ANALYSIS OF TRAVEL PATTERN AND THE NEED TO DEVELOP SUSTAINABLE TRANSPORTATION INFRASTRUCTURE IN SARBAGITA METROPOLITAN AREA

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INTRODUCTION

- Many cities around the world experienced growing urban population including cities in developing countries like Indonesia

- Denpasar city is the capital of Bali Province and has been developed into a metropolitan city

- There has been an agglomeration of four regencies, namely Denpasar, Badung, Gianyar and Tabanan forming a Metropolitan Sarbagita area with a population close to 2 million inhabitants

- The travel freedoms offered by private vehicles and the low performance of public transport services has made it almost impossible to shift people from private vehicles to public transport.

- This requires us to rethink transportation systems as a whole, the use of existing infrastructure, and the integration of public transport and urban planning

- The objectives of this study are to examine the patterns of movement that occur and make a projection for future conditions as a basis for creating a more sustainable transportation infrastructure.

- Study by Salon et al. (2012) in Nairobi, Kenya found that insufficient transport infrastructure has caused travel difficulty across all income groups. Low income residents tend to live in slum areas close to their employment location without being served by good pedestrian and bicycle infrastructures. Middle and high income residents are highly dependent on using private cars which leads to congestion problems.

- This situation is similar to the situation in the Sarbagita metropolitan area of Bali Province. A lack of public transport, pedestrian, and bicycle facilities have caused severe traffic jams in almost all major urban roads.

SARBAGITA METROPOLITAN AREA
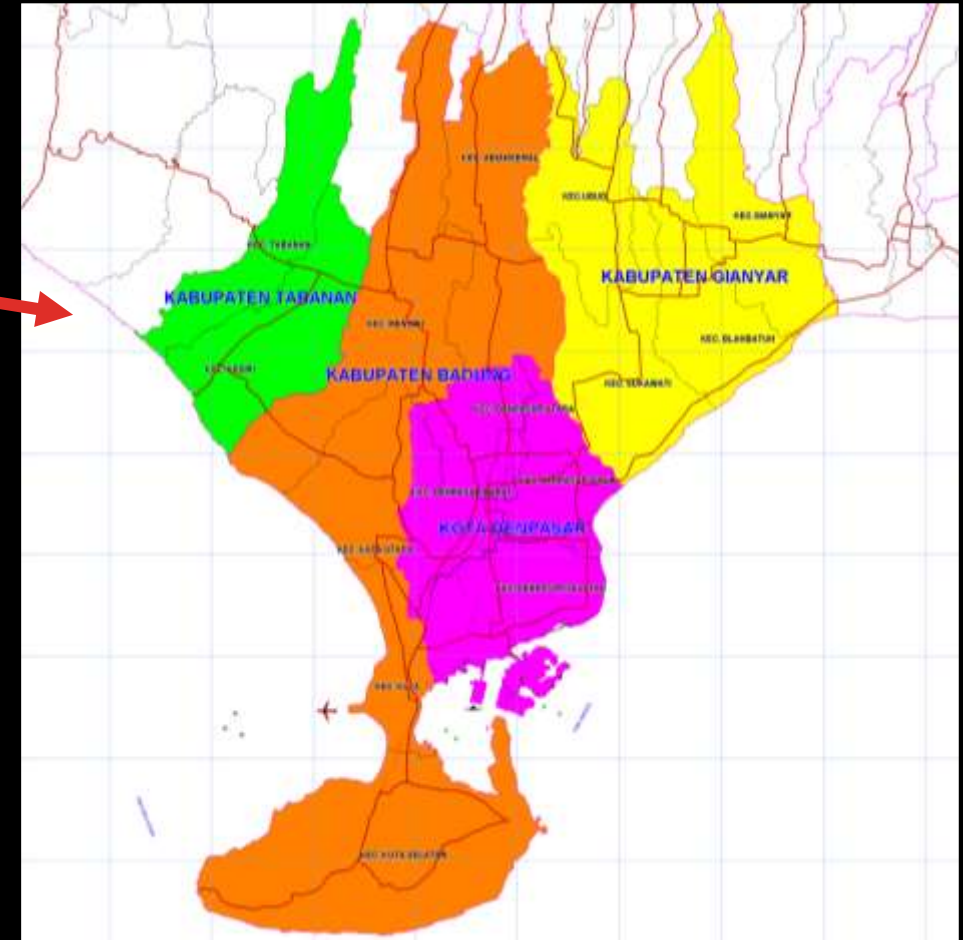
METHOD

- The study area (Sarbagita metropolitan area) consists of 4 regencies, i.e., Denpasar, Badung, Gianyar and Tabanan. The study area was divided into 30 Traffic Analysis Zones (TAZ) in the model

- The origin-destination trip matrices were obtained from the Department of Transport (2011).

- Socio-economic data was obtained from the Bureau of Statistics of Bali Province (2011-2017).

- The average daily traffic (ADT) was obtained from the Department of Public Works (2016).

