SYMPOSIUM

ON THE PATHWAY FOR A LOW-CARBON SOCIETY AND BETTER QOL IN BANGKOK: THE SUKHUMVIT MODEL

"The Project of Smart Transport Strategy for Thailand 4.0", initiated in 2018, is a technical cooperation project between Thai and Japanese research institutions. Our vision is aligned with the Thailand 4.0 initiatives, focusing on the **"Economy for the People"**. Our goal is to disseminate smart transport strategies in Thailand aimed at improving the Quality of Life (QOL) for the people of Bangkok and achieving a low-carbon society. To this end, we have summarised the strategies into a policy package proposal.

On 20 October 2023, we organised a symposium to exchange insights on the proposal with the stakeholders involved in urban transport policies and practices. A total of 82 participants attended the symposium, including delegates from the Bangkok Metropolitan Administration (BMA), the Ministry of Transport (MOT), various governmental organisations, practitioners from the private sector, Japan International Cooperation Agency (JICA), and project members from Thammasat University, Kasetsart University, Chulalongkorn University, NECTEC, Chubu University, and Osaka University.

WHAT IS THE ISSUE ?

Bangkok, the capital city of Thailand, has experienced dramatic economic growth, with an increased population and private car ownership, all of which have resulted in increased traffic congestion, traffic accident risks, CO2 emissions. and air pollution. Consequently, people waste time on the road, lose opportunities to enjoy spending time with their families, and suffer health issues, thereby reducing overall QOL. The project identifies the fundamental causes of these issues as the urban structure of Bangkok, car ownership, transportation accessibility in the first and last mile along with lifestyle and working patterns.

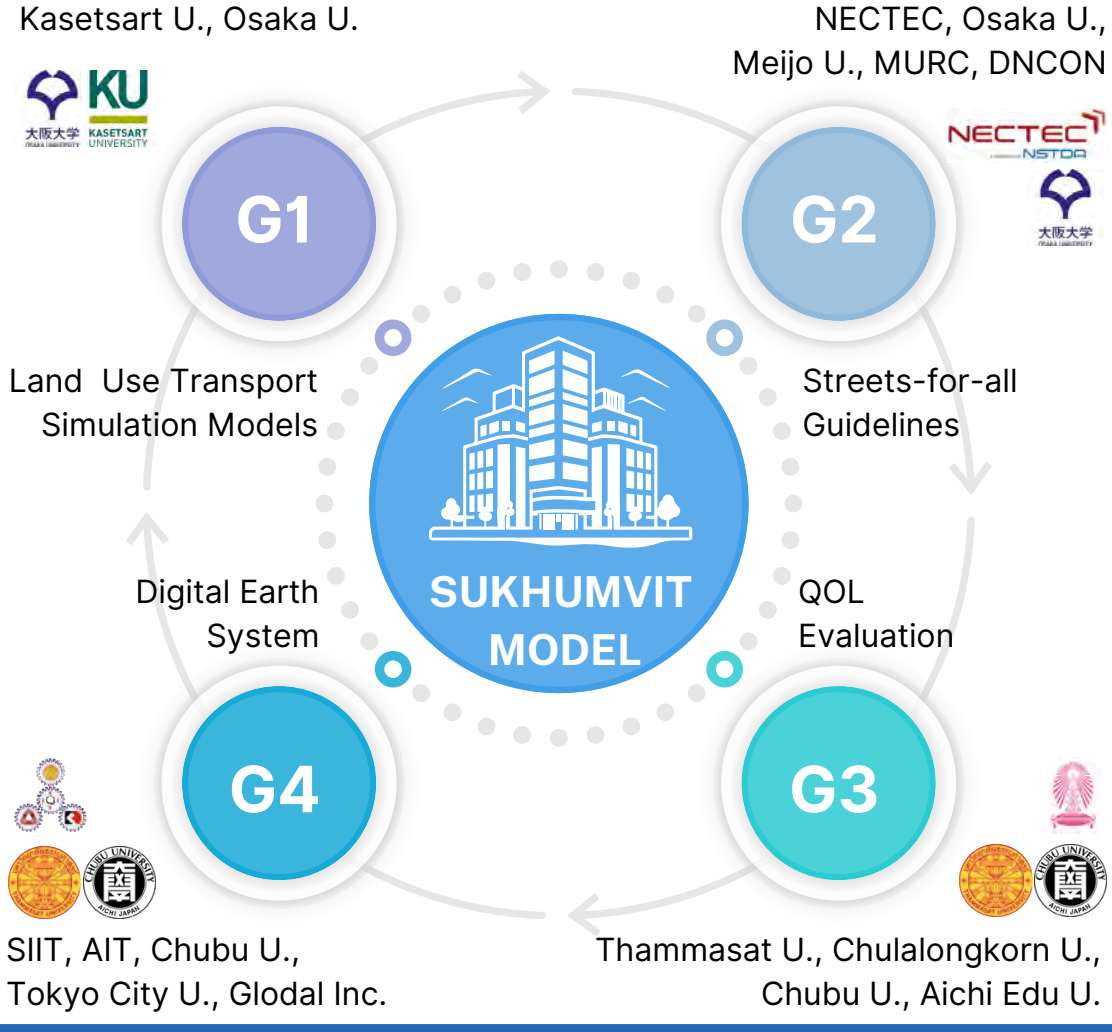
THE PROJECT PROPOSAL

The proposal by the project, entitled the Sukhumvit Model, incorporates policy recommendations, street guidelines, and ICT tools for enhancing QOL and fostering a low-carbon society. This comprehensive proposal is underpinned by scientific findings and innovative technologies, including future analysis for short and long-term goals,

a metropolitan grand design derived from land-transport simulation models, empirical studies on the evaluation of local street walkability, a proof-of-concept experiment on shared mobility in the Sukhumvit District, socio-economical surveys on QOL evaluation, Artificial Intelligence (AI) models for bigdata calculation, development of a QOL-MaaS application, and the creation of a digital platform to visualise all datasets.

WHO IS RESPONSIBLE FOR THE PROPOSAL ?

Four research groups are involved in creating the Sukhumvit Model towards QOL enhancement and a low-carbon society.



