Research Project 2208C

Research on safe and comfortable road environment development under mixed electric mobility

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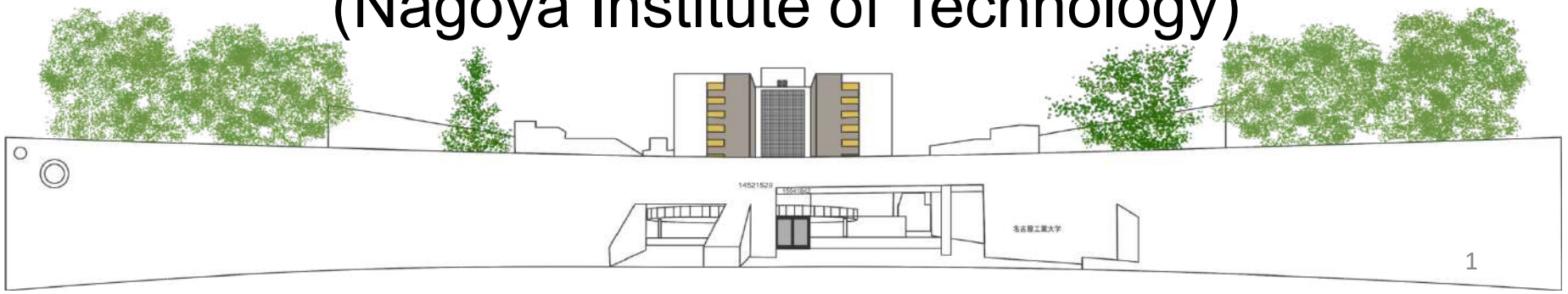
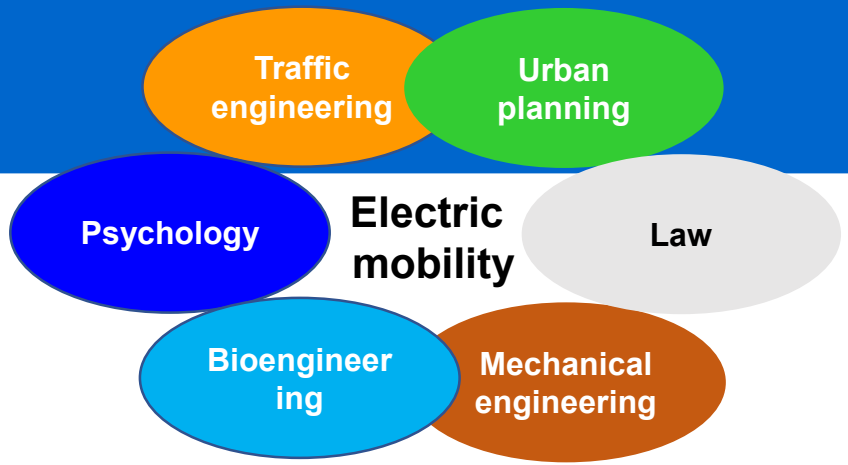


Purpose of research

- Study how sidewalks and roadways should be safely used by multiple entities in a mixed electric mobility environment by investigating previous introduction examples in Europe and conducting multifaceted analyses of user psychology, behaviour, etc.
- Clarify the obstacles that must be cleared when introducing electric mobility through workshops with domestic and international researchers and practitioners.

→Propose specific measures to achieve a safe and comfortable transportation society under mixed electric mobility for countries and cities with automobile- and pedestrian-centred road space structures.

Members



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- Members
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- Special researchers
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- Research collaborators
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- Observers
  - Takashi Miyagi, Shiori Sugiura (Traffic Planning Division, Traffic Bureau, National Police Agency), Takahiro Tsuruga (IATSS Advisor)

Targeted electric mobility

☐ Compact electric mobility for 1–2 people

- Mainly target electric scooters, which have various items to consider for sidewalk and roadway use, and conduct research for other types of mobility, with a focus on domestic introduction cases, and organize issues in anticipation of future development in various regions

Medium speed

Slow speed

Ultra-compact mobility minicar (seats 1-2 people)

Electric scooter (seats 1 person)

Boarding type mobility support robot (seats 1 person)

Electric wheelchair (seats 1 person)

Automatic delivery robot (unmanned)

For sidewalk use

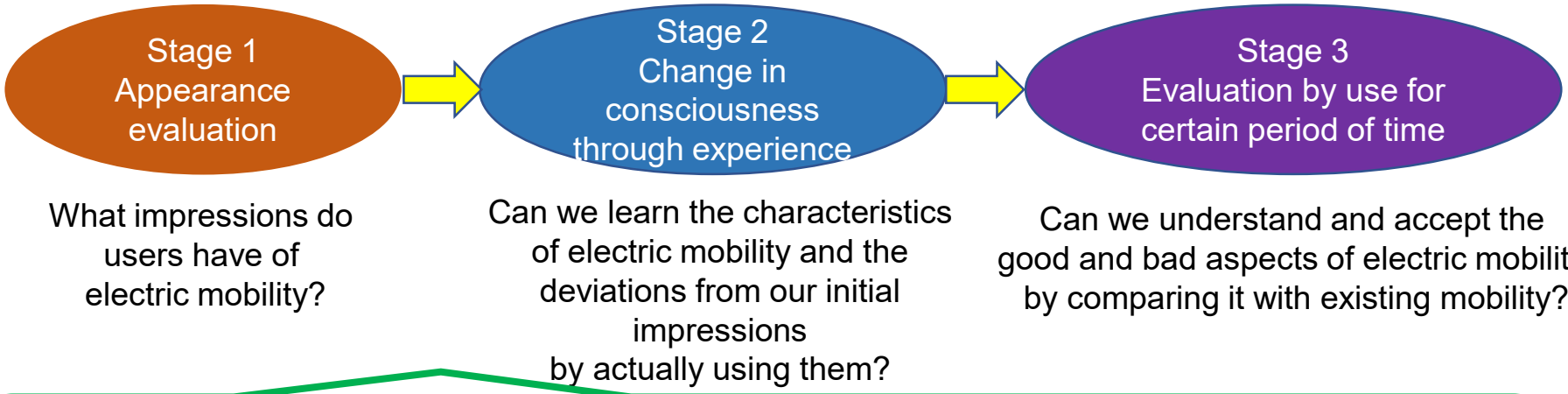
For roadway use

*Image source: Interim report of an expert study group on ideal traffic rules for diverse transportation entities

Results of previous fiscal years and activities of this fiscal year

☐ Results of previous fiscal years

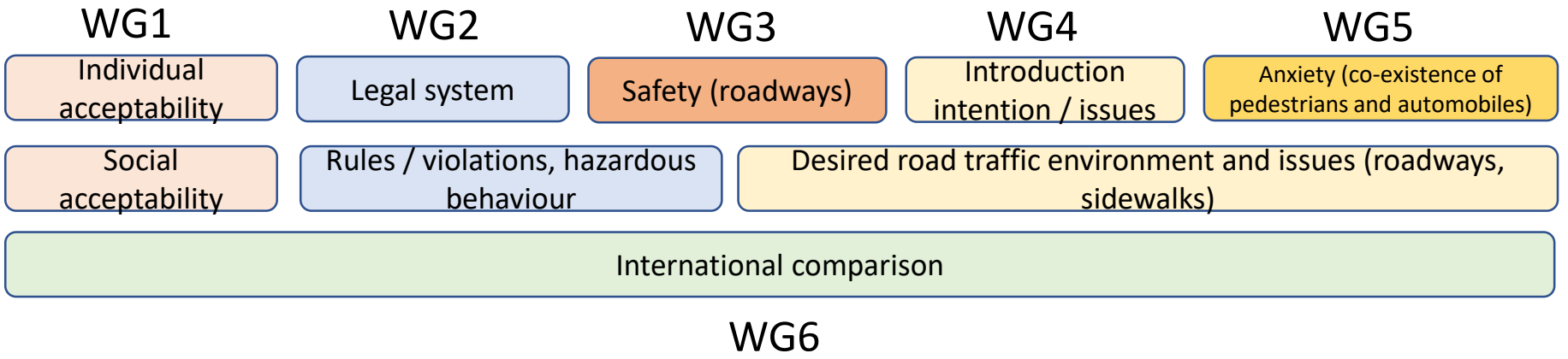
- We conducted research focusing on 'how users perceive' social acceptability of electric mobility, and we confirmed the characteristics and expectations of electric mobility, as well as the obstacles and issues for widespread use, from the perspectives of awareness, evaluations based on actual experience, and evaluation by use for a certain period of time.



Results of previous fiscal years and activities of this fiscal year

Activities of this fiscal year

- Collect information on requirements, necessary infrastructure, and systems to be accepted by society as new mobility (international comparison)…WG1，WG2
- Evaluate interactions with others and psychological load on sidewalks and roadways, and acquire necessary knowledge for considering road space development and the safe use of mobility based on field surveys and road observations…WG3，WG5
- Survey of local governments regarding the intention to introduce electric mobility in Japan, organizing issues at the time of introduction…WG4
- Host an international workshop on the research results, and clarify issues to be considered in future …WG6



Today's report

1. Legal system, literature review, and future issues [WG2]
2. Electric mobility introduction intention and issues according to local government survey [WG4]
3. Characteristics of the use of electric scooters on roadways based on actual road and on-site experiments [WG3]
4. User anxiety and behavioural characteristics based on on-site experiments [WG5]
5. International comparative report on acceptability [WG1]
6. International workshop report [WG6]
7. Summary

1. Legal system, literature review, and future issues [WG2]

Purpose of research and activities

- Review of the legal system
- Interviews with the National Police Agency about questionable items
- Review of international research and reports

- Clarify what is and is not stipulated in the legal system of Japan, and organize issues that may arise in Japan and issues that need to be discussed with regards to the spread of electric scooters

Review and discussion of legal system in Japan
Road Traffic Act vehicle classification and amended laws

☐Revision of Road Traffic Act Revised in April 2022, enforced in July 2023

[New]Specified small motorized bicycle
- Maximum speed ２０ｋｍ/ｈ
- Rated output ０．６０ｋW
- Length １９０ｃｍ
- Width ６０ｃｍ

Driving on public roads

- １６ years or older
- Driver's license : Necessary➡Unnecessary
- Helmet : Unnecessary➡Necessary
- Driving on sidewalks : Not allowed➡Possibly allowed ≤６ km/h

- Compulsory automobile liability insurance
- License plate (taxation label)

Rated output (kW)	>1.00	>0.60, ≤1.00	≤0.60
Road Traffic Act	Motor vehicle	Motor vehicle	Motorized bicycle
Road Transportation Act	Motor vehicle	Motorized bicycle	Motorized bicycle

The rated output differs due to the Road Traffic Act and Road Transportation Act, and this affects the applicable laws and regulations, resulting in a complicated system

Applies to

Parking lot laws
Bicycle laws
Bicycle ordinances

Applies to

Safety standards of the Road Transport Vehicle Act
Act on Securing Compensation for Automobile Accidents
Local tax laws
Garage laws

Review and discussion of the legal system of Japan
Parking vehicles and bicycles on sidewalks

- Sharing services
  - Coordination with other efforts to utilize the public road space required
- Legal propriety of parking on sidewalks
  - Judicial precedents that allow or prohibit vehicles to park on sidewalks, and the judgment is divided.
  - Parking of vehicles/bicycles on sidewalks is controversial

- Authority of forced removal
  - Road Traffic Act：Movement of vehicles by police officers and police chiefs
  - Ordinances of local governments (Bicycle Act): Forced removal of bicycles by local governments
  - It has not been determined who will implement forced removal of electric scooters, wheelchairs for those with physically handicaps, and walking aids

Issues that may arise in Japan, and issues that require further discussion ‘Position as a vehicle’

- Complex position as a vehicle (even with similar shape and appearance, there are electric scooters equivalent to automobiles)
  - Difficulty for users to understand: Possibility that some users will drive on sidewalks with vehicles that can go ≥20 km/h.
- Type certification
  - Japan has a performance confirmation system.
  - Driving places divided according to speed (sidewalk is also possible if ≤6 km/h), but how to How to manage speed limit? Limits of GPS.
- Cases where individual ownership is assumed
  - Europe: Mainly sold at consumer electronics retailers, few scales at bicycle shops.
  - Entry by industries that did not sell 'vehicles'
  - Issues of thorough safety education.
- Consistency with bicycle crime prevention registration
  - License plates of motorized bicycles are taxation labels, and the owner is determined by the municipality.

