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Commercial Vehicle Sensors: Awareness and Impact of Automated Driver Assisted Features on the Customers

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Abstract

Driver information systems are the most important units of the vehicle network which helps the driver as well as the customer to aware about the vehicle sensors.Vehicle innovation is progressing at a quick pace and numerous of vehicles on the road have advanced automated driver assist features. Advance sensor-based vehicles can possibly change car business and all aspects of the network will be influenced. Instrument clusters form an integral part of these systems which are synchronized using controller area network. The colour coded tell-tales and gauges are vital in life threatening situations like brake failure, engine malfunction, etc. It is prudent that all the functionalities of a given instrument cluster are perfect to the mark including the response times, buzzer warnings, etc.Due to various varieties of mandatory and optional sensors, drivers are facing complexity to figure out their requirement in head-up displays. However, sensors in HUDs are important for the safety of passengers and maintenance of vehicle and if advance self-sufficient sensors are received in the correct way, they will give huge financial, ecological and social advantages. Thus, knowing the customer perception about the importance, frequency of usage, rating, satisfaction level of all the sensors in HUD is being required to analyze in in a proper way.Therefore, this review towards satisfaction of drivers to these sensing systems is quite significant. The real time data has been collected from the respondents by preparing structured questionnaire and the collected data is analyzed using multivariate analysis like factor analysis. It is found that the selected attributes are grouped into five component which are highly correlated and helps the respondents to identify the best sensor devices for different category of vehicle.

Keywords: Instrument Cluster, Head-Up Display, Sensing Systems, Driver Satisfaction, Factor Analysis.

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1. Introduction

Display systems in modern vehicles has a blizzard of information to be shared to the driversregularly during their driving. The basic functionalities like vehicle related information, infotainment, navigation and added driver assistance systems are the norms which is to be followed strictly[1]–[3]. The display of sensors information makes more convenient to the drivers as well as to the customers in the form of three main units. They are instrument cluster[4], [5], human machine interface (usually mounted at the center of dashboard)[6], [7], Head-Up Display (HUD) on windshield or combiner glass[8], [9]. The variety of information in the Head-Up Display may distract the driver as well asthe customer for smooth driving.In order to avoid this confusions there is a requirement of customized sensor devices where the driver as well as the customer purpose will be served during their driving[10], [11].

Head-up display is a prominent tool for displaying the enormous information in a better accessible manner for reducing the driver's mental thinking. Due to the up-gradation of electronic devices in an automobile sector, there is a lot of information flow which helps the drivers in choosing appropriate sensor devices. These combined electronic devices has a constant growth which help to make use in heavy traffic areas, amongst them head-up displays plays a vital role from the last decade[12], [13]. Windscreen type HUD is the most cost effective and versatile type of HUD but it is very prominent with ghosting issue[14]. However, ghosting issues are not faced when the combiner type of HUD is used. If cost is not an issue then the most superior HUD which is augmented reality based[15], [16]. However, the HUDs have more advantages than disadvantages[17]. It is necessary in the current traffic scenario with increased amount of vehicles on road and an unlimited amount of road signs and rules to follow. This virtual assistant makes the driving experience easier and safer. The disadvantages in terms of distractions can be curbed with proper optical study.

When it comes to Electronic Control Units (ECUs), instrument clusters are the most important in the case of modern cars[18]. The onset of automation for an increasing number of controls in cars has led to an increase in the complexity of the instrument cluster ECU. The most essential vehicle related information's like speed, rpm, distance covered, warnings, gear selected, etc. is displayed on the instrument cluster which is mostly Liquid Crystal Display (LCD) type now-a-days[19], [20]. The OEMs decide what design to be used and what features to give. The first electronic instrument cluster was seen in 1976 by the manufacturer Aston Martin Lagonda[21]. Originally the instrument clusters' information was analog but it evolved to rich graphics electronically[22]. The most important attribute of an instrument cluster is its reliability. This implies that it is vital that the methods of testing of the instrument cluster functionalities should be detailed and rigorous. Increasingly automated testing techniques are being developed to make the testing process error-free, less tedious and less time taking[23].