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1. **Research Group 1 (G1):** Developing integrated land use and transportation simulation models on the urban structure from the macro perspective, to achieve the preferable future of Bangkok as a compact city with low-carbon mobility.
2. **Research Group 2 (G2):** Working on potential ways to change the local streets, applying the streets-for-all guidelines at the micro level, focusing on travel behaviour at the last mile.
3. **Research Group 3 (G3):** Linking QOL with a digital platform, namely QOL-MaaS, by establishing QOL evaluation methodology.
4. **Research Group 4 (G4):** Constructing a visual digital platform called the Digital Earth System to integrate all outputs and help stakeholders think about the future by visualizing geo-spatial information.

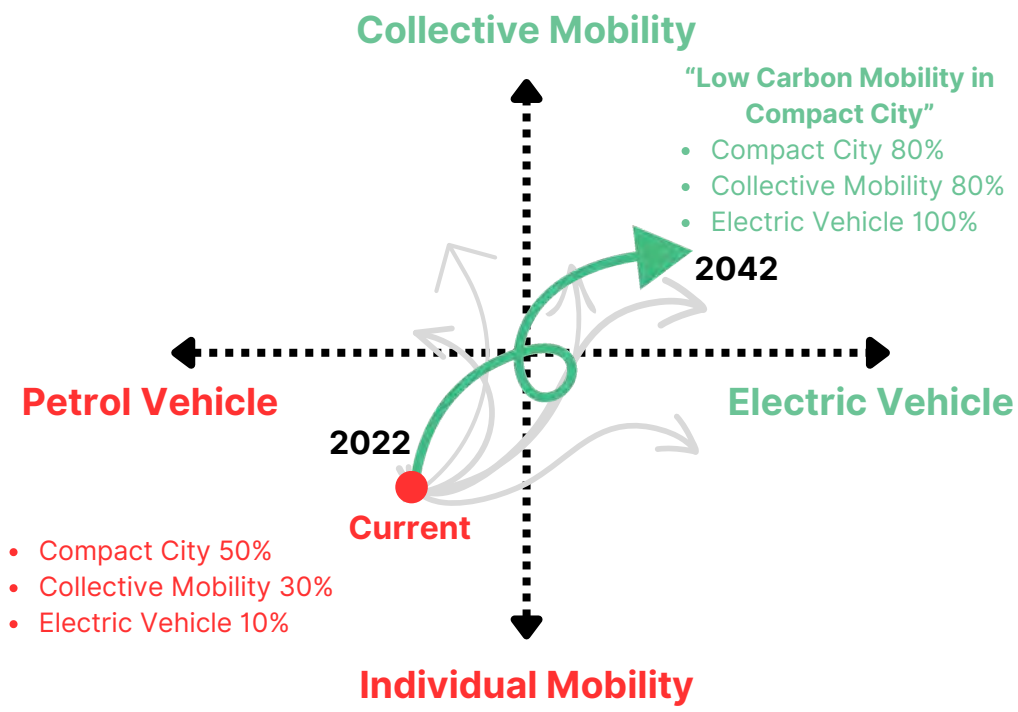
POLICY RECOMMENDATIONS

1. Preferable Future and Pathways

Associate Professor Apiwat Ratanawaraha from Chulalongkorn University, summarised the key points of the policy proposal for better mobility and QOL. The key principles are: (1) Flexibility, (2) Connectivity, and (3) Shareability.

The strategic actions include : (1) Building central places accessible to all, (2) Transforming streets into inclusive social spaces, (3) Mainstreaming QOL, and (4) Integrating and visualising data for better community engagement.

Dr Apiwat analysed future scenarios for Bangkok and proposed a preferable future scenario for low-carbon mobility in a compact city. He suggested pathways towards the preferable future, with a focus on transport accessibility in terms of price (equity) and connection (efficiency). These pathways from now to 2042 involve a shift from individual to collective mobility and from petrol vehicles to electric ones.



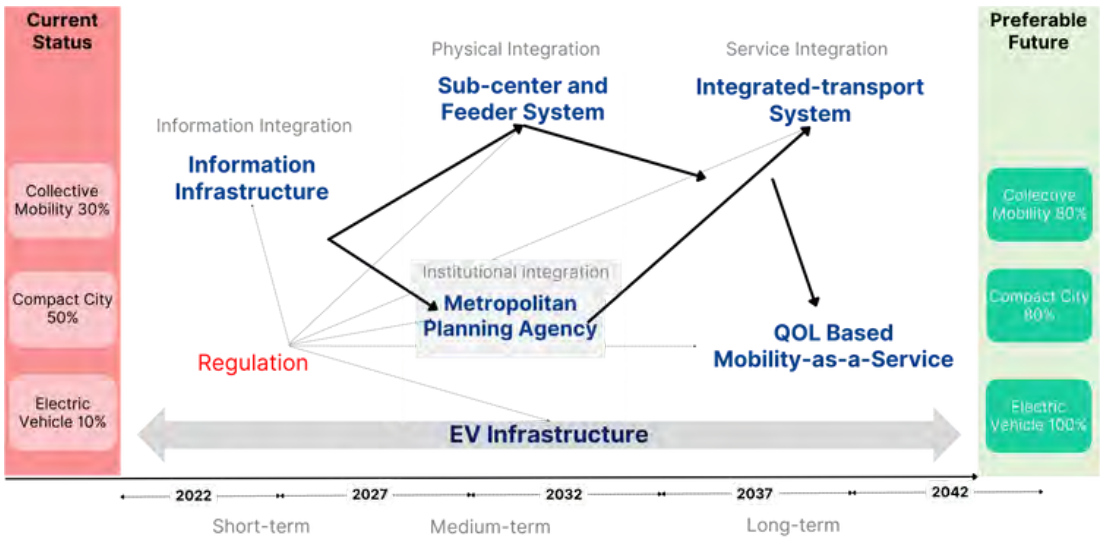
Dr Apiwat identified two bottlenecks in the path towards a preferable future: a lack of up-to-date regulations and integration issues. To unlock these bottlenecks, he recommended two actions:

- **Opening up regulations for a feeder mobility system** such as ride-hailing and small vehicles, promoting urban development into a Transit-oriented Development (TOD).
- **Integrating the data** on transport and land use, **physical and institutional integration**, and service integration.

To this end, he proposed milestones for the next 40 years in the short, middle, and long-term.

- **Short Term by 2027:** Integration of scattered datasets and setting up an integrated digital infrastructure.
- **Middle Term by 2032:** Physical integration of urban and transport systems and institutional integration managed by a metropolitan planning agency.
- **Long Term by 2042:** Service integration, such as with MaaS through public-private partnerships (PPPs).