Issues that may arise in Japan, and issues that require further discussion ‘Driving/driving space on public roads’

- Driving on sidewalks is rare in other countries
- Intersections when sharing driving space with bicycles
  - Bicycle speed in Japan is slower than that in Europe.
  - Even when the direction of travel is the same, speed zones are different, and hazards emerge.
- Road structure characteristics not found in other countries
  - Unknown impact on Japan’s road environment, which has drainage ditches, gutter lids, telephone poles, fire hydrants, etc.
- Helmet wearing
  - Due to the progress of discussions in other countries, the international direction is mandatory wearing of helmets' for further clarity

Issues that may arise in Japan, and issues that require further discussion ‘Bicycle parking/vehicle parking, and other related items’

- Correspondence to bicycle parking lots
  - Trip purpose, trip length, and sex/age of users differ from those for other means of transportation.
    - Use in the afternoon or on weekends, use when going out for entertainment, for short trips, etc.
- Authority for removing illegal bicycle parking (vehicle parking)
  - Unclear and needs to be consistent with the authority for bicycles.
- Use by high school students
  - People aged 16 years and older can drive without a license, so there is a possibility that many people will use it.
  - Increased driving by users who have never driven a motor vehicle
  - Discussion needed on whether national standardization should be done by notification from MEXT or whether each school should stipulate it in its school regulations.

2. Electric mobility introduction intention, and issues according to the local government survey [WG4]

◻ Overview of the surveys

① Conducted questionnaire surveys of local governments to determine the degree of importance of local issues and the expected level of contributions of the introduction of electric mobility to local issues

② Conducted interview surveys with local governments that have introduced electric mobility to understand the effects and issues of introducing them

③ Examined and evaluated applicability methods for electric mobility services based on local characteristics

*Today, results of (1) and (2) from the above survey are extracted and reported

(1) Summary of the questionnaire survey for local governments

■ Targeted mobility

➢ Compact mobility for 1–2 people

Ultra-compact mobility minicar (seats 1-2 people)	Electric scooter (seats 1 person)	Automatic delivery robot (unmanned)	Boarding type mobility support robot (seats 1	Electric wheelchair (seats 1 person)
				

*Image source: Interim report of expert study group on ideal traffic rules for diverse transportation entities

■ Main survey items

➢ Importance of local issues and the degree of contribution of electric mobility

➢ Issues to discuss with stakeholders before introduction

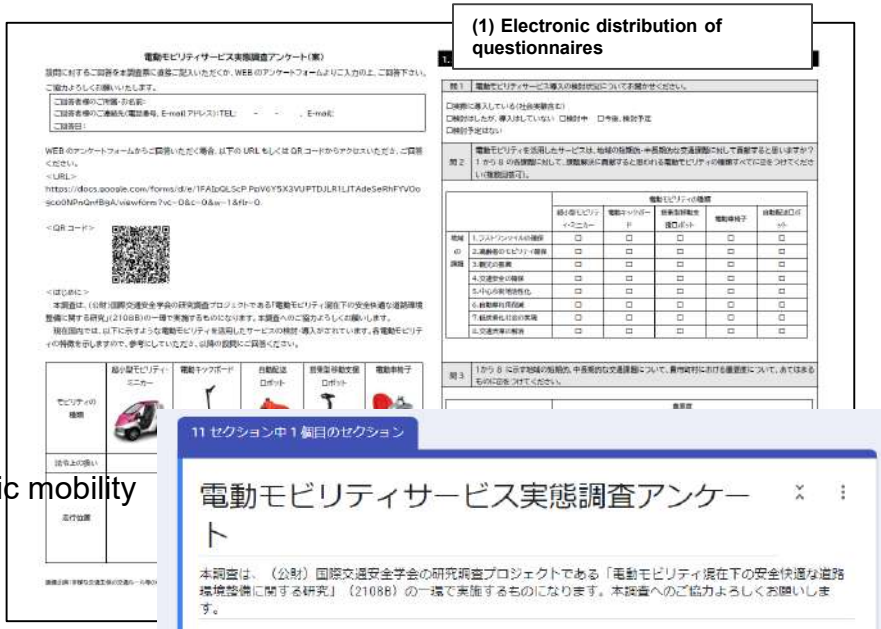
➢ Need for differentiation from existing public transportation

➢ Intention to introduce/continue electric mobility services

*Some local governments that have not introduced the system responded with assumptions for some responses

- Responses received from 53 municipalities (mainly Aichi, Gunma, Osaka, Nara, Hyogo, Mie, Toyama, Shimane, and Ibaraki Prefectures).
- Provided information on photographs of electric mobility, legal treatment, and driving positions (*Regarding electric scooters, due to the revision of the Road Traffic Act in July 2023, it will be possible to drive on sidewalks under some conditions, but this survey presents driving rules based on the current Road Traffic Act).

■ Survey screen

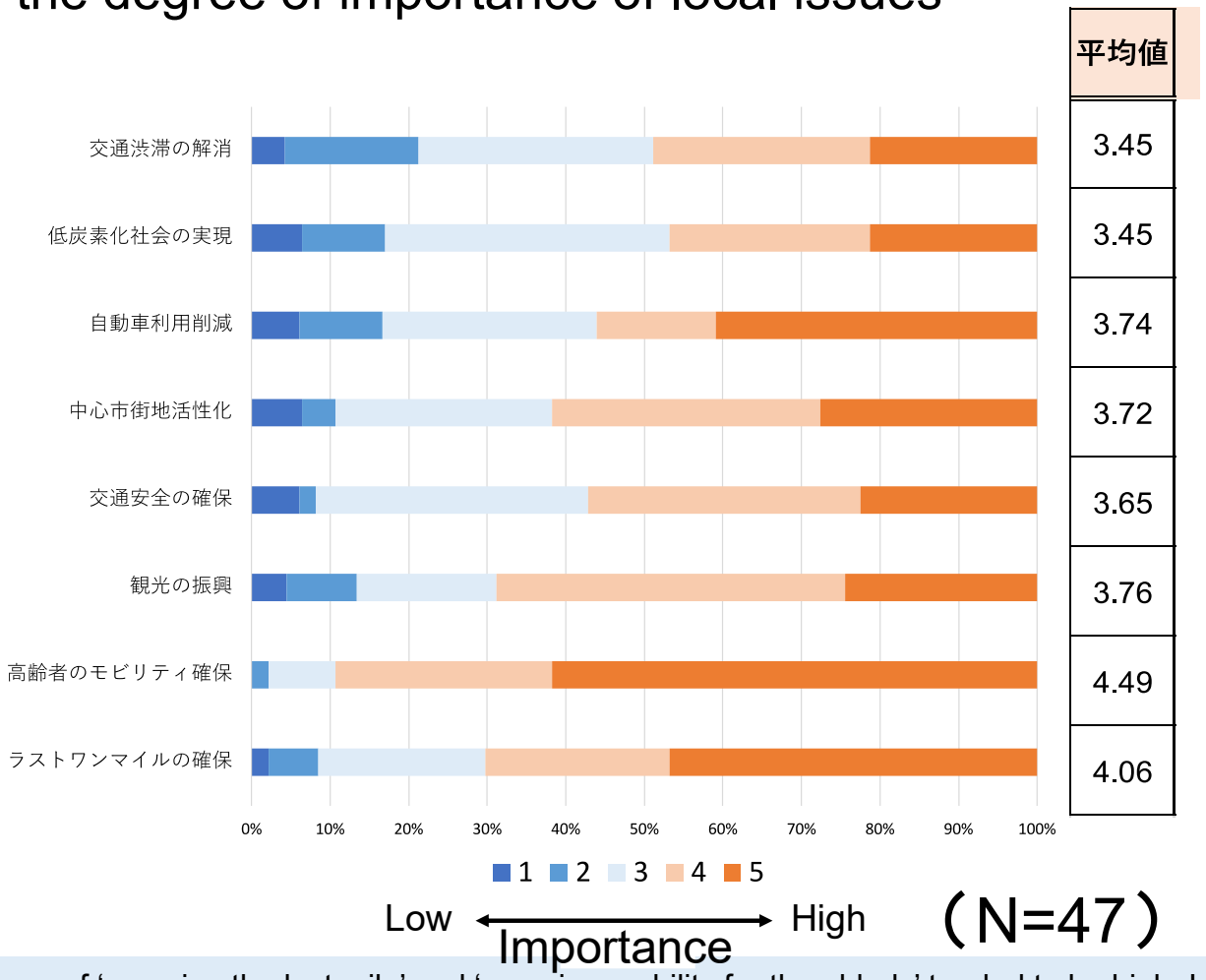


(1) Electronic distribution of questionnaires

(2) Online response (Google Form)

(1) Questionnaire survey results

☐ Evaluation of the degree of importance of local issues



- The average importance of ‘securing the last mile’ and ‘securing mobility for the elderly’ tended to be high. In particular, approximately 90% of respondents gave 4 points or more to ‘securing mobility for the elderly’, and many local governments recognized this as a high-priority issue.
- Many local governments also place importance on items related to local revitalization, such as the ‘promotion of tourism’ and the ‘revitalization of central city areas’.

