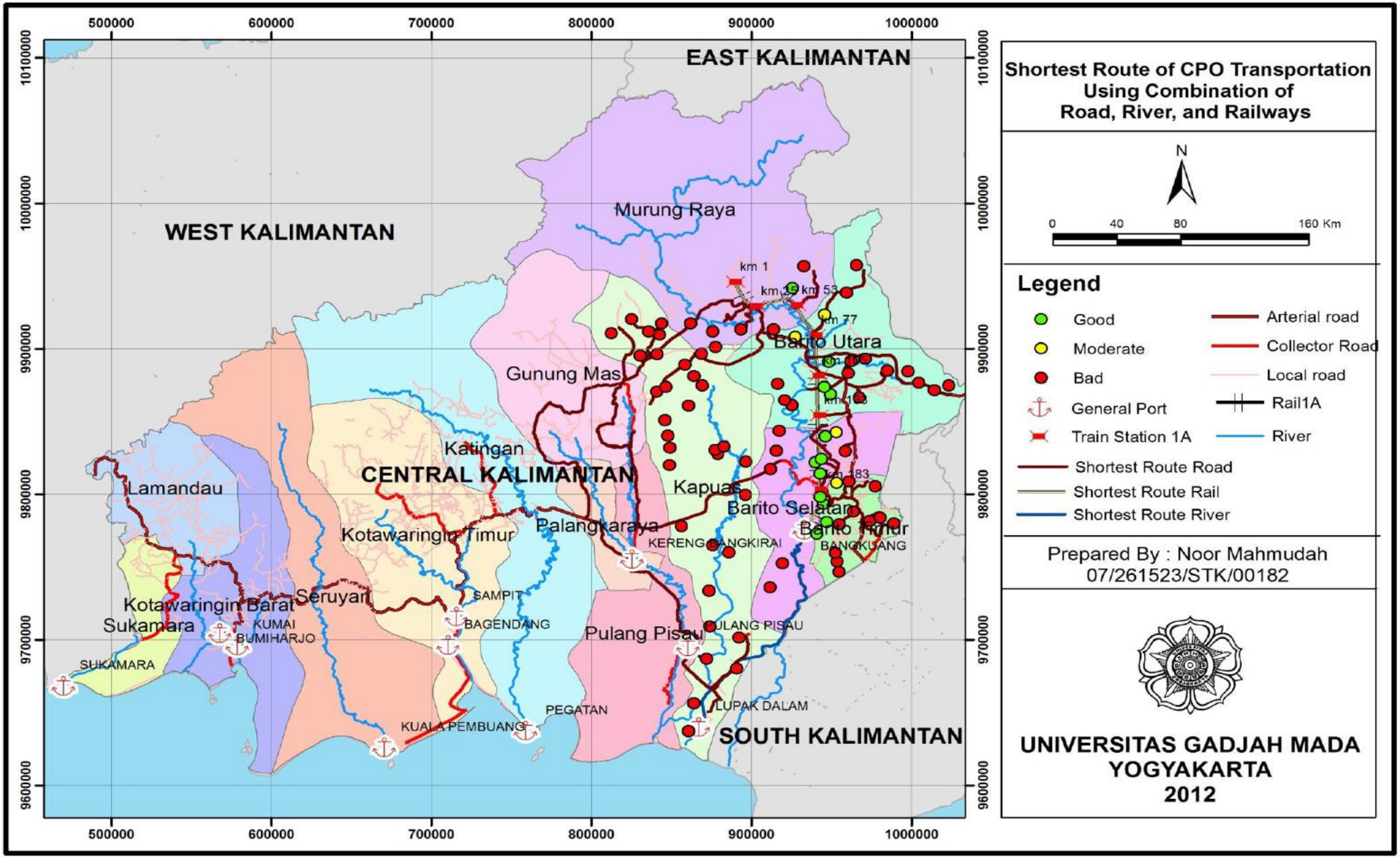
SHORTEST ROUTE OF INTERMODAL ROAD- RAIL LINK 1A - RIVER



CONCLUSIONS

- Several intermodal transportation models have been analyzed to convince the integration of spatial and transportation modeling by using the existing transportation infrastructures (such as road and river networks, ports, etc.).

- The modeling analysis of CPO transportation in Central Kalimantan Province using *geographical information system (*GIS) showed that intermodal transportation, especially combination of road-river networks, is the best alternative obtained from the models. In order to have a more robust model and to predict the likely effect of new transport infrastructures to the cost efficiency (in term of generalized cost), hence, it is required to analyze a future scenario.

- To do so, a case study of spatial and transportation modeling by integrating inter-modality concept between the existing transportation networks and planned railways in Central Kalimantan is also conducted by using ArcGIS. By considering all networks (road, river, railways, and intermodal networks), the reasonable minimum generalized cost (GC) to be applied in the field is a combination of road-rail-river networks.

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