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An international comparative study on driving attitudes and behaviors based on questionnaire surveys

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ABSTRACT

Road traffic crashes (RTCs) are influenced by a driver's awareness and attitude toward road safety, as well as the socio-economic status, infrastructure development level, traffic status, social system, and traffic safety culture of the area to which the driver belongs. In this study, based on the results of a questionnaire survey conducted in seven countries, the characteristics of each country concerning tolerance for traffic violations, dangerous driving, and acceptance for road safety measures were studied. It was suggested that a high tolerance for traffic violations and dangerous driving might affect traffic violations and RTCs in each country. Additionally, to reduce the tolerance for traffic violations and dangerous driving, the promotion of road safety education, especially among young and male drivers, and stricter regulations and enforcement were suggested.

1. Introduction

Road traffic crashes (RTCs) account for approximately 1.35 million fatalities per year [1]. Human factors such as driving behavior have been identified as the leading cause of RTCs [2]. Other significant human factors that cause RTCs include reckless driving (speeding, lack of attention, evasive actions, etc.), driving under the influence of drugs (alcohol, medications, etc.), and distraction (texting while driving, peer passenger, use of navigation systems, etc.) [3–7].

Human factors leading to RTCs are closely associated with traffic safety culture. According to Uzondu et al. [8], the traffic safety culture of a country can be defined by the existing values, beliefs, and social norms. Myers et al. [9] defined traffic safety culture as a socially constructed abstract system of meaning, norms, beliefs, and values pertaining to driving held by a group of people. Traffic safety culture can be used as a contextual variable to categorize drivers into safe or risky driving groups based on their attitude toward specific driving behaviors [10]. Personal and general beliefs and attitudes toward traffic safety of the driver play an important role in determining the traffic safety culture, the acceptance of risk-taking, and instances of risky driving behavior [11–13]. According to Ward et al. [14], similar beliefs and attitudes toward traffic safety are shared among drivers from the same country of origin. This indicates that a driver's ethnicity can be an influencing factor in predicting driving behavior, RTCs, and traffic violations.

According to the World Health Organization (WHO), the number of road traffic fatalities varies for different regions [15]. For example, the traffic safety of high-income countries outperforms the low- and middle-income countries [8,16]. This can be attributed to several factors such as driving behavior, road infrastructure, and law enforcement. For example, traffic fatalities are higher in the African region compared to the European region [17]. In addition, among the middle eastern countries, RTCs and violations are more common in the Gulf countries [18–24].

Therefore, it is more advantageous to study the driving behaviors and habits of sub-culture groups of one country rather than studying the driving behavior of individuals because sub-culture groups are easier to approach, and drivers within the same sub-culture tend to influence each other [25]. Studying traffic safety culture is important because it can reveal the reasons behind safe or unsafe driving behaviors of drivers based on the differences in their beliefs and attitudes [26]. Moreover, it can help to improve the existing traffic laws and policies through information regarding the acceptance of these laws and policies among drivers [27].

To study road safety culture, the American Automobile Association (AAA) uses the Traffic Safety Culture Index, which consists of three types of questions, mainly, distracted driving, dangerous driving, and

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drinking / illegal drug driving. They conduct a yearly questionnaire survey for U.S. residents aged 16 and above to understand the changes in the awareness and attitude of U.S. drivers regarding road safety over time [28]. In addition, questionnaire surveys on speeding violations, drunk driving, distracted driving, seatbelt wearing, fatigued driving, etc., are frequently conducted in the *E*-Survey of Road users' Attitudes (ESRA), which was initiated in 2015 as an international joint research project consisting of 38 countries, including countries from North and South America, Europe, Asia/Oceania and Africa; international comparisons were made on the relationship between road safety measures in each country and the consequent RTC reduction effects [29–31]. Based on ESRA results, most drivers were aware that unsafe driving behavior is a frequent cause of RTCs. In addition, the acceptability of unsafe driving behaviors was low between respondents. However, the percentage of drivers who still commit such unsafe behaviors is high. One possible explanation is because some drivers think that they will not make road crashes and it only occurs to other drivers [32]. When comparing driving behavior across regions, the speeding behavior was more common in North America and Europe regions (more than 55% of respondents) compared to Asia/Oceania and Africa [31]. On the other hand, the use of mobile phone for calling or texting while driving was highest in the African region. Different reasons of why drivers use their mobile phone while driving were reported in previous studies. Some of these reasons include underestimation of risk perception of such behavior and the social expectation that someone returns the received call immediately [33,34].

For drinking and driving behavior, and drug driving, the percentage of respondents who declared doing these behaviors was higher in the Asia/Oceania and Africa regions compared to the other regions. About one in every six drivers and one in every seven drivers reported drinking and driving in Asia/Oceania and Africa regions, respectively [35]. The difference in the percentage of drinking and driving behavior between regions could be attributed to the different legislation and the probability of encountering police check-points on the roads. Other from that, the percentage of drug driving was highest in the US, Canada and African countries. The high percentages in U.S. and Canada are not surprising specially with the new legalization of using drugs (i.e., marijuana) for recreational purposes in Canada and many U.S. states [36].

All the above-mentioned unsafe driving behaviors were reported by most drivers to be contributing factors for RTCs. Other factors which also influence the occurrence and may describe the difference of RTCs between countries are the awareness and attitudes of drivers toward road safety. It is considered that these differences in awareness and attitudes are influenced by not only the socio-economic status, infrastructure development level, traffic conditions, and social system of the country to which a driver belongs, but also the differences in traffic safety culture. Therefore, the International Association of Traffic and Safety (IATSS) started the research survey project titled "International comparison: Target setting for road traffic safety and road traffic culture" in 2016 and has been conducting research on the factors that influence road safety awareness through field surveys, hearings, and questionnaire surveys in collaboration with the researchers from each country.

In this paper, based on the results of the questionnaire survey conducted in this project, we compared the tolerance of drivers for traffic violations and dangerous driving and the degree of acceptance for various regulations and enforcement among countries with different cultural and social norms. The primary purpose of this study was to understand the effect of the aforementioned factors on the difference in RTCs.

