



## Mobile phone related crashes among motorcycle taxi drivers

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### ABSTRACT

In many countries, motorcycle taxis remain an important mode of travel due to their fast, flexible, and inexpensive service. The recent advent of ride-hailing services has led to dramatic growth in the fleet of motorcycle taxis and additional types of motorcycle taxi drivers. Furthermore, mobile phone use while riding a motorcycle is an emerging safety issue, particularly among ride-hailing motorcycle taxi drivers. This paper investigates mobile phone use while riding, crashes and mobile phone related crashes among ride-hailing, traditional, and hybrid motorcycle taxi drivers, using data from a survey in Hanoi, Vietnam. Results show that ride-hailing motorcycle taxi drivers had the highest prevalence of mobile phone use while riding a motorcycle taxi (95.3%), followed by hybrid (88.6%) and traditional taxi drivers (64%). Approximately 32.6%, 19.3%, and 9.7% of motorcycle taxi drivers reported being involved in a crash, injury crash, and mobile phone related crash respectively. Mobile phone related crashes represent 20.5% of all reported crashes. Logistic and negative binomial regression were used to explore factors influencing mobile phone use while riding and crash frequencies. Regression results indicate that ride-hailing taxi drivers were more likely to be involved in a mobile phone related crash. Delivery trips were found to be associated with increases in crashes whereas passenger trips were found to be associated with decreases in crashes. Policy implications are also discussed.

### 1. Introduction

Each year, more than 1.35 million people die and approximately 50 million people are injured on the world's roads (WHO, 2018). It was reported that 28% of all road deaths worldwide were among motorcyclists in 2018, a five percentage point increase compared to 2015 (WHO, 2015, 2018). A faster increase in the proportion of motorcycle road deaths is observed in South-East Asia. Specifically, motorcyclists represent 34% and 43% of all road deaths in South-East Asia in 2015 and 2018 respectively (WHO, 2015, 2018), indicating a nine percentage point increase over the period. Overall, motorcyclist safety remains a formidable challenge worldwide and particularly in South-East Asia.

In many South-East Asian cities, motorcycle taxis remain an important mode of travel due to their fast, flexible, and inexpensive service (Tuan and Mateo-Babiano, 2013; Sopranzetti, 2014). Motorcycle taxis can effectively operate in areas with narrow streets or inadequately served by public transport. The recent advent of ride-hailing services (e.g. GrabBike and GoViet) has led to dramatic growth in the fleet of motorcycle taxis and additional types of taxi drivers. Traditional taxi drivers would often wait for customers at certain locations (e.g. stations, hospitals, interchange, and universities) and negotiate the fare of the trip. They would occasionally receive pickup requests from their

personal network via mobile phones. Ride-hailing taxi drivers rely on customer booking communicated to them via their smartphones. Hybrid taxi drivers are those who choose to operate as either a traditional or a ride-hailing taxi driver at certain times, often to optimise their utility.

Although motorcycle taxi safety has been investigated in previous studies (Akinlade and Brieger, 2003; Wu and Loo, 2016), there is a lack of research into safety issues, particularly mobile phone related crashes, among different types of motorcycle taxi drivers (i.e. traditional, ride-hailing, and hybrid). In addition, little is understood about the safety implications of passenger and delivery trips among motorcycle taxi drivers.

This paper aims to investigate mobile phone use while riding, crashes (all crashes, injury crashes, and mobile phone related crashes), and their associated factors among motorcycle taxi drivers in Hanoi, Vietnam. Three types of motorcycle taxi drivers are considered, including traditional, ride-hailing, and hybrid taxi drivers. Potential safety impacts of factors, e.g. passenger and delivery trips among motorcycle taxi drivers, are also analysed.

In 2018, nearly 8100 people died on Vietnamese roads (NTSC, 2019; Truong et al., 2019b). Approximately 60% of road deaths in Vietnam were among motorcyclists (Ngo et al., 2012; Truong et al., 2016a),

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which was significantly higher than the average proportion of motorcycle road deaths in South East Asia, i.e. 43% (WHO, 2018). Hanoi is the capital city of Vietnam, where motorcycles represent approximately 86% of the traffic flow (Bray and Holyoak, 2015). Motorcycle taxis are a popular mode of travel in Hanoi (Hansen, 2017). The number of motorcycle taxis in Hanoi more than a decade ago was roughly estimated at between 50,000–100,000 (JICA, 2007). Traffic regulations in Vietnam specify penalties for using a mobile phone or portable music device while riding a motorcycle. With regards to driving a car/truck, penalties are however only applied for hand-held mobile phone use while driving.

The remainder of this paper is structured as follows; a review of literature is described in the next section, followed by survey data and analysis approach. A summary of results is presented next. A discussion of the findings and conclusion are then presented.

