PRELIMINARY INVESTIGATIONS TO EVALUATE THE BUS DRIVER'S SAFETY PERFORMANCE [+]

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Abstract :

This study investigates the potential to decrease the number of accidents and at the same time increase the safety for an important constituency in the community (riders of school buses). This potential improvement is examined by studying and tracking two school bus drivers four times and scoring their performance in the Greater Fredericton Area, New Brunswick, Canada. This work is a primary evaluation of the vehicle (trucks and buses) drivers' performance at regions that have high commitments of traffic rules. This method can be used to evaluate trucks and buses drivers' performance in Iraqi cities. The researcher aimed to monitor and track the drivers of school buses while they transported students to and from school in order to study drivers' compliance with speed signs and other traffic signs. By using statistical analysis (Minitab Program), the researcher found real evidence that the drivers' performance needs to be improved. This study used two of the most recent technologies in order to obtain accurate results regarding drivers' performance during their driving. First was the Global Positioning System (GPS) device. Second was Geographic Information System software Arc GIS program.

The combination results from integrating GPS/GIS technology, the researcher suggests several conclusions and recommendations to improve the safety in order to improve their driving performance.

Key wards : Vehicles' Drivers Performance, Traffic Safety, and GIS/ GPS Technology.

دراسة اولية لتقييم الاداء الآمن لسائقي الباصات

رائدة خضير علي

المستخلص :

قام البحث بدراسة اولية للمساهمة في تقليل حوادث الطرق وبنفس الوقت زيادة نسبة السلامة المرورية لشريحة مهمة في المجتمع (الا وهم طلبة المدارس الذين يستخدمون الباص المدرسي). يقوم العمل على اساس متابعة اثنين من سائقي باصات المدرسة ولاربع مرات متتالية ومن ثم تحليل وتقييم كل سائق على حدة، تم اجراء البحث في مدينة فردركتون , نيوبرونزويك, كندا.

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وقد كان هدف البحث دراسة وتحليل طريقة اداء سائق الباص اثناء نقله للطلبة من والى المدرسة للتأكد من التزامه وتطبيقه لآداب وقوانين الطريق (السرعة واشارات المرور). وقد تم تحليل النتائج باستخدام البرنامج الاحصائي المتقدم Minitab , وقد وجدت ادلة تؤيد حاجة السائقين الى تطوير في مهارات السياقة. هذا البحث تم باستخدام اثنين من اهم واحدث ادوات التكنولوجيا الحديثة وهو نظام تحديد المواقع العالمي (GPS) وبرنامج نظم المعلومات الجغرافية (Arc GIS version 9.2). فلقد تم وضع عدة مقترحات لتطوير وتحسين اداء سائقي المركبات.

الكلمات المفتاحية : أداء سائقي المركبات، السلامة المرورية، تكنلوجيا GPS /GIS.

Introduction :

Over the last five decades, the transportation sector has been developed and has increased in terms of volume of transportation, speed of motor vehicles, and operational class of road. These developments are associated with an increased number of accidents that involve vehicles, adult people, and children. Road accidents represent a huge loss in terms of people's lives and the economy as well. More than 1.2 million people are killed every year because of road accidents; there are more than 3000 deaths every day related to road accidents worldwide, and ten million people are injured or disabled every year [1].

The injuries that have occurred on school buses have been found to be more severe than other injuries that occurred in other locations with a cost of $38,000 per injury [2]. Each school bus usually transports 30-40 students.

This work focused on studying the performance of the driver, who is considered to have a significant impact on most of these accidents. A study in the United Kingdom has mentioned that the bored driver tended to be seeking entertainment as a result of boredom during driving. Speeding is the most common mistake that drivers used to overcome boredom. The authors have found that younger drivers drive faster and are more excited about their driving than other age groups are. As well, males were more likely to drive over the speed limit than females in rural areas, on highways, and on main roads, but not on urban roads. Furthermore, younger female drivers were reported to drive at higher speeds on urban roads (usually urban areas have lower speed limits), which explains why urban roads have a considerably higher number of speeders [3].

As one of the United States studies concluded "Driver error is responsible for 95 percent of accidents" [4]. The driver's performance affects the safety of road users. This research studied the behaviour of school bus drivers and their impact on the safety of the riders (students) of the school bus and to provide a set of recommendations. Further objectives in this research are to review and make recommendations to improve the bus drivers' performance with the ultimate goal of reducing the risk of fatalities and injuries of bus riders, to decrease the cost caused by accidents in terms of value of life and health issues by improving bus safety. In comparison from reviewing the study that was done by Zein (2008) in Alberta, the researcher found that 41% of all school bus collisions were due to the school bus drivers' actions. Examples of the errors that school bus drivers have been found to make include exceeding the speed limit, changing lanes without using their signal light, and failing to stop at stop signs [5]. School buses are a considerably safer mode to transport students, although numerous steps can be taken to make them safer, for instance, studying the driving performance of

school bus drivers to improve school bus safety. For instance, improve drivers' compliance with stop signs; they should stop completely at stop signs and then operate the bus when it is safe.
There is no research where the behaviour of drivers of school buses has been studied by using GPS/GIS technology as opposed to the majority of researchers who studied and analyzed school buses that were involved in collisions.

Methodology :

The researcher collected the data using the most recent technology to track the school bus drivers' performance. In order to analyze the data properly, this technology was a combination of different software and devices (Map Source, DNR Garmin, Arc GIS software, and Garmin GPS device). Figure 1. shows the system used for collecting the data. Details will be discussed in the following sections. The case study of this work was completed in the Greater Fredericton Area (GFA).

Garmin GPS Map 60CSx Navigator :

Garmin GPS Map 60CSx Navigator was installed in the vehicle to collect speed and tracking data to monitor the drivers' performance. Map Source software, which is provided by Garmin, and DNR Garmin software was used to transfer the data from the GPS device into Arc GIS software in a point shape file as shown in Figure 4.3. Map source software is a program that allows transferring a GPS data into a gdb file, mps file, txt file, dxf file, and gpx file.