- The four-steps models developed include trip generation model, trip distribution, mode split and trip assignment. Visum software was used for modelling purposes.
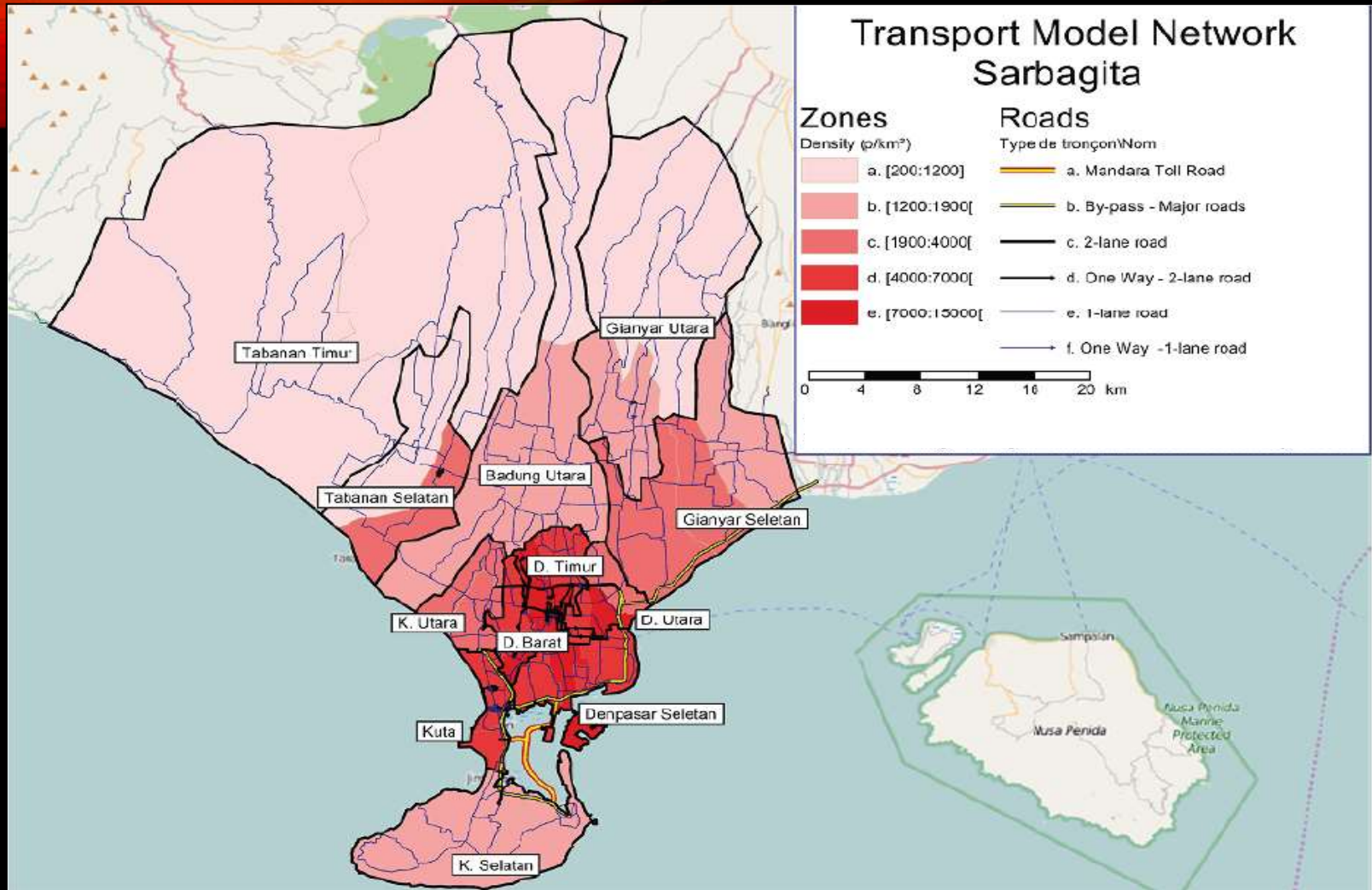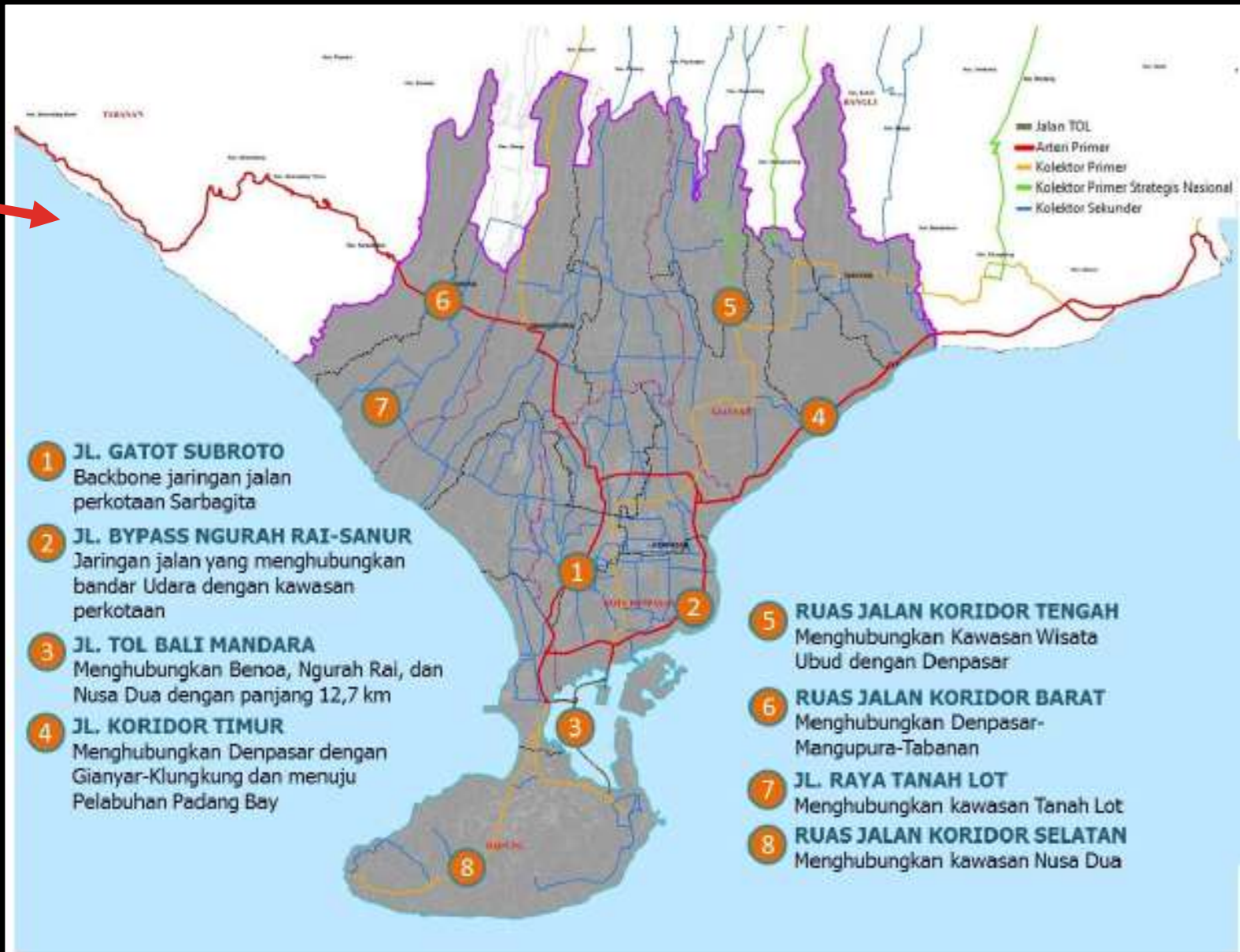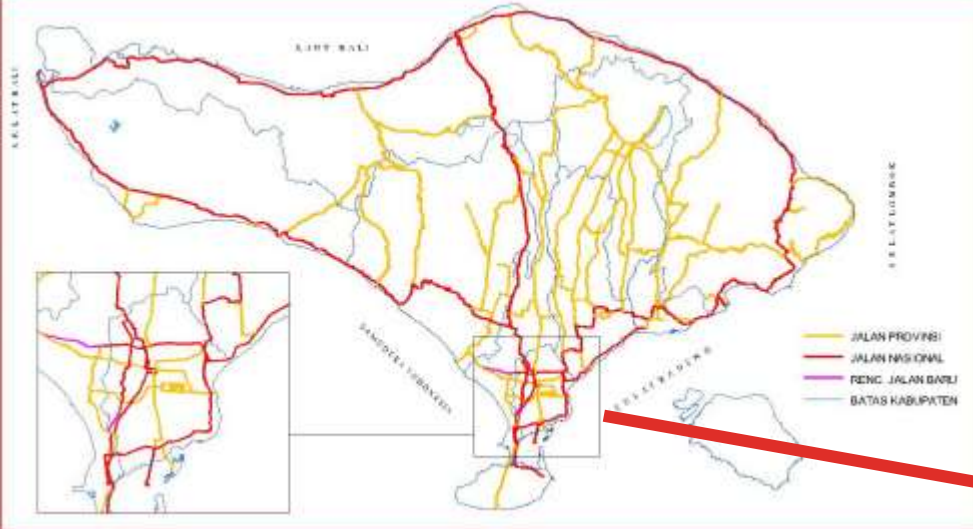
- This figure represents the Sarbagita, the traffic analyses zones, and the links (roads).

- The zones are colored according to their density

- Therefore in the figure, the lightest zones are the least dense and the red areas are the densest

TOURISM LOCATION IN BALI

EKSISTING ROAD NETWORK

Legend:
- Jalan TOL
- Arteri Primer
- Kolektor Primer
- Kolektor Primer Strategis Nasional
- Kolektor Sekunder

1 **JL. GATOT SUBROTO**
Backbone jaringan jalan perkotaan Sarbagita

2 **JL. BYPASS NGURAH RAI-SANUR**
Jaringan jalan yang menghubungkan bandar Udara dengan kawasan perkotaan

3 **JL. TOL BALI MANDARA**
Menghubungkan Benoa, Ngurah Rai, dan Nusa Dua dengan panjang 12,7 km

4 **JL. KORIDOR TIMUR**
Menghubungkan Denpasar dengan Gianyar-Klungkung dan menuju Pelabuhan Padang Bay

5 **RUAS JALAN KORIDOR TENGAH**
Menghubungkan Kawasan Wisata Ubud dengan Denpasar

6 **RUAS JALAN KORIDOR BARAT**
Menghubungkan Denpasar-Mangupura-Tabanan

7 **JL. RAYA TANAH LOT**
Menghubungkan kawasan Tanah Lot

8 **RUAS JALAN KORIDOR SELATAN**
Menghubungkan kawasan Nusa Dua

- Limited road capacity can not accomodate the exponential growth of motor vehicles

- Public transport performance has decreased with a very low load factor. Public trasport share is 2.1% of total population.

- The travel freedoms offered by private vehicles and the low performance of public transport services has made it almost impossible to shift people from private vechilces to public transport
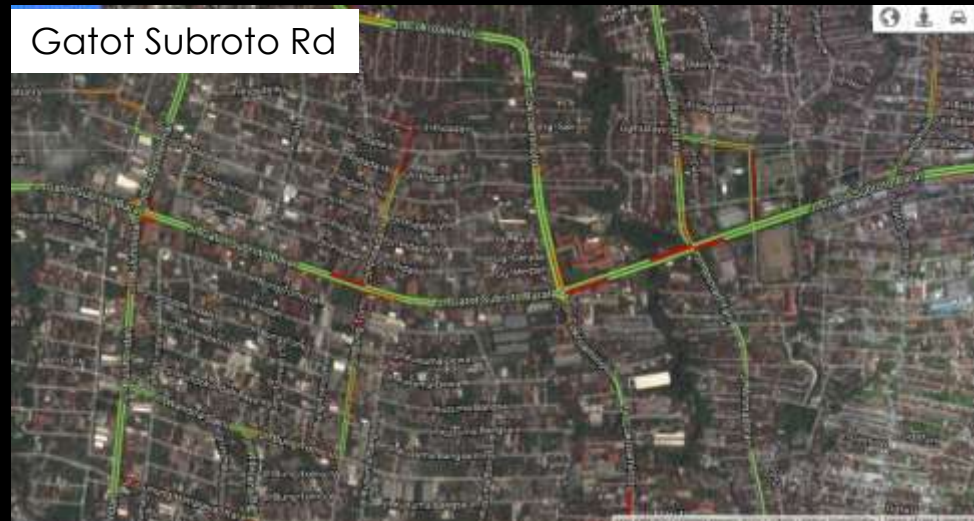
Imam Bonjol Rd
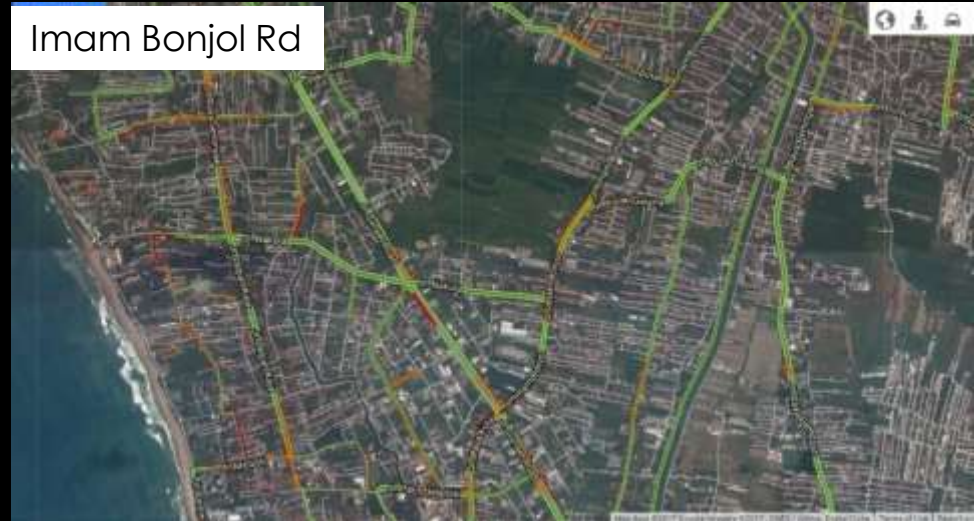
Gatot Subroto Rd