2. Methodology

2.1. Questionnaire

The questionnaire consisted of 15 questions in total across four major categories: 1) individual attributes, 2) changes in awareness regarding various traffic problems compared with the awareness during three years ago, 3) tolerance for traffic violations and dangerous driving, and 4) approval for various regulations and enforcement. Please refer to Tables 3 to 5 for the specific question items.

The questions in category 1 were: Q1) the model of the car that the drivers drive often, Q2) the number of traffic violations enforced in the past two years, Q3) the number of RTCs in the past two years, Q4) the frequency of driving, Q5) the purpose of driving, Q6) years of driving in the surveyed country, Q7) age, Q8) gender, Q9) nationality, Q10) religion, and Q11) annual income (Q10 and Q11 were omitted from this paper).

The questions in category 2 were regarding the five traffic problems, i.e., traffic congestion, road safety, dangerous driving, distracted driving, and drinking / illegal drug driving. In question 12 of category 2, the magnitude of the problems when compared with those of 3 years ago was based on a 5-point Likert scale, where 1 = "much smaller problem" and 5 = "much bigger problem."

The questions in category 3 were regarding traffic violations and dangerous driving such as speeding, driving with a mobile phone, dozing while driving, not wearing a seatbelt, ignoring traffic lights, and drunk driving. The evaluation from the viewpoint of others and self were asked in Q13 and Q14, respectively, based on a four-point Likert scale, where 1 = "completely unacceptable" and 4 = "completely acceptable."

In category 4, the questions were regarding various regulations and enforcement measures pertaining to mobile phone use, wearing of alcohol detector, camera enforcement of speeding and red-light running, and obligation of wearing motorcycle helmet. The questions were based on a four-point Likert scale, where 1 = "completely unacceptable" and 4 = "completely acceptable."

2.2. Target countries and target participants

The target countries of the questionnaire were 10 countries from Asia (Japan, China, Philippines), Middle East (Qatar, the United Arab Emirates (UAE)), Europe (Italy, Germany, the United Kingdom (particularly Great Britain)), Africa (Egypt), and North America (Canada). The target countries were selected based on high to medium economic and infrastructure development levels and low to medium RTC risks. The selection was based on the premise that it is easy to obtain the cooperation of researchers who are familiar with the actual situation in the target countries. The subjects of the questionnaire were holders of driver's license who were aged 18 and above who live in the target countries.

In this paper, we analyzed seven countries, excluding Canada, Germany, and the Philippines, since the collected sample size in these countries did not meet the minimum required sample size of 400 responses for cross-comparison. Table 1 shows the population composition, status of RTC occurrence, and socio-economic status of the target countries. In Table 1, the name of the country is indicated by a country code of 3 letters conforming to the ISO-3166. An overview of the characteristics of each country showed that QAT and ARE have a high proportion of immigrants and are biased toward men. In terms of age composition, JPN, ITA, and GBR have a high proportion of elderly people aged 65 and above, while QAT, ARE, and EGY have a low proportion of elderly people. EGY has a particularly high proportion of young people who are aged under 20 years. The number of RTC deaths per population of 100,000 tends to be high in CHN, ARE, EGY, and QAT, and low in GBR, JPN, and ITA. It can be inferred that the standards for drunk driving are more relaxed in GBR and ITA than in other countries. In addition, wearing seatbelts in all seats is not mandatory in QAT and EGY, and it can be inferred that GBR has a higher seatbelt-wearing rate than other countries.

2.3. Questionnaire survey method and data cleaning

The questionnaire survey was conducted from 2017 to 2019 via e-mail, SNS, etc., mainly in the form of an online questionnaire, and

Table 1
Demographic and socio-economic status of survey countries.

Country		Japan (JPN)	Italy (ITA)	UK (GBR)	Qatar (QAT)	UAE (ARE)	Egypt (EGY)	China (CHN)
Population (× million)		126.5	60.5	67.9	2.9	9.9	102.3	1439.3
Gender	Male	49%	49%	49%	75%	69%	51%	51%
	Female	51%	51%	51%	25%	31%	49%	49%
Age	~19	17%	18%	23%	17%	19%	42%	23%
	20~34	15%	16%	20%	42%	40%	24%	22%
	35~64	40%	43%	39%	39%	40%	28%	43%
	65~	28%	23%	19%	2%	1%	5%	12%
Share of international migrants*		2%	10%	14%	79%	88%	1%	0%
Road length per capita [km/1000 cap]*		9.64	8.07	5.81	2.44	0.41	0.64	3.45
Road length per land area [km/km^2]*		3.22	1.62	1.63	0.61	0.05	0.06	0.52
Number of registered vehicles per capita [veh/person]		0.64	0.88	0.58	0.52	0.37	0.09	0.21
Road traffic deaths per 100k people (WHO estimated, 2016)		4.1	5.6	3.1	9.3	18.1	9.7	18.2
Rank of lower road traffic deaths among 173 countries (Percentile of rank)		13 (8%)	23 (13%)	8 (5%)	46 (27%)	104 (60%)	51 (29%)	107 (62%)
Income group		High	High	High	High	High	Lower Middle	Upper Middle
Seat-belt law applied to front and rear seat occupants		Yes	Yes	Yes	No	Yes	No	Yes
Seat-belt wearing rate	Front	95%	62%	95%	–	–	–	37%
	Rear	36%	15%	90%	–	–	–	
BAC limit (g/dl)		<0.03	≤0.05	≤0.08	–	≤0.01	–	<0.02
% road traffic deaths involving alcohol		6%	20-25%	13%	2%	2%	–	<1%

0 – 100%

Note: Share of international migrants is based on [37,38]. Road length is based on [39]. For other items, refer to [1].

responses were obtained from local university officials, local government officials, the general public, etc. However, some surveys of EGY and QAT were difficult to carry out online due to a lack of reliable internet infrastructure. Therefore, the surveys were carried out by distributing questionnaires. The questionnaire was originally in English, and the local research collaborators (university faculty members) carefully translated it to their native language other than English (Japanese, Italian, Arabic, and Chinese). The accuracy of the translations of the local native languages was checked by translating them back into English.