(1) Questionnaire survey results

◘ Evaluation of the expected level of contribution of electric mobility to local issues

（N=47）	超小型モビリティ・ミニカー	電動キックボード	搭乗型移動支援ロボット	電動車椅子	自動配送ロボット
ラストワンマイルの確保	55%	45%	36%	32%	15%
高齢者のモビリティ確保	40%	0%	11%	81%	13%
観光の振興	53%	79%	62%	21%	9%
交通安全の確保	19%	2%	13%	15%	26%
中心市街地活性化	28%	66%	47%	19%	30%
自動車利用削減	53%	49%	36%	23%	55%
低炭素化社会の実現	77%	64%	49%	45%	49%
交通渋滞の解消	15%	34%	23%	11%	36%

'Securing mobility for the elderly'
⇒Electric wheelchair

'Securing the last mile'
⇒Ultra-compact mobility minicar

'Promotion of tourism', 'Revitalization of central city areas'
⇒ Electric scooter, boarding-type mobility support robot

'Realization of a low-carbon society' **⇒ All mobility**

Ultra-compact mobility minicar (seats 1-2 people)	Electric scooter (seats 1 person)	Automatic delivery robot (unmanned)	Boarding type mobility support robot (seats 1	Electric wheelchair (seats 1 person)
				

*Image source: Interim report of expert study group on ideal traffic rules for diverse transportation entities

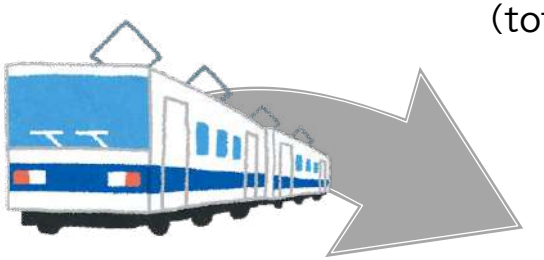
Different trends in expected mobility for each local issue

(2) Understanding the effects and issues of introducing electric mobility

- Introduction case for ‘The purpose of 'promotion of tourism' (Izumo City, Shimane Prefecture)

Approx. 12.5 million people

(total number of visitors in 2019)



Izumo City

Work on revitalization

Specified city area

’Vulnerability of secondary traffic’ is an issue

Examination of the use of ultra-compact mobility minicars

(examined in FY2017, implemented in FY2018–FY2020)

Four themes for introduction of ultra-compact mobility minicars

① 'Improved value of sightseeing spots' by increasing ease and convenience for tourists to move around the city

② 'Free access' not only to famous sightseeing spots but also attractive sightseeing spots in the city

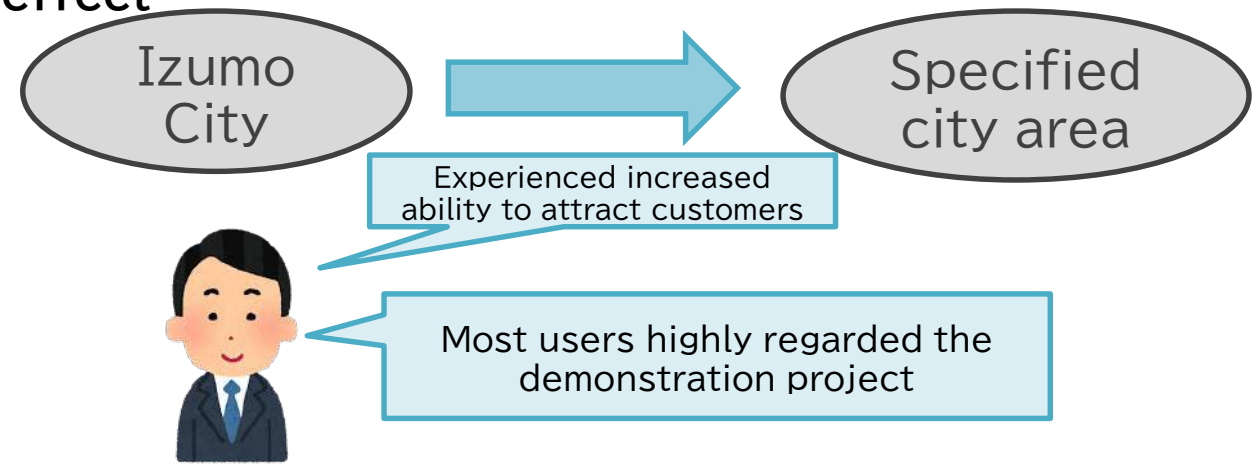
③ 'New attractions' in combination with sightseeing plans

④ 'Contributing to reduced carbon dioxide emissions' through the use of electric vehicles

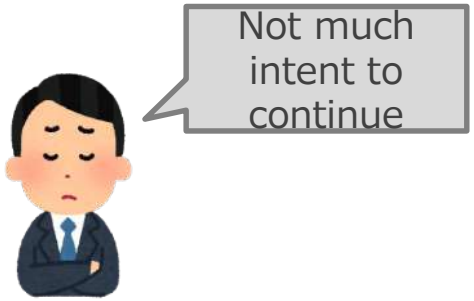
(2) Understanding the effects and issues of introducing electric mobility

☐ Introduction case for 'promotion of tourism' (Izumo City, Shimane Prefecture)

■ Introduction effect



■ Recognition of issues and future prospects



- Due to the presence of **issues in terms of income and expenditure** when implementing project (*in this demonstration project, there were no private business operators as the implementing body)
- Wish to study if a scheme can be built that makes it easy for private businesses to participate as a profitable business by reducing costs, including the costs of the management and operation system of electric mobility
- Currently mainly used as a commercial vehicle, and rather than focusing on profitability of usage fees, it is **used as an SDGs initiative**

⇒Effective for the 'promotion of tourism', but there were problems in terms of management and operation.
Currently being used as an SDGs initiative

3. Characteristics of the use of electric scooters on roadways based on actual road and on-site experiments [WG3]

Actual road survey

<Basic road section>

- Driving position/speed
- Driving side-by-side or overtaking a vehicle
- Other dangerous events, etc.

<Intersection>

- Passage method
- Driving position/speed
- Turning radius
- Other dangerous events, etc.

On-site experiment

In addition to grasping the actual conditions through actual road surveys, some items were also verified through on-site experiments

Driving evaluation when driving side-by-side or overtaking a vehicle
- **Proper separation distance**
- **Comparison with bicycle**

Vehicle dynamics
- **Stability by speed**
- **Turning characteristics**

← Shin-Okubo

↓ Numazu

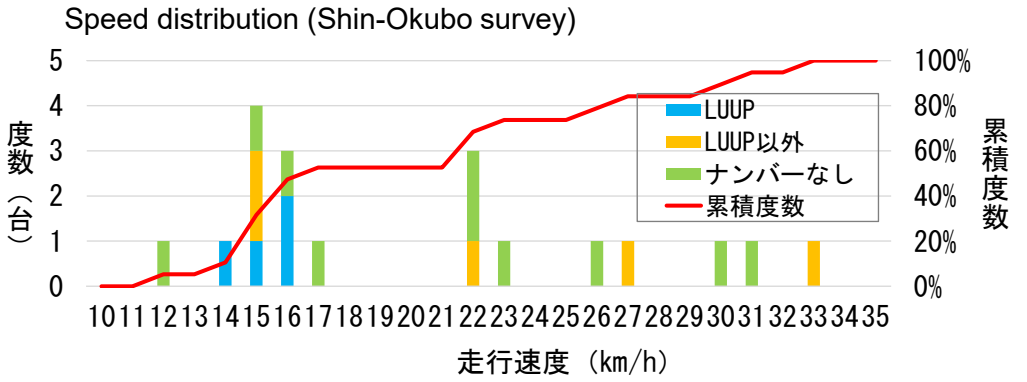
←Nakanoshima

↑ Nihon University College of Science and Technology Funabashi Campus

Survey of driving conditions on actual roads (Basic road section)

☐ Driving speed

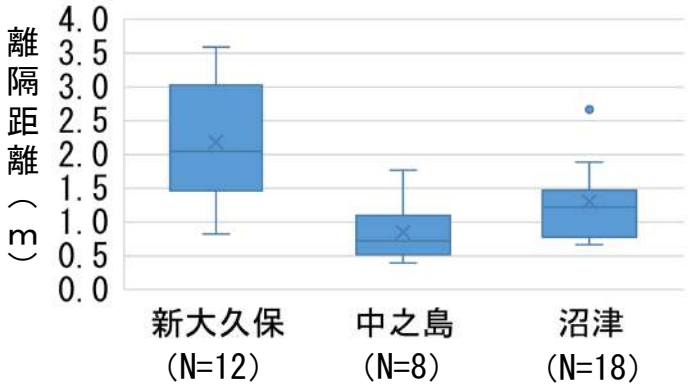
- Two peaks in speed distribution (around 15 km/h and over 20 km/h), and a large difference between sharing and private ownership with the speed limit.



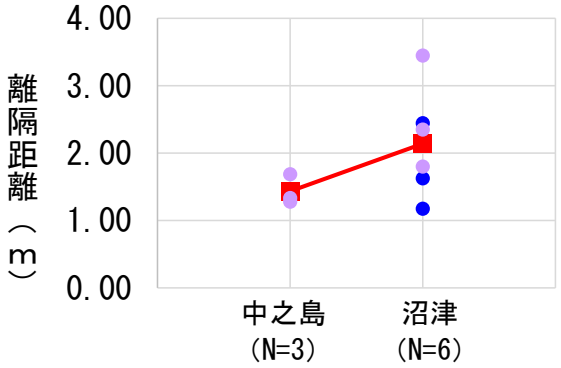
☐ Driving position (distance from curb/vehicle)

- Large variation in driving positions in Shin-Okubo, which has wide lanes, and Numazu, which has many lanes. Meanwhile, in Nakanoshima, where the lane is narrow, driving at a position of 0.8–1.0 m from the curb.
- When being overtaken by a vehicle, the occurrence of overtaking at a minimum separation distance of 1.0 m. The minimum average value is approximately 1.4 m.

Distance from curb



Distance from vehicle when overtaken

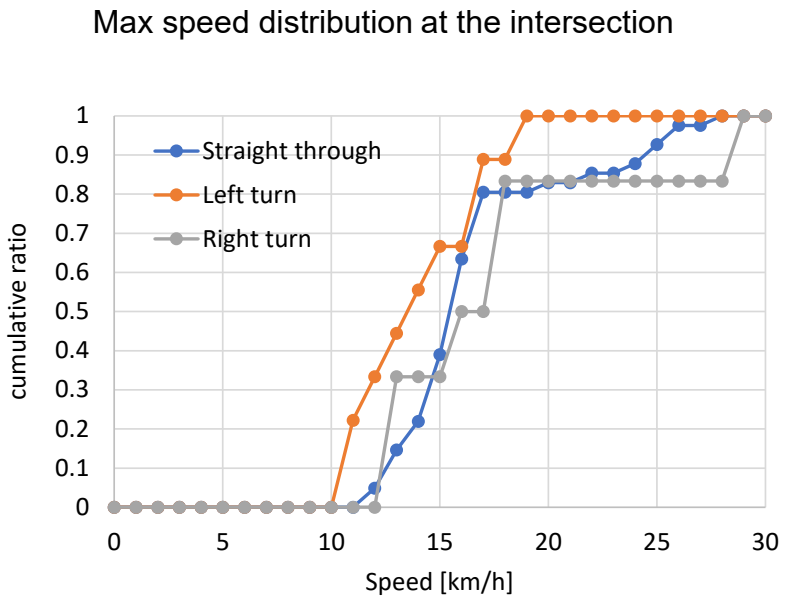


Survey of driving conditions on actual roads (Intersection)