## 2. Literature review

Given the growth in motorcycle taxi service, it is essential to understand traffic crashes among different types of motorcycle taxi drivers. Although few studies on motorcycle taxi safety have been conducted, there is a lack of research into safety issues among different types of motorcycle taxi drivers (i.e. traditional, ride-hailing, and hybrid). Khan (2004) conducted a survey of 208 motorcycle taxi drivers' safety perception in Bangkok, Thailand and found that 62% of them had been involved in a crash and 28.8% had been involved in a hospitalised crash in a 2-year period. In a study of motorcycle taxi safety in Nigeria, Akinlade and Brieger (2003) showed that more than half of motorcycle taxi drivers reported that they had been injured from falling off their motorcycle. Using a survey of motorcycle taxi drivers and nonoccupational motorcyclists conducted in Maoming, China in 2012, Wu and Loo (2016) found that motorcycle taxi drivers had a higher tendency for certain risky behaviours, e.g. running red light. Motorcycle taxi drivers examined in these studies were most likely to be traditional taxi drivers, given the recent widespread of ride-hailing services. In a recent study focusing only on app-based motorcycle taxi drivers in Vietnam, Nguyen-Phuoc et al. (2019) indicated that the prevalence of crashes among app-based motorcycle taxi drivers in a one-year period was approximately 30%.

A number of studies have examined the interactions between attitudes, social norms, and risky riding behaviours (Chen, 2009; Susilo et al., 2015; De Gruyter et al., 2017) and the associations between risky behaviours and crashes among motorcyclists (Chang and Yeh, 2007; Elliott et al., 2007; Vlahogianni et al., 2012). Mobile phone use while riding a motorcycle is an emerging safety issue. Recent research has shown a noticeable level of mobile phone use while riding among motorcyclists (Pérez-Núñez et al., 2013; Truong et al., 2016b). In Vientiane, Laos, approximately 40% of high school students reported using a mobile phone while riding a motorcycle (Phommachanh et al., 2017). In Hanoi and Ho Chi Minh city, Vietnam, a higher prevalence of approximately 81% was reported among university students (Truong et al., 2017). More importantly, recent research has also showed that mobile phone use while riding a motorcycle was associated with other risky riding behaviours e.g. reckless and drink riding (Truong et al., 2018). The relationship between crashes and mobile phone use while riding a motorcycle has also been examined. It was found that texting or searching for information while riding a motorcycle increased the likelihood of crash involvement while calling while riding a motorcycle would double the likelihood of being injured in a crash (Truong et al., 2019a). Motorcycle taxi drivers, particularly those who need a mobile phone for service operation, would also have a relatively high level of mobile phone use while riding. It is therefore important to understand safety implications of mobile phone use while riding among motorcycle taxi drivers. However, very little is understood about mobile phone related crashes among motorcycle taxi drivers.

There is an emerging trend that some motorcycle taxi drivers would

also act as delivery drivers, transporting goods in addition to passengers, which may have important safety implications. Recently, Zheng et al. (2019) presented an investigation into crashes and risky behaviours among delivery riders, who were usually e-bike riders, in China. Yet, little is understood about the potential safety impacts of passenger and delivery services on motorcycle taxi drivers.

Overall, there is a need for research into safety issues, particularly mobile phone related crashes, among different types of motorcycle taxi drivers. It is also essential to explore the impacts of passenger and delivery trips on safety of motorcycle taxi drivers.

## 3. Method

### 3.1. Survey

A structured questionnaire survey of motorcycle taxi drivers (including traditional, ride-hailing, and hybrid taxi drivers) was conducted in Hanoi, Vietnam between January and March 2019. There were no incentives for participating in the survey. The collected survey data was completely anonymous. The survey was part of a wider research project exploring crashes and health conditions among motorcycle taxi drivers in Hanoi. Ethics approval of the project was granted by La Trobe University Human Ethics Committee. This paper specifically focuses on items related to mobile phone use while riding a motorcycle taxi and crashes (including falls and other single vehicle crashes), particularly mobile phone related crashes.

Four trained interviewers approached motorcycle taxi drivers in locations with high activities of motorcycle taxis (e.g. shopping centres, bus interchanges, universities, schools, and hospitals) in both inner- and outer- suburbs. On average, approximately 40% of approached motorcycle taxi drivers agreed to participate in the study. Each interview took approximately 10–15 min to complete. Survey respondents were asked about their age, education, income, motorcycle licence, motorcycle insurance, and alcohol consumption. Their gender information was also recorded by the interviewers. While those who worked as a ride-hailing taxi driver can be generally identified via their uniform jackets and helmets, it was not always possible to identify hybrid taxi drivers. As a result, survey respondents were asked to clarify whether they are traditional, ride-hailing, or hybrid taxi drivers. They were also interviewed about the number of years working as a motorcycle taxi driver, the average numbers of passenger trips and delivery trips per day, the number of working days per week and working conditions (i.e. fulltime or part-time/casual and worked night shift or not). The average numbers of passenger and delivery trips per week were calculated based on trips per day and working days per week.

