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Improving geometric road design through a virtual reality visualization technique

Melhorando projeto geométrico de estradas através de uma técnica de visualização em realidade virtual

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ABSTRACT
Traffic accidents could often be avoided with more in-depth studies of traffic and the geometric layout, using, for example, driving simulators to simulate traffic conditions. The objective of this study is to qualitatively evaluate three types of visualization techniques for examining a road project: one in a 2D printed project and the others using a driving simulator in a virtual immersion system and screen visualization. The results were evaluated by the Analytic Hierarchy Process-AHP method, used to establish different weights for the analyzed variables (technical inconsistencies identified – most important criterion; changes users would make – second most important criterion; and simulation visualization evaluation – third most important criterion). For this, a questionnaire was applied to undergraduate students in Civil Engineering to compare the techniques. The results show that the immersive simulation visualization has sufficient quality and can contribute to the validation of geometric designs.

RESUMO
Acidentes de trânsito muitas vezes poderiam ser evitados com estudos mais aprofundados do tráfego e do traçado geométrico, usando, por exemplo, simuladores de direção para simular as condições do trânsito. O objetivo deste estudo é avaliar qualitativamente três tipos de técnicas de visualização para examinar um projeto rodoviário, uma em um projeto impresso em 2D e as outras usando um simulador de direção em um sistema de imersão virtual e visualização em tela. Os resultados foram avaliados pelo método Analytic Hierarchy Process-AHP, utilizado para estabelecer diferentes pesos para as variáveis analisadas (inconsistências técnicas – critério mais importante; mudanças que os usuários fariam – segundo critério mais importante; e avaliação da visualização na simulação – terceiro critério mais importante). Para isso, foi aplicado um questionário aos alunos de graduação em Engenharia Civil para comparar as técnicas. Os resultados mostram que a visualização em simulação imersiva tem qualidade suficiente e pode contribuir muito para a validação de projetos geométricos.

1. INTRODUCTION

Many Brazilian road geometry layouts were developed without research, using only existing routes or propitious slopes in the 60s and 70s. At that time, the purpose was to minimize costs and take advantage of the relief, not aiming at the user's safety (Bacchieri and Barros, 2011). Due to the minimization of costs, this lack of adequate studies for the construction of highways continues today. These factors, combined with the lack of care/preparation of drivers, vehicles with defects, errors in curvature, accentuated slopes, and absence of signaling, are often responsible for numerous accidents (Gaweesh, Bakhshi and Ahmed, 2021; Jima and Sipos, 2022). Traffic accidents with road-related causes can reach 30% of all accidents (Jurewicz et al., 2015). Furthermore, many accidents are caused by human failure but are initially induced by geometry layout failures (Ahmed, 2013).

Due to the need for advances in this type of research, Brazil has a high potential for new technologies that allow safer and more consistent transit for road users (Bacchieri and Barros, 2011). However, this progress is slow because the use of technologies like driving simulators is considered, in most cases, only in the final presentation step instead of in the conception and development of the geometric project. Driving simulators in immersive virtual reality can be used in conjunction with other computational techniques to improve this process.

Virtual immersion models can improve this process and make the simulation more realistic (Liu et al., 2020). These models simulate traffic conditions, such as lack of signaling, poor visibility or lighting conditions, accentuated slopes, and bend errors, and can be viewed on conventional screens or with virtual reality (VR) glasses (Wynne, Beanland and Salmon, 2019). This technique tends to increase, given the high number of accidents due to inconsistencies in the route. In addition, it provides comfort and safety to users and makes the highway more compatible, avoiding future repairs and works if they are inconsistent (Shi et al., 2022). Through these simulations, the user can interact with the environment and evaluate the defects presented on each road without the need for testing with vehicles and people, which would generate a risk of accidents and higher costs for the simulation (Shi et al., 2022).

A driving simulator consists of equipment with commands such as steering wheel, clutch, accelerator, and brake that are interconnected and allow the user to drive a vehicle along a road project in front of him, on screens, or in an immersive environment (Wynne, Beanland and Salmon, 2019). For the visualization and simulation of a three-dimensional project, there are several types of simulators, but basically, they are divided into virtual immersion simulators and conventional simulators (screen view) (Blissing, Bruzelius and Eriksson, 2022).

Virtual reality (VR) simulators are simulations made through three-dimensional scenarios where the user interacts with the environment through glasses that allow visualization in a three-dimensional environment (Jayaram, Connacher and Lyons, 1997). Research showed that driving simulators are a suitable alternative for this subject. In addition, many studies indicate that driving simulators provide the user with a view with enough information to have the correct perspective of speeds and distances (Dużmańska, Strojny and Strojny, 2018). Conventional or non-immersive simulators occur when the user partially observes the virtual world but continues feeling and interacting in the environment. This simulation uses visualization tools, such as monitors or projection (Wynne, Beanland and Salmon, 2019).

Research using driving simulators to evaluate user behavior has been developed over the years. These studies assess the effects caused by driving after drinking (Yadav and Velaga, 2019), using a cell phone while driving (Mutar, Abduljabbar and Mohammed, 2021), driver fatigue (Farahmand and Boroujerdian, 2018) and sleeping (Ahlström et al., 2018) in monotonous environments or evaluating the profile of drivers more prone to accidents according to age and gender (Scalco et al., 2022). Road conditions were also studied, such as visibility according to weather conditions (Chang et al., 2019), a crossover between vehicles (Difei et al., 2021) and traffic conditions in curves (Babić and Brijs, 2021).

