

Coach Travel Safety Analysis Matrix (CTSAM)

A tool for analysing safety of children travelling by coaches in the UK

Manoharan Ramachandran, Reza Sahandi, Simant Prakoonwit and Wajid Khan

Faculty of Science and technology

Bournemouth University

Bournemouth, United Kingdom

{mramchandran,rsahandi,sprakoonwit,wajid@bournemouth.ac.uk}

Abstract—Coach based school transportation is a less investigated area in the continent of United Kingdom. Though they are considered the safest mode of transport for children, coaches have a significantly high number of fatalities per accident. There are a limited number of studies which have implemented qualitative interviews to analyse the safety of children travelling in coaches but no standard methods were followed to prepare the questions for the interviews. There are no standard methods available to analyse the safety of children travelling in coaches in the UK. To rectify this issue, an interview guide called Coach Travel Safety Analysis Matrix is proposed in this paper. It is based on the Haddon Matrix which is used as a standard tool to analyze bus and coach accidents. The proposed matrix can be utilised to frame questions for the qualitative interviews to systematically analyse the safety of children travelling in the coaches in the UK. As this matrix is generic, it can also be used in continents other than the UK.

Keywords—children safety; school transport; interview guide; CTSAM; haddon matrix;

I. INTRODUCTION

School transport through private coaches is critical for safety, as it involves children, the most vulnerable users[1]. Coach-based school transport in the UK is a less investigated area compared to the other modes of transport for school trips [2]. Though coaches are considered the safest mode of travel for children, they involve a high number of fatalities per accident [3][4]. A total of 371 coach accidents have been recorded between 2006 and 2015 in the UK (excluding Northern Ireland) as a result of which, 1191 children getting injured during the school trips [5]. The common contributory factors for these accidents, as reported, were driver errors and vehicle errors [6]. The UK government is aware of all these contributory factors and that's why they have strict regulations on operator compliance with the government safety policies. But, in the last year alone (2016), 137 coach operator licenses have been revoked in the UK, without public enquiry, due to operator non-compliance [7]. Thus, we can say that the accidents are happening not because of existing regulations, but due to coach operators' failure to follow those regulations which is also confirmed by the contributory factors for those accidents. This raises a question; are school transport through private coaches really safe or not? In England alone, more than 48000 school trips are carried out every year [8] of which, coaches are considered the most desirable mode of

transport for children [9]. Based on the traffic commissioner reports, it is hard to assume that all the coach operators used for the school transport are safe and compliant. This situation puts the children's lives at risk and requires immediate attention. There are only few studies in the past wherein the qualitative research has been used as the methodology to identify the safety related issues in the school transport through coaches. But those studies didn't follow any standard method of preparing the questions for the interviews. So, there is a need for a standard framework or method to create questions for the qualitative interviews to analyse the safety of children travelling by coaches in the UK. This paper presents a systematic interview guide called Coach Travel Safety Analysis Matrix (CTSAM) which is based on Haddon Matrix. CTSAM will act as a standard tool for creating questions for qualitative interviews. The rest of the paper has been organised as follows: literature review on existing studies which focused on identification of safety issues through qualitative studies has been presented in Section II. Section III explains the CTSAM in detail and Section IV illustrates the real time evaluation of it. Conclusion and Future work is presented in the Section V.

II. LITERATURE REVIEW

There have been an increasing number of coach accidents involving children happening every year. Recent coach accidents [10]–[12] involving UK school children had alarmed the UK government and safety professionals to increase the safety standards to reduce the number of coach accidents and fatalities. In 2010, the Scottish government utilized the Transport Research Laboratory (TRL) to improve the existing safety guidelines, procedures and policies related to coach transport [13]. In-depth case studies were carried out to analyse the safety level of coach-based school transport and their effectiveness was analysed after 2 years from the commencement date [14]. Qualitative interviews were used as part of the in-depth case studies and there were no standard methods or guidelines followed to prepare the questions for the qualitative interviews. Other than the Scottish study, not many valid studies have been found in the existing literature that was carried out in the UK. So, we have expanded our literature search outside the UK to the European Union Countries which have similar laws compared to the UK and a related study is found. In 2012, a project called safeway2school was started in Sweden which focused on

planning safe routes, providing active tracking facilities in school transport and real-time monitoring of coach and children which were developed for the schools in few European countries. To evaluate the effectiveness of the study, mixed method research was been carried out [15], [16]. But, no standard method or procedure is followed to create the questionnaire. Other than these studies, no other valid study has been found inside the Europe. So, to identify a common framework to create questions for qualitative interviews in the same context anywhere in the world, a broad literature search was employed.