Pathways to the Preferable Future



2. Transport and Land Use Policies

Associate Professor Varameth Vichiensan from Kasetsart University proposed the concept of "Metropolitan Grand Design".

A crucial aspect is that Bangkok needs to evolve into a multi-centred, interconnectable city with subcentre hubs accessible to all to enhance QOL. The Metropolitan Grand Design consists of **two fundamental proposals:**

1. **Bangkok Polycentric City:** Reconcentrating the city centre and fostering the development of functionally diverse subcentres to transform Bangkok into a polycentric metropolitan city.
2. **Rail-based Development:** Emphasising efficient railway operations to encourage mass transit, advocating TOD. Aiming to create walkable streets and feeder mobilities for connecting nearby stations. The goal is to design accessible and appealing facilities to enhance QOL for residents living in proximity to these stations.

The rationale behind the proposed scenarios comes from computed land use and transport simulation models. His team input current datasets into the simulation models to analyse three future scenarios: Business-as-usual (BAU), subcentre, and reconcentrated. Each scenario predicted changes towards 2050 in people, households, housing, and employment rates. These demographic and spatial changes are correlated with traffic factors such as volume, passenger numbers, and traffic speed.

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Rail Transit Network with Subcenters

- Subcenters based on Traffic Analysis Zone (TAZ)
- Railway Network
  - 2015: 156 Km.
  - 2050: 874 Km.

For example, a rail-based suburban subcentre scenario setting 2050 as the target year includes eight subcentres (e.g., Rangsit, Minburi) and allows enhanced accessibility to each subcentre station through transport connections such as by walking, active mobility, public bus, and on-demand mobility. In contrast, the BAU scenario resulted in increased traffic congestion from the suburban areas to the city centre in 2050. However, the subcentre scenario coupled with a shift in essential social services such as education and healthcare to the suburban areas, could potentially lead to the following improvements:

Advantages of the Suburban Subcentre Scenario

- Increased employment rates in the subcentres;
- Relocation of households to the subcentres;
- Reduction in traffic congestion.

In aiding the design of TOD in the subcentres, according to his corresponding cluster analysis, Dr Varameth recommended implementing TOD by enhancing transit and walkability and introducing smart mobility as a last-mile service.

Smart Mobility for Enhanced Transit-Oriented Development

Simulation at Sena Nikhom Station Area

Smart Mobility Service

Improved Network Connectivity

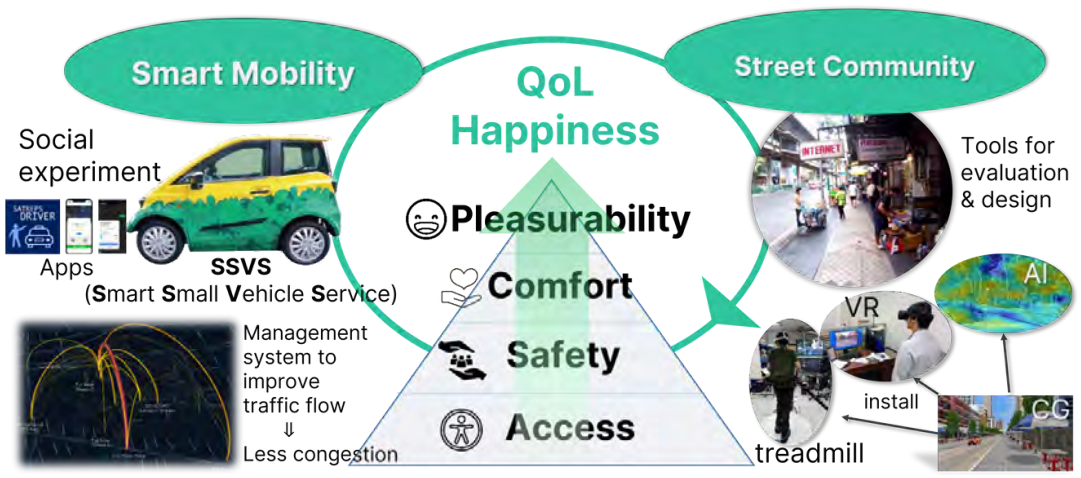
Professor Masanobu Kii from Osaka University offered his comments, stating that in collaboration with Dr Varameth, his team has been developing land use and transport models to address the prevalent issues in Bangkok. Professor Kii expressed his hope for ongoing collaboration between Kasetsart University and stakeholders from both the government and the private sector.

3. Streets-for-All Guidelines

Professor Kenji Doi from Osaka University proposed streets-for-all guidelines from the local viewpoint to design inclusive streets in Bangkok. He highlighted the problems with current streets designed for cars, such as dead-end sidewalks, streets without sidewalks, unwalkable streets, or sidewalks disturbed by many obstacles.

Professor Doi pointed out that all these issues correlate with traffic accident rates. In response to these issues, he emphasised that the concept of the guidelines is to make streets accessible, safe, and comfortable and improve QOL for all people.

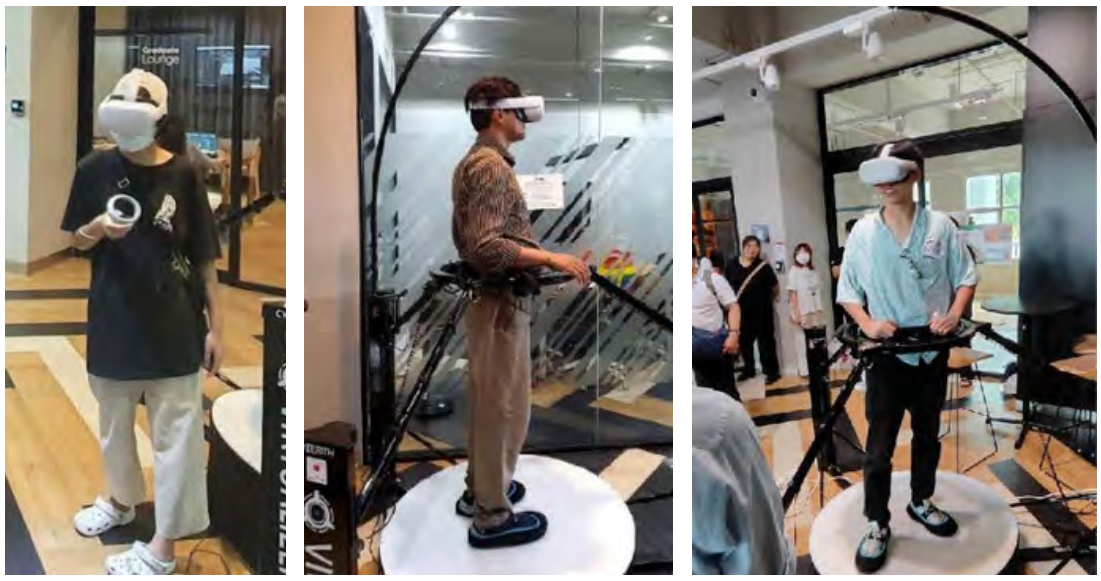
The Concept of "Streets-for-All Guidelines"