Since Controller Area Network (CAN) has come into picture, it has been the most advantageous in terms of cost, diagnostic efficiency and wiring harness, but it needs all the related vehicle modules to be based on CAN to work[24]. This can be seen in electric vehicles where the instrument cluster needs to be based on CAN along with most information in the same form too. The information on the CAN network is what drives the dials and tell-tales on the cluster. It also helps in efficient logging of data and diagnostics[25]. The module for communication of CAN messages can be described as a three level process of initializing the controller, data transmission and reception. Data processing is also a part of this communication module[26]. To increase the reliability of the CAN communication system, the CAN bus needs to be tolerant to faults and with speedy communication ability.

2. Principle and Conceptual Framework

Head-up Display

There are five types of head-up displays which are mostly used in all types of vehicles. These are Reflective type, Projected type, Combiner type, Windshield type, and Hybrid type[27]. In reflective type head-up display Cathode-Ray Tube (CRT) is used as a source of image. The CRT receives information from a signal generator in the form of x-y coordinates. These are depicted as pixels on the CRT screen using an electronic ray which strikes the screen coated with phosphors. The phosphors give off light when electrons hit their surface. CRT is fixed on the top and light is projected on a combiner in driver’s field of view which gives a 30 degree wide view. Combiner works as a collimator too which gives parallel lines compared to the previous non-collimated ones from the CRT[27], [28].

In projected type head-up display a projector is fixed on the top of the windshield. There is a semi-transparent combiner in driver’s FOV. A concave or convex lens is used in the combiner. No space is used under the dashboard which makes it convenient to use in smaller cars. The projector type has advantage over the conventional CRT type due to less use of power and less heating issues [29].

In combiner type head-up display the combiner is attached with a cylindrical lens instead of using the windscreen. The combiner HUD uses a small plastic screen between steering wheel and windshield. This makes it independent of vehicle geometry. The fold mirrors deflect the light coming from the source attached below the dashboard. These rays enter the eye-box, which is the area around the driver’s eyes. This is a self-contained module, integrated into the instrument panel. When car stops, the HUD deactivates and the motors rotates the screen into its casing [30].

In windshield type HUD, the windshield is integrated with the optical functions of a concave mirror. Polarized windshield is required for perfect functioning, but it has a lot of issues so the other option is to use Poly-Vinyl Butyral (PVB) glass. It prevents the ‘ghosting’ issue most prevalent with this type of HUD. Images reflected between two sheets of glass create visual distortion known as ‘ghosting’[31].

In Hybrid type HUD augmented reality is implemented[11], [16], [28]. Cameras, sensors (LiDAR-based), Wi-Fi and GPS modules are the essential building blocks of AR-based head-up display. While the cameras and sensors detect, monitor and guide surroundings as well as driver and pedestrian movements, Wi-Fi and GPS connectivity ensures that the car stays connected with other vehicles and road infrastructure. Fresnel reflector is used for a holographic combiner. It uses constructive and destructive interference of light to make up the picture, allowing the device to be much smaller. The basis for this is provided by Digital Micro-mirror Device (DMD) technology, which is also used in digital cinema projectors.

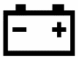
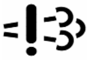
Vehicle Standards

There are mainly four types of display standards in all types of Head-up displays (HUDs), such as Automotive Industry Standards (AIS), Economic Commission for Europe (ECE) standards, International Organization for Standardization (ISO) standards, and safety standards by Automotive Research Association of India (ARAI). These standards are mostly followed by all types of vehicle manufacturers. Automotive Industry Standards (AIS) is prepared by Automotive Industry Standards Committee (AISC), constituted by Ministry of Surface Transport (MOST). The said standards are approved by Central Motor Vehicles Rules Technical Standing Committee (CMVR-TSC), forwarded to the governing authority Ministry of Road Transport and Highways and then finally published by Automotive Research Association of India (ARAI), Pune, which is the AIS committee secretariat. Apart from these India based standards, there are some Europe based standards which are established in 1947 with the name Economic Commission for Europe (ECE) standards are also followed in India. In addition to this, the technical committees of International Organization for Standardization (ISO) prepared the International standards for electronic vehicle gadgets with collaborative to the International Electrotechnical Commission (IEC). Apart from these standards, safety standards are published by Automotive Research Association of India (ARAI) for describing safety and pollution standards in India. They are defined by department of industry and ministry of surface transport, government of India.

