

An Intelligent Recommendation Model for Coach Operators

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Abstract— In recent years, Intelligent Transportation Systems (ITS) have grown rapidly by solving problems in the transport industry through state of the art solutions. Coach Operators' non-compliance is an issue in the UK, which require attention. Last year alone, 137 coach operator licenses have been revoked without public enquiry, equating to invalidating 11 licenses on average every week. The main reasons for this problem is the coach operators' negligence and failing to respond to safety issues associated with their fleet. An Intelligent Recommendation Model for Coach Operators is proposed. The model by analysing the track record of Operator's Compliance Risk Score (OCRS), provides recommendations to improve safety. An initial evaluation shows that the model has achieved its intended purpose and provided accurate and suitable recommendations to the two operators to improve safety of their fleets.

Keywords—*Intelligent recommendation model; intelligent system; coach operator safety; operator non-compliance; coach transport;*

I. INTRODUCTION

Transport has become an essential part of any society and its economy for its sustainable functioning. Recent advances in Intelligent Transportation Systems (ITS) have taken road transport to the next level in terms of safety, accessibility, reliability and communication [1]. ITS advancements in coach based road transport has led to the creation of vehicle routing, vehicle monitoring and driver monitoring systems [2]. An ITS typically consists of elements such as electronics, a control system, communication, sensing, robotics, signal processing and information systems [3]. Even though ITS tries to solve current problems in the transport industry, there are still many issues that need to be solved. Coach operator's non-compliance in the UK is one of them which have created a major safety problem in the transport industry today. There are more than 9000 coach operators in the UK [4]. In the last 10 years, 698 coach operator licenses have been revoked without public enquiry due to non-compliance [5]. Last year alone, 137 coach operator licenses have been revoked without public enquiry. These statistics have serious impact on coach based school transportation. In the last 10 years 1191 children have been injured in 371 coach crashes [6]. Coach operators have not been paying attention to safety issues and problems which existed in their own fleets [7]. In an attempt to overcome this problem, an intelligent recommendation model which can be used to analyse operator's Compliance Risk Score (OCRS) is

proposed. The model provides safety recommendations to the operator based on the data collected. The model consists of three parts. Part one: a comparison of average safety scores of coach operators at the county (local, regional and national levels. Part two: OCRs analysis and safety scores of coach operators over three years. Part three: recommendations to improve fleet safety. To explore its accuracy, the model was tested using real data from two coach operators. The results show that the model has achieved the objectives and can provide accurate recommendations to coach operator on how to improve their fleets' safety. This paper is arranged as follows, section II gives an over view of the existing literature, Section III explains how the OCRS system works and section IV describes the intelligent recommendation model. Finally in Section V, conclusion and future work are discussed.

II. LITERATURE REVIEW

Coach operator's non-compliance is a critical issue which have to be addressed effectively. Coach transport's safety is critical as it has potential for high fatalities per accident, compared to the other modes of ground transport. This is even worse in coach based school transport as it involves children who are most vulnerable users of them [8]. There is not enough literature available addressing the coach operator non-compliance problem. There are only limited studies which addressed the safety of coach transport in the UK [9]–[11]. Coaches in the UK are regulated by the Driver and Vehicle Standards Agency (DVSA). Under the DVSA there are also traffic commissioners for each region who are responsible for licensing and regulations of public service vehicles. Coach operators have to strictly follow the regulations laid down by the DVSA. Coaches might be stopped by the DVSA for road side inspections. DVSA uses a system known as the Operator Compliance Risk Score (OCRS) to decide which vehicle to inspect. If a coach operator is found guilty for serious regulation offenses, its license will be revoked with or without a public enquiry.

To understand the safety operation level of coach operators in the UK, particularly for school based journeys, a qualitative survey was conducted in Luton Borough Council (UK). The full result of the survey will be published in due course. During this survey, when schools were asked on how they ensure that their students are travelling safe, they indicated that they trust the coach operators. But, based on the traffic

commissioner reports, it is hard to assume that the coach operators are always compliant with the government regulations and safe. The Department of Transport has identified negligence about the government regulations and lack of proper care of the fleet as reasons for the operators' non-compliance [7]. To avoid this problem and to help the operators to stay compliant with the government regulations, the Vovlo company has created a system [12]. However, the system focuses on road worthiness, traffic enforcement, monitoring and safety of the fleet. But, it only applies to Volvo vehicles.