Edmonston et al. [17] tried to provide safety recommendations for coach-based school transport for the New Zealand government by analysing the existing safety level through a systematic fashion. First, they reviewed the existing policies, practice and research related to safety of school transport, then they approached community groups to discuss about the school transport safety and confirmed the need for the extensive analysis of the safety of school transport in Queensland. To achieve this, they modified the Haddon Matrix [18] (a tool to analyse the bus accidents in detail) and created “school transport safety matrix” to improve school transport safety in Queensland. Though the matrix helped to achieve their goal, they only focused on creating the interview guide in terms of the coach crash. Other external factors were not considered in the matrix. Our idea is to follow their format to create a safety analysis matrix to improve the coach-based school transportation in the UK. The novelty in the proposed matrix, it considers all the internal and external factors not only in the context of coach crashes but also for the entire coach journey from beginning to end. It also helps to identify the needs of the stakeholders to improve the safety of school transport through coaches. This will help the researchers to gather vast amount of data in a systematic way by making sure all aspects of school-coach transport are covered. The following section will provides further details of the proposed matrix.

III. COACH TRAVEL SAFETY ANALYSIS MATRIX (CTSAM)

Going by the accident statistics recorded in STATS19 [5], traffic commissioners’ reports [7] and lack of literature on coach based school transport, it is apparent that there is a need for a further investigation of current safety of children travelling by coaches in the UK. To achieve this goal, we devised a holistic interview guide which we named as “Coach Travel Safety Analysis Matrix (CTSAM)”. CTSAM can be used to investigate current coach travel safety and identify the needs and problems of stakeholders in coach-based school transport. Each trip may be classified into three phases, Pre – journey (before the trip), journey (during the trip) and post – journey (after the trip). These three phases have been divided based on the three different factors related to coach transportation, namely, Human/Host, Agent/Vehicle and Physical Environment. Inside the CTSAM, various topics related to school transportation with respect to the journey-phase and factor are listed. Table 1 shows the topics which are prepared based on the current coach-based school transport in the UK. School transport using coaches can basically be

classified into two types; home to school transport and specific purpose transport (school trips) [19]. This interview guide can be utilized to analyse the safety of both the types of coach-based school transport.

5.1 Pre-Journey

This phase relates to all the activities which take place before the trip. Analysing pre – journey activities help to identify issues that arise before the trip. Topics in this phase help the investigators to identify the route cause for accidents and ways to prevent them. This phase covers topics which include accident awareness, safety measures taken, driver safety, children safety, vehicle safety, route safety and the operating environment.

5.2 Journey

This phase relates to all activities that take place during the trip, which include children safety, stakeholder communication, and issues faced during travel. By investigating the journey phase, internal/external issues that lead to a coach accident can be identified. It also helps in identifying the issues that may arise during the trip.

5.3 Post-Journey

This phase contains topics relates to all the activities that take place after the trip. Analysing post – journey activities helps the investigator to identify the stakeholder’s experience of the trip. This phase covers topics, which include children safety, experiences, suggestions, issues & needs of the stakeholders and emergency procedures if vehicle meets with an accident. This phase helps the investigator to improve the coach service provided.

TABLE I. COACH TRAVEL SAFETY ANALYSIS MATRIX (CTSAM)

Journey sequence	Human/Host	Agent/Vehicle	Physical Environment
Pre Journey	<ul style="list-style-type: none"> • Accident Awareness • Safety Measures • Driver Check • Children Safety 	<ul style="list-style-type: none"> • Vehicle Safety • Safety Measures • Children Safety 	<ul style="list-style-type: none"> • Coach Operating Environment and Procedures • Route Safety • Children Safety
Journey	<ul style="list-style-type: none"> • Children Safety • Children Behavior Issues • Stakeholder Communication 	<ul style="list-style-type: none"> • Problems During Travel • Vehicle Issues 	<ul style="list-style-type: none"> • Environment and Other Problems
Post Journey	<ul style="list-style-type: none"> • Children Safety • Communication Problems • Preventions, Suggestions & Future Enhancements 	<ul style="list-style-type: none"> • Emergency Procedures 	<ul style="list-style-type: none"> • Pickup/Drop Bus Stop Issues