☐ Behaviour at intersection (Shin-Okubo: Kita-Shinjuku 1-chome intersection)

- Driving position: more than 80% of vehicles driving straight ahead are on the roadway only, but there are approximately 20–30% of cases where the vehicle enters the sidewalk when turning right or left (including cases where the vehicle driver gets off and walks onto the sidewalk)
- Speed: approximately 15 km/h for going straight, 10–15 km/h for right and left turns, and a certain number of 25 km/h
- Minimum turning radius: depends on speed, approximately 5 m when avoiding other vehicles (speed 10 km/h or less), often approximately 10 m when turning left or right (speed 10-15 km/h)

Trajectory of electric scooters near/at the intersection

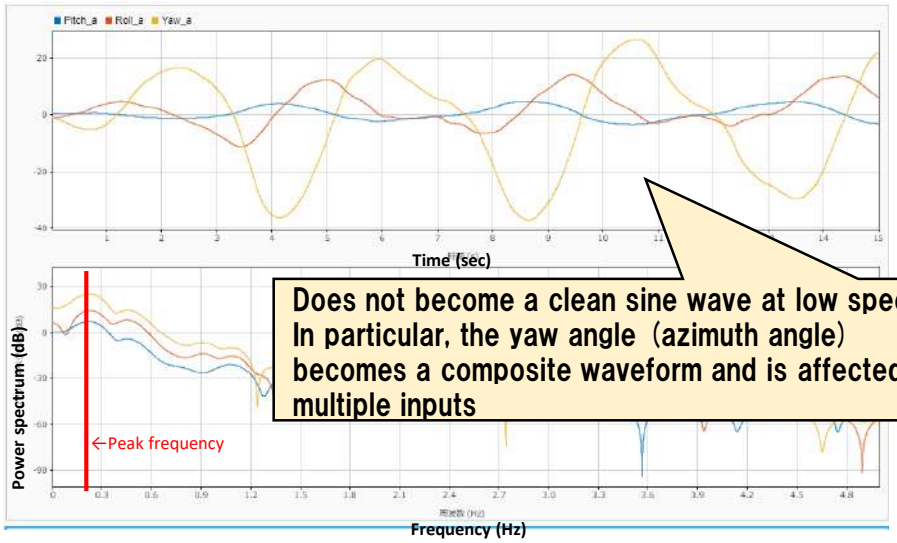


On-site experiment on vehicle motion characteristics

- Vehicle motion response characteristics in slalom driving
  - Difference in steering mechanism occurs at approximately 10 km/h, and the turning radius is kept constant at low speeds by steering to make short turns.
  - Conjectured that the control subject differs depending on the driving speed in situations such as obstacle avoidance during actual driving.

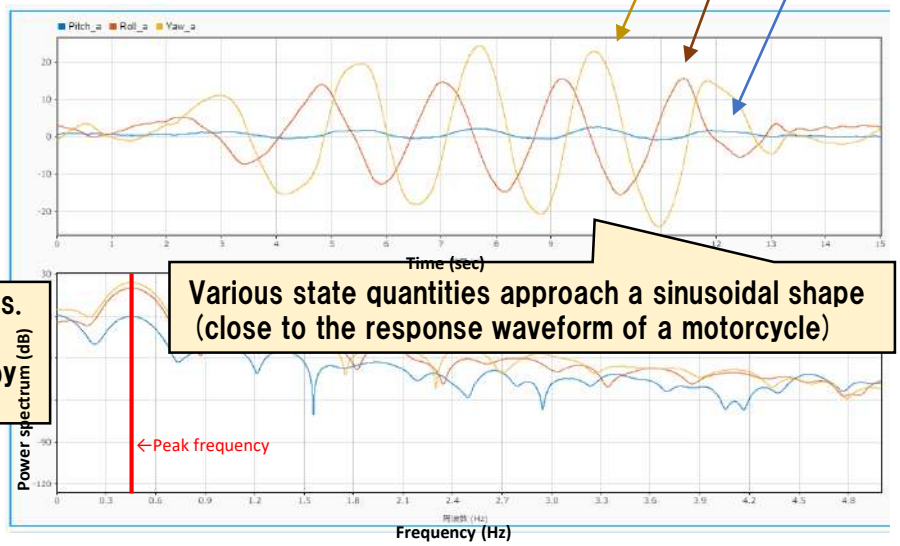
Vehicle behaviour measured based on JASO T014:2013 Motorcycles– Slalom test procedure

Speed 7.1km/h（0.22Hz）



Does not become a clean sine wave at low speeds.
In particular, the yaw angle（azimuth angle）
becomes a composite waveform and is affected by multiple inputs

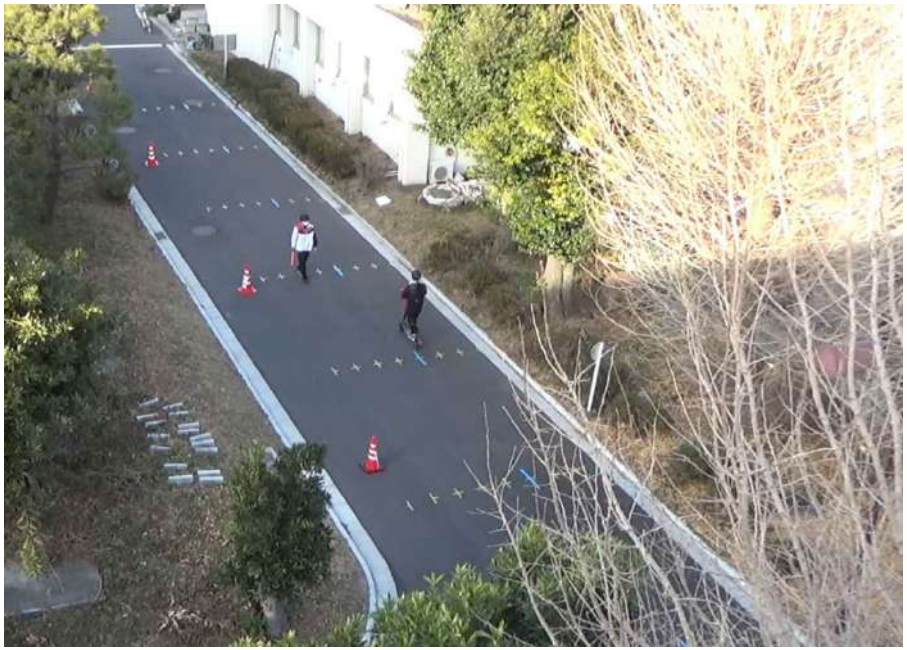
Speed 14.9km/h（0.46Hz）



Various state quantities approach a sinusoidal shape
（close to the response waveform of a motorcycle）

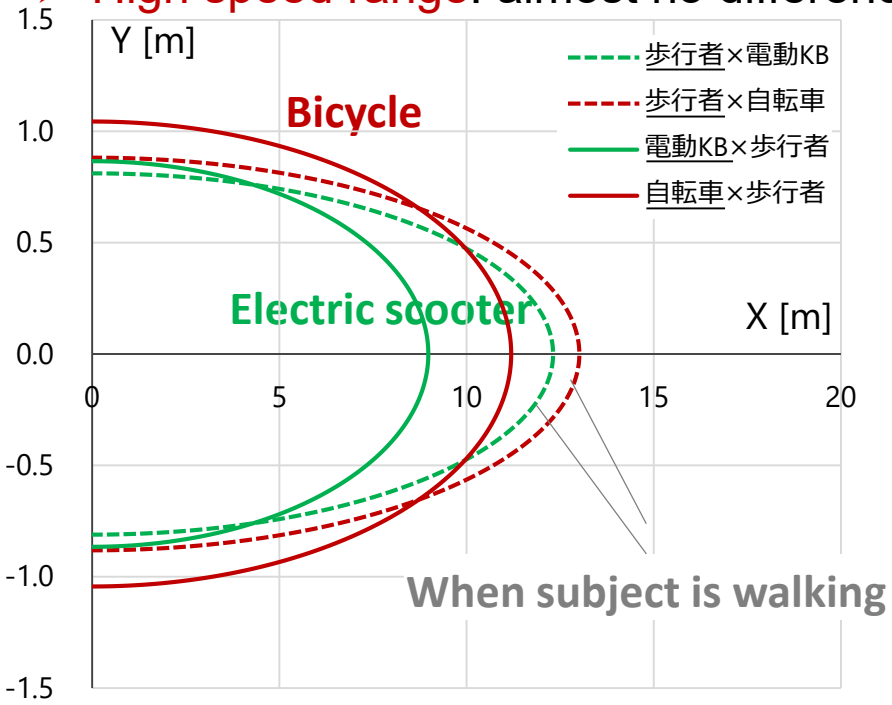
4. User anxiety and behavioural characteristics based on on-site experiments [WG5] ((1) National Institute of Technology Gunma College experiment)

- Clarify avoidance characteristics and sense of anxiety when passing by electric scooters in a mixed pedestrian environment
  - Experiment conducted on subjects when walking and riding
    - When walking: avoid electric scooters or bicycles as a pedestrian
    - When riding: ride electric scooters or bicycles and avoid pedestrians
  - Verification of the effects of different driving speeds and distances from each other



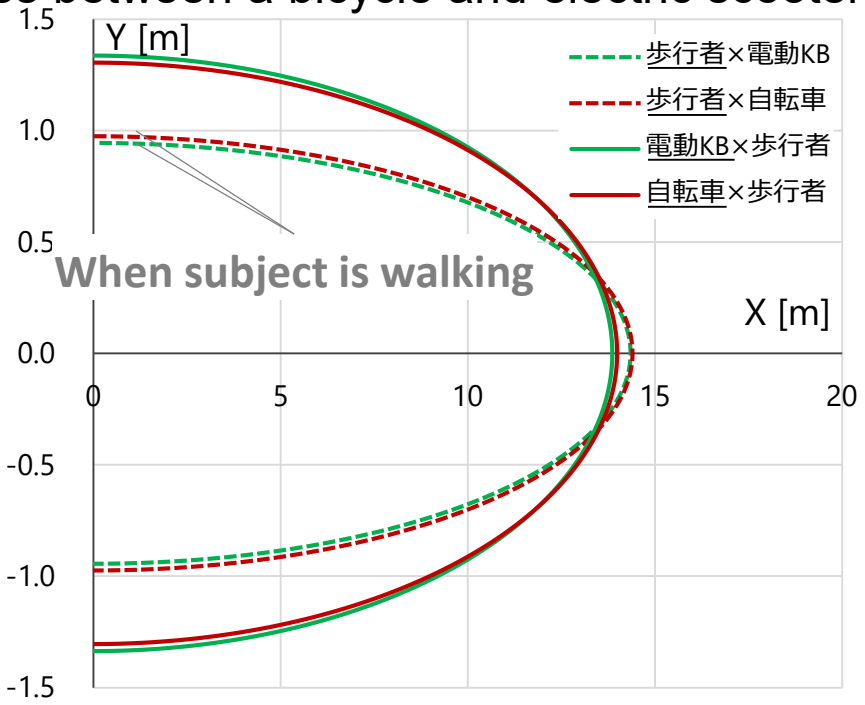
Avoidance probability distribution (50% avoidance probability)