TRAFFIC JAM LOCATION IN BADUNG REGENCY

Simp Tugu Ngurah Rai

Kuta

Sunset Rd
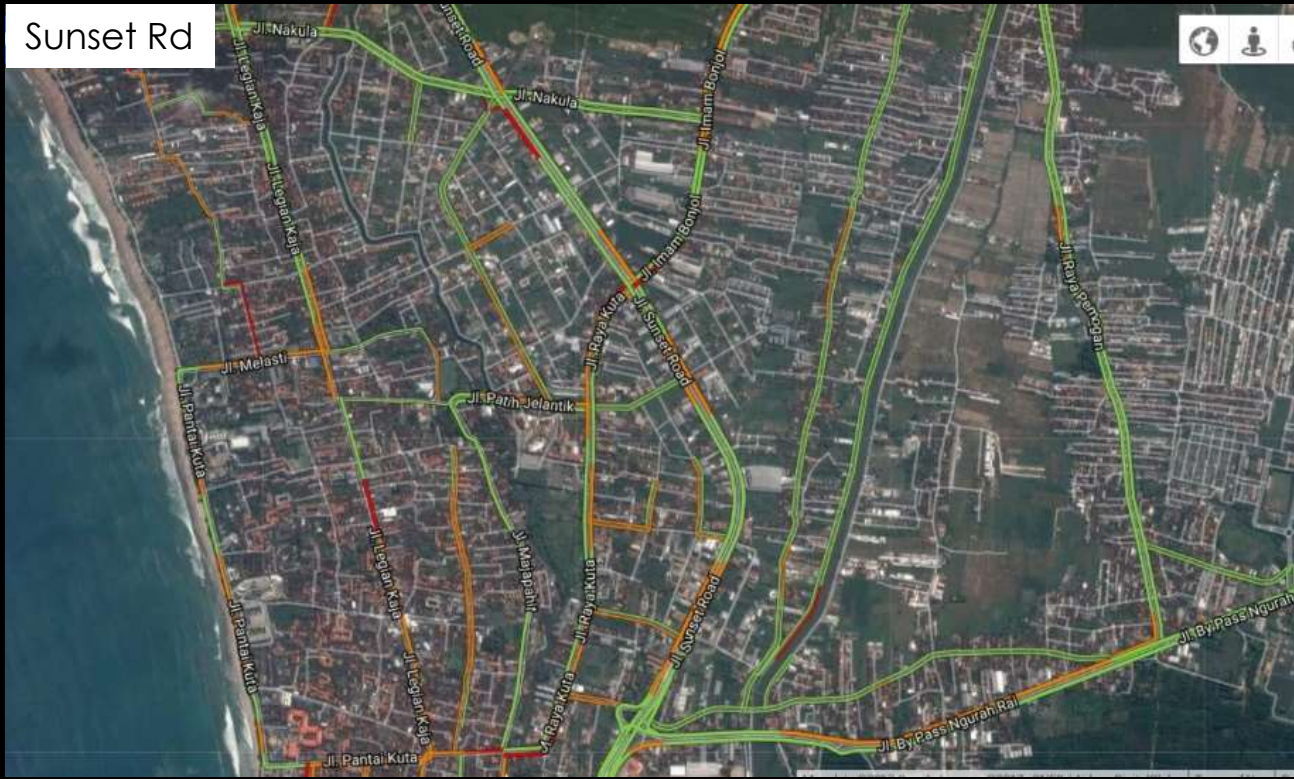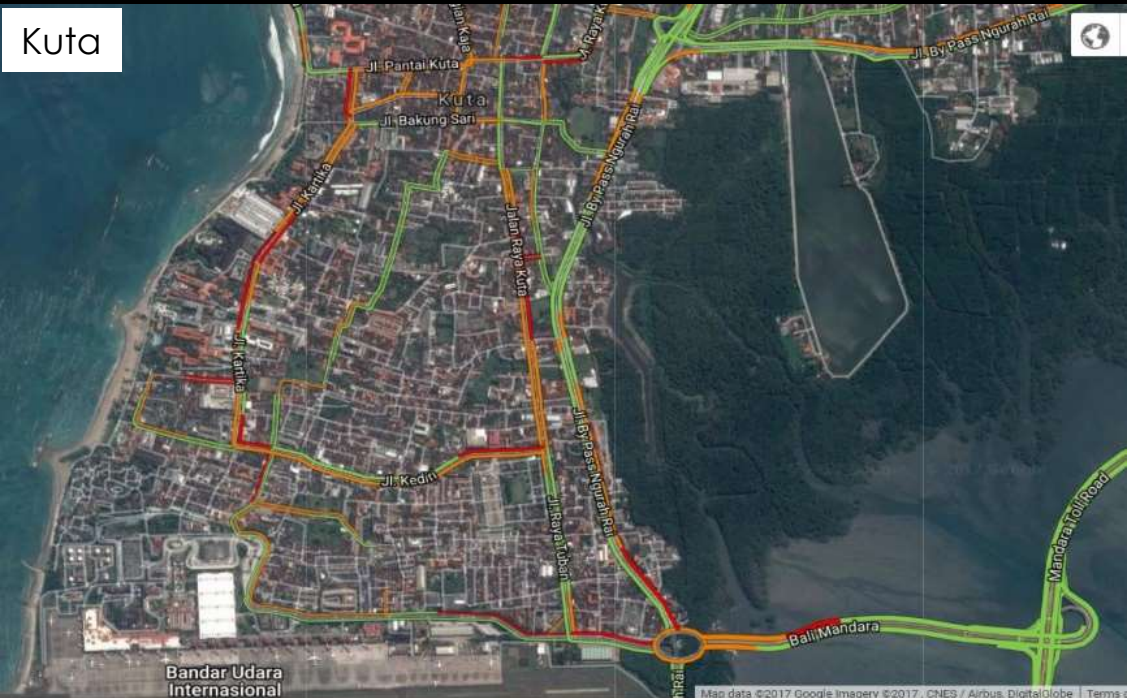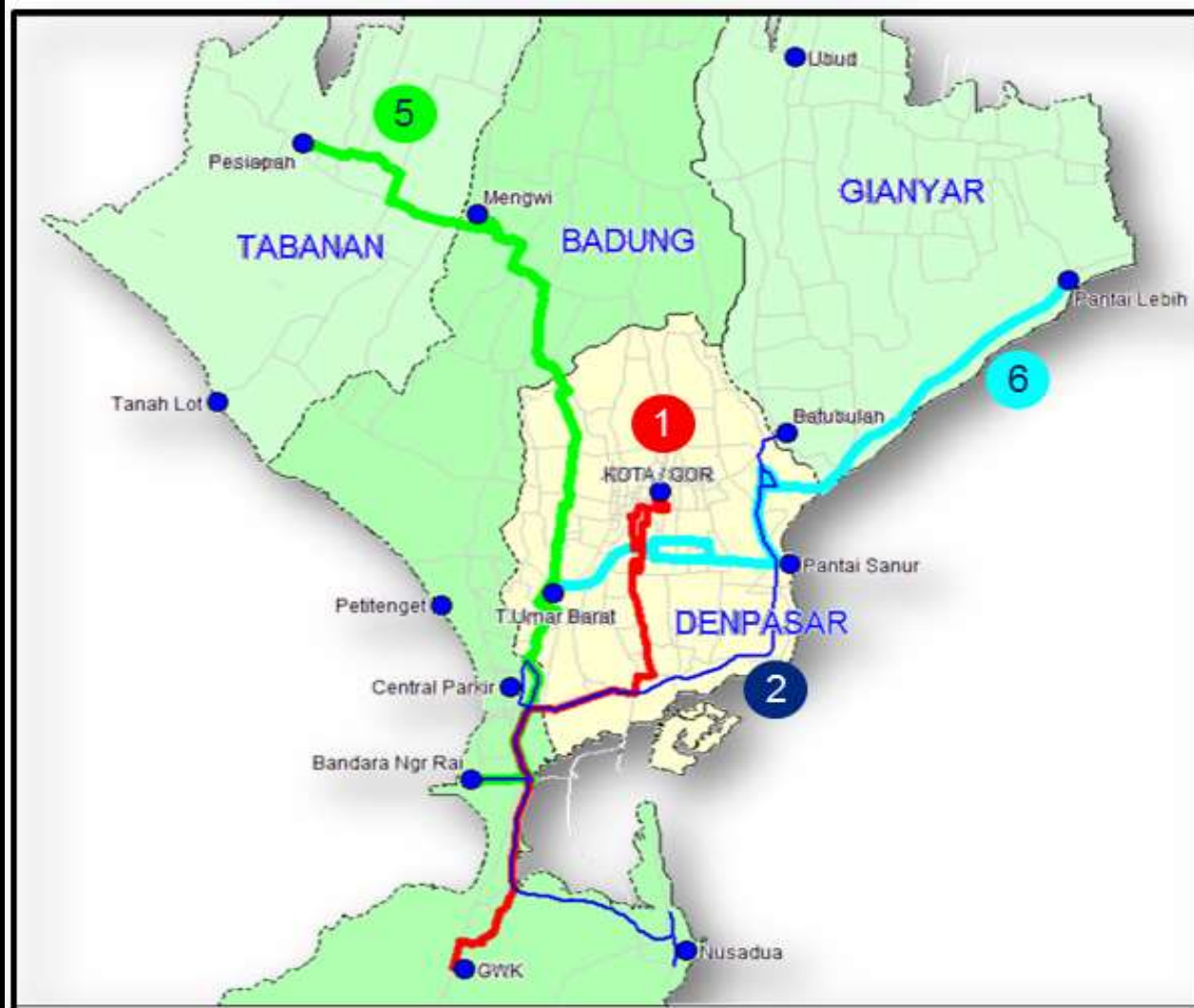
KORIDOR 2 (Batubulan-Nusadua PP)