Instrument Cluster

AIS 071 is an assortment of information related to symbols, their description, color, illumination of tell tales and controls. AIS 053 is an automotive industry standard drafted by the AISC to classify the vehicles based on their performance and subassemblies. ISO 2575 [32] gives the detailed drawing of symbols which are used as sensor representation of all instrument tell-tales cluster as shown in Table-1. The description of all these instrument sensors are given by AIS 071 [33].

Table 1. Instrument Cluster Tell-tales [32], [33]

S.No.	Name of sensors	Symbol	S.No.	Name of sensors	Symbol
1	Head lamp - Main Beam		15	Side impact Airbag	
2	Direction Indicator		16	Co-Passenger Airbag	
3	Low fuel level		17	Safety belt non-usage	
4	Engine oil		18	LDWS (Lane Departure Warning System)	
5	Driver front Airbag		19	Parking brake applied	
6	Front fog lamp		20	ESC (Electronic Stability Control)	
7	Rear fog lamp		21	Electrical charging indicator	
8	Brake Failure		22	Hill descent control	
9	Antilock brake system Malfunction		23	Drowsiness	
10	Engine On-board diagnostic		24	TPMS (Tire Pressure Monitoring System)	
11	Cruise control		25	Diesel preheat	
12	Transmission failure		26	Engine coolant temperature	
13	Engine emission system temperature		27	Cab lock	
14	Engine emission system failure		28	Door ajar	

3. Statement of the Problem

Head-Up Displays brought complexity in today's driving scenario. But these HUDs are important for relevant information on the right time for the vehicle driver. The instrument clusters are an imperative source for the vehicle data. The owner of vehicle is paying huge amount for these instrument clusters. So even if all the sensors in cluster working properly, there should be some driver or customer satisfaction testing which is necessary in terms of convenience and reliability. Thus, the customer perception of any display system with different types of sensors is quite a big aspect for vehicle development.

4. Objectives

1. To determine the factors which influence the driver satisfaction of automated sensor devices.

2. To analyze how these factors helps in satisfying the customer/driver towards automated sensor devices.

3. To examine the buying behavior of automated sensor devices and the driver satisfaction.

5. Hypothesis

Vehicle innovation is progressing at a quick pace. Effectively numerous vehicles on the road have advanced automated driver assist features and it will not be long before highly automated and driverless vehicles become a much larger part of our national fleet. Vehicles equipped with advance sensors will make driving simpler and permit individuals to help in improving road safety and ease congestion. Advance sensor-based vehicles can possibly change car business and all aspects of the network will be influenced. There is no significant relationship between the selected factors and driver satisfaction of automated sensor devices. Therefore, if advance self-sufficient sensors are received in the correct way they will give huge financial, ecological and social advantages.

6. Research Methodology

The validity of any research depends on the systematic method of collecting the data and analyzing the same in a logical and sequential order. In the present study, an extensive use of both primary and secondary data was made. The focus of this study was to establish the driver satisfaction in commercial vehicle sensors. The study also was to concentrate on the people who knows driving of cars and the maximum usage of automated sensor devices.

The structured questionnaire has been prepared and survey method has been adopted for collecting the data from the respondents. Convenience sampling method has been adopted to collect the data from the respondents. The type of research adopted for the study is descriptive research and the sample size is 1000.The data collected were organized as simple tables and further analysis has been carried out using appropriate statistical tools such as percentage analysis, averages, ranges, standard deviation, and two-way tables. Principle Component Analysis, has been used to ascertain the driver satisfaction of commercial vehicle sensors in the study area.

7. Results and Discussion

Factor Analysis is a technique which transforms a set of factors into linear composites, which has a strong correlation with original factors. It measures the complex product or services, where it can identify the major characteristics of real qualities of respondents. The fundamental focus of factor analysis is to investigate and decide on the respondent's statements and those variables will be included for analysis. The responses of the respondents for the selected factors are significantly correlated and also it measures the high level of collinearity among those factors. Usually the factor analysis can be applied for continuous or interval scale variables, which can also be called as regression analysis. Regression analysis is used to determine the relationship between the independent and dependent variable. In order to get the 'best fit' factor from the scattered data 'variance related approach' method is adopted to each statement. The factor analysis for this study has been adopted with different stages like secondary research, formulating questionnaire, collecting relevant data, input, output analysis, factor identification and finally conclusion. "Customer awareness in usage of various automated sensor devices in cars" has been studied by selecting twenty-eight variables. The analysis has been carried out with different stages followed by results and discussion.