- Comparison of distribution of areas of 50% avoidance probability according to speed
  - Low speed range: avoidance tends to be slower when riding an electric scooter than when riding a bicycle
  - High speed range: almost no differences between a bicycle and electric scooter



Relative speed 10km/h

(5 km/h for pedestrians + 5 km/h for vehicles)



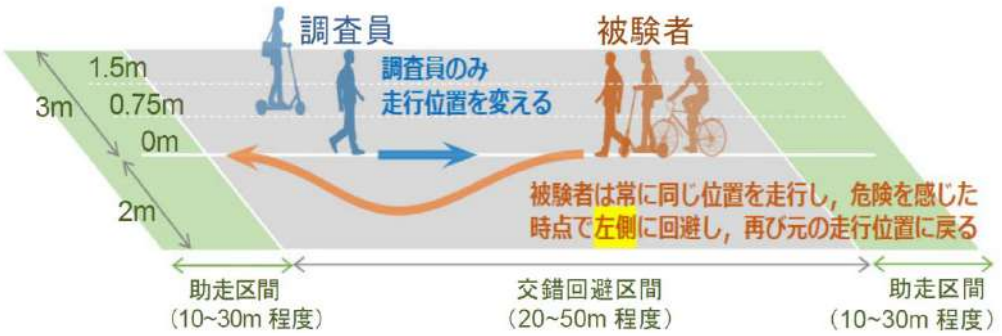
Relative speed 20km/h

(5 km/h for pedestrians + 15 km/h for vehicles)

*Calculated with female dummy = 1

Evaluation of acceptability and anxiety of driving when passing face-to-face (②Nagoya Institute of Technology/on-site experiment)

- Implementation date: a total of five days in November and December 2021
- Location: Nagoya Institute of Technology c
- Subjects: 25 people (14 men, 11 women)
- Flow of experiment
  - ① Preliminary questionnaire
  - ② After driving practice and preliminary drivin passing driving
  - ③ Subject turns left when feeling danger towards the investigator who heads directly towards the subject without avoidance and returns to the original driving position
  - ④ Conducted a questionnaire on the acceptability and anxiety of each drive
  - ⑤ Post-drive, post-experiment questionnaire



- Driving conditions

組合せ	パターン	被験者	調査員	要因/水準 被験者速度 (km/h)	調査員速度 (km/h)	相対速度 (km/h)	走行位置 (m)	パターン数
歩車	A	歩行者	電動KB	5	6/10/15	11/15/20	0/0.75/1.5	9
	B	電動KB	歩行者	6/10/15	5	11/15/20	0/0.75/1.5	9
車車	C	電動KB	電動KB	10/15	6/15	16/21/25/30	0/0.75/1.5	12
	D	自転車	電動KB	10/15	6/15	16/21/25/30	0/0.75/1.5	12
被験者が体験する合計パターン数								42

Subject breakdown

	男性	女性	計
20代	6人	5人	11人
30代	3人	3人	6人
40代	4人	3人	7人
50代	1人	0人	1人
計	14人	11人	25人

Evaluation model of driving acceptability and anxiety during passing

Nominal logistic regression analysis with two categories of dependent variables (responses to questionnaires (1) and (2))

*Only (1) introduced in this presentation

[Dependent variables]

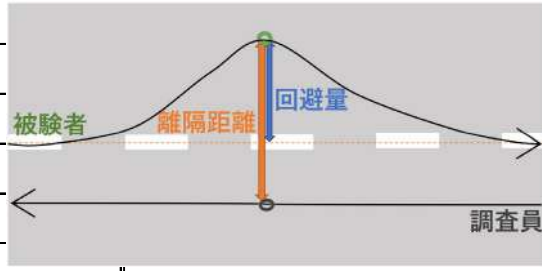
Questionnaire (1)　Driving acceptability

1 , 2 : Not good　　3 , 4 , 5 : Good

Questionnaire (2)　Anxiety during passing

1 , 2 , 3 : Not anxious　　4 , 5 : Anxious

説明変数		定義
属性	年齢	被験者の年齢
	性別ダミー	男性：0，女性：1
	バイク免許別ダミー	バイク免許保有：0，バイク免許なし：1
	自転車利用頻度別ダミー	自転車に乗る：0，自転車に乗らない：1
走行条件	離隔距離	すれ違い時の被験者と調査員の間の距離[m]
	回避量	すれ違い時の被験者の基準線からのずれ[m]
	被験者速度（すれ違い時）	すれ違い時の被験者速度[m/s]
	調査員速度（すれ違い時）	すれ違い時の調査員速度[m/s]
運転特性	1運転スキルへの自信	運転特性の得点 1：全くあてはまらない 2：少しあてはまる 3：かなりあてはまる 4：非常にあてはまる （運転特性の得点は，運転スタイルに関するアンケートにより取得したものを使用する．）
	2運転に対する消極性	
	3せっかちな運転傾向	
	4几帳面な運転傾向	
	5信号に対する事前準備的な運転	
	6ステイタスシンボルとしての車	
	7不安定な運転傾向	
	8心配性的傾向	



Driving acceptability evaluation model

走行の受容性		パターンA 歩行者×電動KB		パターンB 電動KB×歩行者		パターンC 電動KB×電動KB		パターンD 自転車×電動KB	
項		推定値	p値	推定値	p値	推定値	p値	推定値	p値
切片		675.331	0.011	-10.016	<.0001	55.227	0.000	12.817	0.008
属性	年齢	-	-	-	-	0.398	0.011	-0.133	0.001
	性別ダミー	-172.045	0.011	-	-	-29.352	0.002	-3.868	0.005
	バイク免許別ダミー	162.798	0.013	-	-	36.161	0.001	4.820	0.001
	自転車利用頻度別ダミー	88.869	0.009	-	-	-	-	-	-
走行条件	回避量　実測値	-3.523	0.001	-1.086	0.018	-3.105	0.000	-2.101	<.0001
	被験者速度（すれ違い時）	16.170	0.008	1.020	0.001	-	-	-	-
	調査員速度（すれ違い時）	-	-	-	-	-0.564	0.048	-	-
運転特性**	1運転スキルへの自信	-41.513	0.007	0.691	0.031	-	-	-0.828	0.043
	2運転に対する消極性	-103.394	0.013	-	-	-16.859	0.001	-3.680	0.000
	3せっかちな運転傾向	-16.662	0.014	3.043	<.0001	-11.390	0.001	4.740	0.001
	4几帳面な運転傾向	66.991	0.016	-	-	9.244	0.010	3.857	0.002
	5信号に対する事前準備的な運転	-87.016	0.014	-	-	-	-	-	-
	6ステイタスシンボルとしての車	-	-	-	-	-	-	-3.987	0.001
	7不安定な運転傾向	-	-	-	-	-20.027	0.001	-1.788	0.070
	8心配性的傾向	-99.699	0.009	1.182	0.001	7.009	0.006	-	-
R2乗(U)		0.660		0.323		0.605		0.418	
サンプル数		225		224		300		300	

Negative coefficient: Decreases acceptability

All patterns… Large avoidance amount →Low driving acceptability

※下線は被験者　　**Evaluated using driver characteristics checklist (HQL)

When passing an electric scooter (patterns A, C, D)…Low acceptability for 'people who are reluctant to drive'
High acceptability for 'people who tend to drive meticulously'

Vehicles passing each other (patterns C, D)…Low acceptability for 'people who tend to drive in an unstable manner due to mood'.

5. International comparative report on acceptability [WG1]

[Purpose]
Clarify the relationship between the social environment and intention to use/social acceptability through a comparison of the infrastructure development status and the status of dissemination of electric mobility among different countries.

- **Intention to use**: intention of the individual to use the service on their own

≠ Annoying, scary, dangerous… etc., if others use it

- **Social acceptability**: awareness of the advantages and disadvantages of dissemination of the service in society

Target cities: Tokyo, London, Vienna, Doha

2020 onwards
Rapid introduction in anticipation of 2022 WC

End of 2020 onwards

From 2021 onwards, commonly used despite **privately owned vehicles being banned on public roads**

2018 onwards
Early introduction

Survey method

Subjects

- Residents of 23 wards of Tokyo, Greater London, Vienna, and Doha
- Age (20s–40s) and gender are equally divided as a general rule (somewhat biased depending on city)

Question items

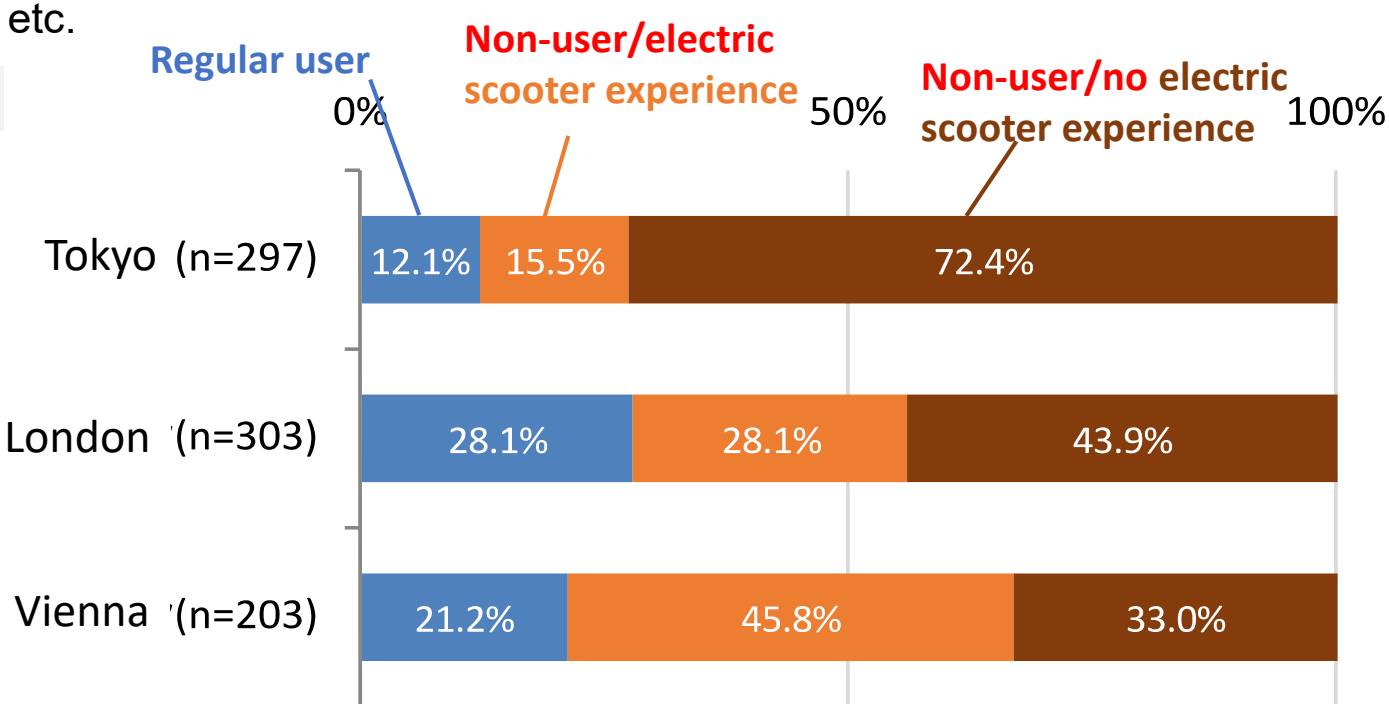
- Usage status of electric scooters, future use intention, evaluation of environment and system related to electric scooters, values regarding electric mobility in general, social acceptability, personal attributes, etc.