Panjang Lintasan	:	68,8 km
Jumlah Bus	:	15
Tipe Kendaraan	:	Bus Besar
Merk	:	HINO 2010
Pengelola	:	UPT. Trans Sarbagita

KORIDOR 1 (Kota-GWK PP)

Panjang Lintasan	:	44,2 km
Jumlah Bus	:	10
Tipe Kendaraan	:	Bus Sedang
Merk	:	HYUNDAI 2011
Pengelola	:	UPT. Trans Sarbagita

KORIDOR 6 (Lebih-Sanur-Teuku Umar PP)

Panjang Lintasan	:	30 km
Jumlah Bus	:	1
Tipe Kendaraan	:	Bus Besar
Merk	:	HINO 2015
Pengelola	:	Perum DAMRI

KORIDOR 5 (Pesiapan-Mengwi-Bandara PP)

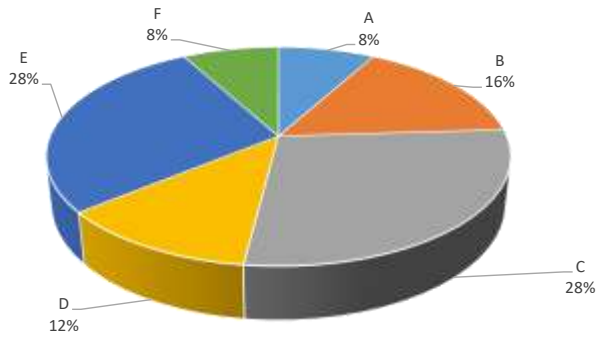|		
Panjang Lintasan	:	41 km
Jumlah Bus	:	2
Tipe Kendaraan	:	Bus Besar
Merk	:	HINO 2015
Pengelola	:	Perum DAMRI

RESULTS AND DISCUSSION

Trip assignment
Sarbagita
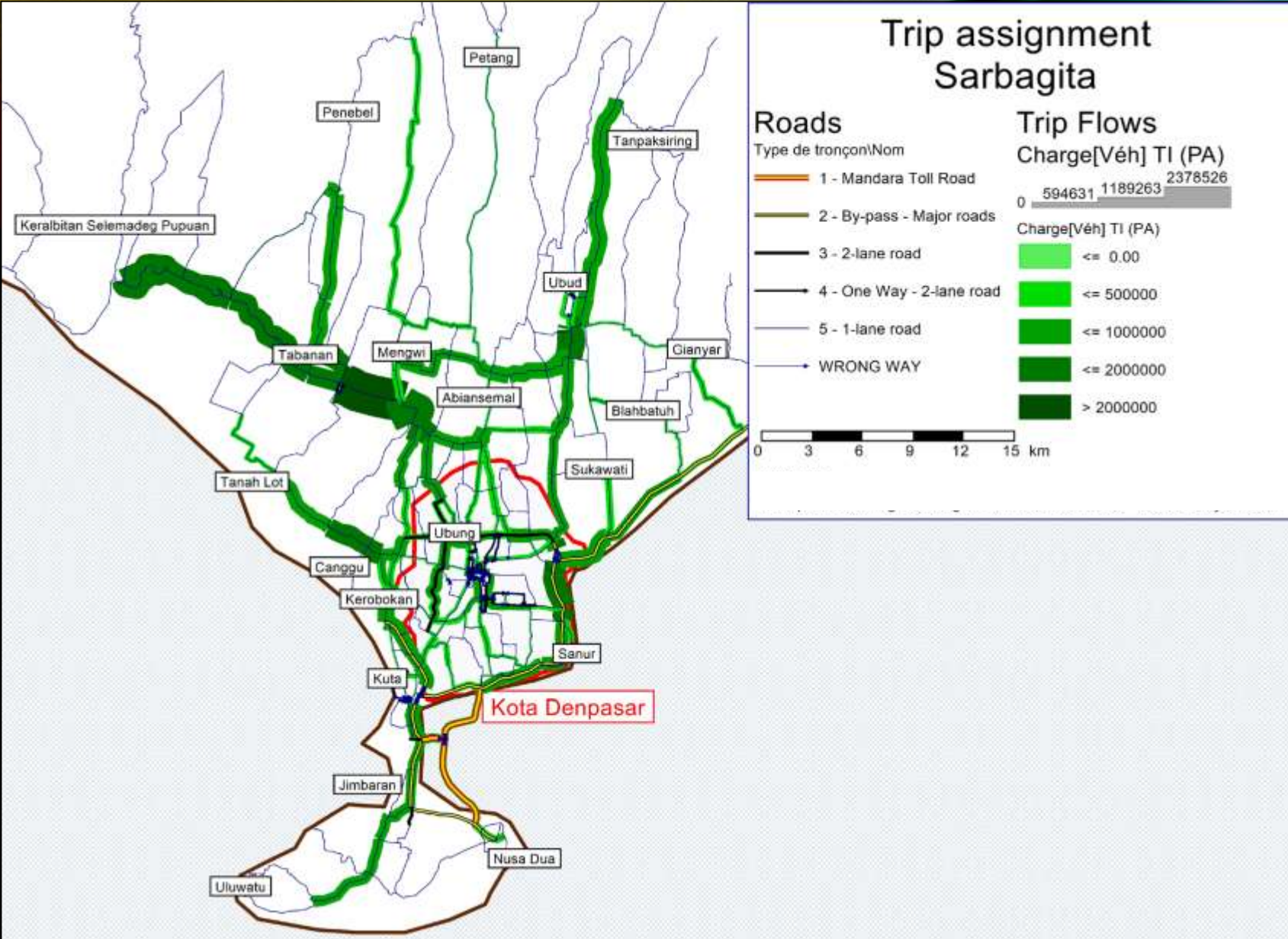
- Gilimanuk-Denpasar road is the most commonly used section.
- The trip flow on the section of this road between Tabanan and Mengwi supports an annual traffic of 4.5 million passengers (half for each way)

- The major tourist spots also generate important flows.

- Roads between these zones are the major inter-Sarbagita movement axes.

- The Kuta-Sanur-Ubud axis and the Nusa Dua-Jimbaran-Kuta-Canggu-Tanah Lot axis are particularly important.

- The centre of Denpasar, where administrative services are clustered, is also a quite important waypoint.

