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## **DRIVERS' TENDENCIES TO ENGAGE IN ABERRANT DRIVING BEHAVIORS THAT VIOLATE TRAFFIC REGULATIONS IN KUWAIT**

**Summary.** Several abnormal driving behaviors in violation of traffic rules can be observed on the road network in Kuwait. These behaviors would likely hinder traffic flow and can worsen traffic congestion. These behaviors may also cause simulation model outputs to deviate from actual traffic conditions. Such aberrant behaviors have not been addressed in the literature, either in terms of the rate of occurrence or in terms of the factors influencing drivers' engagement in these behaviors. This study sheds light on drivers' tendencies to engage in five maneuvers that fall into the category of behaviors that violate traffic rules and could have detrimental effects on traffic conditions in Kuwait. The tendencies of drivers to engage in such behaviors were elicited through self-report questionnaires. The study found that a significant number of drivers in Kuwait display these driving behaviors. The effects of driver gender, driver age, and annual driving distance on the tendency of drivers to engage in such behaviors were investigated.

### **1. INTRODUCTION**

The two main problems encountered on the road network in Kuwait City, as in most metropolitan cities, are traffic congestion and traffic accidents. While the high rate of traffic accidents has been associated with several behaviors displayed by drivers, i.e. speeding, reckless driving, and distraction, very little attention has been directed to the influence of driving behaviors on increasing traffic congestion. Although the problem of traffic congestion stems mainly from traffic demand exceeding roadway capacity, many driving maneuvers could be contributing to increasing traffic congestion due to the disruption and chaos that they create at several points on the road network. Such maneuvers include cutting in through the exiting queue at off-ramps, using a through-lane to complete a U-turn maneuver through a median U-turn opening, and encroaching into the intersection area when a spillback queue has blocked the downstream lanes at a signalized intersection. In addition to their possible influence on traffic flow, if such maneuvers are displayed by a significant number of drivers, they may also lead to significant discrepancies between real traffic data and outputs from traffic simulation models. Edara and Chatterjee contend that for simulation models to achieve their aim of conducting analyses and providing accurate prediction of projected conditions, they must replicate field conditions by accounting for actual driver behavior [4]. They found that accounting for actual driver behaviors through modifying the entry parameters in simulation models resulted in simulation outputs that were more reflective of actual traffic conditions. Similarly, Gowri and Sivanandan concluded that a simulation model that accounted for aberrant road-user behavior, such as seepage of two-wheeled motorized vehicles to the front of a queue of vehicles, yielded outputs that mimicked

actual traffic conditions thoroughly [7]. Kondyli and Elefteriadou studied the merging process under different driving conditions. They recommended the inclusion of variations in driver behavior under congested and uncongested conditions, as observed in the field, in all traffic analysis models and microsimulation models [9]. Frey et al. argue that for traffic models to produce outputs that mirror actual traffic conditions, they must account for the behavioral variations of motorists [5]. The current study addresses several driving behaviors that are encountered on the road network in Kuwait that violate traffic rules. These behaviors may adversely affect traffic conditions. Furthermore, failure to account for these behaviors in simulation models may render outputs from these models to be inaccurate.

There are very few studies in the literature dedicated to addressing the effects of aberrant driving maneuvers on traffic flow. This might be attributed to the fact that the behaviors that this study intends to investigate are more common in developing rather than developed countries. Several studies addressed traffic disruptions that occur at and upstream of off-ramps. Muñoz and Daganzo reported that queues formed at oversaturated off-ramps severely reduce the capacity of the freeway, even more than at on-ramps. They concluded that when the exit lanes at an off-ramp are oversaturated, the through lanes of the freeway segment upstream of the off-ramp experience traffic congestion that results in blockage of these lanes [18]. Cassidy et al. found that the presence of a large queue of vehicles at an off-ramp results in a bottleneck in the highway segment that reduces the capacity of the segment. They reported this observation among generally disciplined driving behaviors. The authors claimed that the reduction in capacity might have been much worse had drivers engaged in less disciplined behaviors by trying to cut in the platoon of queuing vehicles at the ramp [1]. Daganzo et al. argued that the maneuver of vehicles cutting in through a queue of vehicles at an off-ramp exit lane results in blockage of the original through lane as well as significant reduction in the capacity of the exit lane [2]. As for the effects of U-turns, Tanwanichkul et al. found that vehicles executing U-turns through median U-turn openings impede vehicles in the through traffic lanes, especially when the number of turning vehicles is large. This in turn reduces the capacity of the segment [27]. Similarly, Wu et al. found that U-turning vehicles obstruct traffic in the U-turning lane as well as for the adjacent through lanes. The authors attributed this to a queue of U-turning vehicles forming and the subsequent lane changes that they induce [29]. Mohapatra and Dey stated that as the number of U-turning vehicles increases, a queue is formed that blocks through traffic sharing the same lane with U-turners. This ultimately leads to reduction in capacity [17]. Another driving habit that could worsen traffic jams is vehicles occupying the intersection area at a signalized intersection due to queue spillbacks from downstream intersections. Park et al. contend that the presence of vehicles in the intersection area of a signalized intersection severely reduces the capacity of the signalized intersection due to the loss of unutilized time of the green intervals assigned for the different intersecting roads [21].