Statistics Associated with Factor Analysis

Bartlett's Test of Sphericity: The null hypothesis has been tested by using the variables which are not correlated with the sample universe. The acceptance and rejection of null hypothesis is mainly based on the significance value. In this the variables are tested by using Bartlett's test of sphericity.

***Kaiser-Mayer-Olkin Measure of Sampling**:* The correlation co-efficient is compared by the index which also measures the magnitude of the observed correlation co-efficient. Therefore, with this indication, the factor analysis tool for evaluating a particular aspect will not be more appropriate where the next tool which can be used is Eigen Values and Communalities.

Eigen Values and Communalities: The collected data from the sample respondents is indicated based on the eigen values. The eigen value is determined by the sum of squared of its factor loading. The sum of squares of a statement's factor loading describes the communalities of each factor in contributions for the selected variables.

To examine the impact of customer awareness of automated sensor devices in cars, structured questionnaire has been prepared with the perception of various aspects of selected factors. The selected 28 factors will be analyzed using factor analysis with the help of Principle Component Analysis (PCA) of orthogonal rotation. For doing factor analysis there is no constraint in selecting factors, the researcher can choose the factor based on their relationships. To load the factor the cut-off point is selected as 0.50 for convergent validity.

Table 2. Reliability Statistics

Cronbach's Alpha	**No. of Items**
0.969	28

Table 3. KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.607
Bartlett's Test of Sphericity	Approx. Chi-Square	4331.736
	Df	378
	Sig.	.000

The correlations between the selected variables are constructed with the help of matrix loading of factor matrix. A factor loading eigen value is measured and if it is greater than 0.5 then it is a pure variable. A higher loading is considered for complex variables which makes interpretation of the output difficult. In order to attain the significant relationship between variables the researcher rotated the components eight times under five components.

In the Table 2, the reliability statistics for the selected variable supports upto96.9 percentage reliable to do the analysis. Also, the Table3 indicates that the Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy in the study are 96.9 which is a good result, as it exceeds 0.5 Bartlett's Test of Sphericity, meaning the factors that form the variables are adequate. The developed questionnaire has undergone Cronbach Alpha testing for testing its reliability and the value is given in Table 2. The variables with the corresponding extraction communality factor value is shown in the Table 4 using KMO and Bartlett's test.

Table 4. Variable with Extracted Communality Factor Value – Significance of Impact of Driver's Satisfaction of Commercial Vehicle Sensors

Communalities			
	Factor	**Initial**	**Extraction**
Head lamp - Main Beam	Factor 1	1.000	.811
Direction Indicator	Factor 2	1.000	.821
Low fuel level	Factor 3	1.000	.898
Engine oil	Factor 4	1.000	.840
Driver front Airbag	Factor 5	1.000	.825
Side impact Airbag	Factor 6	1.000	.808
Co-Passenger Airbag	Factor 7	1.000	.853
Safety belt non-usage	Factor 8	1.000	.771
LDWS (Lane Departure Warning System)	Factor 9	1.000	.757
Parking brake applied	Factor 10	1.000	.680
Front fog lamp	Factor 11	1.000	.876
Rear fog lamp	Factor 12	1.000	.845
Brake Failure	Factor 13	1.000	.714
Antilock brake system Malfunction	Factor 14	1.000	.723
Engine On-board diagnostic	Factor 15	1.000	.889
ESC (Electronic Stability Control)	Factor 16	1.000	.932
Electrical charging indicator	Factor 17	1.000	.759
Hill descent control	Factor 18	1.000	.902
Drowsiness	Factor 19	1.000	.919
TPMS (Tire Pressure Monitoring System)	Factor 20	1.000	.877
Cruise control	Factor 21	1.000	.825
Transmission failure	Factor 22	1.000	.888
Engine emission system temperature	Factor 23	1.000	.902
Engine emission system failure	Factor 24	1.000	.879
Diesel preheat	Factor 25	1.000	.880
Engine coolant temperature	Factor 26	1.000	.840
Cab lock	Factor 27	1.000	.829
Door ajar	Factor 28	1.000	.736
Extraction Method: Principal Component Analysis.			