- The model establishes a figure of 17 million trips a year all over the Sarbagita. About 3.9 million trips from Tabanan (4 TAZ, 10% internal traffic), 3.3 million from Gianyar (5 TAZ, 18% internal traffic), 4.6 million from Badung (9 TAZ, 22% internal traffic), and 5.7 million from Denpasar (12 TAZ, 40% internal traffic) were estimated.
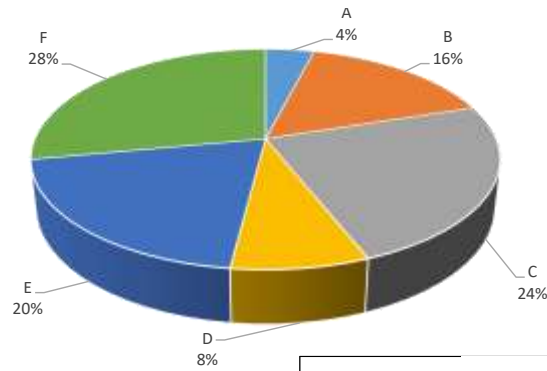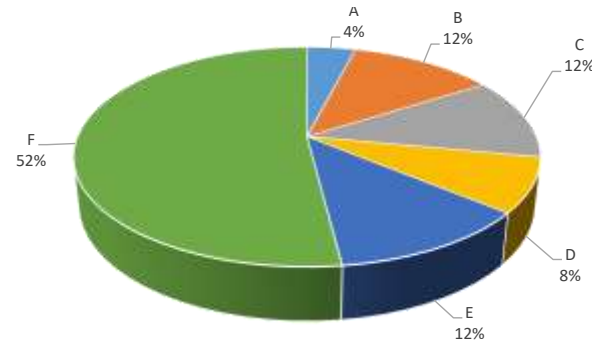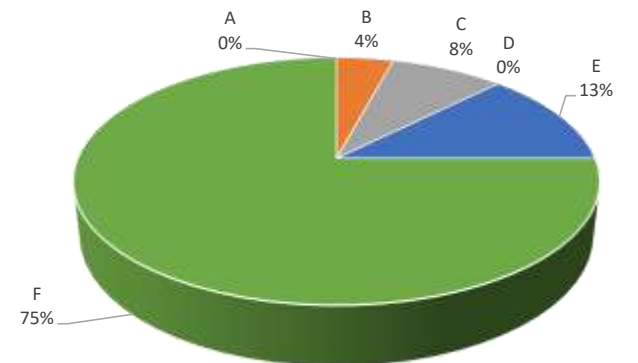
LEVEL OF SERVICE OF THE ROAD NETWORK (2023-2048)
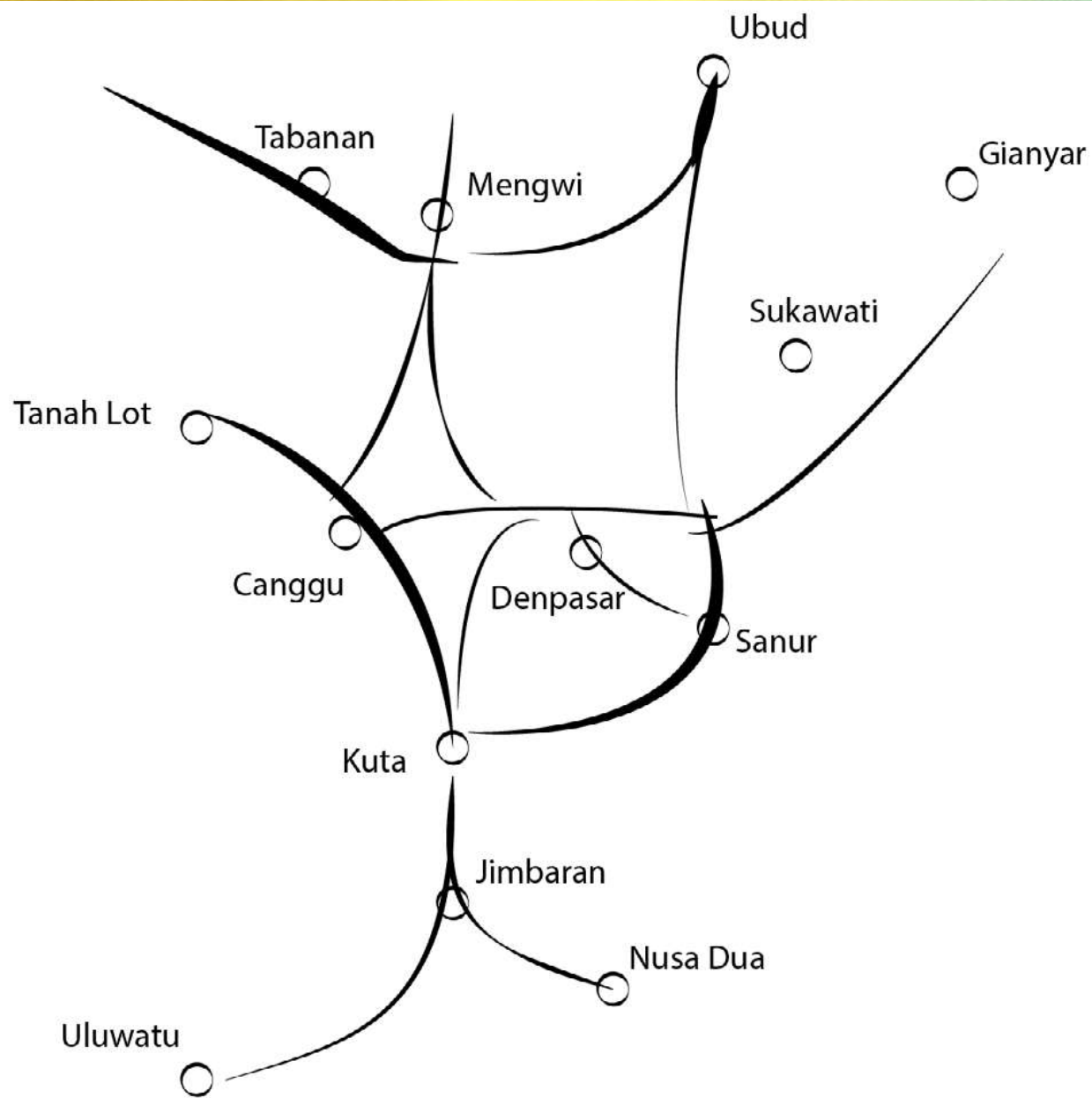
- This figure shows a simplified form of the metropolitan general movement flows.
- This helps one understand the trip shape in the Sarbagita more easily.
- This presents a double loop with three ramifications to Uluwatu, Nusa Dua, and Gianyar. The first loop corresponds to the Ngurah Rai Bypass (including Sunset Road and Gatot Subroto road) around Denpasar.
- The second loop connects Kesiman (north-east of Denpasar city to Ubud, Tabanan-Mengwi and Canggu-Tanah Lot).

A STRATEGY FOR THE SARBAGITA TRANSPORT MASTER PLAN

- The Sarbagita metropolitan area must implement a medium-long term public transportation development programme.
- This programme should not only foresee the development of the Trans Sarbagita bus network, but must also consider the entire mobility chain in the metropolitan area.
- Each of the actors, including economic agents, must be incorporated in the model development.
- To initiate this movement, next figure shows an outline of a proposed Transportation Development Plan for the Sarbagita area.

SARBAGITA TRANSPORT MASTER PLAN

Phase 1 : PuT development

- Classification of transport modes
  - Express lines - Trans Sarbagita BRT, MRT, LRT, monorail or other
  - Conventional lines - Structuring PuT lines but non express
  - Sub-lines - Bemo routes, tourist lines, private lines
  - Irregular transport systems - Taxi, ojek, "on-demand", carpooling, other
- Good picture for PuT
  - Environmentally friendly
  - Social responsibility
- Widespread ICT usage
  - Carrier equipment - Geolocation, wifi, terminal
  - Digital system for mobility support
- Multimodal transportation promotion
  - Transport systems integration
  - Hub-designed stations
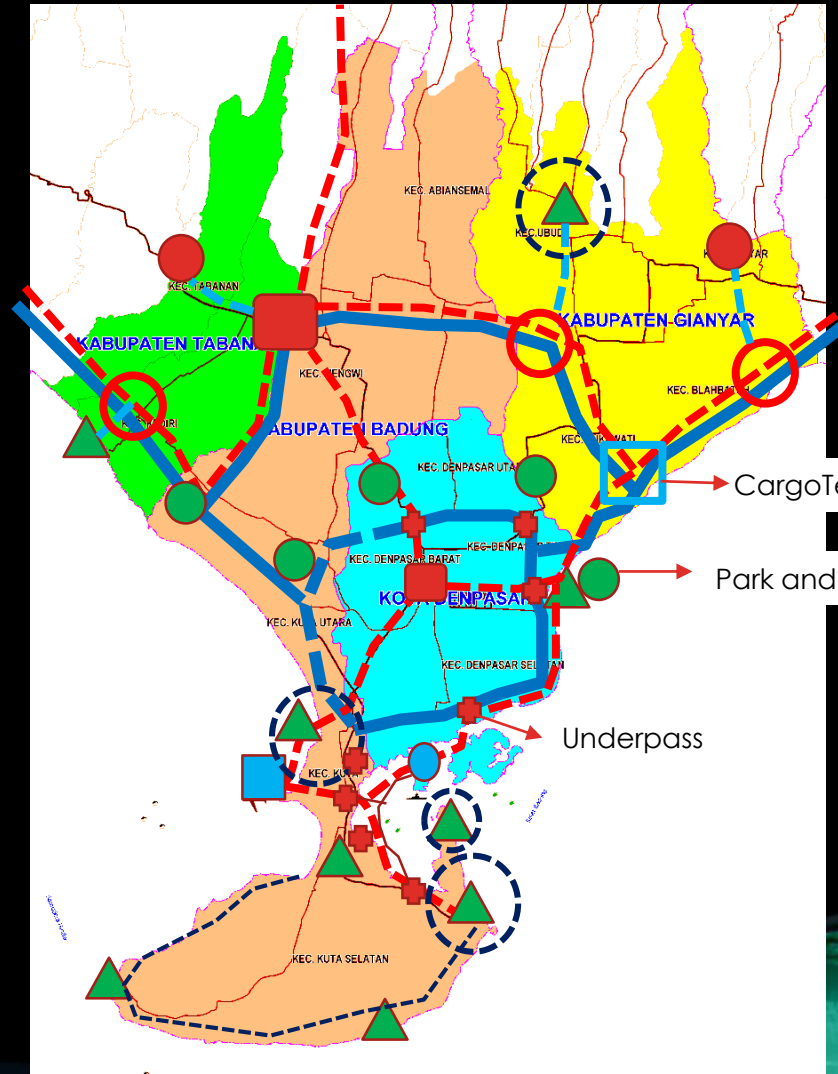
Phase 2 : Traffic restraint