Drivers' inclination to engage in unlawful driving behaviors might be influenced by many factors. Mesken et al. found that male drivers and younger drivers were more likely to violate traffic rules, as were drivers who travel longer distances annually [16]. Similar results were obtained earlier by Stradling et al., who observed that male drivers, young drivers, and longer annual distance drivers were more inclined to violate traffic rules in the form of exceeding posted speed limits [24]. Gonzales et al. concluded that young drivers were more liable to engage in unlawful and risky behaviors than older drivers [6]. Similar conclusions in terms of young drivers' tendencies to violate traffic rules were reached by Koushki et al. [10] and by Letirand and Delhomme [14]. Oleckno and Blacconiere found that young drivers are inclined to engage in risky driving behaviors [19].

In this study, drivers' tendencies to engage in the targeted behaviors are elicited from self-report questionnaires. Several studies have investigated the validity of using self-report questionnaires as a means of measuring driving behavior. Many of these studies attempted to achieve this by investigating the association between responses to self-report questionnaires and accident involvement of respondents. The reasoning behind investigating this relationship is the close association between driver behavior and accident involvement. de Winter and Dodou conducted a meta-analysis on various studies that used the Driver Behavior Questionnaire (DBQ) to measure driving behavior. They found that the DBQ can effectively predict self-reported accidents through two elements, namely, errors and violations [3]. Owing to the close association between accident involvement and driving

behavior, it can be presumed that self-report questionnaires are viable means of measuring driving behavior. Rowe et al. found that a bifactor model based on driving behaviors obtained from questionnaires was able to predict crash involvement of drivers, thus indicating that self-report questionnaires can justifiably be used to gauge driving behavior [23]. Kaye et al. reviewed several studies that addressed the appropriateness of self-report questionnaires for measuring driving behavior. They concluded that driving behaviors obtained from self-report questionnaires were in conformance with driving behaviors as elicited from driving simulators or in-vehicle measuring devices [8]. Taubman-Ben-Ari et al. reported that driving behavior obtained from in-vehicle data retrieval devices corresponded favorably with driving behavior elicited from self-report questionnaires. They also observed similar associations between driving behavior displayed by subjects in a driving simulator and their driving behavior elicited from self-report questionnaires [26]. Zhao et al. observed an association between driving behavior obtained from questionnaires and various facets of driving behaviors displayed on the road by drivers [30].

On the other hand, many researchers question the validity of self-report questionnaires as a means of assessing driving behavior. It is argued that self-report questionnaires are susceptible to bias stemming from impression management and self-deception by the respondents, which together constitute what is termed social desirability. It is believed that many respondents of self-report questionnaires may reveal more socially desirable responses than responses that reflect their actual driving behavior. Lajunen et al. found that responses to self-report questionnaires are affected by social desirability, more so because of impression management than through self-deception [11]. Lajunen and Summala observed that impression management, and hence social desirability, had an influence on drivers' self-reported behavior, albeit a minor one [13]. Lajunen et al. reported that impression management and self-deception had varying effects on drivers' responses to self-report questionnaires, although each of these constituents of social desirability affects certain drivers more than others [12]. However, Sullman and Taylor found that factors related to social desirability did not affect drivers' responses to self-report questionnaires regarding their driving behavior [25]. Other studies attributed differences between observed and reported driving behaviors to the inability to recall one's driving habits accurately when responding to questionnaires. Martinussen et al. contend that young drivers show the greatest discrepancies between reported and actual driving behaviors, and they attributed this to inability to recall one's driving habits, which is caused by inconsistent driving styles [15]. Thus, it can be concluded in this respect that while self-report is an accepted and commonly used means of measuring driving behavior, any results obtained through this method should be treated with caution. The objective of the current study was to determine the proportion of drivers frequently engaging in maneuvers that violate traffic regulations and may have detrimental effects on traffic analysis as well as traffic conditions in Kuwait. The researchers attempt to assess drivers' tendencies to engage in such maneuvers by responding to self-report questionnaires. Furthermore, this study aims to associate the frequency of partaking in such behaviors with three factors: age, gender, and annual driving distance. To the authors' knowledge, this study is the first to address these collective maneuvers both in terms of rates of execution and in terms of characteristics affecting them.