Regarding mobile phone use while riding a motorcycle taxi, survey respondents were asked if they used a mobile phone with their hands, with earphones, or with the mobile phone being mounted to a holder. They were also asked to select up to two main purposes of using a mobile phone while riding a motorcycle taxi from provided choices (operate an app, initiate a call, answer a call, send a text, read a text, and web surf). The limit of two options was adopted to encourage motorcycle taxi drivers to focus on the most important purposes.

Survey respondents were asked about the frequency of crashes (including falls and other single vehicle crashes) that they had been involved in while riding a motorcycle taxi in the last 12 months. If they indicated that they had been involved in a crash, they were further asked about the frequency of crashes that involved injuries and the frequency of crashes that were related to mobile phone use while riding a motorcycle taxi.

### 3.2. Data analysis

Binary logistic regression was adopted to explore factors influencing mobile phone use (hand held, with earphones, and with a mobile phone being mounted to a holder) while riding among motorcycle taxi drivers.

As the response variable, mobile phone use while riding, is a dichotomous variable, the logistic regression is a suitable modelling approach. In traffic safety analysis, Poisson regression, negative binomial regression, or zero inflated negative binomial regression have been widely used to model crash count data (Washington et al., 2011). A restriction of the Poisson distribution is that the mean equals the variance. When the variance is significantly greater than the mean, the data is considered as overdispersed. Negative binomial regression is generally used for overdispersed count data. In addition, zero inflated negative binomial regression can be adopted to account for excessive zeros in count data. Given that crash frequencies are non-negative integers, negative binomial regression was utilised in this paper to explore factors contributing to the frequency of overall crashes, frequency of injury crashes, and the frequency of mobile phone related crashes. Zero inflated negative binomial regression was also tested.

To select a set of contributing factors that provide the best-fitted model, the Akaike Information Criterion (AIC) was utilised (Akaike, 1974), in which a lower AIC score indicates a better fit to data. Multicollinearity was evaluated using the Generalized Variance Inflation Factor (GVIF). As a rule of thumb, a GVIF score of less than 5 indicates no multicollinearity issue. Data was analysed using R (R Core Team, 2019). Logistic regression models were estimated using *glm* function, negative binomial regression models were estimated using *MASS* package (Venables and Ripley, 2002), and GVIF was computed using *car* package (Fox and Weisberg, 2011) in R.

#### 4. Results

##### 4.1. Descriptive statistics

Tables 1 and 2 present summaries of demographic and working characteristics, mobile phone use while riding a motorcycle taxi, and

crash frequencies by motorcycle taxi types. Of the 549 survey respondents, only 15 (2.7%) were female and all of them were ride-hailing taxi drivers. As expected, the majority of survey respondents were ride-hailing drivers. The proportions of traditional, ride-hailing, and hybrid taxi drivers were 9.1%, 78.1%, and 12.8% respectively. Nearly one quarter of ride-hailing taxi drivers were fulltime whereas most traditional and hybrid taxi drivers were full time (80% and 72.9% respectively). It was evident that the flexibility of ride-hailing taxi service attracted many casual and part-time drivers. Overall, almost 70% of all motorcycle taxi drivers either completed or had been pursuing higher education (i.e. above high school), as shown by the higher education variable. With regards to tradition and hybrid taxi drivers, the proportion of completing or attending higher education was much lower at 24–28.6%. Most traditional and hybrid taxi drivers were the main family income whereas only one thirds of ride-hailing taxi drivers were the main family income. This was consistent with the higher propensity for fulltime work among traditional and hybrid taxi drivers. Almost all the taxi drivers had a motorcycle licence, except for few ride-hailing taxi drivers. Similarly, the proportion of taxi drivers having a motorcycle insurance was above 91% for all motorcycle taxi types, with a slightly higher proportion among traditional and hybrid taxi drivers than among ride-hailing taxi drivers. At least four in five traditional and hybrid taxi drivers indicated that they consumed alcohol in the last 30 days. The proportion of alcohol consumption was lower among ride-hailing taxi drivers. A higher proportion of traditional and hybrid motorcycle taxi drivers worked night shift compared to ride-hailing taxi drivers.