There are no studies which provide guidance and assistant to operators to improve compliance. This paper proposes a model to help the operators to improve their safety scores. The model, by analysing the operator's OCRS provides recommendations to improve safety of the operator's fleet. The detailed explanation of the OCRS system and the model are discussed in the next section.

III. OPERATOR COMPLIANCE RISK SCORE (OCRS)

In the UK, each coach operator receives an Operator Compliance Risk Score (OCRS) which reflects the safety level operated by its fleet. The OCSR is used by the Vehicle Standards Agency (DVSA) to decide whether a vehicle should be stopped for safety inspection. If the OCSR is high, it is more likely for a vehicle to be stopped. There are three types of OCSR: Roadworthiness OCSR (vehicle first use checks, annual checks and road side inspections), Traffic OCSR (drivers' hours checks and tachograph checks) and Combined OCSR (total roadworthiness and traffic points divided by total number of events). OCSR is updated every week by a re-scoring process. For Each OCSR type, there are 4 individual bands, Green (Low – risk operator), Amber (Medium risk operator), Red (High – risk operator) and Grey (unknown operator) [13].

An operator is given a Grey OCSR, if it is either new or its vehicle is yet to be taken for the checks. OCSR bands are decided based on the points operators have received during inspections for their fleets' maintenance and safety checks by DVLA. Figure 1 shows the OCSR band scoring guide defined by the UK government. Depending upon the OCSR collected over a 3 year rolling period, the base score for an operator is calculated as shown in the Figure 2. The official weighting factors for the calculation of a base score is, Year 1 – 1, Year 2 – 0.75 and Year 3 – 0.5 [13].

OCRS band	Roadworthiness	Traffic	Combined
Green	10 defect points or below	5 offence points or below	10 defect points or below
Amber	Between 11 and 25 defect points	Between 6 and 30 offence points	Between 11 and 25 defect points
Red	26 defect points or over	31 offence points or over	26 defect points or over
Grey	No score	No score	No score

Fig. 1. OCSR Band Scoring Guide

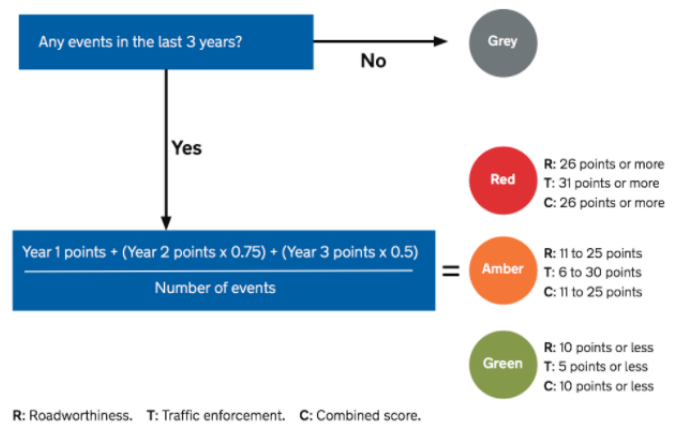


Fig. 2. Operator Base Score Calculation

IV. INTELLIGENT OPERATOR RECOMMENDATION MODEL

The intelligent recommendation model consists of five steps as shown in the Figure 3. They include data acquisition; data processing; local, regional and national safety score comparison; 3 year OCSR analysis and safety scores; and recommendations to improve fleet's safety scores.