Total Variance Explained

In the Table Number 5,the principal-component method shows the extraction of factors and the communalities table are formulated from the initial eigen values which has developed as an extraction of sum of squared loadings with percentage of variance and the relative cumulative percentage. From the initial Eigen values and the extraction sum of squared loading values, the rotation sum of squared loading has been formulated as shown in Table 5.

Table 5. Variance using Principal Component Analysis

Total Variance Explained

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	15.467	55.240	55.240	15.467	55.240	55.240	8.617	30.775	30.775
2	3.453	12.334	67.574	3.453	12.334	67.574	6.722	24.006	54.781
3	1.738	6.207	73.781	1.738	6.207	73.781	3.154	11.266	66.047
4	1.491	5.324	79.105	1.491	5.324	79.105	3.092	11.044	77.091
5	1.131	4.038	83.143	1.131	4.038	83.143	1.695	6.052	83.143
6	.776	2.772	85.915						
7	.651	2.326	88.241						
8	.575	2.053	90.294						
9	.477	1.702	91.997						
10	.435	1.552	93.549						
11	.315	1.126	94.674						
12	.299	1.067	95.741						
13	.253	.902	96.643						
14	.205	.733	97.376						
15	.137	.489	97.865						
16	.122	.435	98.301						
17	.109	.388	98.689						
18	.081	.289	98.978						
19	.069	.247	99.225						
20	.055	.197	99.422						
21	.051	.182	99.604						
22	.041	.146	99.750						
23	.023	.081	99.832						
24	.018	.063	99.895						
25	.011	.040	99.936						
26	.010	.034	99.970						
27	.007	.026	99.996						
28	.001	.004	100.000						

Extraction Method: Principal Component Analysis.

The extraction procedure has been completed by using principal-component analysis method, it is found that the rotation of sum of squared loadings and the absolute sum of 28 factors has been separated and the equivalent has been organized into 5 iterations which have Eigen score of more than one. It ranges from component number 1 to component number 5 with the aggregate percentage from 55.240 % to 83.143 %. The level of variance in percentage ranges from 55.240% to 4.038%.

During factor loading and rotation process the first component of the initial Eigen values, the total, percentage of variance and the cumulative percentage values ranges from 15.467, 55.240% and 55.240% respectively. Also the second component of initial Eigen values, the total percentage of variance and the cumulative percentage values are 3.453, 12.334% and 67.574% respectively.

When the third component has been rotated initial Eigen values, the total percentage of variance and the cumulative percentage values are 1.738, 6.207% and 73.781% respectively. Which follows the fourth component of initial Eigen values, the total, percentage of variance and the cumulative percentage values measures to be 1.491, 5.324% and 79.105% respectively. The initial Eigen values, the total, percentage of variance and the cumulative percentage values for the fifth component are 1.131, 4.038% and 83.143% respectively. The extracted sum of squared loadings for the respective component are1.007, 3.052% and 66.617%. The rotation sum of squared loadings for the above is 1.695, 6.052% and 83.143% respectively. It is inferred that the factor analysis that it has supported upto 83.143% in this study which is highly reliable supportive to the study.

To extract the variables into components the principal component method has been used and Varimax with Kaiser Normalization has been undergone using ‘rotation method’. All the 28 variables have been grouped into five components and each component consists of sets of factors and the analysis has been made to identify the influence of one variable over the other. Hence Principal-Component method and Varimax with Kaiser Normalization helps to identify the grouped variables and correlation amongst the grouped factors.

In the rotated component matrix whose score is more than 0.5 is considered to be the significant factor loadings which has shown in the Table 6.