## 2. METHOD

The tendencies of drivers to engage in certain driving maneuvers that violate traffic rules were elicited through questionnaires. Five different maneuvers were identified and targeted in the study:

- Maneuver 1: drivers completing U-turn maneuvers from lanes dedicated to through traffic (adjacent to designated U-turn lanes), possibly putting drivers attempting to complete the U-turn lawfully at a disadvantage in addition to the possibility of blocking through traffic upstream of the U-turn.
- Maneuver 2: drivers entering intersection areas at signalized intersections when downstream traffic had come to a halt, resulting in these vehicles being stopped in the intersection area and blocking other movements from passing through the intersection during their green phases.

- Maneuver 3: drivers entering intersections controlled by roundabouts when traffic at the roundabout had come to a stop, thus impeding other vehicles, which would otherwise have a clear path, from passing through the roundabout.
- Maneuver 4: drivers using lanes designated for right-turn movements at signalized intersections to encroach on vehicles waiting in queues in the through lanes.
- Maneuver 5: drivers using through lanes of highways or freeways upstream of off-ramps to overtake vehicles queued at exit lanes, which could result in increased delay to vehicles waiting to exit the highway at the ramp lawfully and could also obstruct through traffic on the highway upstream of the ramp.

All items in the questionnaires relating to the five maneuvers had Likert-scale responses on 5 levels of frequency of executing such maneuvers: never, rarely, sometimes, mostly, and always. The items in the questionnaire relating to the frequency of engaging in these maneuvers were supplemented with figures to clarify the targeted maneuvers to respondents.

Prior to asking respondents to reveal their tendencies to engage in these maneuvers, they were asked to respond to general questions about age group, gender, annual driving distance, and whether they drive a personal vehicle as a mode of transport. For the age group, the categories were 18-24, 25-34, 35-44, 45-54, and 55 years or older. For the annual driving distance, respondents were asked to choose the approximate distance they drive annually from three categories: 1000 – 10,000 km, 10,000 – 30,000 km, and over 30,000 km. In case the respondent could not determine the annual driving distance, he/she could respond with “unknown”. To ensure that only active drivers were included in the study, a question was inserted in the questionnaire asking participants whether they drove personal vehicles as a means of transport. Participants could only respond with “yes” or “no” to this question.

Questionnaires written in Arabic were distributed electronically, seeking participation from drivers of personal vehicles in Kuwait. Participation was also sought from students at the College of Technological Studies in Kuwait by distributing paper copies of the questionnaires in classrooms. The electronic version of the questionnaire was created through Microsoft Forms and was made available online. Participation in the survey was sought through several social media platforms such as Twitter and Instagram as well as through smartphone Apps such as WhatsApp. Online participation was the method by which the vast majority of questionnaire responses were gathered. Questionnaires were distributed both electronically and manually during the month of April 2018.