Use an electric scooter
at least once a month

→ Regular user

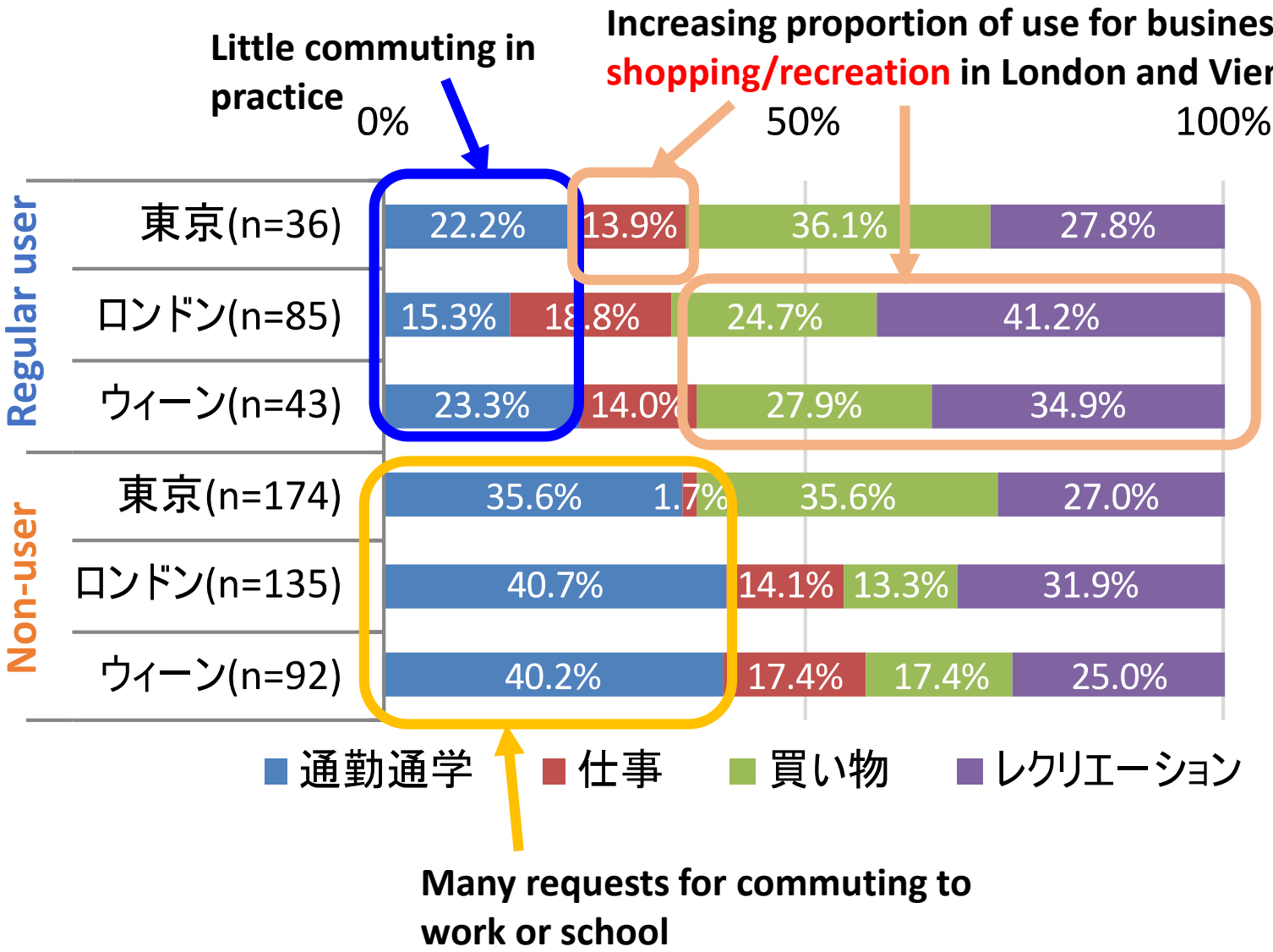
If less

→ Non-user



Basic tabulation results

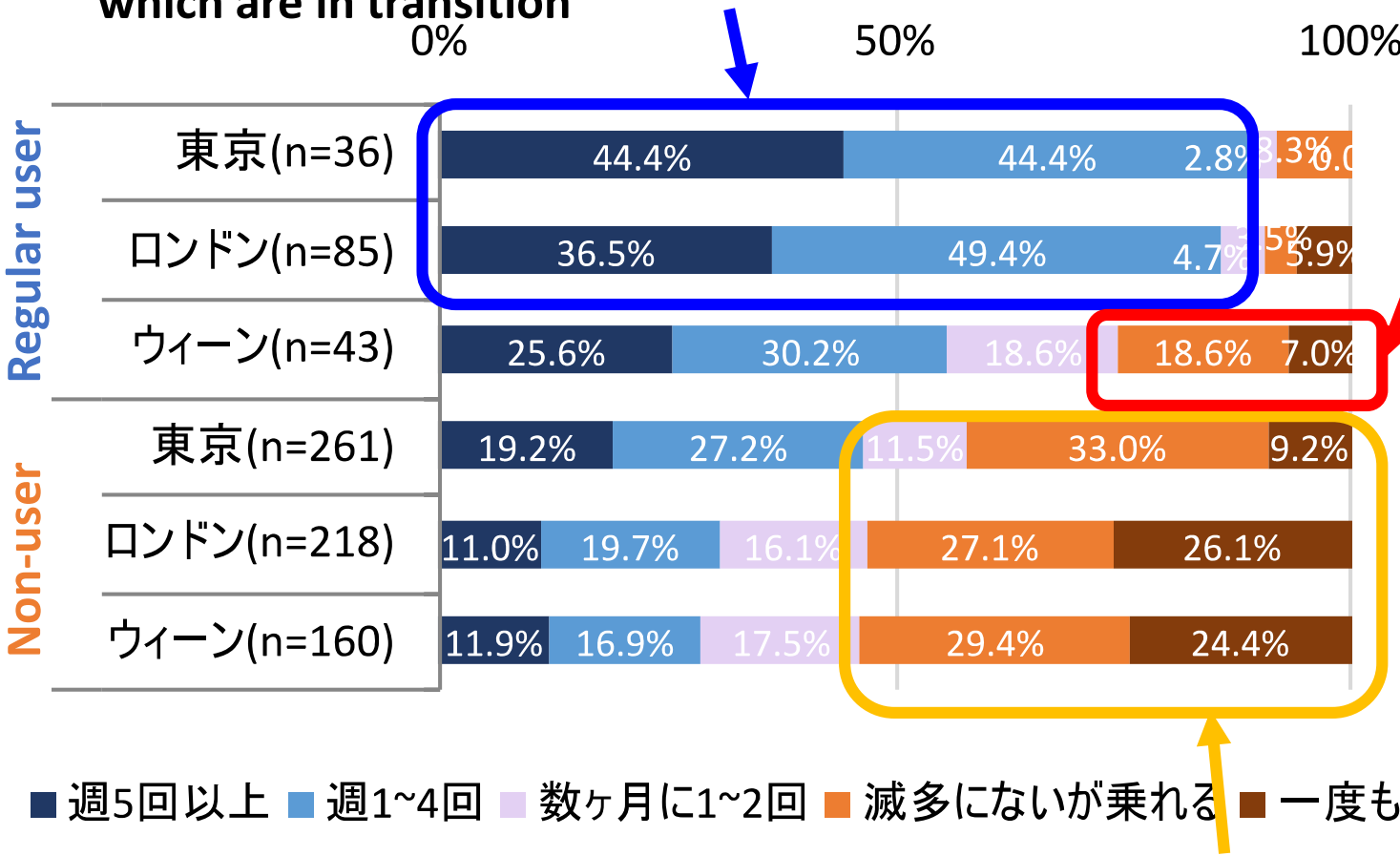
- Purpose of use by regular uses and purpose of use by non-users/prospective users



Basic tabulation results

Frequency of bicycle use by regular users and non-users

Most regular users ride at least once a week in Tokyo and London, which are in transition



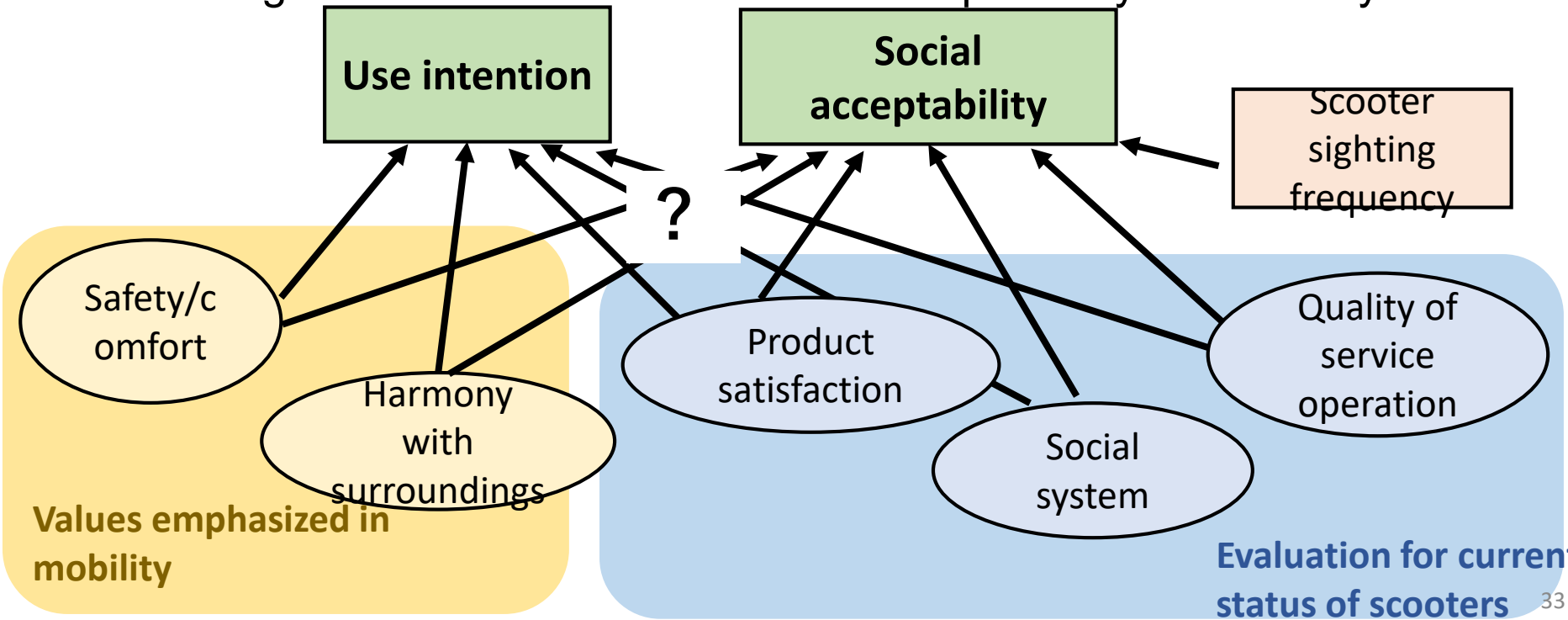
Increasing proportion of non-cyclists in Vienna, where introduction is progressing