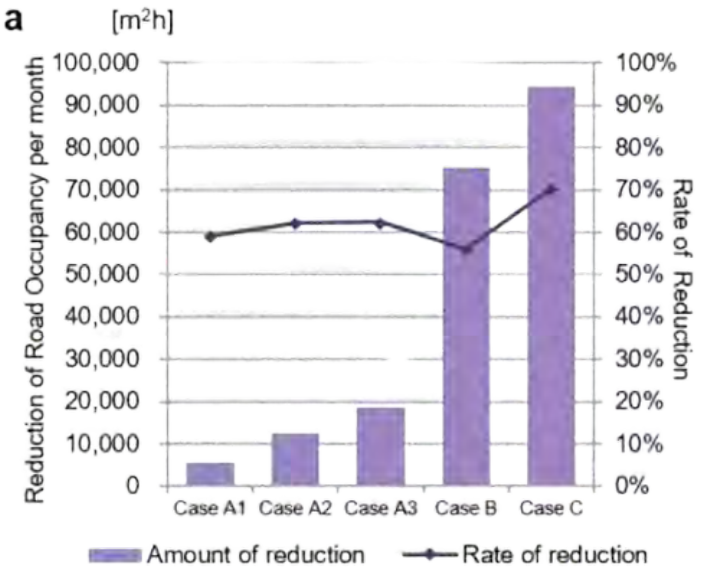
"Streets-for-All" Guidelines for a Low Carbon Society and Better QOL

Two approaches are proposed to design the streets-for-all guidelines: (1) a smart planning system that includes a walkability evaluation and a microsimulation model, and (2) a smart mobility design using the Smart Small Vehicle Service (SSVS).

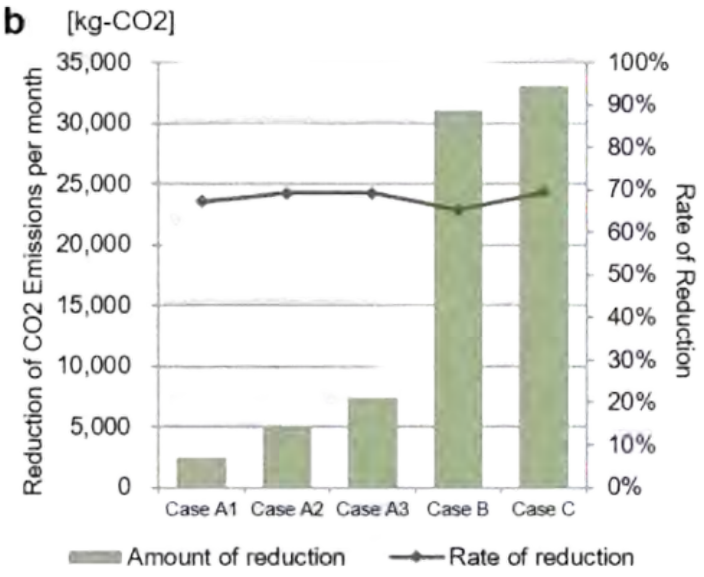
Street Design



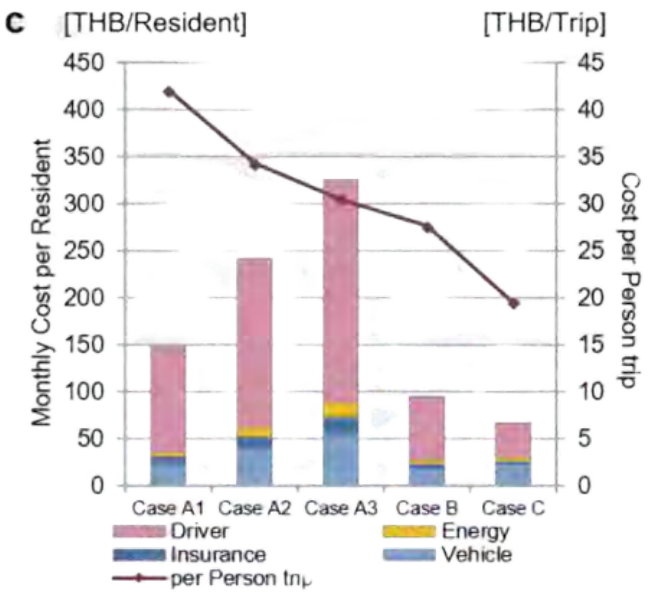
VR Experiment



Reduction of Road Occupancy



Reduction of CO2 Emission



Monthly Cost

The first approach evaluates the walkability of streets using street computer graphics (CGs) and virtual reality (VR) equipment. Professor Doi's team assessed the various street scenarios, including typical sois (side streets) and sois with wider sidewalks, presenting these to Thai respondents. The results revealed a correlation between street design, pedestrian needs, and behavioural willingness, providing valuable insights for developing new street designs.

Regarding the second approach, SSVS is a proof-of-concept experiment using small EVs in the Sukhumvit District, connecting apartments and nearby stations that are sharable for residents through a booking application. The results indicated that SSVS usage increased while the use of private cars and taxis decreased, contributing to a reduction in traffic congestion and CO2 emissions. Notably, a simulation of an increased SSVS user scenario demonstrated further reductions in traffic congestion and CO2 emissions.

4. Mainstreaming QOL

Associate Professor Pawinee Iamtrakul from Thammasat University gave a presentation on "QOL Evaluation" to pin down the influential factors of QOL. In addressing the issues of traffic congestion and reducing residential QOL, her study's key principle in QOL evaluation is the recommendation of urban and transport policies.