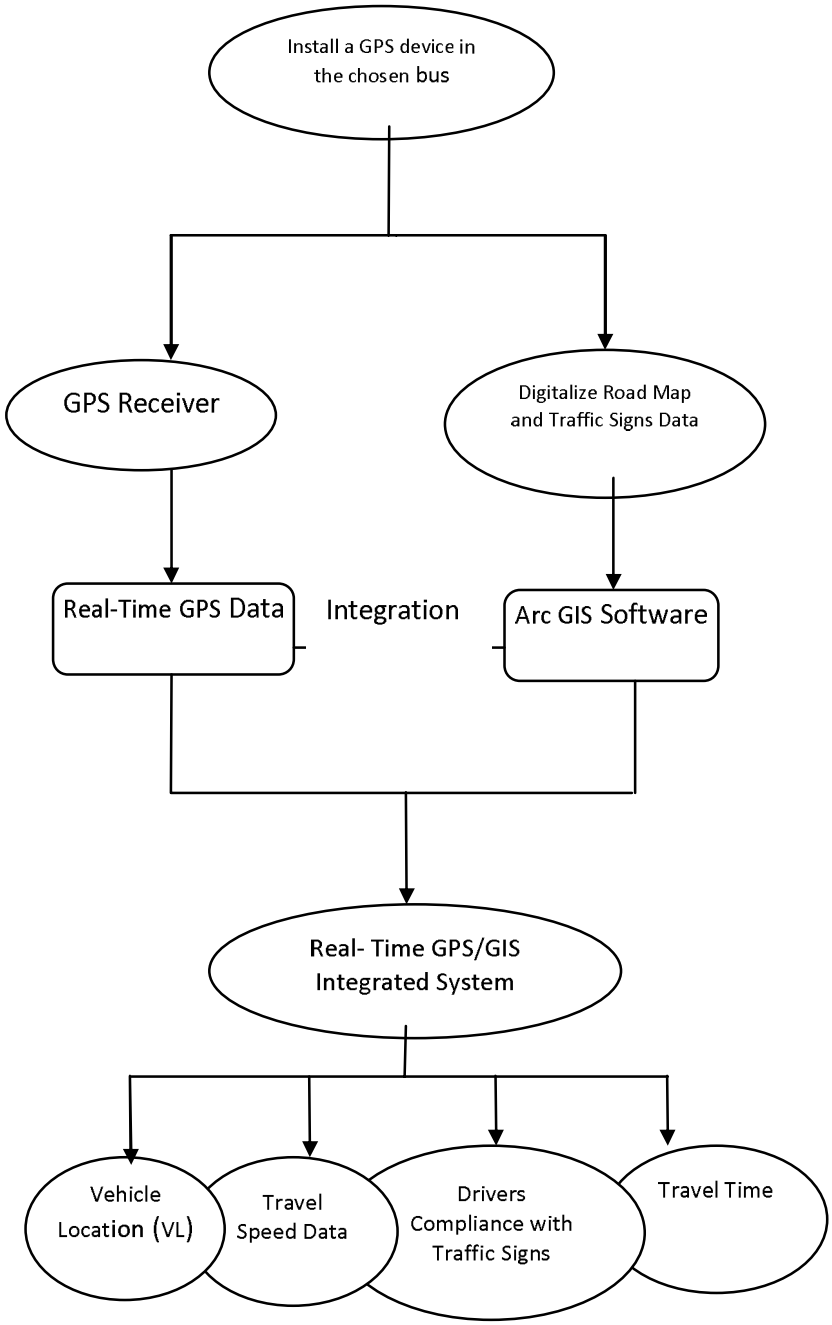


Figure (1): Schematic of Collecting GPS / GIS Data

A sample of speed and tracking data that was collected is shown in Figure 2. each point represents the position (longitude and latitude) at a specific time, date, and speed for the driver along the route. Each point along the route has the attributes shown in the same Figure.

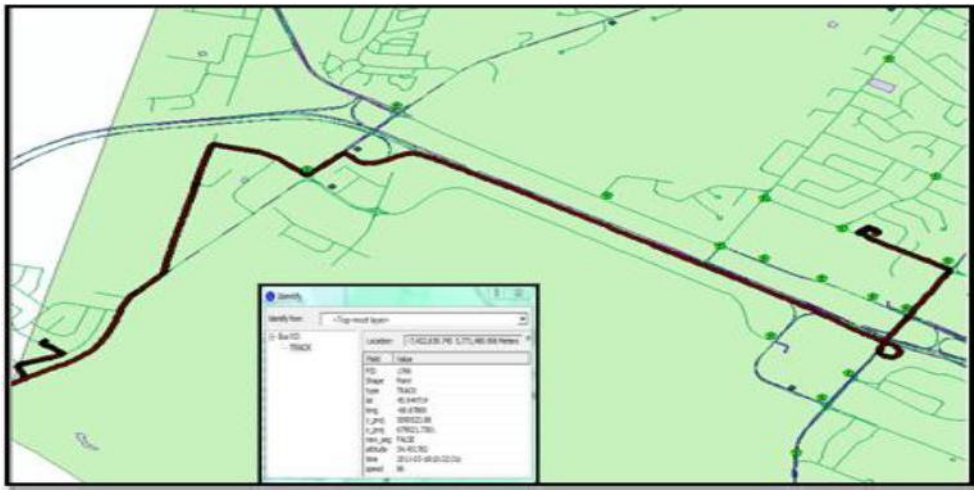


Figure (2): Data Collection by Garmin GPS Map 60CSx

Data Used in the Case Study :

In order to complete this case study, there were two types of data: the first was the traffic sign data and the second was the speed and tracking data.

Traffic Sign Data :

For providing an appropriate digital map for the research, three resources have provided different traffic signs data.

First, the Transportation Department of the City of Fredericton provided a digital map that has the suitable attributes. The attribute table of this digital map includes the name and speed limit of every street in the Greater Fredericton Area. The map is shown in Figure 3.

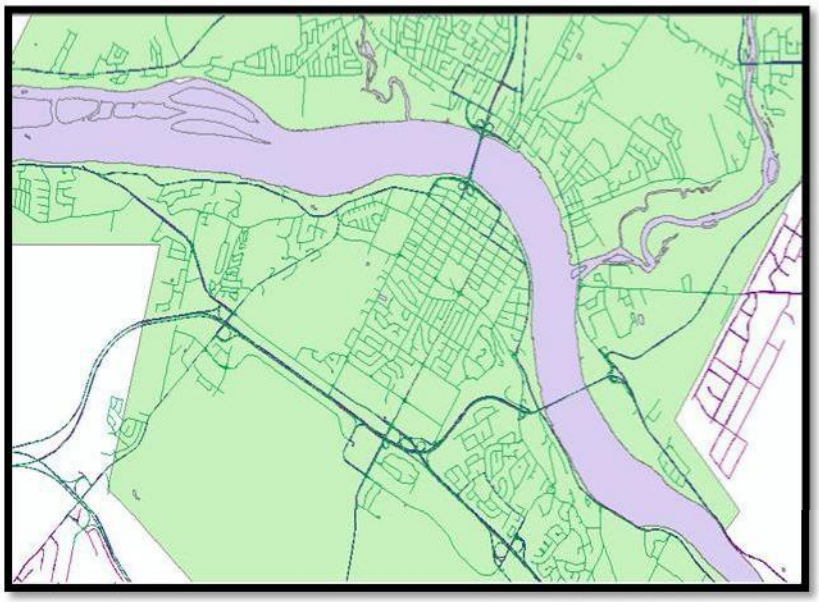


Figure (3): Digital Map of City of Fredericton

Second, the New Brunswick Department of Transportation (NBDOT) provided data on the location of traffic signs on the highways in the whole of New Brunswick. Traffic signs should be on the original map but, unfortunately, just the traffic signals (Figure 4, green points) in Fredericton are available, so besides the traffic signals, other signs had to be collected in the field. The yellow points that are shown in Figure 4 represent all kinds of signs on the highways (regulatory, warning, and crossing control) all over New Brunswick. One problem that has faced the researcher is to combine all data together in one map. The projection of the traffic signs from NBDOT was different from the projection of the original map from the Fredericton transportation department. In order to put them together on one digital map, two steps had to be done. First, since NBDOT signs had no projection, the researcher had to define the projection.