- High occupancy vehicles policy
- Intelligent interzone toll

- The first step is to define and support the development of public transit (Phase 1) and consider the introduction of a traffic restraint policy at a later stage (Phase 2)
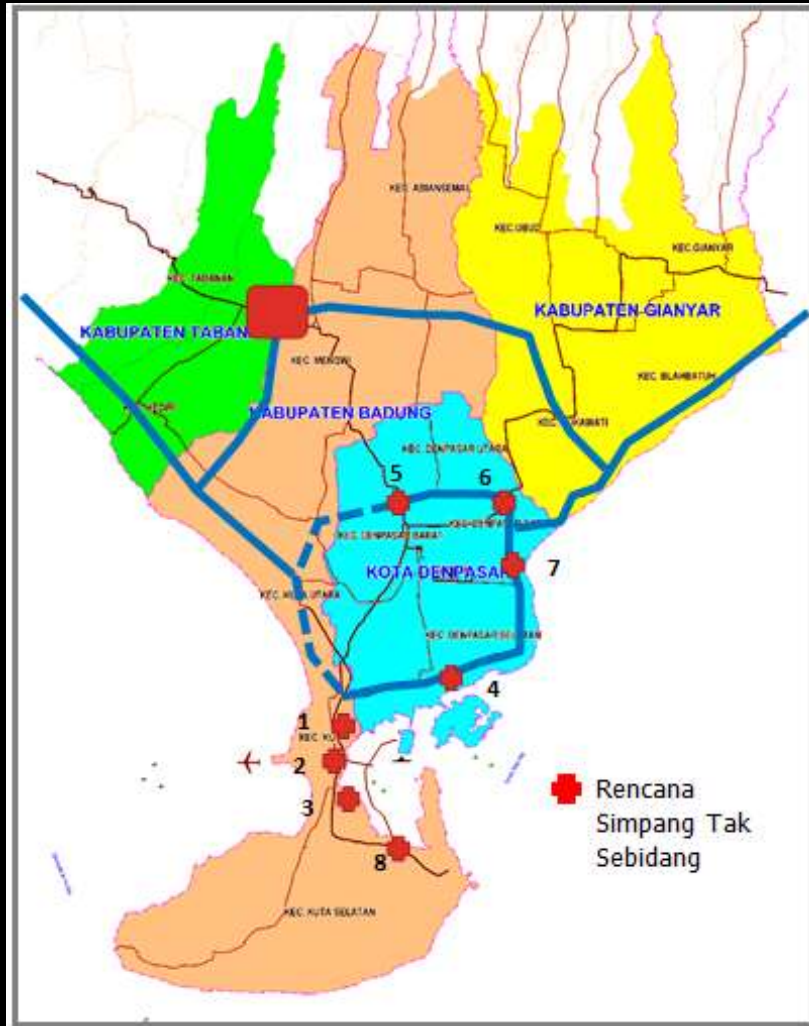
TRANSPORT SYSTEM PLAN

CargoTerminal

Park and Ride
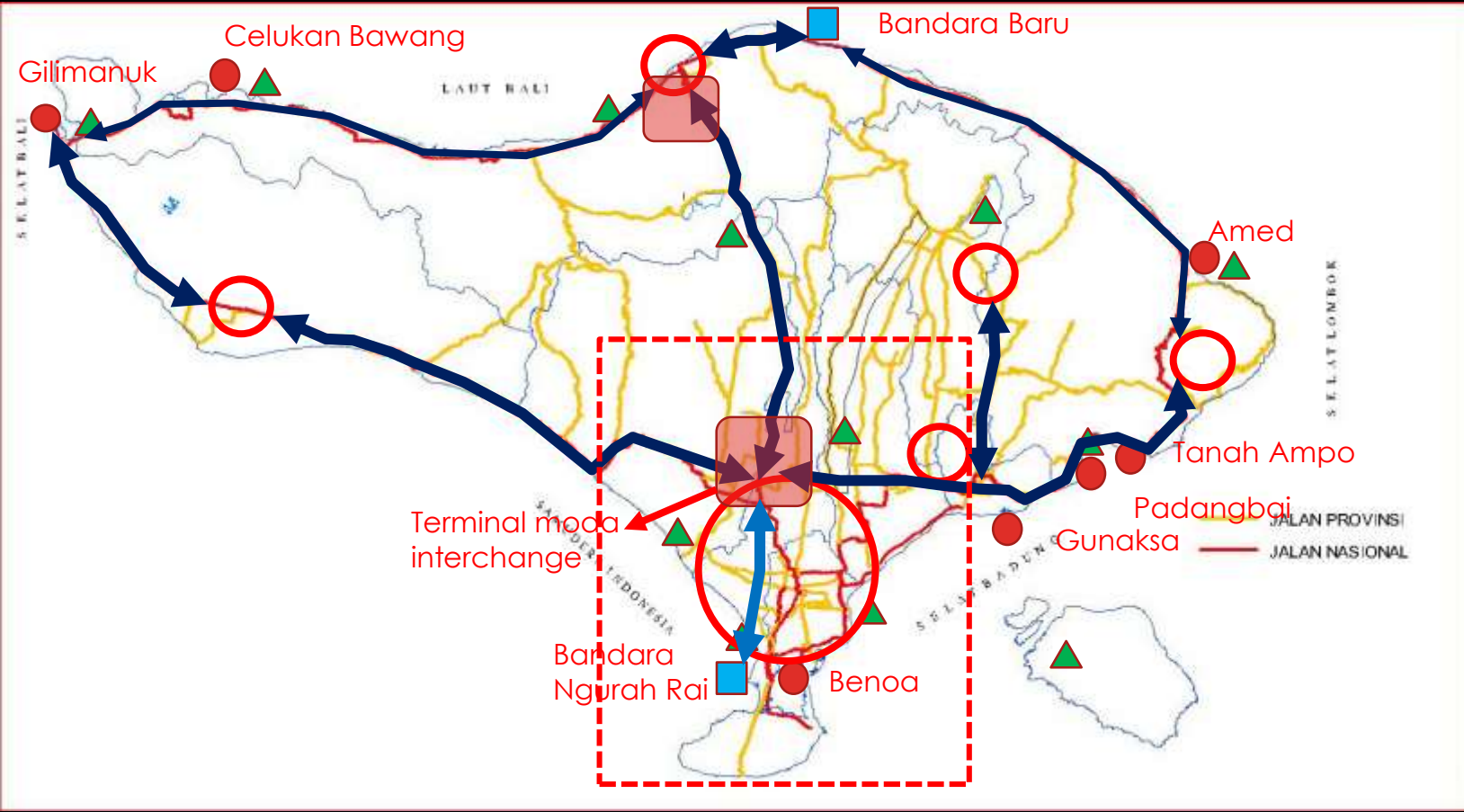
Underpass
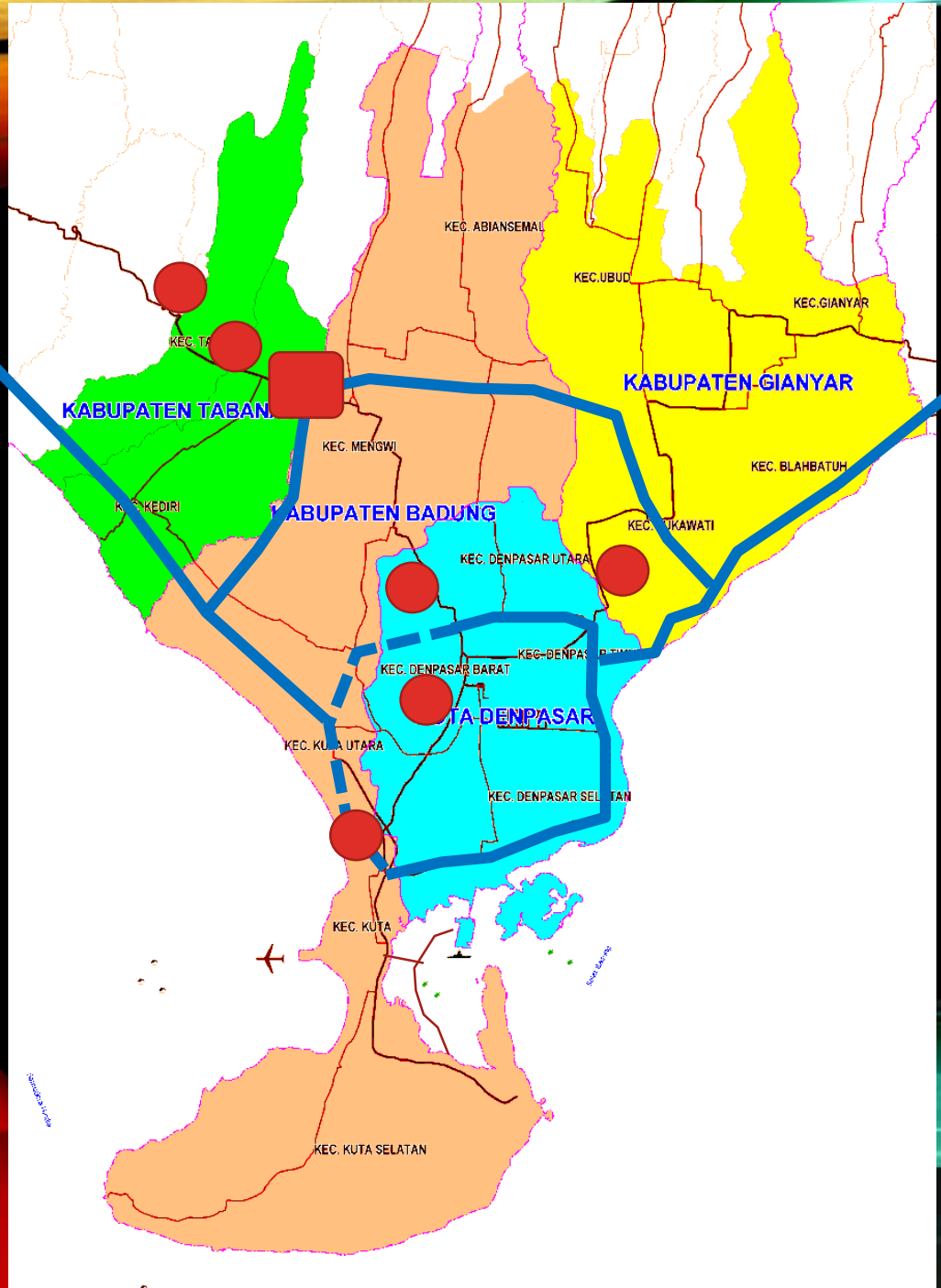
ROAD NETWORK PLAN