Blank answers, generic answers, and answers through online access from outside the target country were termed as abnormal answers, and data cleaning was carried out by excluding them.

2.4. Analytical method

Basic tabulation of the answers from Q12 to Q15 based on the target country was conducted to understand the characteristics of each country's tolerance for traffic violations and dangerous driving and its acceptance for various regulations and enforcement. Next, the relationship between traffic violations and RTCs in young people and other age groups was established by cross-tabulation. Furthermore, the difference in tolerance for traffic violations, dangerous driving, and the difference in acceptance for various regulations/enforcement depending on gender, age, and the presence or absence of traffic violations and RTCs, were determined by aggregating questionnaire items by factor analysis. Factor analysis was performed using the data set for all the countries. Finally, focusing on young men, the introduction of effective regulatory and enforcement measures was considered by comparing the different tolerance and acceptance levels of the target countries.

3. Results and discussion

3.1. Tabulation results

3.1.1. Basic attributes of countries and analyzed objects

Table 2 (a) shows the aggregated results of the sample size and basic attributes of each country. QAT, ARE, EGY, and CHN had a high proportion of young people under the age of 34, and JPN and GBR had the highest proportion of elderly people. In contrast, as for nationality, the proportion of foreign nationalities was high in QAT and ARE, which is consistent with the high proportion of immigrants in both countries in Table 1. In QAT, the ratio of buses was high as the vehicle type, and it was inferred that the high ratio of professional drivers for driving purposes had an effect. Regarding the number of years of driving in the target country, it was presumed that many respondents in QAT, ARE, and CHN had less than three years of driving experience and that many immigrants or young people of foreign nationality had an effect especially in QAT and ARE. Regarding the number of traffic violations and RTCs in the past two years, JPN, ITA, and GBR had a non-violation and crash-free rate of about 90% or more, while QAT, ARE, EGY, and CHN had relatively higher rates of traffic violation and RTC more than once compared to these three countries. In particular, in ARE and EGY, those who experienced RTC twice or more accounted for more than 20%, which is almost the same as the characteristics of the statistical data on the situation of crash occurrence in the surveyed countries shown in 2.2.

To avoid differences in driving experience in the surveyed countries and the effects of bias caused by professional drivers, a comparative analysis was conducted after excluding answers that met the following conditions:

Table 2
Features of survey respondents.

		(a) Original dataset							→ (b) Final dataset (analysis target)						
		JPN	ITA	GBR	QAT	ARE	EGY	CHN	JPN	ITA	GBR	QAT	ARE	EGY	CHN
Sample size		634	871	486	725	480	525	1517	374	567	360	196	337	397	971
Gender (Q8)	Male	56%	60%	58%	86%	50%	85%	66%	55%	62%	54%	66%	52%	84%	72%
	Female	44%	40%	42%	14%	50%	15%	34%	45%	38%	46%	34%	48%	16%	28%
Age (Q7)	~19	1%	0%	0%	4%	6%	0%	1%	–	–	–	–	–	–	–
	20~34	34%	24%	14%	50%	70%	42%	46%	32%	27%	18%	57%	70%	44%	30%
	35~49	26%	41%	26%	39%	16%	41%	43%	38%	42%	34%	33%	21%	42%	56%
	50~64	20%	30%	37%	7%	7%	15%	10%	30%	31%	49%	10%	9%	14%	13%
	65+	20%	4%	23%	0%	0%	1%	0%	–	–	–	–	–	–	–
Nationality (Q9)	Domestic	100%	97%	96%	5%	24%	99%	100%	100%	98%	95%	11%	24%	99%	100%
	Foreigner	0%	3%	4%	95%	76%	1%	0%	0%	2%	5%	89%	76%	1%	0%
Vehicle type (Q1)	Car	75%	76%	87%	41%	79%	69%	68%	77%	79%	87%	57%	77%	77%	74%
	SUV	5%	3%	7%	13%	20%	12%	17%	6%	2%	8%	40%	23%	13%	21%
	Van or minivan	7%	0%	2%	1%	0%	8%	1%	10%	0%	2%	1%	0%	2%	1%
	Motorcycle	6%	5%	3%	0%	0%	6%	3%	4%	3%	3%	0%	0%	7%	2%
	Bus	0%	1%	0%	42%	0%	3%	6%	–	–	–	–	–	–	–
	Truck	0%	0%	0%	1%	0%	1%	1%	–	–	–	–	–	–	–
	Others	7%	15%	0%	1%	1%	2%	5%	3%	16%	0%	2%	0%	2%	2%
Driving frequency (Q4)	Everyday	37%	48%	69%	91%	81%	75%	45%	48%	41%	74%	92%	88%	74%	58%
	Several in a week	24%	31%	27%	7%	11%	18%	21%	25%	37%	23%	7%	9%	19%	25%
	Once in a week	12%	12%	3%	0%	3%	4%	10%	15%	16%	3%	0%	1%	4%	11%
	Once in a month	12%	4%	0%	0%	1%	2%	8%	12%	5%	1%	1%	1%	3%	6%
	Seldom	15%	5%	1%	1%	4%	1%	16%	–	–	–	–	–	–	–
Driving purpose (Q5)	Commuting	21%	24%	45%	22%	52%	57%	57%	33%	35%	58%	57%	60%	70%	68%
	Education	3%	2%	1%	12%	25%	4%	7%	3%	3%	1%	22%	19%	4%	4%
	Business	6%	2%	9%	7%	10%	7%	9%	7%	3%	12%	11%	12%	9%	10%
	Professional driver	1%	27%	3%	54%	2%	17%	3%	–	–	–	–	–	–	–
	Others	68%	44%	42%	4%	10%	16%	24%	56%	58%	29%	10%	9%	18%	18%
Number of driving years in the country (Q6)	1	8%	1%	0%	17%	14%	1%	18%	–	–	–	–	–	–	–
	2	5%	0%	0%	15%	12%	4%	10%	–	–	–	–	–	–	–
	3~5	9%	1%	2%	33%	30%	16%	24%	11%	1%	3%	47%	40%	19%	32%
	6~10	7%	11%	5%	17%	20%	29%	27%	9%	11%	6%	23%	28%	32%	39%
	11+	72%	88%	93%	17%	25%	50%	21%	80%	87%	91%	30%	32%	49%	30%
Number of traffic tickets in the past two years (Q2)	0	90%	89%	95%	68%	23%	44%	48%	89%	89%	96%	42%	15%	41%	34%
	1	8%	0%	1%	14%	18%	15%	16%	9%	0%	1%	24%	18%	17%	20%
	2+	2%	11%	3%	18%	59%	41%	35%	2%	11%	3%	34%	67%	42%	46%
Number of traffic crashes in the past two years (Q3)	0	96%	86%	91%	71%	53%	58%	80%	94%	87%	90%	49%	50%	56%	75%
	1	3%	12%	8%	15%	28%	21%	14%	4%	10%	9%	27%	26%	22%	17%
	2+	1%	3%	1%	14%	20%	21%	6%	2%	2%	1%	24%	23%	22%	8%