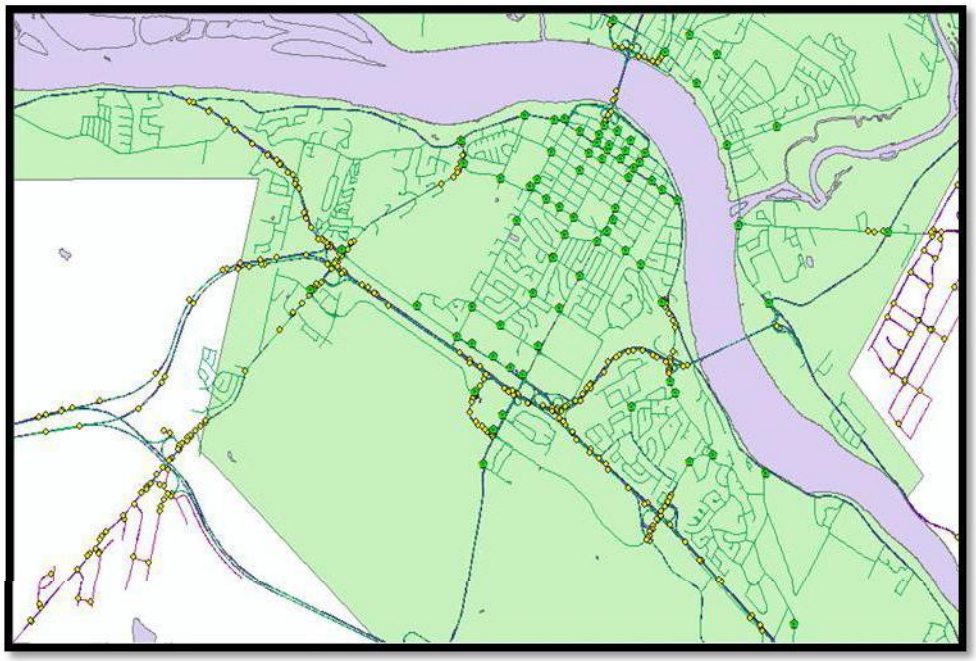


Figure (4): Traffic Sign Data along Highways and Streets in Fredericton

Second, the theme had to be projected according to the same projection of signs that had been provided by the Fredericton transportation department. After that, all signs were combined in one digital map as shown in Figure 4.

The third source of the traffic signs data were collected by the researcher for every sampled school bus route by using a GPS device or manually by going out in the vehicle with a laptop and using Arc GIS software.

Speed and Tracking Data :

In order to have an appropriate track and speed data, every track went through these steps that are presented in the next sections.

1. Data Collection :

1) At the beginning, the GPS device was installed in the two chosen buses for the routes where students are picked up along the Hanwell Road and back to Priestman Street School. Four tracks had been done for each bus for an average of 16.5 km in an average period of 30 minutes each trip. Weather conditions were clear and dry for all the trips; the first driver's age was estimated to be about 55 and the second driver was estimated to be about 25 years old. The GPS device that was used in this case study was the Garmin GPS Map 60CSx handheld navigator, which collects the position, speed, time, and elevation of the tracked vehicle every second. The researcher followed the school bus in order to collect more information along the route by direct observation.
2) Every track was downloaded to the PC using Map Source and / or DNR Garmin software in order to convert the track into text/shape file format.

2. Transfer the Collected Data :

1) Each set of speed and tracking data was transferred and converted into a digital map of the City of Fredericton by using tools, menu, and functions that have been provided by the Arc GIS software. Using these two technologies GIS/GPS as tools provided results efficiently.
2) One combined map, which consists of the digital map of Fredericton City streets and the tracking data from the GPS device, was created in this case study. The attribute table of speed, time, position, and elevation was shown in the GIS database for each track in order to conduct the analysis.

3. Analyze the Collected Data :

In order to prepare the collected data for analyzing, three steps were conducted as follows:

1) After converting the tracking data, each performance was analyzed and scored in order to evaluate the driving behaviour. The speeding behaviour was evaluated along the route. Using the functions and tools that were provided by Arc GIS, every track was displayed to show the performance of every driver.
2) The penalty speed score (PSS) was applied as follows:

$$PSS = \frac{\sum_{i=1}^{n}(TOS * POS)\,i}{Tt} * 100$$

Where:

PSS = Penalty speed score, Tt: Total trip time, n: Number of segments, TOS= Time over speed limit, POS= Percentage over speed limit

Analyzing and Comparing School Bus Driver's Performances :

After transferring the tracks, an analysis was done to evaluate the two drivers' performance. The researcher found several instances where the two drivers exceeded the

speed limit, did not comply with traffic signs, and did not follow the safety rules as shown below:

The drivers' speed was over the speed limit along Hanwell Road and the urban areas, which exposed the students to risk. As shown in Figure 5 the driver was speeding 95 km/h while the posted speed limit was 90 km/h.

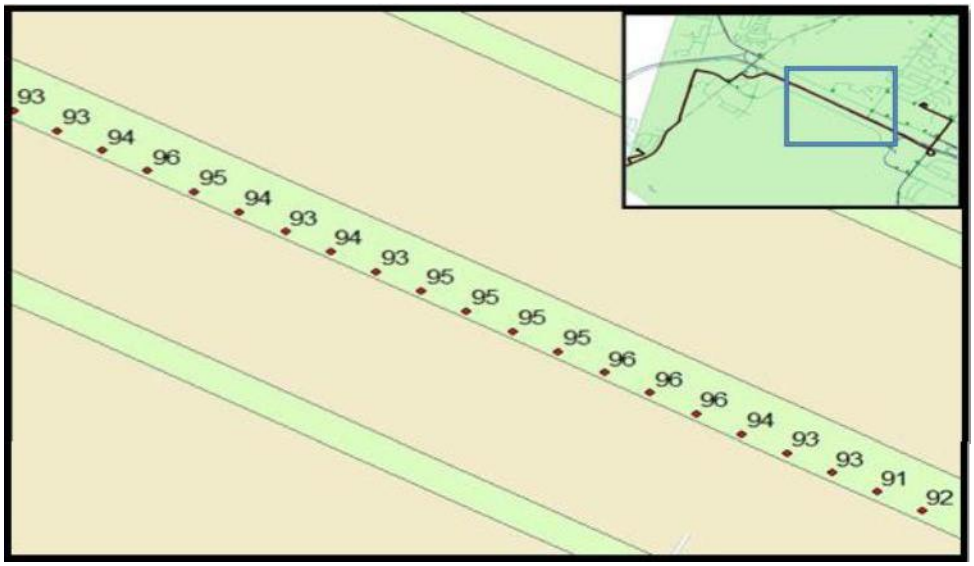


Figure (5): Bus Driver's Speed a bove Speed Limits on the Highway

1) There are four stop signs along the driver number one route; the researcher found that driver number one stopped only twice at any of the four stop signs while operating over his route four times (four tracks). In other words, the driver stopped at two stop signs out of 16 stop signs while operating over his route. The second driver has five stop signs along her route, but she stopped only five times at any of the five stop signs while operating over her route four times (four tracks). In other words, the driver stopped at five stop signs out of 20 stop signs while operating over her route. Sample of the driver's performance at stop signs is shown in Figure 6. Drivers' speed at stop signs were observed as the smaller number appeared on his/her speed record, Figure 6 shows that the least number of speed at the stop sign was 4 and 16 km/h for the left and right picture respectively.