### 3. RESULTS

Overall, 1778 respondents completed the questionnaires. On excluding returned questionnaires of those who reported not driving personal vehicles as the mode of transport, those who did not respond to the question on whether they drove a personal vehicle, and those who failed to report their age or gender, analyses were carried out on 1725 questionnaire responses. Of these, some respondents did not answer one of the questions on the five maneuvers that the study aims to investigate. For such cases, the responses to the other items of the questionnaire were included in their respective analyses. The gender distribution of the sample was 545 female drivers (31.60%) and 1180 male drivers (68.40%). In terms of age, 308 participants were from the 18-24 year age group, 311 participants were from the 25-34 year group, 417 participants were from the 35-44 year group, 403 participants were from the 45-54 year group, and 286 people were from the 55 years or older age group. In terms of annual driving distance, 246 participants drove their vehicles between 1000 and 10,000 km annually and were considered low annual distance drivers, 782 drove 10,000 – 30,000 km annually and were labeled moderate annual distance drivers, 319 drove over 30,000 km annually and were considered high annual distance drivers, and 378 could not determine their annual driving distance. The gender and age distributions of the sample were checked against national figures. According to the General Department of Traffic’s records, the percentage of female drivers among the population of Kuwaiti and Gulf countries’ nationals holding valid driver’s licenses in Kuwait was 39.40% as of the end of 2017 [28]. Hence, there is a slight under-representation of female drivers and over-representation of male drivers in the study sample compared with the population. In terms of age, there was very high

correspondence between the study sample and the population. The percentages of participants aged 18-24, 25-54, and 55 years or older in the sample were approximately 17.8%, 65.6%, and 16.6%, respectively. The corresponding percentages of these age groups in the population as acquired from the Central Statistical Bureau were 17.84%, 66.39%, and 15.77%, respectively [22]. Thus, the study sample could be considered adequately representative of the driver population in Kuwait.

### 3.1. Aggregate Analysis

In terms of Maneuver 1, i.e., drivers completing the U-turn from a lane adjacent to the designated U-turn lane, the results showed that 1722 respondents answered this question. As shown in Table 1, 75 respondents (4.36%) reported engaging in this maneuver "Always", 125 respondents (7.26%) reported engaging in this it "Mostly", 396 respondents (23%) reported engaging in this "Sometimes", 530 respondents (30.78%) reported engaging in this this maneuver "Rarely", and 596 respondents (34.61%) claimed to "Never" engage in this behavior. Since the aim of this study was to identify drivers who engage in these maneuvers frequently, drivers answering this item with responses of "Sometimes", "Mostly", or "Always" were pooled together into a group of frequent violators. Of the 1722 respondents, 596 fell in this group (34.6%), meaning that over one-third of the participants engage in this behavior with significant frequency.

For Maneuver 2, i.e., drivers moving their vehicles to occupy the intersection area at signalized intersections when queue spillback has halted their progression through the intersection, 1722 questionnaires were analyzed. As shown in Table 1, 123 participants (7.14%) reported engaging in this behavior "Always", 198 respondents (11.50%) reported doing so "Mostly", 381 drivers (22.13%) reported engaging in this maneuver "Sometimes", 457 respondents (26.54%) replied with "Rarely", and 563 respondents (32.69%) reported "Never" engaging in this behavior. As was done with Maneuver 1, respondents who provided the responses "Always", "Mostly", and "Sometimes" were pooled into one group of frequent violators. Of the 1722 questionnaire respondents, 702 fell in this group (40.77%). This shows that a significant proportion of drivers engage in this unlawful maneuver.

Table 1

Frequencies and percentages for each maneuver

Maneuver	Category	Never	Rarely	Sometimes	Mostly	Always
Maneuver 1	Number	596	530	396	125	75
	Percentage	34.61%	30.78%	23.00%	7.26%	4.36%
Maneuver 2	Number	563	457	381	198	123
	Percentage	32.69%	26.54%	22.13%	11.50%	7.14%
Maneuver 3	Number	572	489	389	187	85
	Percentage	33.22%	28.40%	22.59%	10.86%	4.94%
Maneuver 4	Number	986	435	240	40	22
	Percentage	57.23%	25.25%	13.93%	2.32%	1.28%
Maneuver 5	Number	819	489	289	98	27
	Percentage	47.56%	28.40%	16.78%	5.69%	1.57%

For Maneuver 3, i.e., drivers moving their vehicles close to stopped vehicles at roundabouts and not allowing space for other vehicles to pass through, 1722 questionnaires were analyzed. As can be seen in Table 1, 85 respondents (4.94%) reported engaging in this maneuver "Always", 187 drivers (10.86%) reported engaging in this maneuver "Mostly", 389 drivers (22.59%) reported engaging in this maneuver "Sometimes", 489 respondents (28.40%) reported engaging in this behavior "Rarely", and 572 drivers (33.22%) reported "Never" engaging in this maneuver. As was the case with the previous maneuvers, respondents with "Always", "Mostly", and "Sometimes" were grouped together as drivers who carry out this maneuver frequently. Of the 1722 respondents who responded to this item in the questionnaire, 661 drivers (38.4%) fell into this group. This amounts to a significant proportion of the participants engaging in this unlawful behavior.