Approximately half of all motorcycle taxi drivers used a mobile phone with their hands while riding a motorcycle taxi. Traditional motorcycle taxi drivers however had the lowest prevalence of hand-held mobile phone use compared to hybrid and ride-hailing taxi drivers (38% versus 47.1% and 52.2% respectively). The overall prevalence of

**Table 1**  
Descriptive statistics of categorial variables by motorcycle taxi types.

Variables		Motorcycle taxi types							
		Traditional		Ride-hailing		Hybrid		All	
		n		n		n		n	
Gender	Female	0	0.0%	15	3.5%	0	0.0%	15	2.7%
	Male	50	100.0%	414	96.5%	70	100.0%	534	97.3%
Fulltime	No	10	20.0%	330	76.9%	19	27.1%	359	65.4%
	Yes	40	80.0%	99	23.1%	51	72.9%	190	34.6%
Higher education	No	38	76.0%	78	18.2%	50	71.4%	166	30.2%
	Yes	12	24.0%	351	81.8%	20	28.6%	383	69.8%
Main family income	No	4	8.0%	291	67.8%	10	14.3%	305	55.6%
	Yes	46	92.0%	138	32.2%	60	85.7%	244	44.4%
Motorcycle licence	No	0	0.0%	3	0.7%	0	0.0%	3	0.5%
	Yes	50	100.0%	426	99.3%	70	100.0%	546	99.5%
Motorcycle insurance	No	3	6.0%	37	8.6%	2	2.9%	42	7.7%
	Yes	47	94.0%	392	91.4%	68	97.1%	507	92.3%
Consume alcohol in the last 30 days	No	9	18.0%	150	35.0%	10	14.3%	169	30.8%
	Yes	41	82.0%	279	65.0%	60	85.7%	380	69.2%
Night shift	No	31	62.0%	313	73.0%	44	62.9%	388	70.7%
	Yes	19	38.0%	116	27.0%	26	37.1%	161	29.3%
Mobile phone use (hand held)	No	31	62.0%	205	47.8%	37	52.9%	273	49.7%
	Yes	19	38.0%	224	52.2%	33	47.1%	276	50.3%
Mobile phone use (earphones)	No	39	78.0%	141	32.9%	23	32.9%	203	37.0%
	Yes	11	22.0%	288	67.1%	47	67.1%	346	63.0%
Mobile phone use (mounted on a holder)	No	36	72.0%	112	26.1%	18	25.7%	166	30.2%
	Yes	14	28.0%	317	73.9%	52	74.3%	383	69.8%
Mobile phone use (overall)	No	18	36.0%	20	4.7%	8	11.4%	46	8.4%
	Yes	32	64.0%	409	95.3%	62	88.6%	503	91.6%

**Table 2**  
Descriptive statistics of continuous and count variables by motorcycle taxi types.

Variables	Motorcycle taxi types	Average	Std.	Min	Max
Age (years)	Traditional	42.90	8.10	29	60
	Ride-hailing	26.30	5.12	18	50
	Hybrid	36.90	9.17	22	65
	All	29.17	8.25	18	65
Taxi experience (years)	Traditional	5.64	3.81	1.17	20
	Ride-hailing	1.33	1.01	0.08	7
	Hybrid	2.92	2.10	0.17	10
	All	1.92	2.06	0.08	20
Weekly passenger trips	Traditional	104.00	45.80	20	245
	Ride-hailing	84.30	41.30	0	210
	Hybrid	121.00	38.70	21	210
	All	90.69	43.21	0	245
Weekly delivery trips	Traditional	18.30	22.20	0	70
	Ride-hailing	8.91	18.90	0	140
	Hybrid	18.00	28.70	0	168
	All	10.92	21.00	0	168
Crash frequency	Traditional	1.37	1.73	0	7
	Ride-hailing	0.58	1.11	0	6
	Hybrid	0.67	1.23	0	4
	All	0.70	1.25	0	7
Injury crash frequency	Traditional	0.69	1.33	0	5
	Ride-hailing	0.32	0.87	0	6
	Hybrid	0.37	0.90	0	4
	All	0.38	0.95	0	6
Mobile phone related crash frequency	Traditional	0.14	0.41	0	2
	Ride-hailing	0.14	0.58	0	5
	Hybrid	0.14	0.50	0	3
	All	0.14	0.55	0	5

Note: statistics for crashes, injury crashes, and mobile phone related crashes were only based on 362 motorcycle taxi drivers who had at least one year of working experience.

using a mobile phone with earphones while riding a motorcycle taxi was 63%, which was higher compared to hand-held mobile phone use. Interestingly, only 22% of traditional taxi drivers reported using a mobile phone with earphones while riding a motorcycle taxi, which was much lower compared to ride-hailing and hybrid taxi drivers (67.1%). Nearly 70% of all motorcycle taxi drivers reported using a mobile phone while riding a motorcycle taxi with the mobile phone being mounted on a holder. As observed with hand-held and earphone mobile phone use, the prevalence of mobile phone use with the phone being mounted on a holder was much lower among traditional taxi drivers (28%), compared to ride-hailing and hybrid taxi drivers (73.9% and 74.3% respectively). Considering all three types of mobile phone use while riding a motorcycle taxi, the overall prevalence was 91.6% for all motorcycle taxi drivers. The highest overall prevalence was among ride-hailing motorcycle taxi drivers (95.3%), followed by hybrid taxi drivers (88.6%), and traditional taxi drivers (64%).