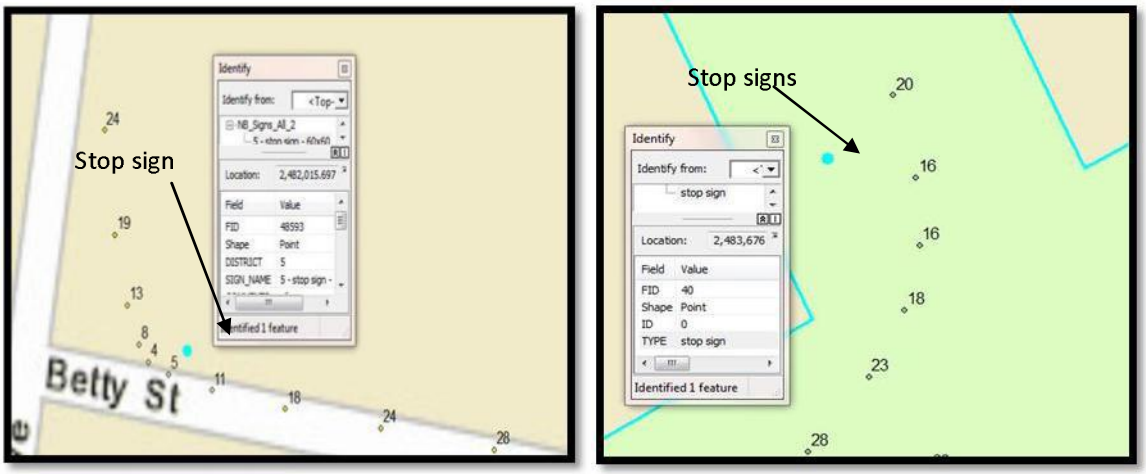


Figure (6): Drivers Failed to Stop at Stop Signs

2) The speed limit in the school zone is 30 km/h and yellow school zone signs indicate the school zone, where every driver should not be driving more than 30km/h by law. The researcher found that the driver was exceeding the speed limit in the school zone as shown in Figure 7 and this was a common performance for the drivers in all eight tracks. The actual speed is depicted along the route shown in Figure 7 where the posted speed limit only 30 km/h and the actual driver's speed were 44, 43, 42 and 41 km/h etc.

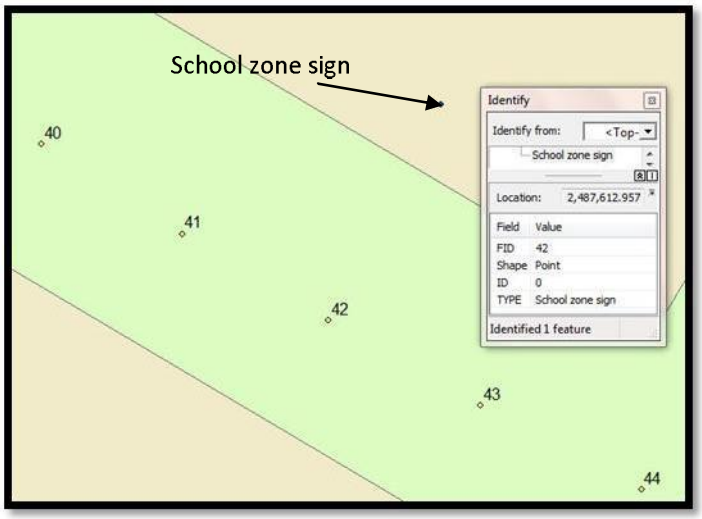


Figure (7): Driver's Speed on the School Zone

3) By regulation (NB Department of Education, 2004) the school bus driver should drive the bus in the loading zone at a speed not exceeding 10km/h. The drivers' speed at the loading and unloading zone in front of the school was exceeding 10km/h for the eight tracks that were tested as shown in Figure 8. The actual speed is depicted in the Figure 8 with a minimum actual speed of 14 km/h.

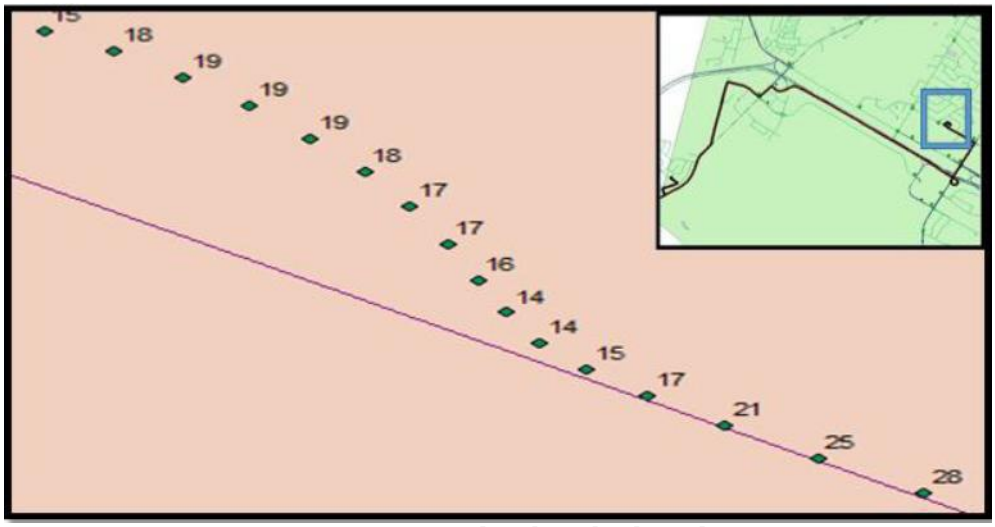


Figure (8): Driver's Speed at the School Loading Zone

Scoring the Driver

Scoring the driver while transporting the students allowed the researcher to identify who the safer driver is and what are the variables and habits that will help to determine the best performance with respect to safety. The researcher invented an equation to score the drivers. Each school bus driver in this study was scored depending on his or her driving behaviour. For speeding behaviour each of the two drivers received a penalty according to his or her speed over the speed limits and the amount of time and that was calculated by using the equation below.

$$PSS = \frac{\sum_{i=1}^{n} (TOS * POS)\, i}{Tt} * 100$$

The drivers for this case study received penalty scores for speeding along their routes as shown in the Table 1.

Table (1): Drivers' Speeding Penalty Score for Their Four Tracks

	Track 1	Track 2	Track 3	Track 4	Mean	Standard deviation
Driver 1	84	87	85	119	93.9	16.9
Driver 2	156	78	41	44	79.6	53.7

For regulatory signs like yield signs, the driver was complying with yield signs along the route with an appropriate speed of 24 km/h, which is below the speed limits. As well, compliance with pedestrian crossing control signs was good because the driver decelerated at these signs. From Figure 9, the speed behaviour of the driver implied that the driver slowed down when the yield signs and crossing control signs had been reached. The dark blue colour means the driver was speeding and the light green colour means that the driver decelerated the

speed; the colour was graduated from dark blue to dark green, which means the speed was depicted as follows: (0-11km/h) dark green, (12-30km/h) light green, (31-50km/h) light blue, (51-72km/h) dark blue, (73-90km/h) darker blue. In addition, for warning signs, the driver reduced the speed of the vehicle to a range that meets the criteria of the Transportation Association of Canada (TAC, 1998). That requires caution and reduction in the vehicle speed as well.