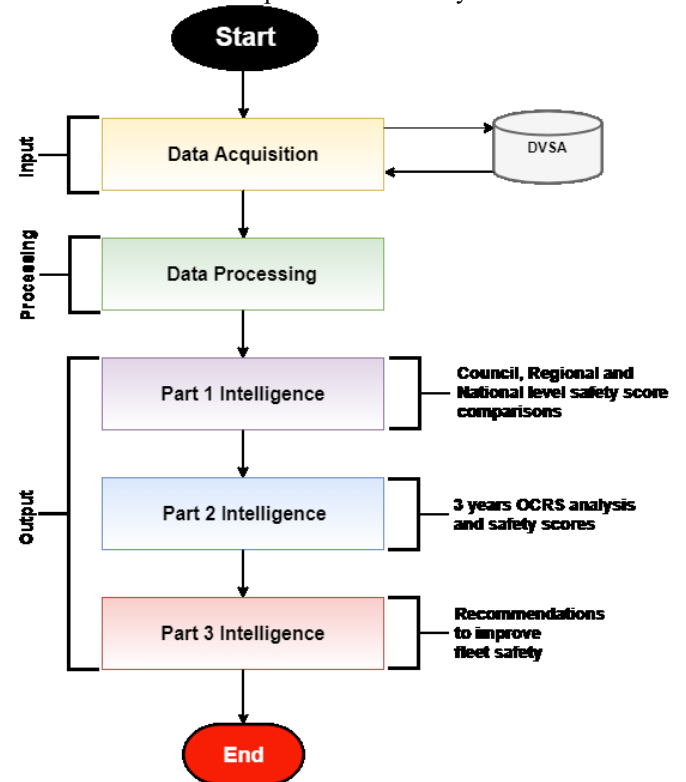


Fig. 3. Intelligent Operator Recommendation Model

A. Data Acquisition

The OCSR data for a coach operator along with the roadworthiness points and traffic points are obtained from the DVSA. If a coach operator is in the Red band, the operator must have received more than 26 defects points and 31

offence points. The complete list of points for defects and offence may be found in [13].

B. Data Processing

Once the relevant data for a coach operator is collected, it is processed for analysis. The OCR scores are updated every week. By analyzing the combined OCR scores over the years, they can reveal the fleet’s performance and maintenance during the period time. To analyse the possible OCRS combinations for an operator over three years, it is necessary to consider all the possible combinations and sort them in most safe to least safe order. Table I shows the possible combined OCRS for a 3 years period (α – Year 1, β – Year 2 and μ – Year 3 - is the present year). To sort them in safety order, safety scores are used. To calculate the safety score, Equation 1 is used. Safety score is calculated based on the weighted average where year 1, 2 and 3 are multiplied with 0.5, 0.75 and 1 weights respectively (these weights are based on the UK government weighting system [14]). Depending on the calculated values, OCRS bands will be: 3 = Green, 2= Amber and 1 = Red. For an example let’s take first row as example, Safety Score = $(3*0.5) + (3*0.75) + (3*1) = 6.75$. Equation 1 is repeated for all the combinations and safety scores are calculated. Some of the combinations will have same safety score as shown in the Table I. To break the tie, recent year OCR score is given with priority. For an example, No. 4 and No. 5 have the same safety score but No. 4 is given with higher priority because the present year (Year 3) OCRS is Green compared to the No.5 Amber. To show the trends and ties, values are color coded as shown in the Table I.

$$\text{Safety Score} = (\alpha * 0.5) + (\beta * 0.75) + (\mu * 1) \quad (1)$$

For Part 3 intelligence, Table II is prepared which shows the possible combinations of roadworthiness OCRS and traffic OCRS which reflects the safety level of vehicles and drivers. For an example, if an operator has Amber for traffic offences and Green for roadworthiness, then possibly the operator’s vehicles are average and drivers are good. Using the Table II, the category for the Coach Operator can be identified. Based on this category safety recommendations are provided (Part 3).

C. Part 1 Intelligence – Local to National Level Safety Score Comparison

Based on the safety scores calculated using the Table I, it is possible to measure safety level of an operator. Using the same formula, safety scores for all the operators in the county can be calculated. Based on the safety scores of all the operators at county level, regional level and national level, ranks can be calculated. Following is the logical code for the safety score comparison.

Logical Code:

Begin

//council rank calculation

If (all the safety scores of operators in a council is calculated)
then

{

Arrange the safety scores in descending order;

Calculate the ranks for the operators inside the council;

}

//Regional rank calculation

If (all the safety scores of operators in a region is calculated)
then

{

Arrange the safety scores in descending order;

Calculate the ranks for the operators inside each council;

Compare the ranks of operators in each council;

Find council average and compare it with other councils;

}

//National rank calculation

If (all the safety scores of operators in the nation are calculated)
then

{

Arrange the safety scores in descending order;

Calculate the ranks for the operators inside each council;

Compare the ranks of operators in each council;

Find council average and compare it with other councils;

Find the average of each region and compare it with other regions;

}

End

D. Part 2 Intelligence – 3 years OCRS analysis and safety scores

Part 2 intelligence helps to observe the trends over a 3 years period. It also provides the current status of the fleet and recommendations to improve the overall safety of it. This will be helpful to see whether an operator is improving the safety of the fleet or doing the exact opposite. Table III shows the OCRS trends over the last 3 years period. Safety scores range from 1.875 to 6.75 marking least safe to most safe operator.