For maneuver 4, i.e., drivers using a designated right-turn lane at signalized intersections to cut in the queue of through-moving vehicles, the analysis included 1723 questionnaires. For this maneuver, 22 drivers (1.28%) stated "Always" engaging in this maneuver, 40 respondents (2.32%) reported doing so "Mostly", a further 240 respondents (13.93%) reported engaging in this behavior "Sometimes", 435 respondents (25.25%) reported engaging in this maneuver "Rarely", and 986 drivers (57.23%) reported "Never" engaging in this behavior, as shown in Table 1. The respondents who reported engaging in this maneuver "Always", "Mostly", and "Sometimes" were grouped together, as was done with previous maneuvers, to determine the percentage of drivers who engage in this maneuver repeatedly. This showed that 302 respondents (17.5%) fell in this group.

With respect to maneuver 5, i.e., drivers cutting in through a queue of exiting vehicles from through traffic lanes upstream of off-ramps, the analysis comprised of 1722 questionnaires. Table 1 shows that 27 respondents (1.57%) reported engaging in this maneuver "Always", 98 respondents (5.69%) do so "Mostly", 289 respondents (16.78%) reported engaging in this behavior "Sometimes", while 489 respondents (28.40%) reported "Rarely" engaging in this maneuver, and a further 819 respondents (47.56%) reported "Never" engaging in this maneuver. Once more, the respondents who replied to this item with "Always", "Mostly", and "Sometimes" were pooled together to form the frequent violators group. This resulted in 414 drivers (24%) falling in this group.

### 3.2. Effects of Age, Gender, and Annual Driving Distance

Proportional odds models (ordinal logistic regression models) were used to investigate the effects of age, gender, and annual driving distance on drivers' inclinations to engage in the five maneuvers. The data from participants who could not estimate their annual driving distances were removed from these analyses to eliminate possible confounding effects. The results of assessment of the suitability of these models along with the significance of the characteristics investigated are shown in Table 2. The likelihood ratio chi-square tests for the models yielded p-values that were less than 0.05. Additionally, the p-values of Pearson goodness-of-fit tests for the models all exceeded 0.05. Hence, these tests suggest the suitability of the models to analyze the data. The deployed models showed that maneuver 1 was affected only by annual driving distance, while maneuver 2 was affected only by age. Age and gender had significant influences on Maneuver 3. Maneuver 4 was affected by gender and annual driving distance. Maneuver 5 was influenced by age and annual driving distance.

Table 2

Suitability of the models and significance of the examined factors

Maneuver	Likelihood Ratio Chi-Sq. Test	Pearson Goodness-of-Fit Test	Test of Parallel Lines	Significance (Age)	Significance (Gender)	Significance (Annual Distance)
Maneuver 1	0.005	0.078	0.423	0.096	0.152	0.044
Maneuver 2	0.013	0.113	0.002	0.004	0.670	0.565
Maneuver 3 (full model)	<0.001	0.075	0.020	<0.001	0.002	0.461
Maneuver 3 (new model)	<0.001	0.149	0.087	<0.001	0.003	excluded
Maneuver 4	<0.001	0.413	0.514	0.126	0.007	0.013
Maneuver 5	<0.001	0.582	0.469	0.001	0.104	0.040

The test of parallel lines yielded p-values greater than 0.05 for maneuvers 1, 4, and 5, supporting the assumption of proportional odds and further validating the suitability of the models for these maneuvers. On the other hand, the tests of parallel lines for maneuvers 2 and 3 resulted in rejection of the assumption of proportional odds. The test of parallel lines has been noted to reject the assumption of proportional odds irrationally [20]. Nonetheless, these results were taken into consideration by applying some modifications to the models. This was done first by removing the independent variables that were not significant. For maneuver 3, this resulted in a p-value for the test of parallel lines of