Table 6. Rotated Component Matrix

Rotated Component Matrix

	Component				
	1	**2**	**3**	**4**	**5**
Head lamp - Main Beam		.649			
Direction Indicator		.838			
Low fuel level		.862			
Engine oil		.817			
Driver front Airbag		.768			
Side impact Airbag		.725			
Co-Passenger Airbag		.743			
Safety belt non-usage		.737			
LDWS (Lane Departure Warning System)		.686			
Parking brake applied		.636			
Front fog lamp			.798		
Rear fog lamp			.735		
Brake Failure	.533				
Antilock brake system Malfunction	.590				
Engine On-board diagnostic	.829				
ESC (Electronic Stability Control)	.844				
Electrical charging indicator				.594	
Hill descent control	.738				
Drowsiness	.868				
TPMS (Tire Pressure Monitoring System)	.714				
Cruise control				.740	
Transmission failure	.886				
Engine emission system temperature	.903				
Engine emission system failure	.877				
Diesel preheat	.866				
Engine coolant temperature				.865	
Cab lock					.614
Door ajar					.763

Method of Extraction: Principal Component Analysis.
Method of Rotation: Varimax with Kaiser Normalization.
a. Rotation converged in 8 iterations.

Every single chosen factor have given proper names based on the variable spoke to for each situation.

Table 6explains the rotated component matrix, in which the extracted components are rotated and grouped together and those grouped factors has been given a separate name. From the Table 6 it is noticed that all the stacking factors which are having the stacking esteem under 0.5 are rejected from the investigation.

a) The first kind of factor explained 30.775% of the variation. The factors as Brake Failure (0.533), Antilock brake system malfunction (0.590), Engine On-board diagnostic (0.829), ESC(Electronic Stability Control) (0.844), Hill descent Control (0.738), Drowsiness (0.868), TPMS(Tire Pressure Monitoring System) (0.714), Transmission failure (0.886), Engine Emission System temperature (0.903), Engine emission system failure (0.877), Diesel preheat (0.866) are significantly correlated with each other. These statements reflect the ‘Brake-Up Intimation Factor’

b) In this segment the second group of factors explains 54.781% of the variances. Therefore the researchers grouped the following variables based on eigen values. The variable are Head lamp-Main Beam (0.649), Direction Indicator (0.838), Low fuel Level (0.862), Engine oil (0.817), Driver front Airbag (0.768), Side Impact Airbag (0.725), Co-Passenger Airbag (0.743), Safety belt non-usage (0.737), LDWS (Lane Departure Warning System) (0.686), Parking brake applied (0.636). These statements mainly focus on the safety measures of the automated sensor devices, so it has named as ‘Safety Indication Factor’.

c) The third group of factors explains 66.047% of variances. In this segment, the researchers took two variables such as Front fog lamp (0.798), Rear fog lamp (0.735). These statements are embossed the employees working environment with regard to their Job enrichment. Hence, the grouped variables can be named as ‘Vigilance Factor.

d) The fourth group of factors explains 77.091% of variances. In this segment, the researchers took three variables such as Electrical Charging Indicator (0.594), Cruise Control (0.740), and Engine Coolant temperature (0.865). These statements are embossed the characteristics of knowledge worker. Hence, the grouped variables can be named as ‘Inspection Factor.

e) The fifth group of factors explained 83.143% of variances. In this segment, the researchers took two variables such as Cab lock (0.614), Door Ajar (0.763). These statements are highly related with the satisfaction with the compensation offered by the IT sector where they can show the high commitment to their job in their workplace. Hence, the grouped variables can be named as ‘Anxiety Factor’

8. Conclusion

The present study has highlighted the significance of driver satisfaction in commercial vehicle sensors into five categories. The factors like brake-up intimation, safety indication, vigilance, inspection and anxiety will help the respondents to be aware about the various sensor devices which are incorporated in their vehicles. The sensor under these factors mainly gives the intimation on the HUD through electronic control units. Among these instrumentation clusters, sensors are categorized for different vehicle standards such as M1, M2 and N1 vehicles. Due to various varieties of mandatory and optional sensors, drivers are facing complexity to figure out their requirement in head-up displays. However, sensors in HUDs are important for the safety of passengers and maintenance of vehicle. Thus, knowing the customer perception about the importance, frequency of usage, rating, satisfaction level of all the sensors in HUD are analyzed in this paper. From the analysis it is found that the various related factors like brake-up intimation, safety indication, vigilance, inspection and anxiety play an important role among customers. Also, these factors help the customer to identify which sensor can manage their uncertain situation for different category of vehicle. This paper helps the automobile sector to know the customer expectation of different category of sensor devices, also to understand the driver satisfaction for the usage of instrument cluster tell-tales and sensor devices.

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