E. Part 3 Intelligence – Recommendations to Improve Fleet Safety

To provide the safety recommendations, operator roadworthiness OCRS and traffic OCRS is used. Safety recommendations are provided based on the offenses an operator is committed. The offenses data is collected as part of the data acquisition process. Using the Table II combinations, the possible combined OCRS and the possible defects that might have occurred are listed along with all possible recommendations as shown in the Table IV. Based on the data gathered, the accurate safety recommendation is provided.

TABLE I. POSSIBLE THREE YEARS OCRS COMBINATIONS WITH SAFETY SCORES

S.No.	Year 1 (α)	Year 2 (β)	Year 3 (μ)	Safety Score
1	green	green	green	6.75
2	amber	green	green	6.25
3	green	amber	green	6
4	red	green	green	5.75

5	green	green	amber	5.75
6	amber	amber	green	5.5
7	green	red	green	5.25
8	amber	green	amber	5.25
9	red	amber	green	5
10	green	amber	amber	5
11	amber	red	green	4.75
12	red	green	amber	4.75
13	green	green	red	4.75
14	amber	amber	amber	4.5
15	red	red	green	4.25
16	green	red	amber	4.25
17	amber	green	red	4.25
18	red	amber	amber	4
19	green	amber	red	4
20	amber	red	amber	3.75
21	red	green	red	3.75
22	amber	amber	red	3.5
23	red	red	amber	3.25
24	green	red	red	3.25
25	red	amber	red	3
26	amber	red	red	2.75
27	red	red	red	1.875

TABLE II. POSSIBLE COMBINATIONS OF ROADWORTHINESS AND TRAFFIC AND THEIR OUTCOMES

		Roadworthiness		
		Green	Amber	Red
Traffic	Green	Vehicles: G Drivers: G (Less risk operator)	Vehicles: A Drivers: G	Vehicles: B Drivers: G
	Amber	Vehicles: G Drivers: A	Vehicles: A Drivers: A (Medium risk operator)	Vehicles: B Drivers: A
	Red	Vehicles: G Drivers: B	Vehicles: A Drivers: B	Vehicles: B Drivers: B (High risk operator)

Vehicle and Driver Condition - G – Good, A – Average, B – Bad

V. CONCLUSION AND FUTURE WORK

Coach transport is safety critical as it involves more fatalities per accident compared to the other modes of land transport. Operator non-compliance in the UK is an issue which has to be solved effectively. In this paper an intelligent safety recommendation model is proposed. An initial evaluation of the model shows the recommendations provided have been accurate. As our future work, a machine learning algorithm will be implemented to enhance the recommendations to operators and further improve safety.

Acknowledgment

This research is funded by County Coaches and Bournemouth University.

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TABLE III. THREE YEARS OCRS WITH SAFETY SCORES

Year 1	Year 2	Year 3		Analysis	Recommendation
green	green	green	6.75	Your fleet Maintenance is fabulous over last 3 years	Keep up the good work
amber	green	green	6.25	Your fleet Maintenance is fabulous over last 2 years	Keep up the good work
green	amber	green	6	Your fleet Maintenance is good	Keep up the good work
red	green	green	5.75	Your fleet Maintenance is fabulous over last 2 years	Keep up the good work
green	green	amber	5.75	Your fleet Maintenance is fair	Please check the previous recommendation section
amber	amber	green	5.5	Your fleet maintenance is good	Keep up the good work
green	red	green	5.25	Your fleet Maintenance is good	Keep up the good work
amber	green	amber	5.25	Your fleet Maintenance is fair	Please check the previous recommendation section
red	amber	green	5	your fleet Maintenance is fabulous and improved over the last 3 years	Keep up the good work
green	amber	amber	5	Your fleet Maintenance is fair	Please check the previous recommendation section
amber	red	green	4.75	Your fleet Maintenance is good	Keep up the good work
red	green	amber	4.75	Your fleet Maintenance is fair	Please check the previous recommendation section
green	green	red	4.75	Your fleet Maintenance is bad this year	Please check the previous recommendation section
amber	amber	amber	4.5	Your fleet Maintenance is average over last 3 years	Please check the previous recommendation section
red	red	green	4.25	Your fleet Maintenance is good this year compared to previous years	Keep up the good work
green	red	amber	4.25	your fleet Maintenance is fair and improving	Please check the previous recommendation section
amber	green	red	4.25	Your fleet Maintenance is bad this year	Please check the previous recommendation section
red	amber	amber	4	Your fleet Maintenance is fair over last 2 years	Please check the previous recommendation section
green	amber	red	4	Your fleet Maintenance is bad and degraded over last 3 years	Please check the previous recommendation section
amber	red	amber	3.75	Your fleet Maintenance is fair	Please check the previous recommendation section
red	green	red	3.75	Your fleet Maintenance is bad	Please check the previous recommendation section
amber	amber	red	3.5	Your fleet Maintenance is bad	Please check the previous recommendation section
red	red	amber	3.25	Your fleet Maintenance is poor but improved this year	Please check the previous recommendation section
green	red	red	3.25	Your fleet Maintenance is very bad	Please check the previous recommendation section
red	amber	red	3	Your fleet Maintenance is bad	Please check the previous recommendation section
amber	red	red	2.75	Your fleet Maintenance is very bad	Please check the previous recommendation section
red	red	red	1.875	Your fleet Maintenance is very worst	Please check the previous recommendation section