0.087, indicating that the new model for maneuver 3 (excluding annual distance) conformed to the assumption of proportional odds. The results from the new model for maneuver 3 on the effects of age and gender remained unchanged, as did the within-factor trends. The results for both the full and reduced models for maneuver 3 are shown in Table 2. Similar results were not obtained for maneuver 2 when the non-significant factors were removed. Thus, a binary logistic regression model was fitted to the data. This required dichotomizing the dependent variable, where respondents with “always”, “mostly”, or “sometimes” were considered the violators, while respondents with “rarely” or “never” were considered the non-violating drivers. The likelihood ratio chi-square test ( $p$ -value = 0.001) and the Hosmer–Lemeshow test ( $p$ -value = 0.884) indicated the suitability of the model. The results from this model were highly consistent with those obtained from the proportional odds model, as age ( $p$ -value = 0.001) was the only significant factor affecting drivers reporting this maneuver. The trends among age groups also corresponded with those obtained from the proportional odds model. Therefore, the results from the proportional odds model for maneuver 2 were considered valid.

The within-factor variations among the different categories of the studied characteristics are depicted in Table 3, presented as odds ratios in comparison with the respective reference groups. For all maneuvers, drivers who were 55 years of age or older, male drivers, and high annual distance drivers were the reference groups. For maneuver 1, low annual distance drivers were least likely to engage in this maneuver, followed by moderate annual distance drivers. For maneuver 2, drivers aged 25-34 years were the most likely to engage in this maneuver, followed by drivers aged 18-24 years. Drivers from the other two age groups did not differ significantly from the reference group. For maneuver 3, where the results shown are for the model excluding annual distance, drivers aged 18-24 years were the most likely to engage in this maneuver, followed by those aged 25-34 years. Drivers aged 45-54 years did not differ significantly from drivers who were 55 years of age or older in reporting this maneuver. Female drivers were less likely than their male counterparts to engage in maneuvers 3 and 4. Moderate annual distance drivers were least likely to report maneuver 4, followed by low annual distance drivers. For maneuver 5, drivers aged 25-34 years were most likely to report this maneuver, followed by those aged 18-24 years. Drivers aged 45-54 years did not differ significantly from those who were 55 years of age or older in engaging in this maneuver. Low annual distance drivers were least likely to engage in maneuver 5, followed by moderate distance drivers.

Table 3

Drivers' involvement in the 5 maneuvers according to age, gender, and annual driving distance

Maneuver	Driver Age				Gender	Annual	Distance
	18-24	25-34	35-44	45-54	Female	Low	Moderate
1: U-Turn from Undesignated Lane	NS	NS	NS	NS	NS	0.709	0.763
2: Blocking Signalized Intersection	1.448	1.866	NS	NS	NS	NS	NS
3: Blocking Roundabout	2.503	2.265	1.545	NS	0.749	--	--
4: Cutting in Right-Turn Lane	NS	NS	NS	NS	0.683	0.711	0.692
5: Cutting in Off-Ramp	1.649	1.923	1.490	NS	NS	0.670	0.781

#### 4. DISCUSSION

It can be seen from the results that a significant segment of the driving population engages in acts that violate traffic regulations and could lead to traffic jams. According to the results of the survey, close to 35% of drivers engage in U-turn maneuvers from a lane designated for through movement with significant frequency. This may put drivers who complete the U-turn movement from the designated lane, i.e., the law abiders, at a severe disadvantage since the violating driver's vehicle blocks the vision of drivers completing the U-turn lawfully. Furthermore, this unlawful maneuver could create bottlenecks at U-turn locations, which may hinder traffic flow upstream of the U-turn. Likewise, more than 40% of drivers participating in the study admitted to entering signalized intersections when the queue spillback had completely blocked their progression through the intersection, resulting in these vehicles occupying the intersection area and blocking the progress of other movements. This could lead to more queue spillbacks and less utilization of intersection

capacities. Similarly, over 38% of drivers taking part in this study reported not allowing enough space at roundabouts for other vehicles to pass through when their preferred path was blocked. In other words, a significant proportion of drivers prefer to gain an advantage of only a few meters than to allow several vehicles whose paths were not blocked to pass through the roundabout. This could eventually lead to an accumulation of vehicles in the lanes leading to the roundabout. It could also lead to reduction in roundabout capacity. In terms of drivers unlawfully using the designated right-turn lane at signalized intersections, the percentage of drivers who reported engaging in this behavior frequently was relatively low (17.5%) compared with those engaging in the other maneuvers. Nevertheless, this percentage of drivers could be sufficient to block the right-turn lane and hinder the movement of the otherwise unblocked path of those who wish to turn right. It could also lead to an increase in the delay for vehicles in the through lanes. The last maneuver addressed was drivers cutting in at off-ramps through platoons of vehicles queuing at designated exit lanes. Almost one-quarter (24%) of the surveyed drivers reported engaging in this maneuver with appreciable frequency. In addition to putting vehicles in the exit lane at a disadvantage, this behavior could possibly create bottlenecks at through lanes upstream of the off-ramp that may reduce capacity. These aberrant behaviors are usually not accounted for in traffic simulation models. Integrating these behaviors into traffic simulation models, whether at the reported rates obtained in this study or at rates obtained from future field observation studies, could yield different outputs that might reflect actual traffic conditions more accurately.