Fig. 1 summarises main purposes of mobile phone use while riding a motorcycle taxi, in which taxi drivers could select up to two options. It was evident that only a small proportion of taxi drivers (approximately 2–3%) used a mobile phone mainly for texting, either sending or reading a text, while riding a motorcycle taxi. Web surfing had a higher prevalence of about 9% across all motorcycle taxi types. However, operating an app or calling while riding a motorcycle taxi were much more prevalent. Approximately 36% of motorcycle taxi drivers used a mobile phone mainly for operating an app while riding, which would be attributed to the fact that 40% of ride-hailing taxi drivers used a mobile phone mainly for operating an app. Initiating a call had the highest prevalence as approximately two thirds of motorcycle taxi drivers used a mobile phone while riding mainly for initiating a call. Answering a

call had an overall prevalence of 31%. However, this prevalence was much higher among traditional taxi drivers (74%), compared to ride-hailing or hybrid taxi drivers (27% and 32%).

Table 2 shows that motorcycle taxi drivers' age ranges between 18 and 65, with an average of 29.2 years old. Traditional drivers had the highest average age of 42.9 years old, followed by hybrid (36.9) and ride-hailing taxi drivers (26.3). The experience working as a motorcycle taxi driver varied significantly between 1 month (i.e. 0.08 years) and 20 years. Of 549 survey respondents, 362 had at least one year of taxi experience. On average, traditional motorcycle taxi drivers had a higher level of experience (5.6 years), compared to hybrid (2.9 years) and ride-hailing taxi drivers (1.3 years). On average, each motorcycle taxi driver made nearly 91 passenger trips and 11 delivery trips per week. Since a higher proportion of ride-hailing drivers worked part-time or casual, they had lower numbers of passenger and delivery trips compared to traditional and hybrid taxi drivers.

Given that survey respondents were asked about crash frequencies in the last 12 months, only those who had at least one year of taxi experience were considered in crash analyses. Crash frequencies based on 362 motorcycle taxi drivers who had at least one year of taxi experience were also presented in Table 2. The average number of crashes, injury crashes, and mobile phone related crashes experienced by motorcycle taxi drivers was 0.7, 0.38, and 0.14 per year respectively. This suggests 53.9% and 20.5% of crashes experienced by motorcycle taxi drivers were injury and mobile phone-related respectively. In terms of overall crash involvement, 32.6% of 362 motorcycle taxi drivers (i.e. who had at least one year of working experience) had crash involvement while riding a motorcycle taxi (in which, 13% reported one crash while 19.6% reported two or more crashes). Furthermore, 19.3% of these 362 motorcycle taxi drivers had injury crash involvement (in which 9.9% reported one injury crash while 9.4% reported two or more injury crashes). In addition, 9.7% of these 362 motorcycle taxi drivers had mobile phone-related crash involvement (in which 7.5% reported one mobile phone related crash while 2.2% reported two or more mobile phone related crashes).

#### 4.2. Mobile phone use modelling

Binary logistic regression was used to explore factors contributing to mobile phone use while riding a motorcycle taxi. Table 3 summarises results of best fitted models for mobile phone use while riding a motorcycle taxi. All models were statistically significantly at  $p < 0.001$ . GVIF scores indicated no multicollinearity issues.

Results indicated that hand-held mobile phone use while riding a motorcycle taxi was negatively associated with increasing age ( $p < 0.01$ ). An increase in passenger trips was found to be associated with a decreased likelihood of hand-held mobile phone use ( $p < 0.05$ ). Motorcycle taxi drivers who worked night shift were 1.8 times more likely to engage in hand-held mobile phone use while riding a motorcycle taxi ( $p < 0.01$ ). There was some evidence (i.e.  $p < 0.1$ ) that hand-held mobile phone use increased for those who were males or the main family income.

A lower likelihood for using a mobile phone while riding with earphones was found for those who worked full time ( $p < 0.05$ ), night shift ( $p < 0.001$ ), and had longer taxi experience ( $p < 0.001$ ). Motorcycle taxi drivers who consumed alcohol in the last 30 days or those who had more delivery trips were more likely to use a mobile phone while riding with earphones. There was a positive link between mobile phone use with earphones and passenger trips, which was however only at  $p < 0.1$ . Results also indicated that ride-hailing and hybrid taxi drivers were 2.7 and 4.7 times as likely to use a mobile phone with earphones while riding, compared to traditional taxi drivers ( $p < 0.05$  and  $p < 0.001$  respectively).