TABLE II. CTSAM EVALUATION

Journey sequence	Human/Host	Agent/Vehicle	Physical Environment
<p>Pre-Journey</p>	<p>Accident Awareness:</p> <ol style="list-style-type: none"> Are you aware of any school transport related crashes in your school or any other schools? (T, S,P,C, D) What might be the possible cause of school transport accidents? (T, S, P, C, D) <p>Safety Measures:</p> <ol style="list-style-type: none"> What are all the safety measures taken in your council for the school transportation (bus stops, route planning, campaigns)? (T) Are there any safety protocols followed while waiting at the bus stop, boarding into the coach, travelling in the coach and getting down from the coach? (T, S,C, D) How strictly are the guidelines are followed in school transportation? (T, S, P, C, D) <p>Driver Check:</p> <ol style="list-style-type: none"> Who will verify the drivers CRB, license and driving hours? (T, S, C, D) Do you prove any special training for the school coach drivers? (C) Do you have any assessment of driver physical and mental health? Would you tell more about it? (C) <p>Children Safety:</p> <ol style="list-style-type: none"> Are children provided with any safety briefing before using the school transportation for the first time? (C) 	<p>Vehicle Safety:</p> <ol style="list-style-type: none"> How do you know that the coaches are in good condition? Do you have any daily checks? (T, S, C, D) Who usually checks MOT, Insurance, safety checks and general condition? (T, S, P, C, D) Do the schools check any of the above? OR does the council verify any of the above? (T, S, P, C, D) How do you know that the companies are adhering to these guidelines? (T, S, P, C, D) Are the selected vehicles always safe? Could you a say few words on how safe they are? (T, S, P, C, D) Are there any restrictions on what you supply? (e.g.) age of vehicle? (C) <p>Safety Measures:</p> <ol style="list-style-type: none"> Which safety measures (technical, educational, bus stops, road design) were taken on the coach concerning school transportation? (C, D) <p>Children Safety:</p> <ol style="list-style-type: none"> How safe are the children while getting onto the coach? (T,S,P,C,D) 	<p>Coach Operating Environment and Procedures</p> <ol style="list-style-type: none"> What kind of road constraints have been considered for school transportation? E.g. [40km/h] zones. (C, D) How important is it to have proper Student, Driver education? (C, D) Have you had a special training as a coach driver for school transportation? If yes, please describe the training. (D) <p>Route Safety:</p> <ol style="list-style-type: none"> What safety measures (technical, educational, bus stops, road design) were taken on your route concerning school transportation? (T, D) Who is in-charge of selecting the coach routes? (T, S, P, C, D) Are the selected routes always safe? Could you say a few words on how safe they are? (T, S, P, C, D) Are you using any software for route planning or is it done manually? (T, S, C) Do you use any safety framework for school transportation? (T, S, C) What are all the constraints that have been considered in route planning? (T, S, C) Have any safety related constraints been considered in planning the routes? (T, C) Are parents involved in route planning? (T, C) <p>Children Safety:</p> <ol style="list-style-type: none"> How safe are the children are at the bus stops? (T, S, P, C, D)
<p>Journey</p>	<p>Children Safety:</p> <ol style="list-style-type: none"> How safe are the children while travelling on the coach? (T, S,P,C, D) How do you make sure that children are wearing the seatbelt on the coach? (C, D) How do you react when a student is coming out of the seat or disturbing you while driving or fighting with each other? Do you ever face such problems in your driving experience? (D) <p>Stakeholder Communication:</p> <ol style="list-style-type: none"> Do you communicate or would you like to communicate for safety reasons with the following actors during travel? (D) <ol style="list-style-type: none"> School transport department? Why? Parents e.g. if a child does not appear or has (health) problems? Authorities e.g. you detect a “nearly accident” and want to report it? (D) What kind of technology do you use to communicate with parents and school transport department? (D) 	<p>Stakeholder Communication:</p> <ol style="list-style-type: none"> How important it is to let the parents know about the school coach location (Phone call or GPS)?(D) <p>Problems During Travel:</p> <ol style="list-style-type: none"> What unsafe/risky situations have you experienced while driving the coach? Please describe the situation. What increases the safety in coaches for school transportation? (D) What unsafe/risky situation have you experienced driving on a particular route? Are all the short routes safe? (D) What are all the problems that arise in the short/long routes? (D) What defines a safe route in your opinion? (D) 	<p>Problems:</p> <ol style="list-style-type: none"> How do you reroute during travel if a normal route is blocked due to road work or accident? (D) How to you mitigate the weather problems arise during the journey? (D)