Half of the non-users rarely ride

Understanding causal relationships by Structural Equation Modeling

Analysis of factors that determine use intentions and social acceptability of non-users (frequency of less than once a month)

- Particular focus on the values of users, surrounding environment, and systems, while referencing previous research (UTAUT (Venkatesh et al., 2003), etc.)
- The following factors are assumed based on exploratory factor analysis:

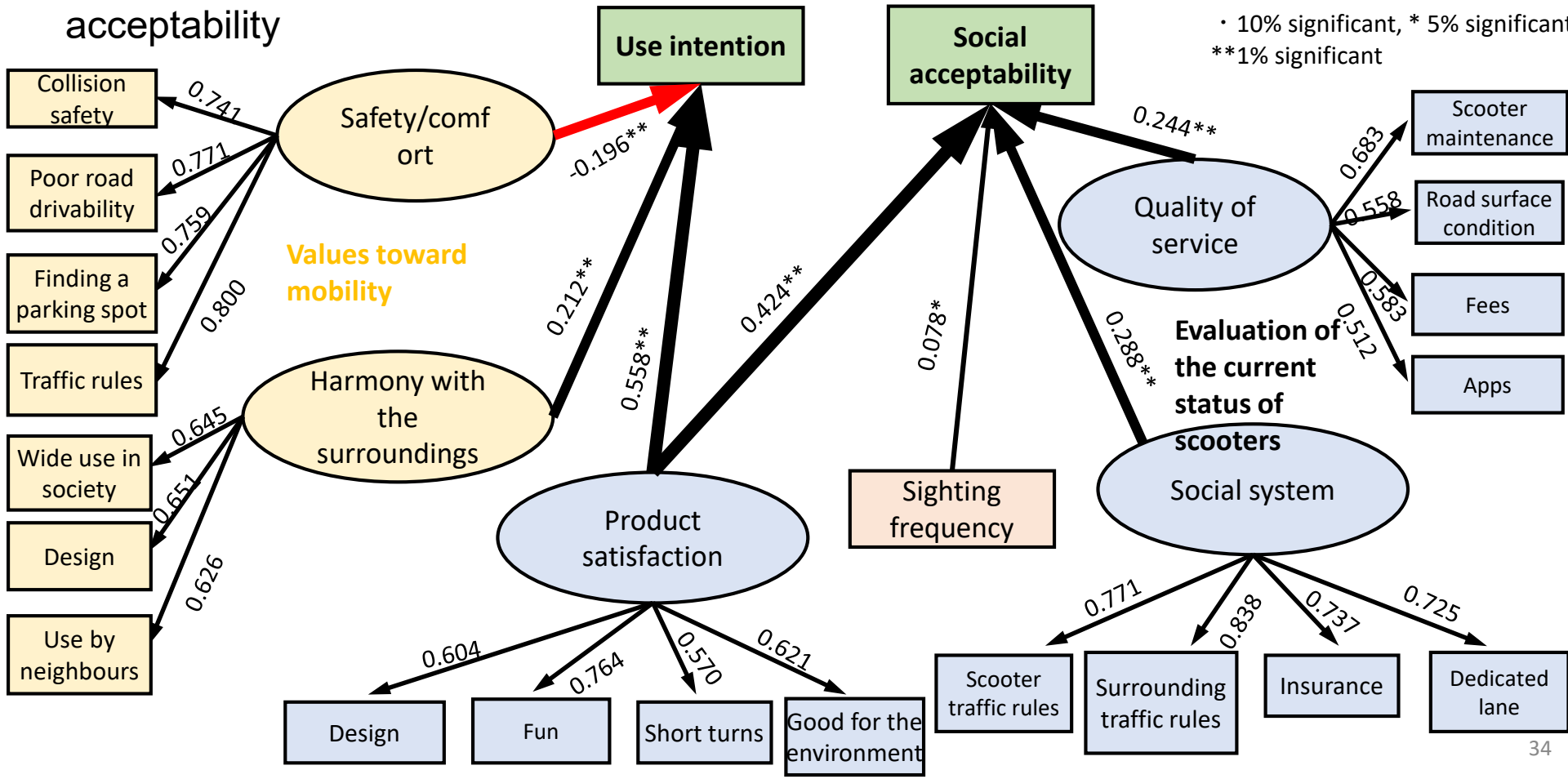


Structural Equation Modeling/non-users (three countries integrated)

- Among non-users, those who place importance on harmony with their surroundings and not on safety have a higher intent to use.
- Higher product satisfaction results in higher use intention and social acceptability
- Quality of social systems and operational services improve social acceptability

n	639
GFI	0.987
AGFI	0.981
CFI	0.898
RMSEA	0.056

・10% significant, * 5% significant
**1% significant

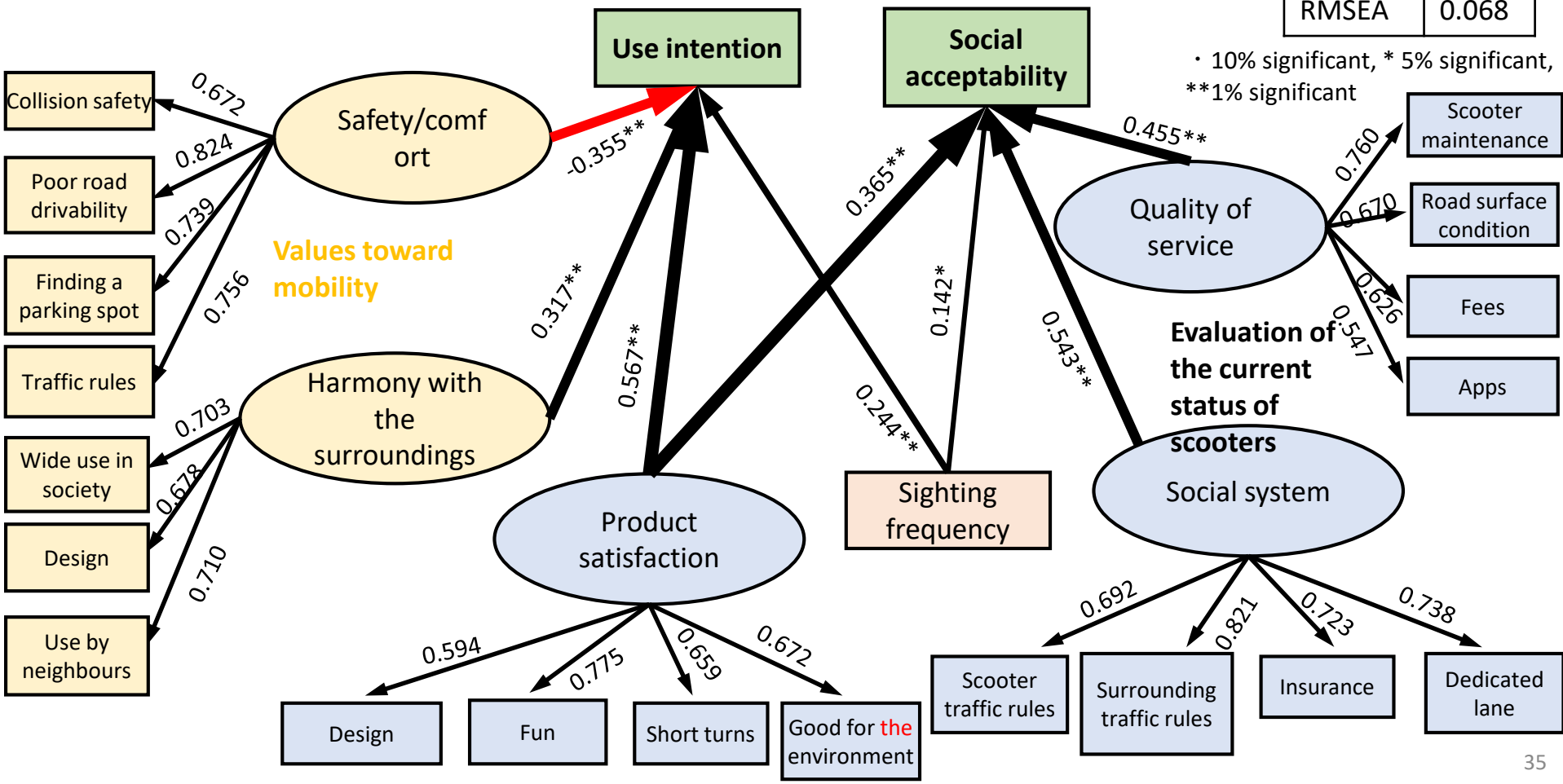


Structural Equation Modeling/non-users (London)

- In London, social systems and quality of services have a relatively large impact on social acceptability