0 – 100%

i) Less than 20 years old or 65 years old or older.
ii) The driving purpose was "professional driver."
iii) Drives a bus or truck, where the driver was likely to be a professional driver.
iv) The driving frequency was "seldom."
v) Less than 3 years of driving in the target country.

Table 2 (b) depicts the aggregated results, excluding these answers. Subsequent analysis results were based on the sample shown in Table 2 (b).

3.1.2. Changes in awareness of traffic problems

Table 3 shows the average response values of the change in awareness of various traffic problems in each country compared with three years ago (Q13). In EGY, all items tended to worsen, while in CHN they tended to improve except for traffic congestion. It was observed that dangerous driving and distracted driving tended to worsen in all countries except for CHN, especially in developed countries. A possible reason is that many traffic enforcement cameras have been implemented in Chinese cities in recent years, and meanwhile traffic safety polices against dangerous and distracted driving are becoming stricter. Dangerous driving and distracted driving were recognized as a larger

Table 3
Cognition of traffic related issues (Q12) (5-point Likert scale from 1 "much smaller problem" to 5 "much bigger problem").

Question	JPN	ITA	GBR	QAT	ARE	EGY	CHN
For each of the following issues, please tell us how much of a problem it is, compared to 3 years ago.							
1. Traffic congestion	3.3	3.5	4.2	4.0	3.9	4.7	3.6
2. Traffic safety	3.6	3.3	3.6	3.4	3.3	4.2	2.9
3. Aggressive drivers	4.1	3.9	4.0	3.6	3.6	4.6	2.7
4. Distracted drivers	3.8	4.4	4.4	3.9	3.9	4.5	3.0
5. Drivers under the influence	3.7	3.3	3.3	2.5	2.7	3.9	2.0

1.0 — 3.0 — 5.0

social problem than traffic congestion and RTC. Especially in JPN, dangerous driving was recognized as the biggest problem compared to other traffic problems, and it was presumed that the survey period overlapped with the time when dangerous driving became a social problem [40]. After that, JPN enforced the Revised Road Traffic Act in June 2020 and stricter punishment for "tailgating."

3.1.3. Tolerance for traffic violations and dangerous driving

Table 4 shows the average response values for tolerance for traffic violations and dangerous driving by others (Q13) and self (Q14) in each country.

It can be seen that every country had a higher tolerance for speeding (1–4) than other items by both others and self. However, every country had the lowest tolerance for speeding in a school zone. Tolerance for using mobile phones (5–7) and hands-free calling (5), which was permitted in every country, was high for both self and others. In contrast, hand-held calls (6), which are prohibited in every country, had a high tolerance by others in ITA, EGY, ARE, and QAT, and considering the results of the social problem of distracted drivers in Q12 of these countries, it can be seen that the percentage of violators is high.

Regarding non-fastening of seat belts (9 to 10), in QAT and EGY, where only wearing seat belts in the front seats is mandatory, the tolerance for non-fastening of seat belts in the driver's seat was high by others. In addition, ITA, ARE, and CHN, where wearing seatbelts in all seats is mandatory, had a high tolerance for not wearing seatbelts in the rear seats. Therefore, it was inferred that the obligation to wear seatbelts was not fully observed in these countries. For other traffic violations and dangerous driving (8, 11–12), all the countries had a low tolerance by others and self. However, only ITA had a remarkably high tolerance for red-light running (11), and it was inferred that red-light running was likely to occur. In particular, ITA had a higher tolerance by others than self compared to other countries.

Table 4
Tolerance of traffic violations and risky driving behaviors by others (Q13) and self (Q14) (4-point Likert scale from 1 "completely unacceptable" to 4 "completely acceptable").