Regarding mobile phone use while riding with the phone being mounted to a holder, a negative effect of working night shift was also found ( $p < 0.001$ ). The negative effect of working full time was not

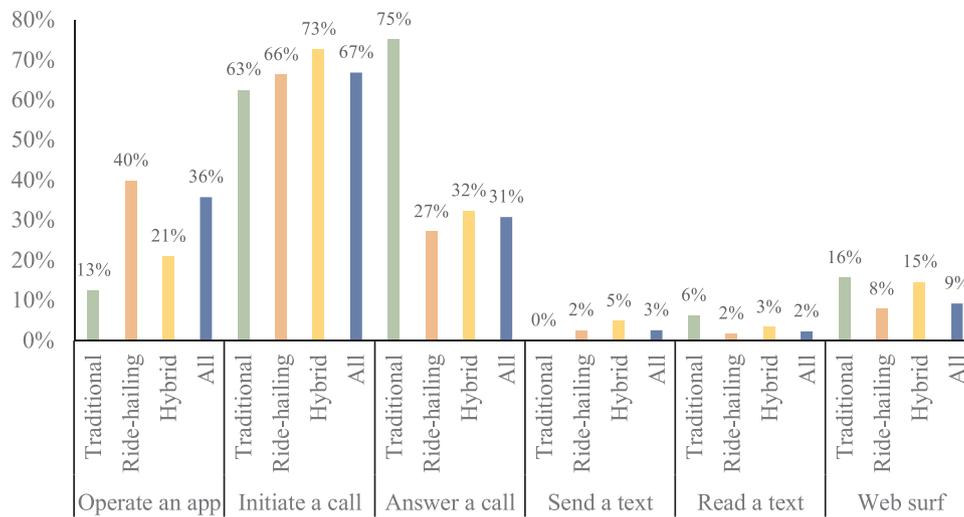


Fig. 1. Main purposes of using a mobile phone while riding a motorcycle taxi by taxi types.

significant ( $p < 0.1$ ). Motorcycle taxi drivers who had a motorcycle insurance, alcohol consumption, a higher number of passenger trips were more likely to use a mobile phone while riding with a holder ( $p < 0.001$ ,  $p < 0.05$ , and  $p < 0.05$  respectively). Results also showed that ride-hailing and hybrid taxi drivers were more than 7 times as likely to use a mobile phone while riding with a holder ( $p < 0.001$ ).

#### 4.3. Crash frequency modelling

Crash frequency modelling was conducted using data from 362 motorcycle taxi drivers who had at least one year of working experience. Negative binomial regression was utilised to investigate factors influencing the frequency of crashes, injury crashes, and mobile phone related crashes. Results of best-fitted models are presented in Table 4. Models for crashes, injury crashes, and mobile phone related crashes were statistically significant at  $p < 0.001$ ,  $p < 0.001$ , and  $p < 0.01$  respectively. The dispersion parameters were also significant, suggesting that negative binomial regression was more suitable than Poisson regression. GVIF scores indicated no multicollinearity issues. It

was noted that zero inflated negative binomial regression was also tested, which however did not improve model fit significantly according to Vuong's test results.

Results showed that increasing age was associated with an increase in the frequency of mobile phone related crashes ( $p < 0.05$ ). It is noted that age was however not included in final models for crash and injury crash frequencies. The specific effect of age on mobile phone related crashes would be attributed to reduced reaction times, which would make older drivers more vulnerable to risk associated with mobile phone related distraction while riding. Working full time was found to be associated with increases in frequencies of all crashes and injury crashes ( $p < 0.001$ ). This is a logical result given that fulltime taxi drivers have a higher level of exposure compared to part-time/casual taxi drivers. In the mobile phone related crash frequency model, full-time also had a positive coefficient, but not significant. This would be partly attributed to the relatively smaller shares for mobile phone related crashes in the data. An increase in passenger trips was associated with reductions in frequencies of all crashes, injury crashes as well as mobile phone related crashes ( $p < 0.001$ ,  $p < 0.01$ , and  $p < 0.01$

Table 3  
Results of logistic regression for mobile phone use while riding a motorcycle taxi.