The QOL evaluation can cover both static and dynamic dimensions, for instance, considering residential QOL in a monocentric urban city, QOL when using a private car in sprawling conditions, and QOL when riding public transport in a polycentric city.

Framework for QOL Evaluation

The conceptual framework of QOL evaluation in the transportation context incorporates four dimensions of **well-being: physical, mental, social, and economic.** Using this framework, Dr Pawinee conducted a QOL evaluation survey in the Bangkok Metropolitan Region (BMR), encompassing central Bangkok and five provinces. This survey involved a spatial analysis of urban characteristics and a statistical analysis of QOL questionnaires focusing on the dimensions of well-being. Dr Pawinee emphasized that the study results provide **accessible values** such as travel time, **perceived values** such as individual satisfaction levels, and **mental values** such as stress within the local context, and these findings enable the proposal of policy scenarios based on QOL indicators.

Economic Opportunity	Employment level	unemployment rate
	Rent level	Rent per month
	Commuting level	Commuting time
Living Opportunity	Commercial access	Access time to Retail
	Medical access	Access time to hospital or clinic
	Public service access	Access time to Station or CBD
	Other service access	Access time to other city facilities.
Disaster Risk	Natural disaster	Mortality risk from natural disasters
	Traffic accident	Risk of encountering traffic accidents
	Health Damage	Air quality level (SPM)
Residential Amenity	Housing environment	Living space per parson
	Natural Environment	Access time to park or green
	Noise environment	Noise level
Environmental Friendliness	Low carbon life	GHG emission
	Biodiversity	Opportunities to see wildlife
	Waste management	Waste discharge

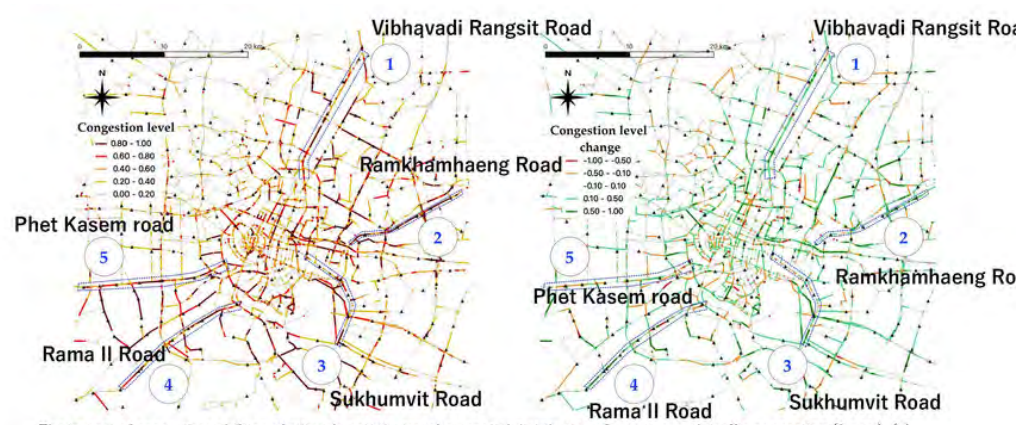
QOL-Accessibility Model

Reviewing the limits of traditional cost-benefit analysis, Dr Pawinee referred to Professor Hayashi's QOL-Accessibility Model. This model places emphasis on considering the perception of individuals from diverse backgrounds to quantify an individual's QOL. For example, one person may perceive it to be nice when they can easily access to their favourite place facilitated by rich data accessibility, compared to another who values accessibility to a different place even without using a digital application. The QOL-Accessibility Model can evaluate the perceived values of accessibility and an individual's happiness and contribute to the integration of regional happiness, such as Gross National Happiness (GNH) . Dr Pawinee stressed that the model helps in assessing factors such as **economic opportunity, living opportunity, disaster risk, residential amenity, and environmental friendliness.**

QOL-oriented Scenarios

Finally, to demonstrate the impact of QOL-oriented scenarios, Dr Pawinee presented the simulation results analysed by **Dr Achariyaviriya Witsarut** from Chiang Mai University. The comparison between the BAU and flexible working scenarios revealed that QOL-oriented flexible working significantly reduces traffic congestion levels.

It was concluded that the project emphasises the **importance of sufficiency and advocates for the transition to flexible working in co-working spaces.**



The impact of space-time shifting of citizen's activity-travel on spatial distribution of morning peak traffic congestion (8 a.m.): (a) spatial distribution of traffic congestion level of BAU scenario; (b) the difference of traffic congestion level between BAU scenario and flexible working scenario (at 100% of FP, 3.0 of alpha, and 500 locations of co-working space), where the black triangle markers represent coworking space locations

Simulation Results

QOL Evaluation Using AI

Assistant Professor Pittipol Kantavat from Chulalongkorn University addressed the technical aspect of QOL evaluation using AI. He first defined QOL as a Key Performance Indicator (KPI) used to evaluate urban design, assessing the well-being and happiness of citizens, incorporating individual needs and social interaction.

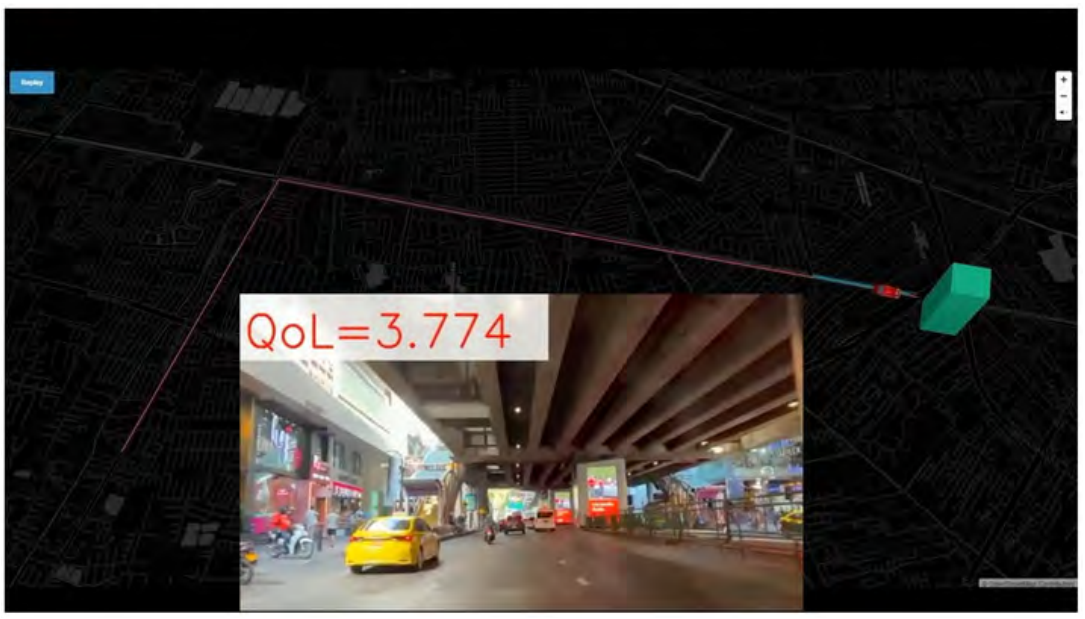
Then, he demonstrated the advantages of AI over the traditional approach, such as saving costs and time, and its ease of application in other computer systems.