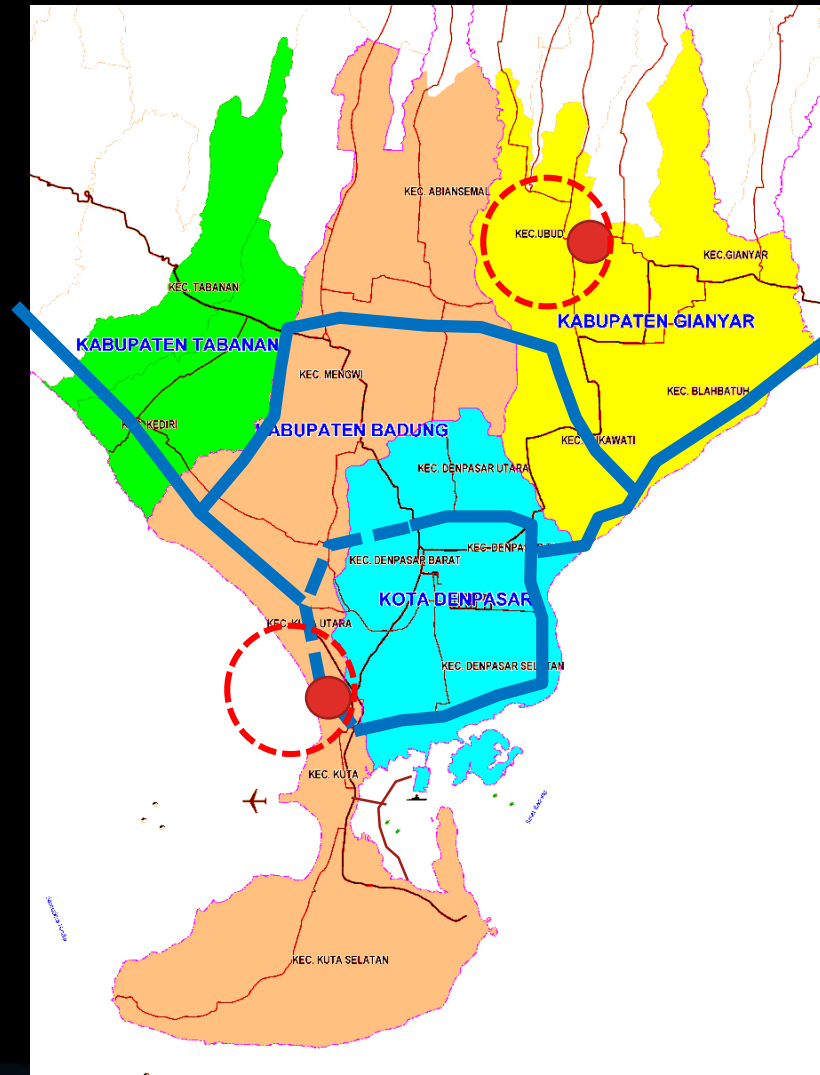1. Underpas Dewa Ruci (built in 2011)
2. Undepass Tugu Ngurah Rai (under construction)
3. Underpass Bypass Ngurah Rai-Kampus Unud
4. Undepass Benoa (Pesanggaran)
5. Underpass Gatot Subroto-Cokroaminoto
6. Underpass Gatot Subroto-Supratman
7. Underpass Bypass Ngurah Rai-Hang Tuah
8. Underpass Bypass Ngurah Rai-Tol Bali Mandara

TERMINAL
DEVELOPMENT
PLAN
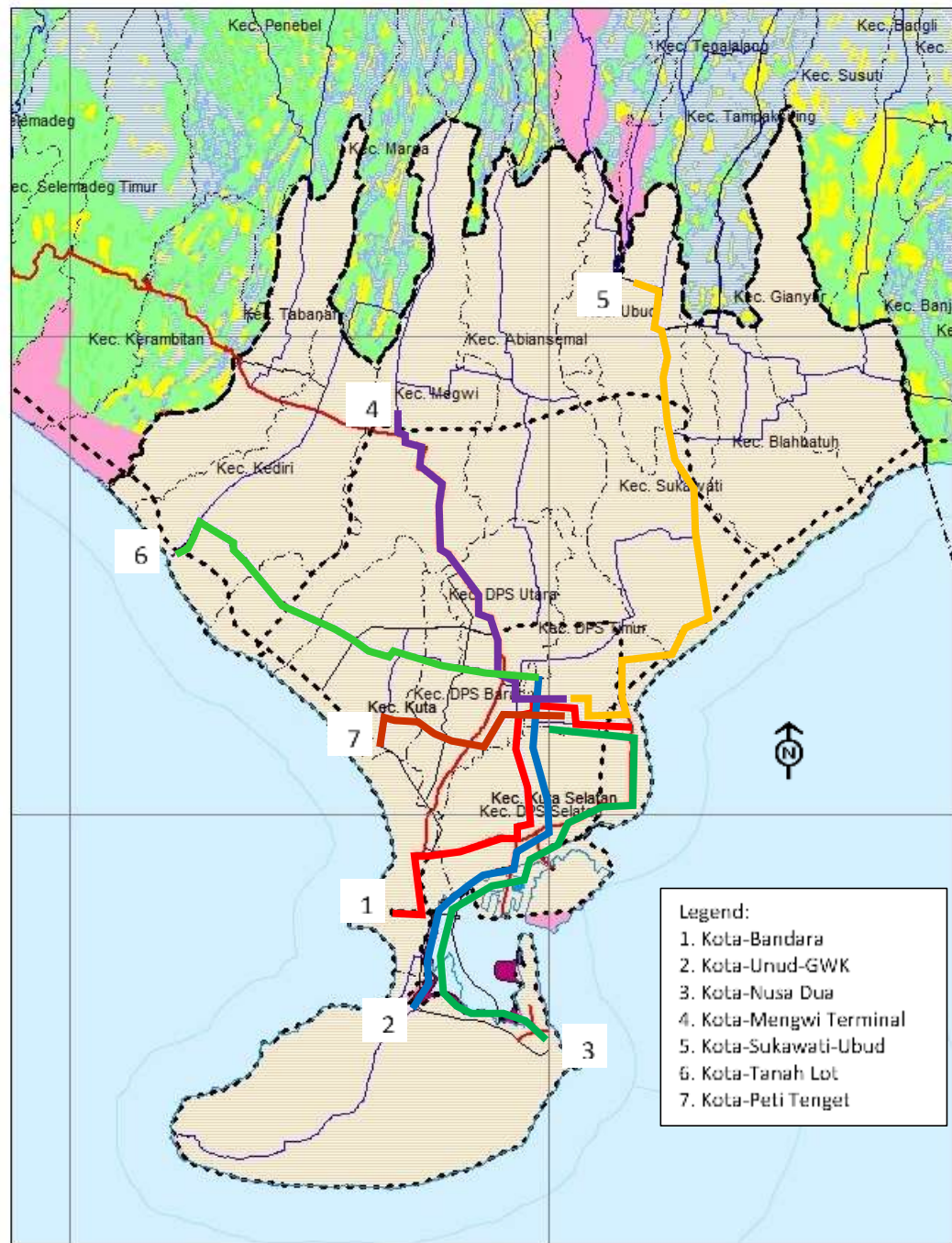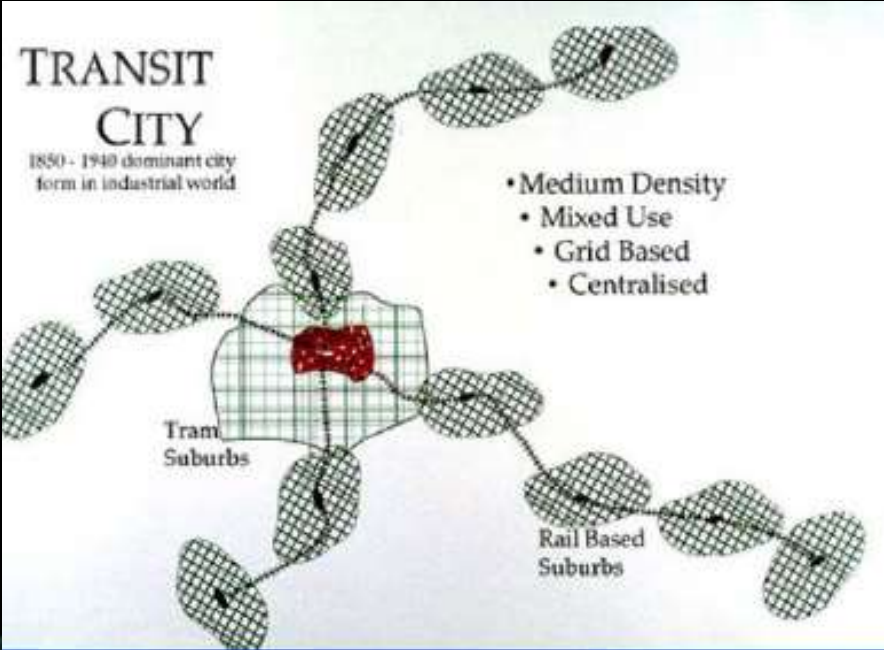
CENTRAL PARKING AND SHUTTLE BUS SERVICE