Variables	Phone use (hand held)			Phone use (earphones)			Phone use (mounted on a holder)					
	Estimate	Std. Error	Adj odds ratio	Estimate	Std. Error	Adj odds ratio	Estimate	Std. Error	Adj odds ratio			
Intercept	0.219	0.810		0.682	0.860		-1.314	0.922				
Age (years)	-0.048	0.016	0.953	**								
Male (binary)	1.231	0.661	3.425	a	-1.008	0.695	0.365	-1.203	0.803	0.300		
Full time (binary)					-0.550	0.273	0.577	*	-0.498	0.277	0.608	a
Higher education (binary)	-0.345	0.236	0.708									
Main family income (binary)	0.398	0.238	1.489	a								
Insurance (binary)								1.233	0.364	3.430	***	
Alcohol consumption (binary)				0.637	0.218	1.891	**	0.454	0.228	1.574	*	
Taxi experience (years)				-0.305	0.085	0.737	***					
Weekly passenger trips	-0.010	0.005	0.990	*	0.005	1.005	1.005	a	0.007	0.003	1.007	*
Weekly delivery trips				0.012	0.005	1.013	*					
Night shift (binary)	0.588	0.199	1.800	**	-1.119	0.214	0.327	***	-1.068	0.220	0.344	***
Motorcycle taxi type												
Ride-hailing				1.007	0.437	2.738	*	1.997	0.377	7.368	***	
Hybrid				1.557	0.471	4.743	***	2.003	0.441	7.413	***	
Traditional				ref				ref				
AIC	743.670			636.660				596.820				
Log likelihood (restricted)	-380.530			-361.697				-336.459				
Log likelihood	-364.837			-308.329				-289.408				
Number of observations	549			549				549				

Note: <sup>a</sup>  $p < 0.1$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

**Table 4**  
Results of negative binomial regression for crash frequencies.

Variables	Crash			Injury crash			Phone-related crash		
	Estimate	Std. Error		Estimate	Std. Error		Estimate	Std. Error	
Intercept	0.019	0.258		-0.899	0.383	*	-4.207	1.429	**
Age (years)							0.062	0.031	*
Full time (binary)	1.208	0.220	***	1.476	0.326	***	0.653	0.513	
Weekly passenger trips	-0.009	0.003	***	-0.010	0.004	**	-0.018	0.005	**
Weekly delivery trips	0.014	0.004	***	0.015	0.005	**	0.014	0.007	*
Night shift (binary)	-0.488	0.209	*	-0.651	0.311	*			
Motorcycle taxi type									
Ride-hailing							1.612	0.803	*
Hybrid							0.863	0.764	
Traditional							ref		
Phone use (hand held)	0.344	0.206	<sup>a</sup>	0.646	0.305	*			
Phone use (mounted on a holder)	-0.875	0.209	***	-0.753	0.310	*			
Dispersion parameter	0.861	0.202	***	0.364	0.088	***	0.230	0.082	**
AIC	758.800			523.120			291.470		
Log likelihood (restricted)	-406.971			-273.616			-146.999		
Log likelihood	-371.402			-253.558			-137.733		
Number of observations	362			362			362		

Note: <sup>a</sup>  $p < 0.1$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

respectively). In contrast, an increase in delivery trips was associated with increases in all crashes, injury crashes as well as mobile phone related crashes ( $p < 0.001$ ,  $p < 0.01$ , and  $p < 0.05$  respectively). Working night shift was found to be associated with reductions in both all crashes and injury crashes ( $p < 0.05$ ).

It was evident that ride-hailing motorcycle taxi drivers were more likely to be involved in mobile phone related crashes compared to traditional taxi drivers ( $p < 0.05$ ). In addition, results indicated that hand-held mobile phone use while riding a motorcycle taxi was associated with increases in injury crashes ( $p < 0.05$ ). However, mobile phone use with the phone being mounted to a holder was found to be associated with reductions in all crashes and injury crashes ( $p < 0.001$  and  $p < 0.05$  respectively).

## 5. Discussion

Using data from a survey in Hanoi, Vietnam, this paper has explored mobile phone use while riding, crashes and mobile phone related crashes among motorcycle taxi drivers (including traditional, ride-hailing, and hybrid taxi drivers).

The overall prevalence of mobile phone use while riding a motorcycle taxi was found to be 91.6%, which was higher compared to the prevalence of mobile phone while riding among university students in Vietnam, i.e. nearly 81% (Truong et al., 2017). Ride-hailing motorcycle taxi drivers had the highest prevalence (95.3%), followed by hybrid (88.6%) and traditional taxi drivers (64%). These findings are intuitive since motorcycle taxi drivers, especially ride-hailing and hybrid taxi drivers, tend to use a mobile phone for their work. Logistic regression results further confirmed that ride-hailing and hybrid taxi drivers were more likely to use a mobile phone while riding with earphones or holders. It was also found that the prevalence of mobile phone use with a holder while riding (69.8%) was higher compared to mobile phone use with earphones (63%) and hand-held mobile phone use (50.3%). Results also showed associations between mobile phone use while riding and crashes. More specifically, negative binomial regression results showed that motorcycle taxi drivers who use a mobile phone mounted to a holder had a lower risk of crashes whereas those who use hand-held mobile phone had a higher risk of crashes. While it was not possible to identify tasks associated with mobile phone use with a holder from the survey, a mobile phone mounted to a holder would be potentially used for navigation.