TABLE IV. RECOMMENDATIONS FOR POSSIBLE OCRS COMBINATIONS

Roadworthiness and Traffic OCRS combination	Possible combined OCRS	Roadworthiness and Traffic OCRS Score	Reason for the score	Recommendation
Roadworthiness- Green Traffic - Green	Green	Vehicles: Good Drivers: Good Less risk operator	-	Keep up the good work
Roadworthiness- Amber Traffic - Green	Amber	Vehicles: Average Drivers: Good	Defect No. 4 or 10	If it is No. 4 – Please ensure that, daily walk around checks are carried out properly and the defects identified were rectified. If it is No. 10 – Please double check your vehicle for any defects before you go for vehicle annual test.
Roadworthiness- Red Traffic - Green	Red	Vehicles: Bad Drivers: Good	Defect No. 1 or 2 or 3 or 5 or 6 or 7 or 8 or 9	If it is No. 1, 3, 5, 7 and 10 – Please maintain your vehicle’s tyres, brakes and steering properly and make sure daily safety checks, weekly and annual checks are carried out properly. If it is No. 2, 4, 6 and 8– Please make sure daily walk around check and weekly maintenance checks are carried out properly.
Roadworthiness- Green Traffic - Amber	Green	Vehicles: Good Drivers: Average	-	
Roadworthiness- Amber Traffic - Amber	Amber	Vehicles: Average Drivers: Average	Defect No. 4 or 10	If it is No. 4 – Please ensure that, daily walk around checks are carried out properly and the defects identified were rectified. If it is No. 10 – Please double check your vehicle for any defects before you go for vehicle annual test.
Roadworthiness- Red Traffic - Amber	Red	Vehicles: Bad Drivers: Average	Defect No. 1 or 2 or 3 or 5 or 6 or 7 or 8 or 9	If it is No. 1, 3, 5, 7 and 9 – Please maintain your vehicle’s tyres, brakes and steering properly and make sure daily safety checks, weekly and annual checks are carried out properly. If it is No. 2, 4, 6 and 8– Please make sure daily walk around check and weekly maintenance checks are carried out properly.
Roadworthiness- Green Traffic - Red	Green	Vehicles: Good Drivers: Bad	-	
Roadworthiness- Amber Traffic - Red	Amber	Vehicles: Average Drivers: Bad	Defect No. 4 or 10	If it is No. 4 – Please ensure that, daily walk around checks are carried out properly and the defects identified were rectified. If it is No. 10 – Please double check your vehicle for any defects before you go for vehicle annual test.
Roadworthiness- Red Traffic - Red	Red	Vehicles: Bad Drivers: Bad High risk operator	Defect No. 1 or 2 or 3 or 5 or 6 or 7 or 8 or 9	If it is No. 1, 3, 5, 7 and 9 – Please maintain your vehicle’s tyres, brakes and steering properly and make sure daily safety checks, weekly and annual checks are carried out properly. If it is No. 2, 4, 6 and 8– Please make sure daily walk around check and weekly maintenance checks are carried out properly.