Question	JPN	ITA	GBR	QAT	ARE	EGY	CHN
A. Where you live, how acceptable would MOST OTHER PEOPLE consider for a driver to...? (Q13)							
1. Drive 20 kilometers per hour over the speed limit on a freeway/highway	2.7	3.4	3.3	2.7	3.1	3.0	2.6
2. Drive 10 kilometers per hour over the speed limit on a residential street	2.5	3.3	2.6	2.5	2.8	2.8	2.3
3. Drive 10 kilometers per hour over the speed limit in an urban area	2.7	3.2	2.7	2.6	2.8	2.8	2.6
4. Drive 10 kilometers per hour over the speed limit in a school zone	2.0	2.6	1.8	2.0	2.1	2.4	2.0
5. Talk on a hands-free cell phone while driving	2.5	3.5	3.2	2.8	3.2	2.6	2.8
6. Talk on a hand-held cell phone while driving	1.5	2.7	1.7	2.2	2.2	2.4	1.9
7. Type text messages or e-mails while driving	1.4	2.4	1.5	1.9	1.9	2.0	1.3
8. Drive when they're so sleepy that they have trouble keeping their eyes open	1.3	1.8	1.5	2.0	1.8	2.1	1.5
9. Drive without wearing their seatbelt	1.6	1.9	1.5	2.1	2.0	2.4	1.8
10. Drive with passengers not wearing seatbelts	1.7	2.5	1.6	2.6	2.6	2.8	2.3
11. Drive through a traffic signal light that just turned red, when they could have stopped safely	1.5	2.4	1.9	1.7	1.6	1.8	1.3
12. Drive when they think they are under the influence of alcohol/illegal drug	1.2	1.7	1.4	1.3	1.3	1.6	1.1
B. How acceptable do you PERSONALLY FEEL it is for a driver to...? (Q14)							
1. Drive 20 kilometers per hour over the speed limit on a freeway/highway	2.6	2.5	2.9	2.4	3.0	2.8	2.3
2. Drive 10 kilometers per hour over the speed limit on a residential street	2.3	2.2	1.9	2.0	2.5	2.6	2.1
3. Drive 10 kilometers per hour over the speed limit in an urban area	2.5	2.1	2.0	2.2	2.6	2.5	2.4
4. Drive 10 kilometers per hour over the speed limit in a school zone	1.9	1.4	1.2	1.6	1.8	2.1	1.8
5. Talk on a hands-free cell phone while driving	2.4	3.0	2.7	2.6	3.1	2.5	2.6
6. Talk on a hand-held cell phone while driving	1.5	1.3	1.1	1.5	1.8	2.2	1.7
7. Type text messages or e-mails while driving	1.3	1.1	1.1	1.3	1.3	1.8	1.3
8. Drive when they're so sleepy that they have trouble keeping their eyes open	1.3	1.1	1.1	1.4	1.3	1.8	1.3
9. Drive without wearing their seatbelt	1.6	1.2	1.2	1.5	1.4	2.1	1.4
10. Drive with passengers not wearing seatbelts	1.7	1.6	1.2	1.9	1.9	2.3	2.0
11. Drive through a traffic signal light that just turned red, when they could have stopped safely	1.4	1.5	1.3	1.2	1.2	1.5	1.2
12. Drive when they think they are under the influence of alcohol/illegal drug	1.2	1.1	1.1	1.1	1.1	1.4	1.1

1.0 — 2.5 — 4.0

Table 5
Acceptance of traffic safety policy and enforcement (Q15) (4-point Likert scale from 1 "completely unacceptable" to 4 "completely acceptable").

Question	JPN	ITA	GBR	QAT	ARE	EGY	CHN
How strongly do you support or oppose...?							
1. Having a law against reading, typing, or sending a text message or email while driving	3.3	3.6	3.8	3.5	3.6	3.6	3.4
2. Having a law against using a hand-held cell phone while driving, for all drivers regardless of their age	3.3	3.6	3.8	3.5	3.4	3.5	3.3
3. Having a law against using any type of cell phone while driving, hand-held or hands-free, for all drivers regardless of their age	2.6	2.5	2.6	2.6	2.5	2.7	2.9
4. Having a law requiring all drivers who have been convicted of DWI (Driving While Intoxicated) to use a device that won't let the car start if they have been drinking, even if it's their first time being convicted of DWI	3.4	3.3	3.3	3.6	3.6	3.6	3.3
5. Requiring all new cars to have a built-in technology that won't let the car start if the driver's alcohol level is over the legal limit	3.4	3.3	3.2	3.4	3.6	3.6	3.2
6. Using cameras to automatically ticket drivers who drive more than 20 kilometers per hour over the speed limit on freeways/highways	2.5	2.6	2.1	3.0	3.1	3.4	3.0
7. Using cameras to automatically ticket drivers who drive more than 10 kilometers per hour over the speed limit on residential streets	2.5	2.7	2.5	2.9	2.9	3.4	2.9
8. Using cameras to automatically ticket drivers who drive more than 10 kilometers per hour over the speed limit in urban areas	2.4	2.7	2.3	2.9	2.9	3.4	2.8
9. Using cameras to automatically ticket drivers who drive more than 10 kilometers per hour over the speed limit in school zones	2.8	3.3	3.1	3.4	3.4	3.6	3.2
10. Using cameras to automatically ticket drivers who run traffic signal red lights in urban areas	3.1	3.3	3.0	3.6	3.6	3.7	3.4
11. Using cameras to automatically ticket drivers who run traffic signal red lights on residential streets	3.2	3.3	3.2	3.6	3.7	3.7	3.4
12. Having a law requiring all motorcycle riders to wear a helmet	3.5	3.9	3.9	3.8	3.8	3.6	3.5
13. Having the government regulate non-driving-related technologies in cars to make sure they don't distract drivers	2.4	3.1	3.1	3.0	3.1	3.2	2.9

1.0 — 2.5 — 4.0

Table 6
Traffic tickets/crashes within past two years by gender and age.

Gender		Male			Female		
Age		20~34	35~49	50~64	20~34	35~49	50~64
Sample size		719	909	459	436	440	240
Traffic tickets	0	46.6%	49.4%	66.7%	55.0%	62.3%	84.6%
	1	15.3%	14.1%	10.2%	9.9%	14.5%	6.7%
	2+	38.1%	36.5%	23.1%	35.1%	23.2%	8.8%
Traffic crashes	0	63.4%	75.6%	83.9%	63.8%	83.2%	90.8%
	1	20.2%	17.5%	10.2%	19.5%	11.8%	5.8%
	2+	16.4%	6.9%	5.9%	16.7%	5.0%	3.3%

0 — 100%

3.1.4. Degree of acceptance for various regulations and enforcement

Table 5 shows the average value of acceptance responses to various regulations and enforcement measures in each country. Every country had a high acceptance for sending e-mails while driving, restricting the use of mobile phones such as handheld calls (1–3), and requiring the installation of alcohol detectors (4–5). However, the acceptance for speeding camera enforcement (6–8) was low for JPN, ITA, and GBR but high for QAT, ARE, and CHN, while EGY had the highest acceptance. In contrast, speeding camera enforcement (9) in a school zone was highly approved in all the countries. Red-light running camera enforcement (10—11) had a high acceptance in every country and was particularly high in emerging countries such as QAT, ARE, and EGY. In addition, as an overall feature, it can be seen that EGY had a higher acceptance for tightening regulations than other countries in almost all items.