The overall prevalence of crashes and injury crashes while riding a motorcycle taxi in a 12-month period was 32.6% and 19.3%

respectively. This prevalence among motorcycle taxi drivers was relatively high compared to university students in Vietnam who reported the crash and injury crash prevalence of 40% and 24% while riding a motorcycle in a 24-month period, respectively (Truong et al., 2019a). It is noted that young motorcyclists are a high risk group as they have a higher tendency for risky behaviours (Chang and Yeh, 2007). Motorcycle taxi drivers also had a higher crash prevalence compared to car taxi drivers in Vietnam, who reported a crash prevalence of 22.7% in a three-year period (La et al., 2013). More importantly, results showed that nearly 10% of motorcycle taxi drivers had been involved in a crash that is related to mobile phone use while riding for work. Considering crash frequencies, results indicated high proportions of injury crashes (53.9%) and mobile phone related crashes (20.5%) among all crashes. Negative binomial regression, which accounted for various factors showed that ride-hailing taxi drivers were more likely to be involved in a mobile phone related crash. Overall, results clearly demonstrate a significant safety issue of mobile phone use while riding a motorcycle taxi, particularly among ride-hailing taxi drivers.

It was found that a higher number of delivery trips among motorcycle taxi drivers was associated with increases in crashes, injury crashes, and mobile phone related crashes. On the contrary, a higher number of passenger trips was found to be associated with decreases in these crashes. A possible reason is that motorcycle taxi drivers during a passenger trip would be more cautious and the passengers would discourage the drivers from risky behaviours for their own safety. In addition, motorcycle taxi drivers during a delivery trip might carry oversized goods or be under pressure of delivery time, which might lead to engagement in risky behaviours. There was some evidence from previous research indicating that motorcyclists in Vietnam, who carried a passenger, were less likely to use a mobile phone while riding (Truong et al., 2016b) and delivery e-bike riders in China reported a relatively high level of engagement in risky behaviours (Zheng et al., 2019).

Older motorcycle taxi drivers had a lower tendency to use a hand-held mobile phone. This was in alignment with previous research, which showed that phone use were more prevalent among young cyclists (de Waard et al., 2015) and motorcyclists and e-bike riders (Truong et al., 2016b). Older motorcycle taxi drivers however were more likely to be involved in a mobile phone related crash. These results suggest that older motorcycle taxi drivers were more vulnerable to risks associated with mobile phone use while riding. Results also indicated effects of working night shift on mobile phone use while riding and crashes. Motorcycle taxi drivers who worked night shift had a higher tendency for hand-held mobile phone use, but lower tendency

for mobile phone use with earphones or a holder. Interestingly, motorcycle taxi drivers who worked night shift were less likely to be involved in a crash and injury crash. A possible explanation is that smoother traffic flow and fewer conflicts would be expected at night. In addition, motorcycle taxi drivers generally operate in Hanoi's urban areas with adequate street lighting. A relatively safer and less stressful working environment at night may contribute to the higher prevalence of hand-held mobile phone use while riding among taxi drivers who worked night shift.

While this paper provided important insights into the safety of traditional, ride-hailing, and hybrid motorcycle taxi drivers, it also has several limitations. As the survey data are self-reported, there may be social desirability biases in responses related to mobile phone use while riding and crashes. Crashes while riding a motorcycle taxi may also be underreported since motorcycle taxi drivers who have been seriously injured or killed would not have been included in the survey. Different injury levels (serious or minor) and specific tasks of using a mobile phone mounted to a holder (e.g. navigation) were not captured in the survey. To further investigate the safety issues among motorcycle taxi drivers, empirical data (e.g. historical crashes or field observations) should be employed in addition to in-depth questionnaire surveys.

## 6. Conclusions

In conclusion, this paper has revealed a high prevalence of mobile phone use while riding a motorcycle taxi among ride-hailing, hybrid, and traditional taxi drivers and a noticeable prevalence of crashes, especially mobile phone related crashes, while riding a motorcycle taxi. It has also highlighted a higher risk group of motorcycle taxi drivers who also act as delivery drivers. Given the growth in motorcycle taxi service and increasing use of motorcycle taxis for delivery, urgent interventions need to be made by authorities. For example, illegal riding behaviours would be enforced by both the police and ride-hailing service providers (e.g. GrabBike and GoViet). While current traffic regulations in Vietnam specify penalties for using a mobile phone or a portable music device while riding a motorcycle, they do not provide details for different types of mobile phone use. As discussed above, motorcycle taxi drivers would be benefited from mounting a mobile phone on a holder while riding, e.g. for navigation. Motorcyclists in many places, e.g. Victoria, Australia, can use a mobile phone strictly as a GPS device legally. It would be important for Vietnamese authorities to consider the specification of mobile phone use types while riding a motorcycle in traffic regulations.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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