Dr Pittipol explained three modes and objectives for evaluating QOL using AI:

- Driving mode for analysis and urban design.
- Walking mode for analysis and urban design.
- Route planning for integrating with a QOL-MaaS application.

He recommended applying these modes to other applications to achieve:

- High-level simulation for city planning.
- Low-level prediction in the QOL-MaaS application.



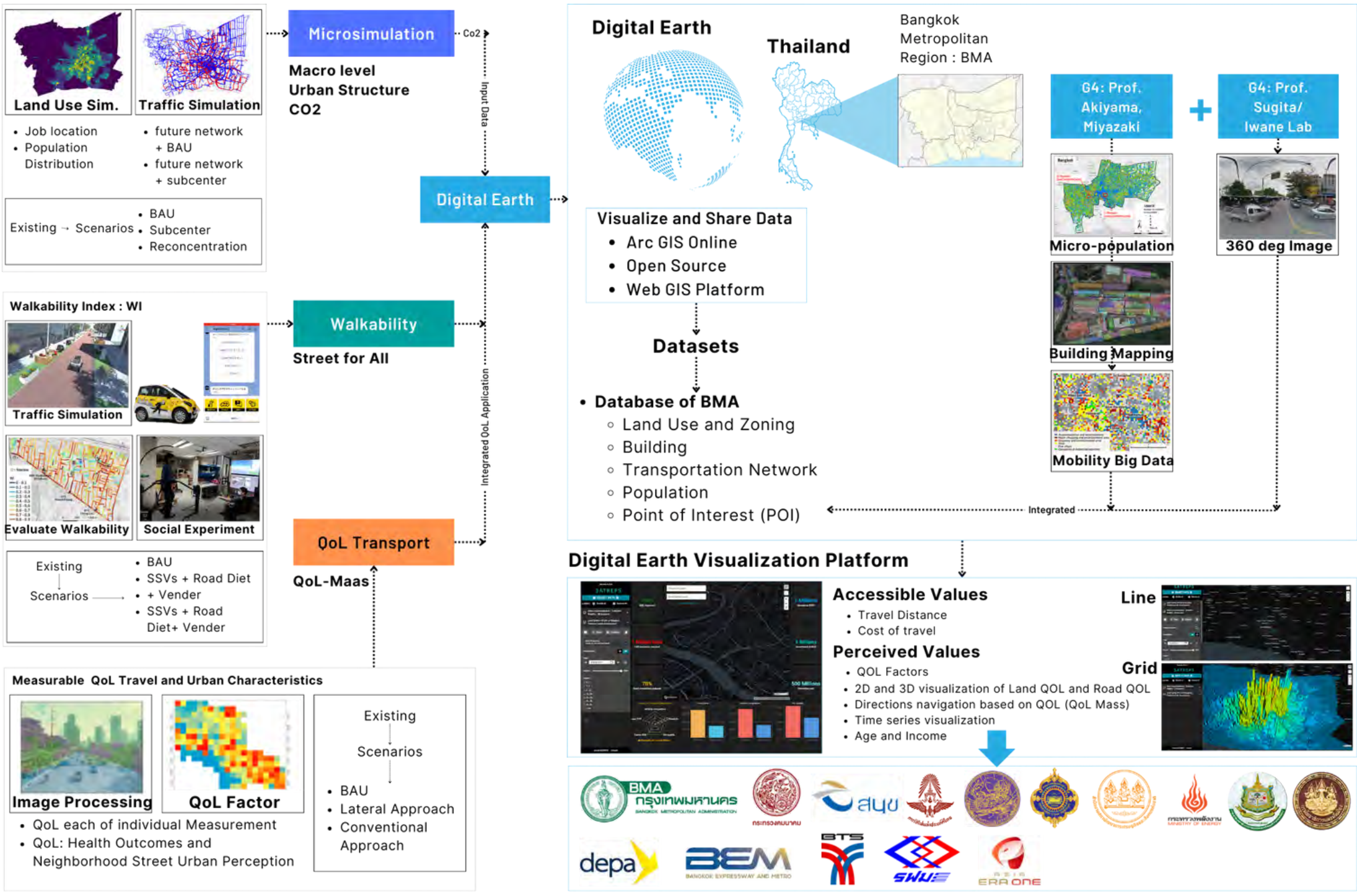
Traveling QOL Estimated by Street Scenes

He demonstrated how the AI dynamically shows the QOL scores from street scenes. For example, while a driver moves through a particular route in Bangkok, a lower QOL score is shown when the road is congested with many cars but rises when there is no congestion. Similarly, QOL scores during the walking mode were calculated. Dr Pittipol emphasised that, in combination with a questionnaire, he can capture both positive and negative factors, such as buildings, activities, footpaths, and roadways, all of which influence each QOL score. Regarding the route planning mode, he has been training an AI model to predict the QOL score on a particular road by using Dr Pawinee's questionnaire data obtained from real individuals. He concluded that all findings are to be embedded in the QOL-MaaS application.

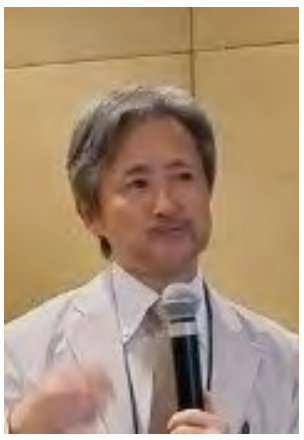
5. Digital Earth System

Associate Professor Teerayut Haranont from the Sirindhorn International Institute of Technology (SIIT) at Thammasat University introduced the Digital Earth System with the aim of making use of all available datasets to improve individual QOL and **help stakeholders plan urban development easily and understandably.**

The Digital Earth System integrates other research group outputs, including simulation models from Dr Varameth's study, walkability from Prof. Doi, and QOL data from Dr Pawinee's team. He explained that the Digital Earth System consists of such data layers as traffic, air quality, QOL, buildings, and more.