3.1.5. Comparison of traffic violations and dangerous driving by gender and age

Table 6 summarizes the composition ratios by gender and age group according to the number of traffic violations and RTCs in the past two years for all countries. From this, it can be inferred that a high proportion of those who experienced traffic violations and RTCs at least once, and especially those who experienced them at least twice, was young and male.

Table 7
Factor analysis of tolerance of others toward risky behavior (Q13).

Item	Factor loading		
	Factor 1	Factor 2	Factor 3
7. Typing a text	**0.998**	0.011	−0.076
6. Hand-held phone	**0.812**	0.023	0.059
8. Drowsy driving	**0.734**	−0.044	0.134
12. Alcohol/illegal drug	**0.701**	0.032	0.036
11. Red-light running	**0.525**	0.145	0.132
2. Over 10 km/h on a residential street	0.042	**0.885**	−0.055
3. over 10 km/h on freeways	−0.079	**0.878**	0.061
4. over 10 km/h in a school zone	0.136	**0.706**	−0.024
1. over 20 km/h on freeways	−0.003	**0.629**	0.059
10. Passengers without seatbelt	−0.044	0.044	**0.946**
9. Without seatbelt	0.137	−0.047	**0.795**
% of variance	29.4%	23.4%	15.8%
Cum. % of variance	29.4%	52.8%	68.6%

Note: Those with factor load of 0.4 or more are indicated in bold.

Table 8
Factor analysis of personal tolerance on risky behavior (Q14).

Item	Factor loading		
	Factor 1	Factor 2	Factor 3
2. over 10 km/h on residential street	**0.936**	−0.012	−0.039
3. over 10 km/h on freeways	**0.900**	−0.05	0.015
4. over 10 km/h in a school zone	**0.694**	0.2	−0.018
1. over 20 km/h on freeways	**0.664**	−0.06	0.077
12. Alcohol/illegal drug	−0.033	**1.029**	−0.031
11. Red-light running	0.045	**0.73**	0.02
8. Drowsy driving	0.119	**0.512**	0.303
7. Typing a text	0.173	**0.495**	0.281
9. Without seatbelt	−0.01	0.041	**0.932**
10. Passengers without seatbelt	0.005	−0.04	**0.875**
% of variance	27.8%	23.9%	20.2%
Cum. % of variance	27.8%	51.7%	72.0%

Note: Those with factor load of 0.4 or more are indicated in bold.

Table 9
Factor analysis of acceptance toward traffic safety policy (Q15).

Item	Factor loading			
	Factor 1	Factor 2	Factor 3	Factor 4
7. Over 10 km/h on residential streets	**0.983**	−0.056	0	0.006
8. Over10 km/h over in urban areas	**0.977**	−0.008	−0.015	−0.024
6. Over 20 km/h on highway	**0.755**	0.071	−0.015	0.018
9. Over 20 km/h in school zone	**0.663**	0.16	0.083	0.053
10. Ignore traffic light in urban areas	−0.019	**1.026**	−0.018	−0.019
11. Ignore traffic light on residential streets	0.057	**0.825**	0.04	0.048
1. Prohibition of typing text	−0.02	0.007	**0.927**	−0.02
2. Prohibition of hand-held cell phone	0.024	−0.011	**0.846**	0.028
5. Alcohol detector on new car	−0.012	−0.006	−0.038	**1.021**
4. Alcohol detector for convicted driver	0.035	0.022	0.108	**0.732**
% of variance	30.5%	18.8%	16.4%	16.5%
Cum. % of variance	30.5%	49.3%	65.8%	82.2%

Note: Those with factor load of 0.4 or more are indicated in bold.

3.2. Factor analysis

3.2.1. Factor analysis of tolerance for traffic violations/dangerous driving and acceptance for various regulations/enforcement

Factor analysis (maximum likelihood estimation method, direct oblimin rotation) [41] was performed using the final data set for all the countries shown in Table 2 (b) to extract the factors that influence the tolerance for traffic violations/dangerous driving and the response regarding acceptance for various regulations/enforcement. The sphere test of Keiser-Meyer-Olkin (KMO) and Bartlett were performed to confirm the validity. The KMO reference value was 0.8 or higher, and Bartlett's sphere test resulted in $p < 0.001$, confirming the validity of applying factor analysis. In factor analysis, the number of factors was determined based on parallel analysis and the Minimum Average Partial (MAP) test, and the items whose absolute value of factor loading was less than 0.40 were deleted. The results of factor analysis are shown in Tables 7–9.

Regarding the permissible surroundings for traffic violations and dangerous driving, three factors were extracted: Factor 1 = factor related to dangerous driving, Factor 2 = factor related to speeding, and Factor 3 = factor related to non-fastening of seat belts (Table 7). Similarly, in terms of self-tolerance, three factors were extracted: Factor 1 = factor related to speeding, Factor 2 = factor related to dangerous driving, and Factor 3 = factor related to non-fastening of seat belts (Table 8). In contrast, in the acceptance for various regulations and enforcement, four factors were extracted: Factor 1 = factor related to speeding camera enforcement, Factor 2 = factor related to red-light running (RLR) camera enforcement, Factor 3 = factor related to mobile phone use regulation, and Factor 4 = factor related to alcohol detector installation (Table 9).

3.2.2. Comparison of factor scores by gender/age, and presence or absence of traffic violations / RTCs

Factor scores were calculated for each respondent based on the factors extracted in 3.2.1. Table 10 summarizes the average values of factors related to tolerance for traffic violations/dangerous driving and acceptance for various regulations and enforcement by others and self, according to gender and age group. It can be inferred that the factors related to tolerance for traffic violations and dangerous driving were higher in both males and younger people, both by others and self.

Table 10
Mean factor scores by gender and age.