<p>Post Journey</p>	<p>Children Safety:</p> <ol style="list-style-type: none"> How safe are the children while getting down from the coach? (T, S, P, C, D) <p>Problems:</p> <ol style="list-style-type: none"> What kind of experiences (good/bad) from coach/bus stop are usually reported by the coach driver? (T, S, P, C) What kind of experiences (good/bad) from coach/bus stop are usually reported by the pupils (students)? (T, S, P, C) What kind of experiences (good/bad) from coach/bus stop are usually reported by parents? (T, S, C) What kind of risks are usually faced by the drivers/students during the travel that are reported to the management? (T, S, P, C) What kind of experiences (good/bad) are usually reported by the school? (C, P) <p>Preventions, Suggestions & Future Enhancements:</p> <ol style="list-style-type: none"> What are all the safety aspects that must be on a route for school transportation to prevent accidents? (T, C, D) What is your suggestion to enhance the safety of school travel? (T, S, P, C, D) What are the criteria that can be considered during the safe school route planning? (T, S, P, C, D) What kind of system/technology do you expect that will improve the safety in school travel? (T, S, P, C, D) Is there anything important concerning school transportation, that wasn't spoken about? (T, S, P, C, D) 	<p>Emergency Procedures:</p> <ol style="list-style-type: none"> What kind of safety measures are in place if a school vehicle meets with an accident? (T, S, C, D) 	
----------------------------	---	--	--

Legends:

- T – Town Council – Local Authorities – Road Safety Analysts
- S – School head teachers/ School transport in charge
- P – Parents
- C – Coach providers
- D – Coach Drivers

IV. CTSAM EVALUATION

To evaluate the CTSAM, we have incorporated it into our research [19], [20] in order to study the safety of children in coach-based school transport safety in Luton Borough Council. Using the Table I, questions related to the coach-based school transport were prepared and validated by experienced stakeholders (coach operators, drivers, school headmasters and council transport officers) using pilot studies before initiating the actual interviews. Pilot interviews were conducted not only to validate the topics and questions but also to amend the topics and questions where ever necessary. After the questions were validated, CTSAM was utilized for the main stakeholders' (parents, head masters, coach operators, coach drivers, council transport officers and road safety analysts) qualitative interviews. CTSAM helped to cover all the aspects of school transport using coaches in Luton Borough Council. It helped to identify the safety related

issues and requirements related to coach-based school transport. It also helped to identify an important knowledge gap present between the stakeholders in Luton Borough Council. The results of the study will be published as a separate paper. Results of our qualitative survey proved that CTSAM has achieved its intended goal of analysing safety of children travelling in coaches, in a systematic way.

V. CONCLUSION AND FUTURE WORK

Safety of children is a critical issue which has to be addressed effectively. Coach-based school transport is a less investigated area compared to the other modes of transport to school in the UK. From the literature it is clear that a systematic study has to be done to identify the safety level of coach-based school transport. Existing studies didn't follow any standard models to prepare the questions for the qualitative surveys. There are no standard models available

which ensures the safety of children travelling in coaches. This paper has presented a holistic interview guide to prepare questions for the qualitative study in systematic manner. Evaluation showed that CTSAM helped to achieve its intended purpose by producing useful and new results. As our future work, CTSAM will be implemented in other councils in the UK to compare the safety results of various councils in the UK.

Acknowledgment

This research is funded by Bournemouth University and County Coaches, United Kingdom.