The drivers received penalties for not complying with traffic sign rules. Complying with stop signs along the route was not satisfactory; the drivers did not stop the bus completely at almost all stop signs; in other words, the first driver complied with 12.5% of all stop signs and the second driver complied with 25% of all stop signs. Therefore, the drivers received the average penalty of 87.5 and 75 out of 100, respectively. By using the simple statistics for the four tracks for each driver, the researcher found the average speed and standard deviation for the stop signs as shown in Table 2. The comply percentage with regard to the stop signs were 12. 5 and 25 for the first and second driver respectively and the total complies of both drivers was 19.4%.

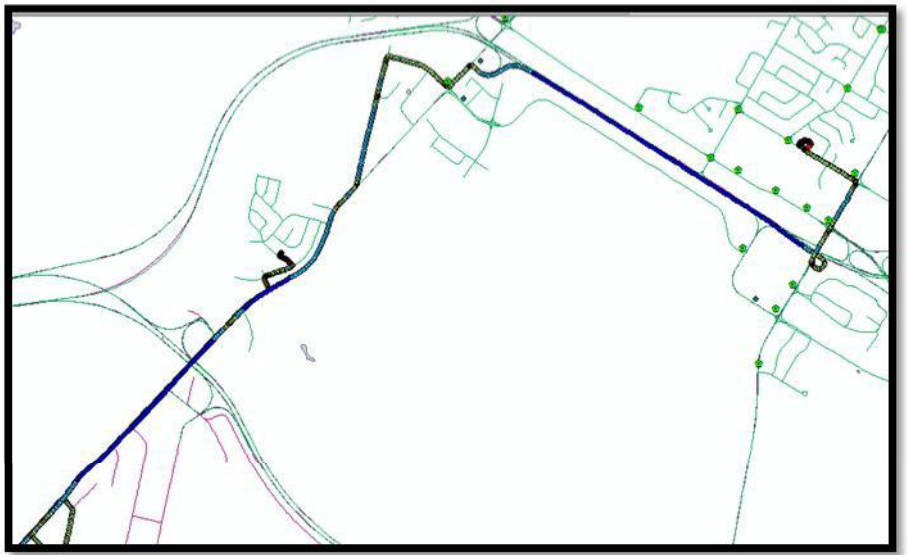


Figure (9): Graduated Colours Shows the Deceleration of Speed

Table (2): Average and Standard Deviation of Speed at Stop Signs

Driver	Average speed km/h	Standard deviation	No. of stop signs	Comply	Not comply	Average penalty score	Comply %	Total comply%
1	3.875	47.5	16	2	14	87.5	12.5	19.4
2	4.79	50.3	20	5	15	75	25	

Statistical Analysis :

The researcher tested several hypotheses using ANOVA: the first hypothesis is that there is no significant difference between tracks that had been operated by the first driver. The first driver's speed at four stop signs for four tracks was analyzed. The result indicates, first, that the driver showed no significant differences with the four tracks he operated because the P value for track is large (0.437), with small F value (1.00), thus rejecting the null hypothesis. The second hypothesis is that there are no significant differences for complying with stop signs for the first driver. The result indicates that there are significant differences for the first driver's compliance with stop signs because the P value is small (0.009), with large F value (7.14) with 95% confidence interval, therefore the hypothesis is rejected. This model showed a good relationship between the dependent variable (speed) and independent variables (track and sign) with R^2 exceeding 73 % as shown in Figure 10.

General Linear Model: First driver's speed versus track, sign

Factor	Type	Levels	Values
Track	random	4	1, 2, 3, 4
sign	fixed	4	1, 2, 3, 4

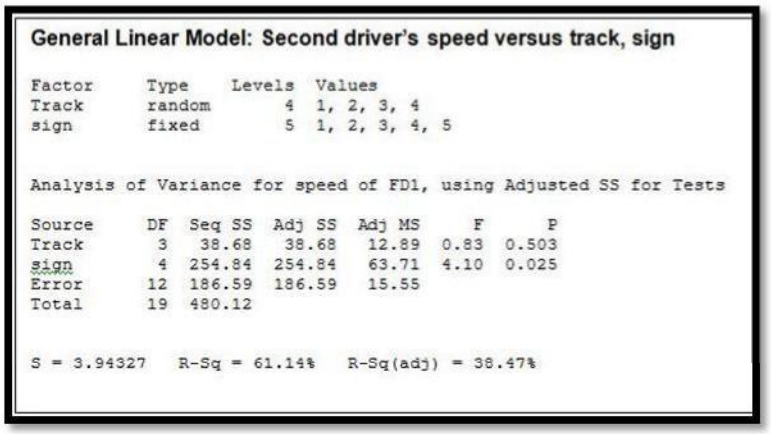
Analysis of Variance for speed, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
track	3	30.34	30.33	10.11	1.00	0.437
sign	3	217.12	217.12	72.37	7.14	0.009
Error	9	91.17	91.17	10.13		
Total	15	338.63				

S = 3.18277 R-Sq = 73.08% R-Sq(adj) = 55.13%

Figure (10): Statistical Analyses (ANOVA) of the First Driver's Performance at Stop Signs

The researcher analyzed the second driver's speed at stop signs for four tracks with the first hypothesis that there is no significant difference between tracks that had been operated by the second driver. The result indicates that there are no significant differences with the four tracks she operated because the P value is large (0.508) with small F value (0.83) at 95% confidence interval, thus rejecting the null hypothesis. The second hypothesis that was tested, that there are no significant differences for complying with stop signs for the second driver. The result indicates that there are significant differences for the second driver's compliance with stop signs because the P value is small (0.025) with large F value (4.10) at 95% confidence interval, thus rejecting the hypothesis. This model showed a relationship between the dependent variable (speed) and independent variables (track and sign) with R^2 exceeding 61% as shown in Figure 11. This indicates that there is no significant difference for the first driver as he operates over his route every day as does the second driver. Also, there are significant differences with regard to the speed at stop signs for both drivers (P values are small) and that might be because of the differences of the speed limits on the roads where they operate. As well, the drivers operate at different speeds at each stop sign although they must stop completely even if there is a gap for the bus.