Gender	Male			Female		
Age	20~34	35~49	50~64	20~34	35~49	50~64
Sample size	719	909	459	436	440	240
Others						
Speeding	**0.133**	0.006	-0.046	0.059	**-0.172**	-0.124
Dangerous driving	**0.141**	-0.019	-0.040	0.121	**-0.201**	-0.125
No seatbelt	**0.180**	0.040	-0.089	0.099	-0.187	**-0.359**
Self						
Speeding	**0.365**	0.067	-0.213	0.073	-0.321	**-0.485**
Dangerous driving	**0.253**	0.113	-0.157	-0.064	-0.237	**-0.335**
No seatbelt	**0.275**	0.089	-0.123	-0.036	-0.240	**-0.421**
Regulations & enforcement						
Speed camera enforcement	-0.033	-0.017	**-0.074**	0.053	**0.115**	0.000
RLR camera enforcement	**-0.023**	-0.017	0.017	0.034	**0.038**	-0.033
Mobile phone use regulation	**-0.131**	-0.050	0.161	0.008	0.021	**0.220**
Alcohol detector policy	-0.090	**-0.100**	-0.029	0.169	0.120	**0.178**

(Maximum value in table) — 0 — (Minimum value in table)

Note: Minimum values within items indicated in bold, and maximum values indicated in underlined bold.

Especially in men aged between 20 and 34 years, the average score of factors related to speeding and non-fastening of seat belts was significantly higher than that of other age groups. In addition, the factor scores related to acceptance for various regulations and enforcement were lower in men than in women in the same age group, and it can be seen that men were less receptive to the strengthening of regulations and enforcement than women.

Table 11 summarizes the relationship between the presence or absence of traffic violations and RTCs by age group, targeting only men who had a higher tolerance for traffic violations and dangerous driving than women. All age groups were more tolerant than those who had experienced traffic violations/RTCs at least once. In particular, tolerance by self was highest among 20–34 year-old with experience of traffic violations and RTCs, and lowest among 50–64 years old non-violation and crash-free drivers. It was also observed that the high tolerance of surroundings and self and traffic violations/dangerous driving in the younger generation contributed to the risk of traffic violations/RTCs, and thus it is necessary to expand road safety education for young people and strengthen regulations and enforcement.

3.2.3. Comparison of factor scores by country

In 3.2.2, it was observed that young men aged 20 to 34 had a high rate of experience with traffic violations and RTCs. Therefore, we compared by country only for men aged 20–34. Table 12 summarizes the average value of factor scores and the composition ratio of traffic violations and RTCs by country for men aged 20–34 years. This result was discussed with reference to the statistical data of each country excerpted from Table 1.

First, we investigate the relationship between the level of tolerance for traffic violations and dangerous driving and statistics on RTCs and violations in each country. Countries with lower tolerance such as JPN, ITA, and GBR, had fewer road traffic deaths per capita than countries with higher tolerance, such as QAT, ARE, and EGY. These trends were consistent with the reported values of traffic violations and RTCs by respondents. In particular, ITA had the highest number of road traffic deaths per capita among three countries of JPN, ITA, and GBR, and the tolerance of others was also remarkably high. While the respondents' experience of traffic violations was low, their experience of RTCs tended to be slightly higher than in the other two countries. It suggests that the ITA has a high-risk environment for traffic crashes and that people may be involved in traffic crashes even if they drive carefully.

Next, we discuss the tolerance for not wearing seatbelts. In QAT and EGY, where it is not mandatory to wear seatbelts in all seats, the tolerance of self and others for not wearing seatbelts were higher than in other countries. On the other hand, among the countries with mandatory use of seatbelts, GBR and JPN, where lower tolerance of others for not wearing seatbelts was reported, had high wearing rates in the front seat. Especially in GBR, which also has lower tolerance of self, had high seatbelt wearing rates in the rear seat as well. It suggests that while the effectiveness of seatbelts is well recognized in GBR, it is not well understood in JPN, resulting in a low seatbelt wearing rate in the rear seat where enforcement is less likely.

Finally, we examine the acceptability of regulations and enforcement in each country. It can be seen that the acceptance related to various regulations and enforcement were relatively high in EGY, ARE, and QAT compared to other countries. In these countries where motorization is progressing rapidly, and the level of road infrastructure is not sufficient, it can be seen that there was a strong desire to strengthen regulations and enforcement. On the other hand, JPN, ITA, and GBR, where road infrastructure is well developed and the number of traffic fatalities is low, had lower acceptance of regulations and enforcement. Even in CHN, where traffic fatalities are high but road safety has been improving due to rapid infrastructure development in recent years, the acceptance of regulations and enforcement was relatively low.

Table 11
Mean factor scores by age and number of traffic tickets/crashes within two years (male only).

Age	20~34		35~49		50~64	
Number of tickets/crashes	0	1+	0	1+	0	1+
Sample size	456	263	687	222	385	74
Traffic tickets						
Others						
Speeding	**0.169**	0.101	0.093	-0.079	0.088	**-0.315**
Dangerous driving	**0.143**	0.140	0.041	-0.078	0.016	**-0.151**
No seatbelt	0.085	**0.263**	-0.019	0.098	**-0.188**	0.109
Self						
Speeding	0.254	**0.462**	-0.029	0.161	**-0.278**	-0.085
Dangerous driving	0.219	**0.282**	0.052	0.173	**-0.213**	-0.045
No seatbelt	0.131	**0.401**	-0.050	0.225	**-0.268**	0.166
Traffic crashes						
Others						
Speeding	0.112	**0.168**	0.011	-0.007	-0.045	**-0.051**
Dangerous driving	0.076	**0.253**	-0.056	0.093	**-0.067**	0.101
Non seatbelt	0.051	**0.403**	-0.014	0.207	**-0.139**	0.172
Self						
Speeding	0.286	**0.502**	0.036	0.164	**-0.231**	-0.123
Dangerous driving	0.206	**0.334**	0.067	0.256	**-0.198**	0.058
Non seatbelt	0.151	**0.490**	0.023	0.293	**-0.168**	0.110

(Maximum value in table) — 0 — (Minimum value in table)

Note: Minimum values within items indicated in bold, and maximum values indicated in underlined bold.

Table 12
Mean factor scores by country (gender = male, age = 20– 34 years old).