References

- [1] K. Kalogirou, E. Chalkia, E. Bekiaris, and F. Diederichs, "An Application for the Information of Children According their School Transportation," *Procedia - Soc. Behav. Sci.*, vol. 48, pp. 363–372, 2012.
- [2] M. Ramachandran, R. Sahandi, S. Prakoonwit, and W. Khan, "Intelligent Safety Transport Framework for Schools: A Review of Route Planning and Tracking Systems," vol. 7, 2016.
- [3] P. Albertsson, U. Björnstig, and T. Falkmer, "The Haddon matrix, a tool for investigating severe bus and coach crashes," *Int. J. Disaster Med.*, vol. 1:2, s. 10, pp. 109–119, 2003.
- [4] I. Doohan and B. I. Saveman, "Impact on life after a major bus crash - a qualitative study of survivors' experiences," *Scand. J. Caring Sci.*, vol. 28, no. 1, pp. 155–163, 2014.
- [5] DfT, "Department for Transport (Great Britan) Road Safety Data - Datasets," Data.Gov.Uk, 2016. [Online]. Available: <https://data.gov.uk/dataset/road-accidents-safety-data>. [Accessed: 17-Nov-2016].
- [6] DfT, "Department for Transport (Great Britan): Contributory factors for reported road accidents," Data.Gov.Uk, 2016. [Online]. Available: <https://www.gov.uk/government/statistical-data-sets/ras50-contributory-factors>. [Accessed: 17-Nov-2016].
- [7] T. Commissioners, "Traffic Commissioners' Annual Reports," gov.uk, 2016. [Online]. Available: <https://www.gov.uk/government/collections/traffic-commissioners-annual-reports>.
- [8] R. Drake, "Schools, pupils and their characteristics," Data.Gov.Uk, 2016. [Online]. Available: <https://www.gov.uk/government/statistics/schools-pupils-and-their-characteristics-january-2016>. [Accessed: 17-Nov-2016].
- [9] D. G. Move, "Comprehensive Study on Passenger Transport by Coach in Europe," no. April, 2016.
- [10] J. Espinoza, "Coach driver killed as bus carrying British schoolchildren crashes in Belgium," *telegraph.co.uk*, 28-Jun-2015.
- [11] R. Bishop and S. Campbell, "France coach crash: Two British school kids critically injured and 13 hurt in motorway accident," *mirror.co.uk*, 23-Jul-2016.
- [12] A. Fox and R. Bumett, "British teen crawled through bus wreckage with a broken back to escape Spain crash that killed 13 students," *mirror.co.uk*, 21-Mar-2016.
- [13] N. Kinnear and L. Smith, "A Guide to Improving School Transport Safety: Casualty risk, responsibilities and legal requirements, and ten ways to reduce risk on the school journey," 2010.
- [14] R. Hutchins and N. Kinnear, "PUBLISHED PROJECT REPORT PPR648 Review of 'A Guide to Improving School Transport Safety' R Hutchins and N Kinnear," 2012.
- [15] E. Aigner-Breuss, M. Pilgerstorfer, A. Anund, T. Dukic, E. Chalkia, C. Ferrarini, R. Montanari, J. Wacowska, D. Jankowska, F. Diederichs, and A. Pauzie, "Comparison and analysis of user and stakeholder needs across different countries," no. September, 2010.
- [16] A. Anund, T. Dukic, S. Thornthwaite, and T. Falkmer, "Is European school transport safe?—The need for a 'door-to-door' perspective," *Eur. Transp. Res. Rev.*, vol. 3, no. 2, pp. 75–83, 2011.
- [17] C. J. Edmonston and M. C. Sheehan, "' Safe school travel is no accident!' - Applying the Haddon Matrix to school transport safety," 2001.
- [18] H. William, "A logical framework for categorizng highway safety phenomena and activity,," *Journal of Trauma*, vol. 12, pp. 193–207, 1972.
- [19] M. Ramachandran, R. Sahandi, S. Prakoonwit, W. Khan, and S. A. Mohd Selamat, "A Safety Transport Model for Validation of UK Coach Operators for School Journeys," in *Intelligent Transport Systems – From research and development to the market uptake*, 2017 (accepted).
- [20] M. Ramachandran, R. Sahandi, S. Prakoonwit, and W. Khan, "Mathematical Model for Safety Score Calculation for Validation of Coach Operators in the UK," in *Intelligent Transport Systems – From research and development to the market uptake*, 2017 (accepted).