For example, this platform allows the visualisation of static land QOL and dynamic road QOL alongside traffic simulation, giving insights at both regional and local levels in 2D and 3D modes. Moreover, in response to Dr Pawinee's approach to QOL, it allows the examination of diverse groups of people with different QOLs. To promote policy planning through the Digital Earth System, he presented sample visualisations in the BMR at a 500-metre mesh, comparing Land QOL and Road QOL between city centres and suburbs.



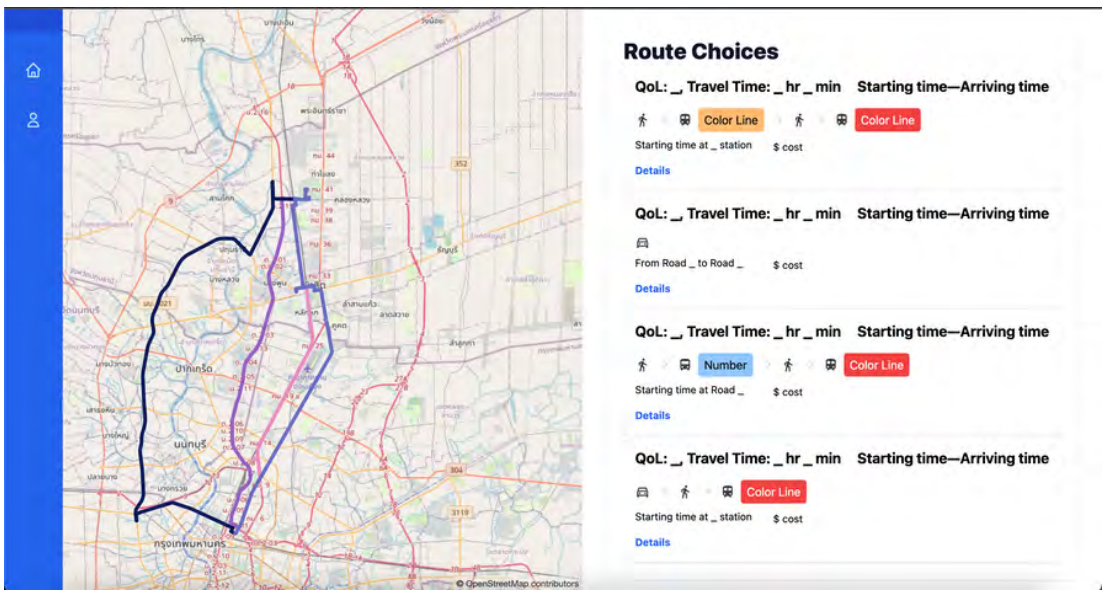
Professor Hiromichi Fukui from Chubu University added two advantages to the Digital Earth System as a communication platform:

1. **Multi-resolution from various dimensions** (e.g., QOL, carbon neutrality, resilience, biodiversity): Visualising trade-offs and co-benefits among different dimensions.
2. **Counter-mapping concept:** Prioritising the perspective of citizens via open-source data or software. This concept aims to shift from intentional and irrational viewpoints, facilitating inclusive decision-making on complex matters concerning environmental justice.

6. QOL-MaaS Application

Mr Titipakorn Prakayaphun, a doctoral student at Chubu University studying abroad from SIIT, demonstrated the QOL-MaaS application. The application is designed to enhance QOL through a tool for community engagement. It firstly asks an individual to specify their preferences, such as transit mode, selected personal satisfaction on QOL, CO2, and cost.

After providing their daily schedule and location, the QOL-MaaS application recommends several route scenarios for the individual's convenience. In contrast to existing applications, he emphasised that the QOL-MaaS provides **flexibility in travel choice, allowing greater adaptability in the timing and location of activities.**



For example, it may suggest an individual leaves home earlier to avoid the rush hour or work at a co-working space or at home instead of an office. Mr Titipakorn concluded by highlighting the QOL-MaaS strategy, which focuses on recommending ways to enhance daily QOL while minimising social costs.

Remarks

Professor Thanaruk Theeramunkong, the Project Director from SIIT, delivered his welcome remarks. He expressed that the project members, in collaboration with BMA, have worked diligently to develop solutions aimed at helping Thai society reduce carbon emissions in Bangkok and create a healthier society with high QOL, as well as providing potential benefits for other countries.

Dr Witoon Apisitpuvakul, the Deputy Director General of the Strategy and Evaluation Department at BMA, emphasised in his opening remarks that the goals of the project's proposals align with the BMA's mission and the challenges facing Bangkok. He shared that the Governor of Bangkok is currently focused on nine guiding policies, some of which prioritise mobility and environmental issues.

Dr Witoon stressed the importance of the data collected by the project as it can be applied by the BMA to adopt a people-centric approach and enhance the QOL for Bangkokians. He also stressed the importance of ongoing collaboration between researchers and the BMA to work towards a more sustainable and liveable city.

Professor Yoshitsugu Hayashi, the Principal Investigator from Chubu University, in his closing remarks, emphasised the future challenge of population decline as an inevitable constraint for Thailand and underscored the shift in focus from "people for economy" to an "economy for people", as initiated by Thailand 4.0.

To support this transition, he summarised the project's proposals, including the Metropolitan Grand Design, SSVS, walkability evaluation to enhance the accessibility of local streets, the QOL-MaaS application, and Digital Earth System, all of which are aimed at establishing a new infrastructure for the next generation and reducing the planetary burden made by greenhouse gases. He concluded by emphasising the capacity development achieved through the project over the last five years, noting that many Thai researchers have developed the skills and knowledge necessary to address current and future challenges in Thailand.