		JPN (n=65)	ITA (n=90)	GBR (n=32)	QAT (n=70)	ARE (n=111)	EGY (n=142)	CHN (n=209)
Tolerance (Others)	Speeding	-0.090	0.765	0.021	-0.105	0.241	0.313	-0.153
	Dangerous driving	-0.316	0.706	-0.101	0.302	0.119	0.592	-0.271
	No seatbelt	-0.446	0.340	-0.378	0.437	0.243	0.714	-0.091
Tolerance (Self)	Speeding	0.257	0.126	-0.098	0.077	0.572	0.722	0.317
	Dangerous driving	0.274	0.113	-0.142	0.085	0.106	0.904	0.059
	No seatbelt	0.113	-0.182	-0.443	0.362	0.229	1.030	0.116
Acceptance (Regulations & enforcement)	Speed camera enforcement	-0.244	-0.352	-0.925	-0.079	-0.101	0.644	-0.103
	RLR camera enforcement	-0.246	-0.482	-0.978	0.063	0.124	0.555	-0.110
	Mobile phone use regulation	-0.258	-0.188	-0.187	-0.138	-0.082	0.170	-0.285
	Alcohol detector	0.010	-0.488	-0.734	-0.006	0.116	0.345	-0.285
Traffic violations	0	91%	94%	97%	33%	12%	37%	34%
	1	6%	0%	3%	27%	14%	16%	22%
	2+	3%	6%	0%	40%	74%	47%	43%
Traffic accidents	0	94%	86%	91%	39%	43%	45%	72%
	1	5%	11%	9%	29%	32%	26%	18%
	2+	2%	3%	0%	33%	25%	29%	11%
Socio-economic status of survey countries (Excerpt from Table 1)								
Road length per capita [km/1000 cap]		9.64	8.07	5.81	2.44	0.41	0.64	3.45
Road length per land area [km/km^2]		3.22	1.62	1.63	0.61	0.05	0.06	0.52
Number of registered vehicles per capita [veh/person]		0.64	0.88	0.58	0.52	0.37	0.09	0.21
Road traffic deaths per 100k people (WHO estimated, 2016)		4.1	5.6	3.1	9.3	18.1	9.7	18.2
Rank of lower road traffic deaths among 173 countries (Percentile of rank)		13 (8%)	23 (13%)	8 (5%)	46 (27%)	104 (60%)	51 (29%)	107 (62%)
Seat-belt law applied to front and rear seat occupants		Yes	Yes	Yes	No	Yes	No	Yes
Seat-belt wearing rate	Front	95%	62%	95%	–	–	–	37%
	Rear	36%	15%	90%	–	–	–	
BAC limit (g/dl)		<0.03	≤0.05	≤0.08	–	≤0.01	–	<0.02
% road traffic deaths involving alcohol		6%	20-25%	13%	2%	2%	–	<1%

0 – 100%

These results suggest that as road traffic becomes safer, people do not find the need to further improve road safety and are reluctant to accept additional burdens and constraints imposed by new regulations and enforcement. Furthermore, a comparison of the acceptance of individual measures shows that the acceptance of alcohol detectors installment was particularly low in ITA and GBR, where the rate of drunk driving crashes was high. This result may reflect the different attitudes toward alcohol consumption in both countries, as shown in the loose standards for drunk driving in each country.

The level of tolerance for traffic violations and dangerous driving in each country is considered one of the indicators of traffic safety culture. This study showed that the level of tolerance differs from country to country, which is reflected in the differences in traffic crashes and compliance rates among countries. Reducing individual and community tolerance for traffic violations and dangerous driving, in other words, building a culture of traffic safety in the community, may reduce the risk of crashes and violations. In order to improve a traffic safety culture, it is essential to raise people's awareness and attitude toward desirable traffic behaviors through regulations, enforcement, and traffic safety education, in addition to road infrastructure development.

4. Conclusions

In this study, the characteristics of each country were compared with reference to tolerance for traffic violations and dangerous driving, acceptance for road safety measures, etc., based on the results of a questionnaire survey conducted in seven countries. The changes in traffic problems over the past three years showed that in most of the countries surveyed, distracted driving and dangerous driving are becoming social problems in addition to the conventional social problems such as traffic congestion and road safety. Regarding the tolerance for traffic violations and dangerous driving in each country, high tolerance may contribute to the risk of traffic violations and RTCs, and it was suggested that it is necessary to expand road safety education, especially for young drivers, to strengthen regulations and enforcement, to reduce the tolerance for traffic violations and dangerous driving, and to improve the level of infrastructure development. In addition, this study showed that the level of tolerance for traffic violations and dangerous driving differed from country to country, which was reflected in the differences in traffic crashes and compliance rates among countries. In order to decrease the risk of crashes and violations, it is essential to reduce the tolerance of individuals and communities to traffic violations and dangerous driving, in other words, to construct a local traffic safety culture.

There are several limitations in this study. First, since the survey relies on self-reported data from respondents, the influence of social desirability was inevitable. In particular, the responses tend to be mainly university-related, and it should be noted that the social and economic backgrounds of the respondents may have an impact on the results. In addition, online surveys via the Internet tend to be biased toward younger people in developed countries where the population is aging. In this study, we focused on the gender and age of the respondents and also compared the results by country, limiting the results to males and young adults. Third, people's awareness and attitude toward road safety can change depending on the time of the survey. If a particular traffic behavior becomes a social problem due to repeated news coverage, it may have a short-term effect on the awareness and attitude not only of the respondents themselves but also of those around them. Therefore, it is necessary to continue the survey multiple times and evaluate the results over the mid-to-long term.

In the future, further data collection in Canada, Germany, and Philippines, which did not reach the required sample size for cross-comparison, will be carried out to include these countries in the comparative analysis. In addition, it will be necessary to closely examine the effects of the progress of infrastructure development in each

country and the introduction of various regulations and enforcement measures by continuously conducting similar surveys, and by studying people's awareness of traffic problems and changes in tolerance for traffic violations and dangerous driving over time.

Declaration of Competing Interest

None.

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