General Linear Model: Second driver's speed versus track, sign

Factor	Type	Levels	Values
Track	random	4	1, 2, 3, 4
sign	fixed	5	1, 2, 3, 4, 5

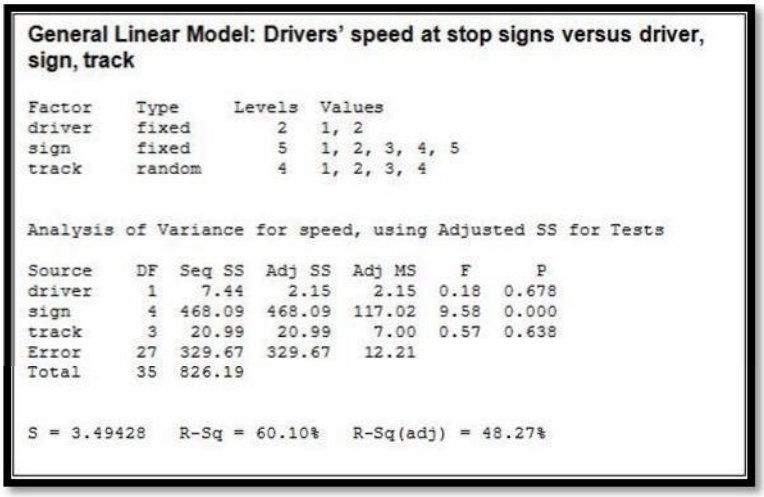
Analysis of Variance for speed of FD1, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Track	3	38.68	38.68	12.89	0.83	0.503
sign	4	254.84	254.84	63.71	4.10	0.025
Error	12	186.59	186.59	15.55		
Total	19	480.12				

S = 3.94327 R-Sq = 61.14% R-Sq(adj) = 38.47%

Figure (11): Statistical Analyses (ANOVA) of the Second Driver's Performance at Stop Signs

By comparing the two drivers' performances using ANOVA, the first hypothesis is that there are no significant differences between the two drivers' performance. The result shows that there are no significant differences between the first driver and the second driver because the P value is large (0.678) with small F value (0.18) at 95% confidence interval, thus rejecting the null hypothesis. The second hypothesis is that there are no significant differences for complying with stop signs for each driver. Figure 1.10 shows that drivers' compliance with stop signs is significantly different as the P value is small (0.00) with large F value (9.58) at 95% confidence interval, thus rejecting the hypothesis. The third hypothesis is that there are no significant differences between drivers' performance over their routes for four tracks. Figure 10 shows that there are no significant differences for both drivers' performance over their routes for four tracks because the P value is large (0.638) and small F value (0.57), thus rejecting the null hypothesis. This model showed a relationship between the dependent variable (speed) and independent variables (track, sign, and drivers) with R^2 exceeding 60% as shown in Figure 12.



General Linear Model: Drivers' speed at stop signs versus driver, sign, track

Factor	Type	Levels	Values
driver	fixed	2	1, 2
sign	fixed	5	1, 2, 3, 4, 5
track	random	4	1, 2, 3, 4

Analysis of Variance for speed, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
driver	1	7.44	2.15	2.15	0.18	0.678
sign	4	468.09	468.09	117.02	9.58	0.000
track	3	20.99	20.99	7.00	0.57	0.638
Error	27	329.67	329.67	12.21		
Total	35	826.19				

S = 3.49428 R-Sq = 60.10% R-Sq(adj) = 48.27%

Figure (12): Statistical Analyses (ANOVA) of Both Drivers' Performance at Stop Signs

The drivers' speed frequency at the stop signs that was analysed is shown in Table 3 and Figure 13. It has been shown that one of the driver's speed was between 16-18 km/h at one of the stop signs, which means that the driver operates his or her bus at the stop sign as if it was a yield sign. Besides, drivers' speed was between 8-10 and 10-12 km/h at stop sign for three times. The two drivers had a speed between 4-6 and 6-8 km/h for 5 and 4 times respectively out of 36 times. These imply that these drivers operate their school buses at the stop signs as if they were yield signs where the school bus driver should stop properly at stop signs.

Table (3): Driver's Speed Frequency at Stop Signs

Speed km/h	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18
Frequency	16	2	5	4	3	3	0	2	1
Frequency %	44.4444	5.5556	13.8889	11.1111	8.3333	8.3333	0.0000	5.5556	2.7778

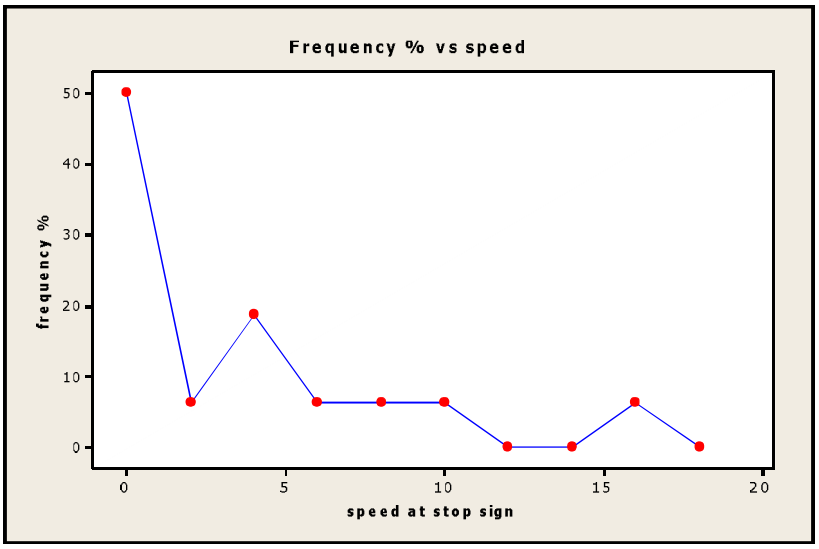


Figure (12): Driver's Frequency Speed at Stop Signs

Every track was divided into six segments because the route was divided into six segments already, Table 4 and Figure 13 show the divided segments along the routes. Driver's performance over these segments was compared using ANOVA for each driver.

It has been found that there is no significant difference in the driver behaviour for three segments out of six (these segments where the driver was above the speed limit), which is considered unsafe performance.

Both drivers were speeding in both urban areas and along the highway. For the urban area for example, the first driver was speeding in 27.67% of all the time he spent above speed limits and for the highway he was 72.33% above the speed limit of all the time he spent above speed limits. Moreover, the driver exceeded 20% over the posted speed limit by 10.7% of the time in the urban area and 0% on the highway for all his tracks. As has been posted in WHO (2004

report), reduction of 1km/h of average speed will result in 2% reduction in the number of crashes.
For merge signs through to the highway, the drivers were accelerating and their speed was greater than 50 km/h in order to merge on to the highway along their four tracks. The drivers did not receive any penalty for this sign.

Table (4): The Speed Limit along the Six Segments of the Route

Segment number	1	2	3	4	5	6
Speed limits km/h	70	50	70	50	90	50 and 30
Segment' colour in the map	Orange	Black	Red	Yellow	Purple	Blue

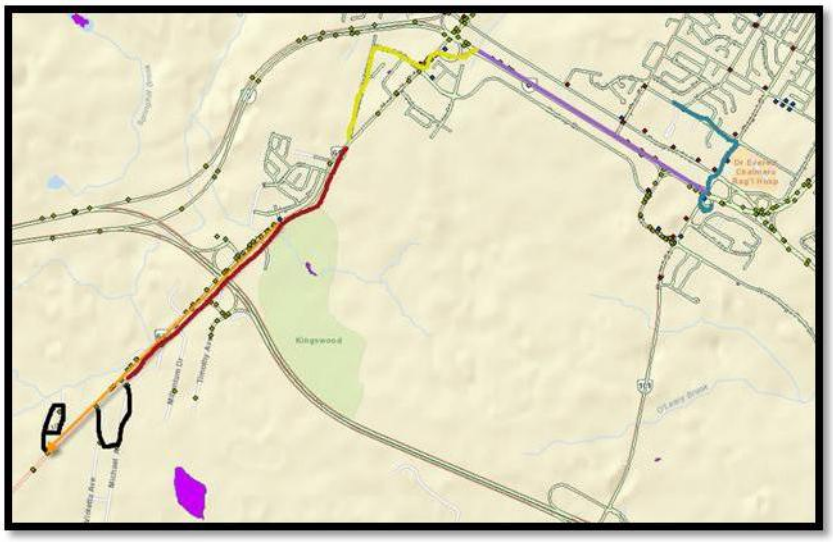


Figure (13): The Divided Six Segments Along the Route

The drivers complied with crossing control signs; there were four crossing control signs along the route and the drivers' speed was less than the speed limits at all these signs for all four tracks. So, the drivers did not receive any penalty for this sign.
Both drivers complied with yield signs. For instance, there was one yield sign along the route for the first driver and he decelerated; his speed was as follows: 0.9, 0, 6, and 23 km/h for the track 1, 2, 3, and 4 till he found the acceptance gap, and the driver did not get any penalty for this sign.