RESEARCH OUTCOMES OF THE PROJECT

The project proposals are grounded in the research findings, all of which have been reviewed by academic professionals and published in international academic journals. The project members believe that these academic findings, proven to provide reliable evidence, contribute to informed decision-making. **As of December 2023, the project members published a total of 32 academic articles in international journals.**

AI-Based Evaluation of Streets for People in Bangkok: Perspectives from Walkability and Lingerability
Yuka Bando, Kento Yoh, Kanyou Sou, Chun-Chen Chou, and Kenji Doi
Sustainability 15, no.24 (Dec 15, 2023): 16884.
https://doi.org/10.3390/su15241688417

Statistical Analysis of Rainfall Impacts on Urban Traffic in Bangkok, Thailand
Tsuyoshi Takano, Hiroyoshi Morita, Piamsa-nga Napaporn, Varameth Vichiensan, and Shinichiro Nakamura
Hydrological Research Letters 17(4), 2023 (Dec 8, 2023): 85-91.
https://doi.org/10.3178/hrl.17.85

Determining the Role of Self-efficacy in Sustained Behavior Change: An Empirical Study on Intention to Use Community-based Electric Ride-sharing
Chun-Chen Chou, Pawinee Iamtrakul, Kento Yoh, Masato Miyata, and Kenji Doi
Transportation Research Part A: Policy and Practice 179, January 2024 (Available online Dec 6, 2023): 103921.
https://doi.org/10.1016/j.tra.2023.103921

Identifying Impacts of School-Escorted Trips on Traffic Congestion and the Countermeasures in Bangkok: An Agent-Based Simulation Approach
Titipakorn Prakayaphun, Yoshitsugu Hayashi, Varameth Vichiensan, and Hiroyuki Takeshita
Sustainability 15, no. 23 (Nov 23, 2023): 16244.
https://doi.org/10.3390/su152316244

Influence of Urban Railway Network Centrality on Residential Property Values in Bangkok
Varameth Vichiensan, Vasinee Wasuntarasook, Titipakorn Prakayaphun, Masanobu Kii, and Yoshitsugu Hayashi
Sustainability 15, no. 22 (Nov 16, 2023): 16013.
https://doi.org/10.3390/su152216013

Deep Learning for Remote Sensing Image Scene Classification: A Review and Meta-Analysis
Aakash Thapa, Teerayut Horanont, Bipul Neupane, and Jagannath Aryal
Remote Sensing 15, no. 19 (Oct 2, 2023): 4804.
https://doi.org/10.3390/rs15194804

Quality of Life Prediction on Walking Scenes Using Deep Neural Networks and Performance Improvement Using Knowledge Distillation
Thanasit Rithanasophon, Kitsaphon Thitisiriwech, Pittipol Kantavat, Boonserm Kijsirikul, Yuji Iwahori, Shinji Fukui, Kazuki Nakamura, and Yoshitsugu Hayashi
Electronics 12, no. 13 (July 2, 2023): 2907.
https://doi.org/10.3390/electronics12132907

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RESEARCH OUTCOMES OF THE PROJECT (CONTINOUS)

Estimating Urban Spatial Structure Based on Remote Sensing Data
Masanobu Kii, Tetsuya Tamaki, Tatsuya Suzuki, and Atsuko Nonomura
Scientific Reports 13 (May 31, 2023): 8804.
https://doi.org/10.1038/s41598-023-36082-8

Quality of Life Prediction in Driving Scenes on Thailand Roads Using Information Extraction from Deep Convolutional Neural Networks
Kitsaphon Thitisiriwech, Teerapong Panboonyuen, Pittipol Kantavat, Boonserm Kijsirikul, Yuji Iwahori, Shinji Fukui, and Yoshitsugu Hayashi
Sustainability 15, no. 3 (February 3, 2023): 2847.
https://doi.org/10.3390/su15032847

Exploring the Spatial Effects of Built Environment on Quality of Life Related Transportation by Integrating GIS and Deep Learning Approaches
Pawinee Iamtrakul, Sararad Chayphong, Pittipol Kantavat, Yoshitsugu Hayashi, Boonserm Kijsirikul, and Yuji Iwahori
Sustainability 15, no. 3 (February 3, 2023): 2785.
https://doi.org/10.3390/su15032785

The Relationship Between Walkability and QOL Outcomes in Residential Evaluation
Kazuki Nakamura
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https://doi.org/10.1016/j.cities.2022.104008

The Bangkok Urbanscapes Dataset for Semantic Urban Scene Understanding Using Enhanced Encoder-Decoder with Atrous Depthwise Separable A1 Convolutional Neural Networks
Kitsaphon Thitisiriwech, Teerapong Panboonyuen, Pittipol Kantavat, Yuji Iwahori, and Boonserm Kijsirikul
IEEE Access 10 (May 20, 2022): 59327-59349.
https://doi.org/10.1109/ACCESS.2022.3176712

Extraction and Calculation of Roadway Area from Satellite Images Using Improved Deep Learning Model and Post-Processing
Varun Yerram, Hiroyuki Takeshita, Yuji Iwahori, Yoshitsugu Hayashi, M. K. Bhuyan, Shinji Fukui, Boonserm Kijsirikul, and Aili Wang
Journal of Imaging 8, no. 5 (April 25, 2022): 124.
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Urban Rail Transit in Bangkok: Chronological Development Review and Impact on Residential Property Value
Varameth Vichiensan, Vasinee Wasuntarasook, Yoshitsugu Hayashi, Masanobu Kii, and Titipakorn Prakayaphun
Sustainability 14, no. 1 (December 28, 2021): 284.
https://doi.org/10.3390/su14010284

Impact of Decentralization and Rail Network Extension on Future Traffic in the Bangkok Metropolitan Region
Masanobu Kii, Varameth Vichiensan, Carlos Llorca, Ana Moreno, Rolf Moeckel, and Yoshitsugu Hayashi
Sustainability 13, no. 23 (November 29, 2021): 13196.
https://doi.org/10.3390/su132313196

Digital Earth: A Platform for the SDGs and Green Transformation at the Global and Local Level, Employing Essential SDGs Variables
Hiromichi Fukui, Duc Chuc Man, and Ahn Phan
Big Earth Data 5, no. 4 (August 28, 2021): 476-496.
https://doi.org/10.1080/20964471.2021.1948677

COVID-19 Countermeasures and Passengers' Confidence of Urban Rail Travel in Bangkok
Varameth Vichiensan, Yoshitsugu Hayashi, and Sudarat Kamnerdsap
Sustainability 13, no. 16 (August 20, 2021): 9377.
https://doi.org/10.3390/su13169377

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More Information

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