REROUTING TRANS SARBAGITA BUS

Legend:
1. Kota-Bandara
2. Kota-Unud-GWK
3. Kota-Nusa Dua
4. Kota-Mengwi Terminal
5. Kota-Sukawati-Ubud
6. Kota-Tanah Lot
7. Kota-Peti Tenget

MRT DEVELOPMENT PLAN
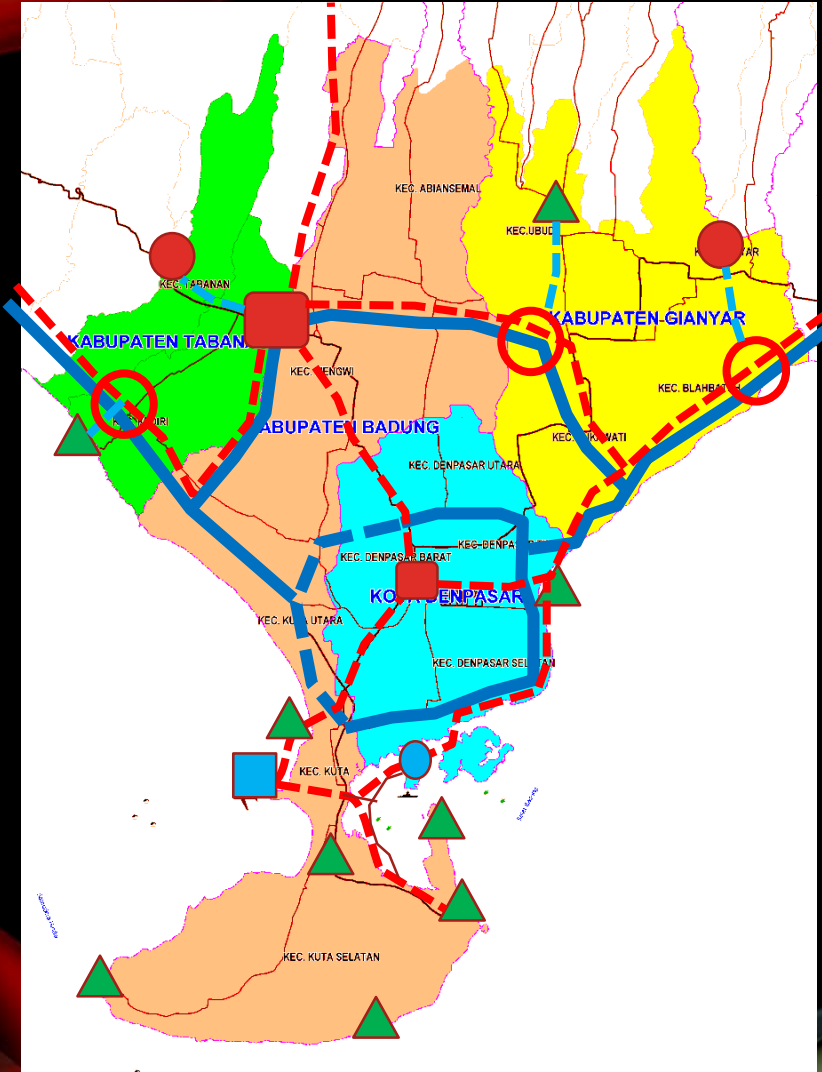
TOWARDS A STRONG ECOLOGICAL AND SOCIAL IMAGE OF PUBLIC TRANSPORT

- A strong ecological image of public transport (PuT) is very important for the user

- The use of natural gas or electric buses needs to be promoted

- A restriction policy needs to be applied on polluting private buses, for example by giving higher tax to the polluting vehicles and providing subsidy to promote clean vehicles

- The transport system must integrate a social dimension

- A major effort must be made to invite more young people to use public transport (ecology and urbanism workshops, mobility training, and advertising)

CLASSIFICATION OF TRANSPORT MODES

- The public interest transport network is divided into three capacity categories: the conventional network (large capacity), the irrigating lines (medium capacity), and the irregular transportation (low capacity)

- term "public transportation" is used to refer to all public interest modes (from BRT, taxi, micro bus (*bemo*) and motorcycles (*ojek*)).

- The conventional network is characterized by expressways and non-express routes connecting the main points of interest of the Sarbagita (Ubud, Tanah Lot, Kuta, Jimbaran, Sanur, Nusa Dua, Denpasar Centre, Mengwi, and other locations).

- Ultimately, the goal is that all non-express routes become express routes
- In order to be qualified as an express line, a route must operate exclusively on own site (or almost exclusively) ; it may be a BRT, MRT, LRT, monorail or even cable car system or other as long as the level of service is sufficient (large capacity, high frequency, the range of operating hours is a least 15h minimum between the first and last vehicle in service, minimum commercial speed 20 kph)

IMPROVEMENT AND PROGRESSIVE USE OF ICT

- In order to contribute to the achievement of smart mobility, information communication technology (ICT) improvement is required, for example by improving smartphone application to support transportation performances in order to contribute to the achievement of smart mobility,

- This is also done to promote the development of ICT on a large scale, and beyond the world of transportation (for example: as part of the tourism industry or the building sector). This must be supported by a strong political will to integrate ICT in the Balinese society.

MULTIMODAL TRANSPORTATION PROMOTION

- Integration between different modes of transport is essential for reaching efficiency.
- This requires from the infrastructure point of view a competent design of the stops of the structuring lines that must be visualized as transportation hubs.
- A stop of a BRT line should be more than a simple stop; it should be a real little station, a multimodal transit hub.
- Implementing a smart card system to support public tranpsort performances

TRAFFIC RESTRAINT POLICY

- If all of the points developed in phase 1 are deemed to have been achieved, phase 2 may optionally be implemented

- Initially, conventional taxation is implemented on the purchasing and use of private vehicles (at least in terms of pollution and, maybe, in order to reduce private transport possession

- An intelligent interzone toll system may be implemented. The principle of this interzonal toll system is to tax the trips on the metropolitan scale
- Thus, whenever the vehicle crosses a non-adjacent boarder, the driver is taxed. The further the trip, the more the driver is likely to be taxed.
- Finally, it would be smart to scale the price on vehicle occupancy. The toll fare should be less expensive for a full vehicle (high occupancy vehicle (HOV) policy).

- It is also possible to consider dedicated lanes for HOV on roads with multiple lanes (as it is implemented in Los Angeles for example).

- The implementation of coercive policies on the use of private transport, such as in Singapore, is extremely efficient in order to increase the use of public transport.

- This study has highlighted key issues of the Sarbagita transport systems

- It has been predicted that about 75% of the main road networks in Sarbagita area will be in the level of service F in the year 2048.

- This chaotic traffic in appearance certainly affects the image that international tourists have made of Bali.

- There are few alternatives to private transportation in Bali, although metropolitan public transporta are being implemented.

- The modeling of this study indicated the need to strengthening of prospects of mass transit development

- It has been observed that transit in the Sarbagita metropolitan area is predominantly done between the main touristic points, which are also strong employment areas

- The development of the public transport must be made a priority on these axes (the double loop)

- Finally, an issue that has not been investigated in this study but nevertheless deserves special consideration is the issue of financing of infrastructure and urban networks.

THANK YOU