Conclusion :

Both of the monitored driver's performances were above the posted speed limits almost at the same segments, which are segments 1, 3, and 6. The speed limit on Hanwell Road is 70 km/h and the researcher found that the drivers were speeding in places where they do not need

to stop to pick up students. From this perspective, both drivers have a habit of speeding when they drive unless they have to slow down in order to stop and pick up students. By conducting a statistical analysis, on the somewhat limited sample, using ANOVA, the researcher found that there is no significant difference in the driving behaviour for each of the tested drivers. Also, there is no significant difference in the driving behaviour for both drivers along their eight tracks and that their exceeding the speed limit is a habit. This implies that this driving performance needs to be improved and they should be aware of the risks of speeding in order to help prevent accidents from occurring.
With respect to traffic signs, for stop signs the drivers did not stop properly at 7 out of 36 stop signs. This case study implied that the drivers have several habits that indicate unsafe driving, especially with students on board; these habits are:

1. Drivers were exceeding the speed limits even on the highway or in urban areas.
2. Not stopping at the stop sign unless there is no gap or heavy traffic forces him/ her to stop. While by law every driver must stop completely at a stop sign and look right and left to see if it is clear, he/ she would continue; otherwise the driver stops until the road is safe to continue.
3. Unsafe performance when students are getting on the bus. The first driver starts moving the bus while students are still walking in the aisle in order to get to their seats. By regulation the school bus should not be in motion unless all pupils on board are seated. The researcher recorded a video to prove that the driver often drives the school bus before all students have been safely seated.
4. Speeding 20% above the speed limits is a very dangerous situation and the researcher found that the first driver drove at this rate 10.7% of the time he was speeding in the urban area, which exposes the students to high risk. From the researcher opinion 30km/h at school zone is appropriate especially for school bus because they operate their buses in front of schools at 8:00 am and 2:00 pm and 4:00 pm where there is a large number of pedestrian crossing the road.
5. Unsafe performance of several drivers for example loading and unloading students in the middle of the street, running through the yellow light at intersections, and no signal light applied when the driver changed lanes.

It has been concluded that there is evidence based on these findings for the very limited sample size, although statistically limited, that a more detailed study should be pursued. The more detailed study should include a statistically valid sample size, should be based on random sample. A detailed statistical analysis should be undertaken to verify the current findings and to develop the different criteria examined beyond the current limited information provided by tracking only two drivers, one female and one male.

Recommendations :

Based on the results of this study that was conducted, recommendations are made for further studies to improve drivers' behaviour.

1. The researcher suggests further and more comprehensive statistical analyses that are statistically significant with a legitimate sample size based upon this study.
2. This study recommends using the score equation that was invented by the researcher to evaluate drivers' performance because it reflects the driver behaviour in terms of speeding and complying with traffic signs. Besides, other equations could be considered.
3. This study suggests study whether there is relationship between the attendance of driver training and compliance with traffic rules and safe driving. In addition, the number of kilometres travelled since becoming a school bus driver is expected to be significant too; the more the driver travels on his/her route, the more likely he/she may be to speed and drive confidently, but potentially carelessly.
4. For further studies, this research suggests studying and identifying the circumstances that cause driver error performance, for instance studying the previous collision locations and the effect of the road surface condition, environment, school bus type, and traffic control type.
5. As Hildebrand said "there is no such thing as a "safe" driver; conversely, there is no such thing as an "unsafe" driver. There are only varying levels of risk that can be associated with different drivers as a result of their skills, behaviours, knowledge, cognition, physical capabilities and attitudes" [6].Using this method to evaluate the Iraqi drivers in order to enhanced their performance on the roads, especially the companies and agents' drivers.
6. Develop the digital map of the transportation system in Iraq that allowed using this method.