The analyses on the effects of driver characteristics on the likelihood of engaging in these maneuvers returned variable results. Some driver characteristics were found to affect certain maneuvers but not others. Age had significant effects on occupying the intersection area at signalized intersections, blocking oversaturated roundabouts, and cutting in through queuing vehicles at off-ramps. Gender had significant effects on blocking oversaturated roundabouts and cutting in from the designated right-turn lane at signalized intersections, while annual driving distance significantly affected making U-turns from lanes designated for through movements, cutting in through queuing vehicles at off-ramps, and cutting in from the designated right-turn lanes at signalized intersections. Nonetheless, the trends among these characteristics were similar regardless of the maneuver. For all maneuvers where age was found to have significant effects, drivers under the age of 35 years were the most likely to engage in these maneuvers. Similarly, male drivers were more likely to engage in the maneuvers where gender was found to be influential. These results are in general agreement with findings generally reported in the literature, where young drivers and male drivers are more likely to engage in driving behaviors in violation of traffic rules or have aggressive driving styles. Likewise, high annual distance drivers were more likely to engage in maneuvers likely to be affected by annual driving distance. This finding indicates that high annual distance drivers are more likely to adopt behaviors in breach of traffic rules. This result needs to be investigated in a future study to explore the motives that may lead high annual distance drivers to engage in such behaviors. These results imply that while efforts to discourage such behaviors must be directed at all drivers, these should be aimed more at male drivers, drivers under the age of 35 years, and high annual distance drivers.

## 5. CONCLUSIONS AND LIMITATIONS

This study addressed several driving habits that violate traffic rules and could have harmful effects on traffic flow. These habits could also have detrimental effects on traffic analyses that use simulation models as tools for assessment and decision-making. These aberrant behaviors, although relatively widespread in many developing countries, have not been addressed previously in the literature. It was shown that an appreciable proportion of drivers in Kuwait engage in these maneuvers, with the percentage of drivers frequently engaging in such acts differing from one maneuver to another. The analyses showed that gender influenced two of the five maneuvers, with male drivers being more likely than female drivers to engage in these maneuvers. Age was found to significantly affect three of the five addressed maneuvers, with drivers under the age of 35 years more likely to engage in these maneuvers. Similarly, annual driving distance was found to have significant effects on drivers engaging in three of the five maneuvers, with high annual distance drivers consistently being more

likely to engage in these maneuvers. Additional research is needed to learn more about other factors that are associated with reporting these behaviors such as drivers' repeated use of certain roads, history of violations, and accident record. Furthermore, more research is needed to quantitatively assess the effects of these aberrant behaviors on the outputs obtained from traffic simulation models, since such models are frequently used to evaluate the viability of proposed road network strategies before implementing them. Moreover, further research is called for to investigate the quantitative effects of these maneuvers on road capacity.

The current study had several limitations. The first may possibly be the nature of the method used to elicit information on driving behavior. What drivers report in self-report questionnaires does not necessarily reflect their actual driving behaviors during different time periods, with varying trip purposes, and in different surroundings, although several studies found a significant association between reported and observed behaviors as stated in the Introduction section. Another limitation of the study relates to the method of distribution of questionnaires. As participation was largely sought through social media platforms and smartphone apps, it is possible that a significant proportion of participants had similar demographic characteristics and represented certain socioeconomic sectors of the Kuwaiti society. It is also unknown whether expatriate drivers were represented in the study in a manner that reflects their proportion in the driving population. Non-Arabic-speaking drivers were also not represented in the study since only Arabic versions of the questionnaires were disseminated. It is also unknown whether all Kuwaiti drivers with varying socioeconomic backgrounds were represented.

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