n	218
GFI	0.977
AGFI	0.968
CFI	0.870
RMSEA	0.068

・10% significant, * 5% significant, **1% significant

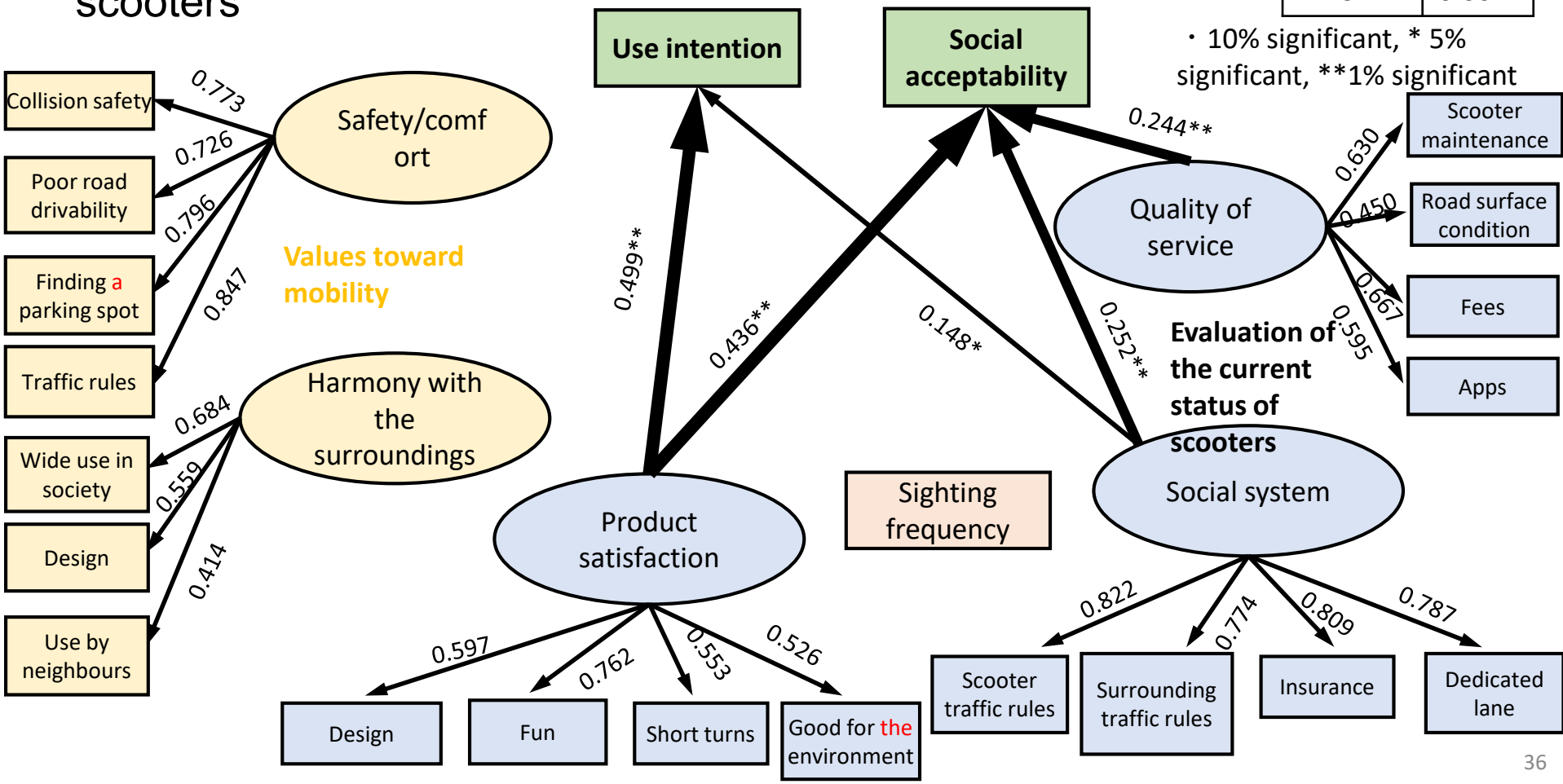


Structural Equation Modeling/non-users (Tokyo)

- In Tokyo, impacts of values and sighting frequency are not significant
- Ultimately determined by evaluation of the current status of scooters

n	261
GFI	0.984
AGFI	0.977
CFI	0.899
RMSEA	0.062

・10% significant, * 5% significant, **1% significant



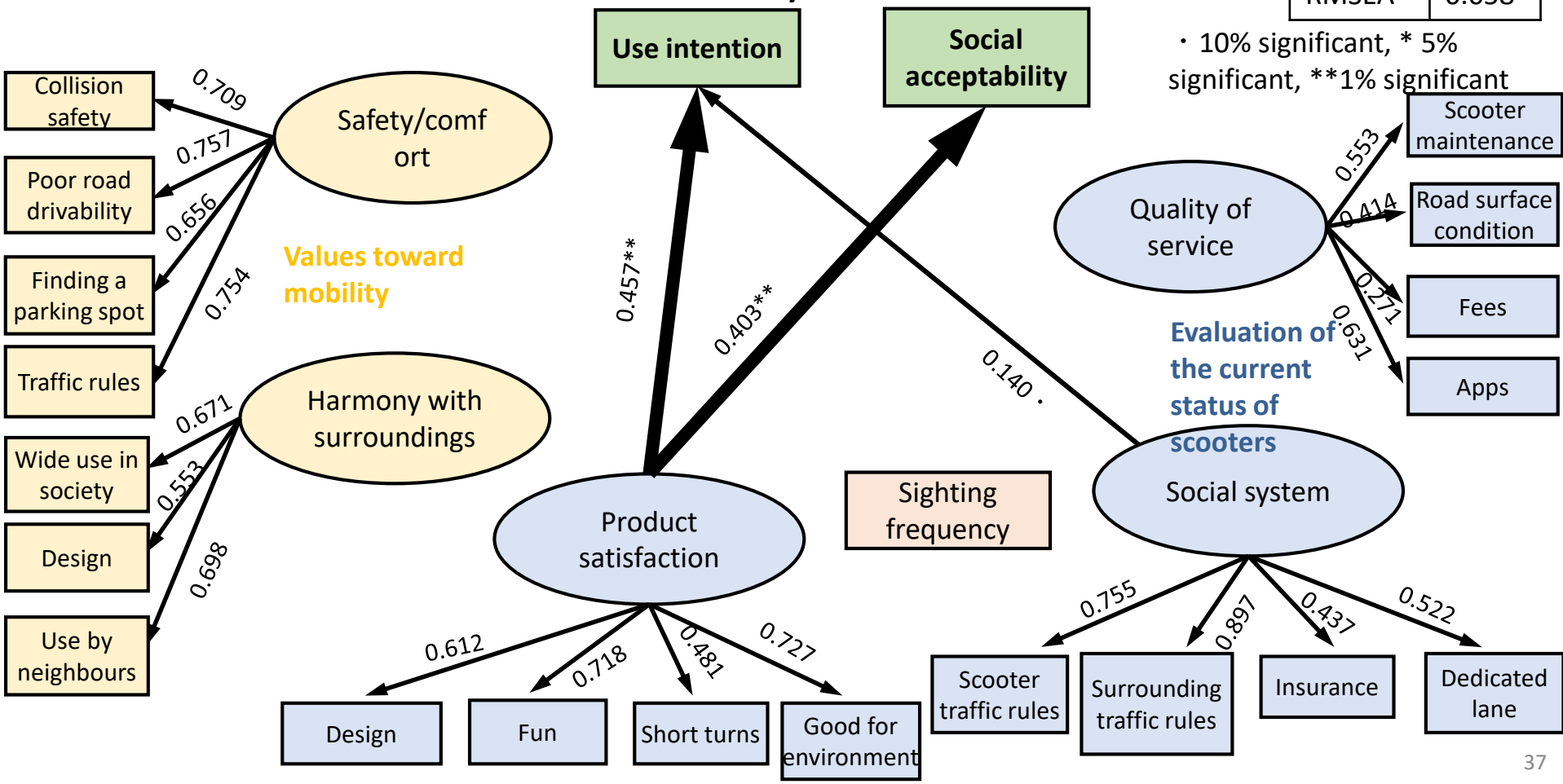
Structural equation modeling/non-users (Vienna)

- In Vienna, only product satisfaction and social systems were significant

n	160
GFI	0.979
AGFI	0.971
CFI	0.864
RMSEA	0.058

Suggests the possibility that the structure of consciousness differs depending on the spread of electric mobility

・10% significant, * 5% significant, **1% significant



6. International workshop report [WG6]

- Theme: **Role of Micro-E-Mobility in Modern Transportation Systems: challenges and future expectations**
  - **Co-sponsored with WCTRS SIG C4 and G2**
- Date: 28 February 2023, 9:00–13:00 (Central European Time, UTC+1)
- Venue: Technical University of Vienna, hybrid format by Zoom
- Program
  - Report
    - Report by three 2208C project members
    - Presentation by two international researchers and practitioners
      - ✓ E-scooters: an evolutionary approach to Acoustic Vehicle Alert Systems (Prof. Nick Tyler --- University College London, UK
      - ✓ Macro Managing Micro Mobility (Mr. Pedro Homem de Gouveia --- POLIS)
  - Panel discussion
    - Moderator: Dr. Wael Alhajyaseen (Qatar University, QAT)
    - Panelists: Prof. Guenter Emberger, Prof. Nick Tyler, Mr. Pedro Homem de Gouveia, and Dr. Koji Suzuki

6. International workshop report [WG6]

- Participants　Approximately 110 people (90 people online, approximately 20 people on-site)
- Main discussion points in the panel discussion
  - Infrastructure suitability
    - Single accident problem→Importance of maintenance and management
  - Safety risk
    - Innovations for reducing speed (relative speed between different forms of mobility)
      → Decrease speed limit, strengthen enforcement, and provide technical support
    - Innovations for reducing contact opportunities　→Separate passage space
  - Future of micro-E-mobility
    - Whether mobility is sustainable, whether it will replace walking (health aspects), consideration for the future
    - Introduction according to trip length (e.g., walking for 1 mile, micro-E-mobility for several km), ideal city structure (importance of hierarchies of road networks to create parking spaces (car → micro-E-mobility) and allow mobility with different speed levels)

Micro-E-mobility usage environment in Vienna

30 km/h speed limit and traffic space separate from other forms of mobility

Connections between sidewalks, bike lane, and crossing facilities

Innovations (markings) for handling connections with arterial roads and intersections

7. Summary

- Compact electric mobility expected to solve local issues
  - **'Securing mobility for the elderly' ⇒ Electric wheelchair**
  - **'Securing last mile' ⇒ Ultra-compact mobility minicar**
  - **'Promotion of tourism', 'Revitalization of central city areas' ⇒ Electric scooters, boarding-type mobility support robots**
- Obtained knowledge and issues for the future spread and development of electric scooters (1)
  - Actual usage analysis
    - Mostly driving on roadway, but some cases of diving on sidewalk (intersections)

      → Necessity of being familiar and thoroughly following rules
    - Space of 1.0 m each from curb and vehicles needed for driving side-by-side and overtaking. Passage space equivalent to a bicycle lane needed. In cases of narrow widths, improvement of urban-type side ditches are also possible.
  - Vehicle motion dynamics
    - Differences in the steering mechanism between low-speed and high-speed areas, and confirmed effectiveness of balance manipulation by steering at speeds lower than approximately 10 km/h. Concerns about avoidance behaviour of vehicles entering and exiting the road, and the danger of driving at intersections. → Necessary to improve the understanding of users regarding motion characteristics such as responsiveness due to speed and differences in the turning radius during lectures.

7. Summary

Obtained knowledge and issues for the future spread and development of electric scooters (2)

- User acceptability
  - The amount of avoidance and differences in normal driving characteristics influence anxiety and acceptability when riding an electric scooter, and evaluations also differ depending on the combination of subjects that pass each other.

    → Also necessary to reduce relative speeds between subjects when scooters pass each other, issue warnings during usage, and raise awareness to increase acceptability that considers driver characteristics.
- Social acceptability
  - Potential differences in the structure of consciousness depending on the spread of electric mobility.

  →During the dissemination transition period, the development of legal systems and improvement of operational services will increase social acceptance.
- Future issues based on the analysis of international cases
  - Electric scooters are relatively easy to own due to the cheap vehicle body and taxes. → Issue of thorough safety education for users who do not have driver's license. Also examinations on bicycle parking.
  - Future-oriented multifaceted study on whether micro-E-mobility such as electric scooters can be called sustainable mobility (aging society, economic impacts)
  - Introduction and deployment of mobility according to the trip length, ideal city structure, and importance of hierarchical road networks to allow for mobility with different speed levels (direction of comprehensive traffic space development)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