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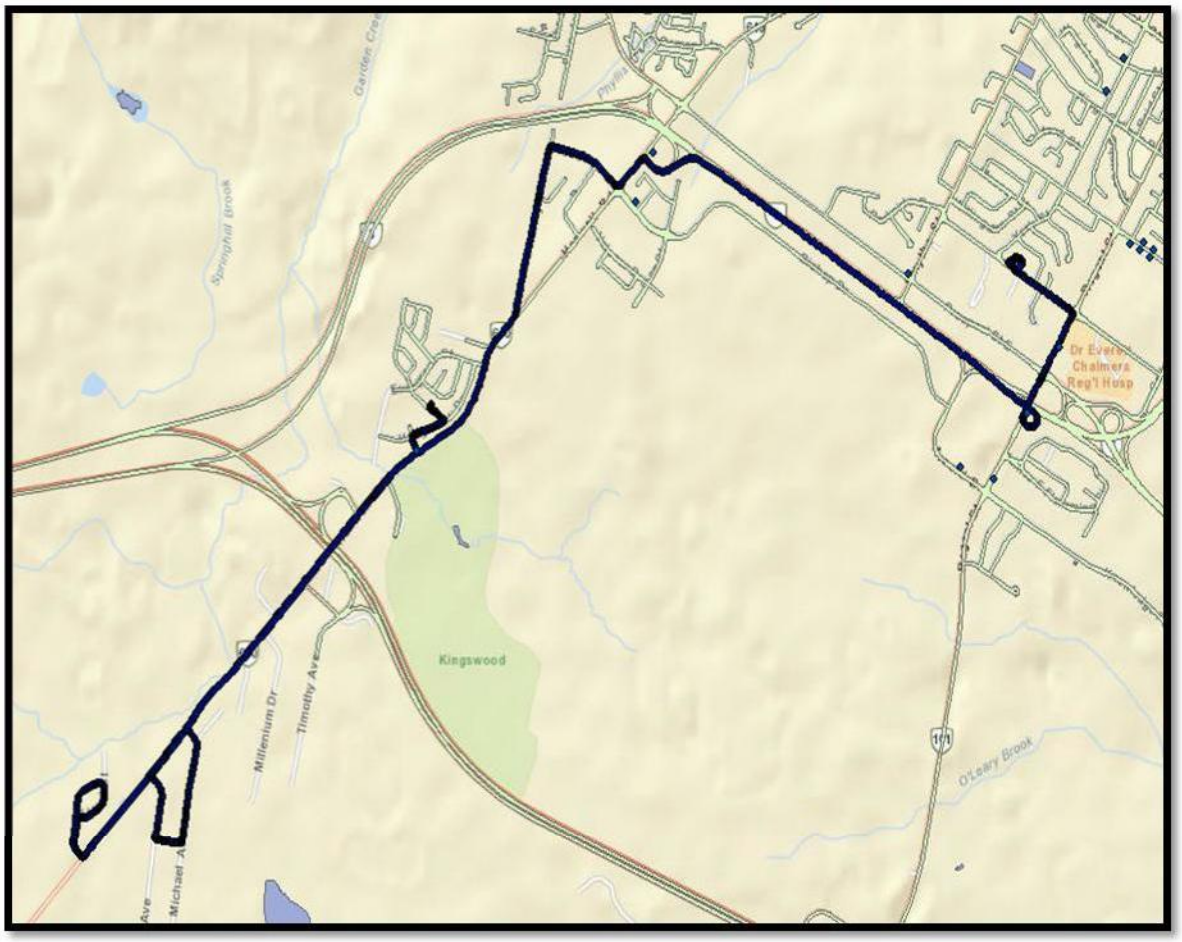
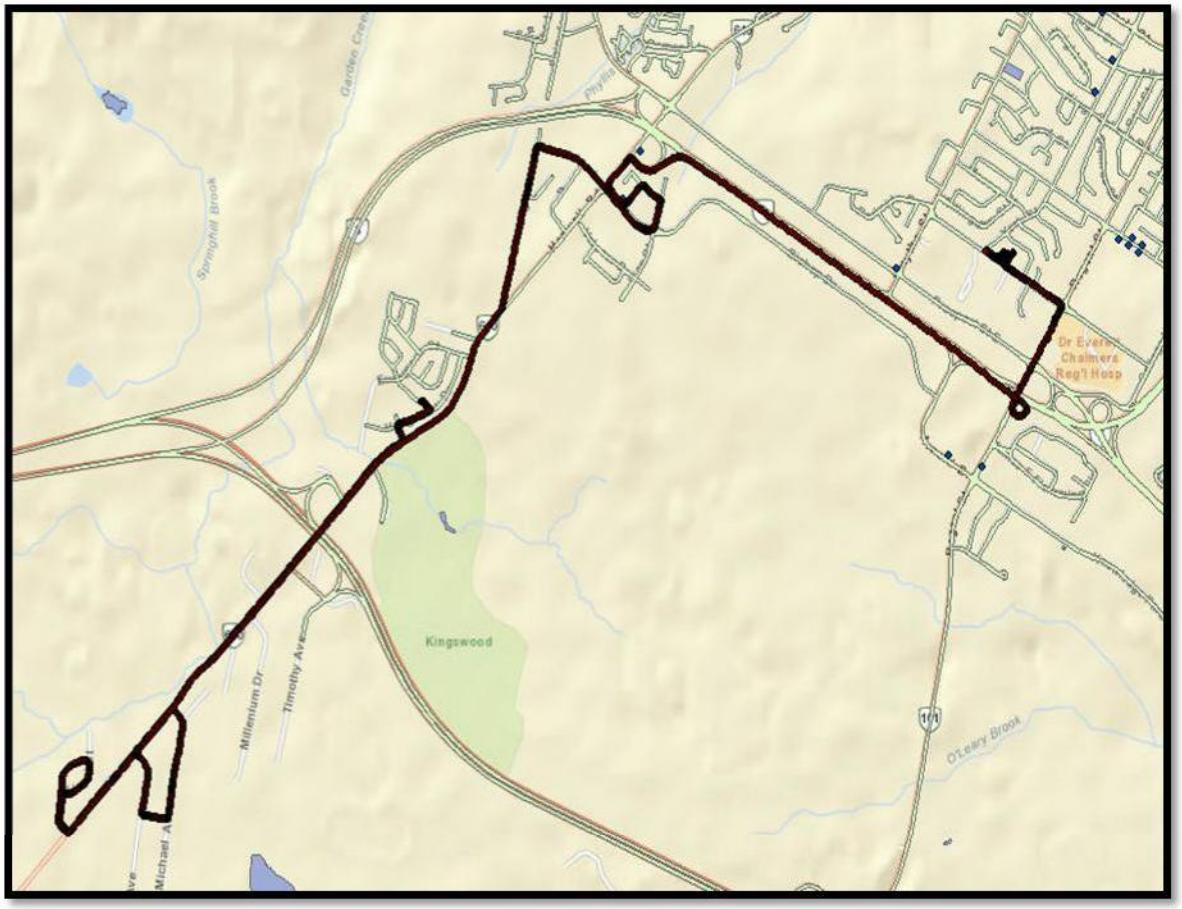
Appendix A

Map of the Route of the First Driver



Appendix B

Map of the Route of the Second Driver



Appendix C

Sample of the Attribute Table of the Track and Speed Data

Sample of attribute table of the track data

FID	type	lat	long	y_proj	x_proj	altitude	time	speed
0	TRACK	45.936207	-66.708977	5089510.787	677601.4527	23.208984	2011-09-28T10:08:58Z	3
1	TRACK	45.936212	-66.708972	5089511.377	677601.8624	23.208984	2011-09-28T10:08:59Z	2
2	TRACK	45.936211	-66.708963	5089511.296	677602.5165	22.728272	2011-09-28T10:09:00Z	3
3	TRACK	45.936209	-66.708953	5089511.084	677603.2751	23.208984	2011-09-28T10:09:01Z	4
4	TRACK	45.936206	-66.70894	5089510.747	677604.3012	23.208984	2011-09-28T10:09:02Z	5
5	TRACK	45.936201	-66.708925	5089510.27	677605.4864	23.208984	2011-09-28T10:09:03Z	3
6	TRACK	45.936198	-66.708914	5089509.95	677606.3723	23.208984	2011-09-28T10:09:04Z	4
7	TRACK	45.936194	-66.708902	5089509.522	677607.3389	23.208984	2011-09-28T10:09:05Z	4
8	TRACK	45.93619	-66.70889	5089509.082	677608.2825	23.689575	2011-09-28T10:09:06Z	4
9	TRACK	45.936185	-66.708877	5089508.589	677609.2898	23.689575	2011-09-28T10:09:07Z	3
10	TRACK	45.936182	-66.708865	5089508.214	677610.185	23.208984	2011-09-28T10:09:08Z	4
11	TRACK	45.936177	-66.708855	5089507.761	677611.0437	23.208984	2011-09-28T10:09:09Z	4
12	TRACK	45.936173	-66.708844	5089507.285	677611.9108	23.689575	2011-09-28T10:09:10Z	4
13	TRACK	45.936169	-66.708832	5089506.878	677612.8147	23.689575	2011-09-28T10:09:11Z	0.2
14	TRACK	45.936169	-66.708832	5089506.91	677612.7827	23.689575	2011-09-28T10:09:12Z	3
15	TRACK	45.936165	-66.708821	5089506.501	677613.6556	23.689575	2011-09-28T10:09:13Z	4
16	TRACK	45.936161	-66.70881	5089506.038	677614.5534	23.208984	2011-09-28T10:09:14Z	4
17	TRACK	45.936156	-66.708799	5089505.563	677615.4515	23.208984	2011-09-28T10:09:15Z	4