Research has promoted comparisons between the systems to assess the usability of driving simulators. It investigated the influence of non-VR (using 2D, 3D stereoscopic) and VR (using Head Mounted Display - HDM) on physiological responses, simulation diseases, and driving performance in a single driving simulator (Weidner et al., 2017). The results indicate that a VR-HMD leads to similar data as stereoscopic 3D or 2D displays. However, they found a significant increase in simulator sickness in the VR-HMD condition compared to stereoscopic 3D. In another research, a study with 20 participants used a racing game as simulation software to compare simulation types (Walch et al., 2017). The results indicate that using a VR headset promoted a higher perception of immersion than flat screens. However, participants felt more discomfort when using the VR HMD. Another study did similar research and showed little changes in driver behavior when comparing projectors and a head-mounted display (Blissing, Bruzelius and Eriksson, 2022). The most notable difference in favor of HMD was observed when screen resolution is critical to the driving task. The choice of the type of display did not affect the simulator's sickness or the realism evaluated by the subjects.

To complement these studies, this paper aims to compare three techniques for visualizing a geometric design (one through the 2D visualization of a printed design and two using a 3D driving simulator - on screen and in an immersive environment) to identify the best method of visualization of inconsistencies in geometric tracings. For this comparison, undergraduate students in Civil Engineering replied to a questionnaire about a project developed in a transportation discipline by them after using a driving simulator. The results of this questionnaire were assessed using the Analytic Hierarchy Process-AHP, and from this, the best method to identify inconsistencies was stipulated (Saaty, 1977; Farooq, Moslem and Duleba, 2019; Moslem et al., 2020).

2. MATERIAL AND METHODS

The proposed method consists of project development and assessment of the best way to identify errors between three forms of visualization. A questionnaire was applied to civil engineering students in an undergraduate course after experiencing the three visualization forms. As an inclusion criterion, the students needed to have been approved in the disciplines regarding transport and transit projects. Furthermore, all simulator users must have a driver's license to know the commands of a vehicle. The results were analyzed by the AHP method. Figure 1 presents the methodology flowchart.

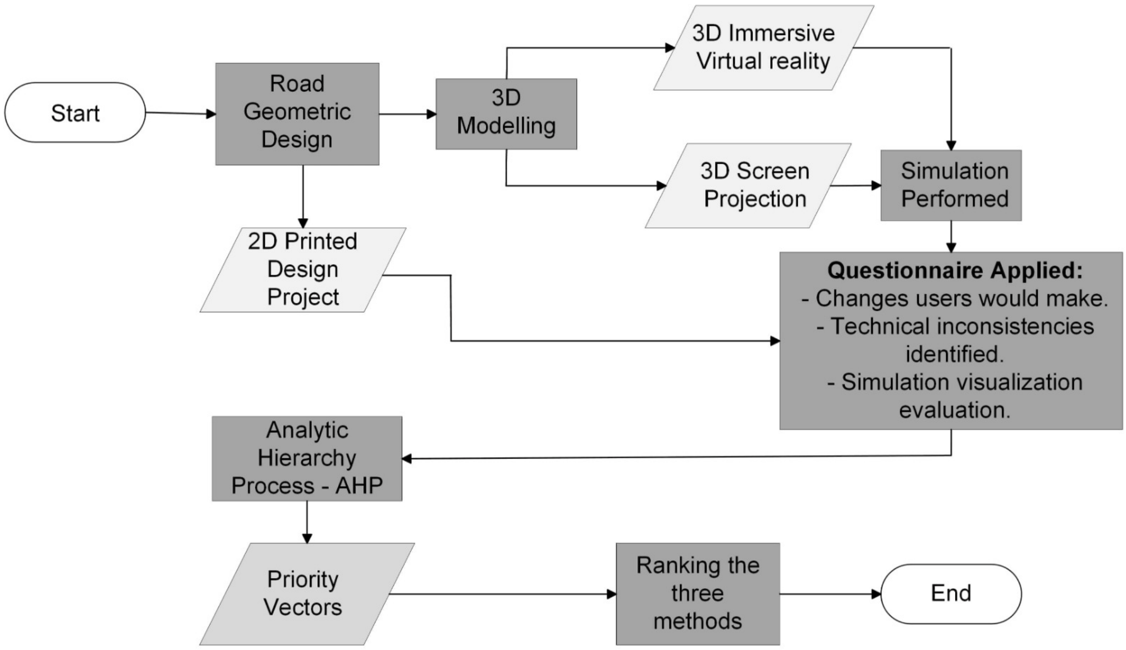

Figure 1. Methodology flowchart

2.1. Road geometric design

For this research, the software used to create the 2D geometric layout was DataGeosis Office® (DataGeosis, 2005). This software has availability in the academic environment and is used by the class's professors. The first stage of the study is the generation of the road layout (developed by the students of a traffic area of the Civil Engineering graduation course).

To design the road project, it is essential to consider some criteria for geometric layouts, such as their topographic location and altimetric level adjustment. The contour lines are the reference in the background so that the axis of the road can be established there, thus promoting the correct perception of the topographic profiles where the geometric layout will be inserted. After considering the topography, the road axis is positioned, inserting it into the topographic plane. In the software, it is possible to generate the mass diagrams, as well as the earthwork estimation, and it is possible to verify how much cut/fill will be necessary for the development of the road. Considerations in horizontal alignment design include safety, installation type, design speed, topography, and construction cost.

In this study, the designed route does not correspond to an existing highway and was developed based on contour lines used for the class projects. It has 3542.3 meters and four curves designed to cover different angles of curvature (Figure 2). The layout is to minimize soil movement, not considering current technical regulations. These are to create possible inconsistencies in the project to be evaluated by the three visualization forms. The technical information of each curve is in Table 1. In Table 1, AC is the central angle that corresponds to the circular section, R is the constant radius of the curve's circular branch, Oc is the center of curve, T is the tangent line, D is the total curve length and Ls is the transition curve length. These properties are essential to the identification of particularities differentiated by the users of the simulator.

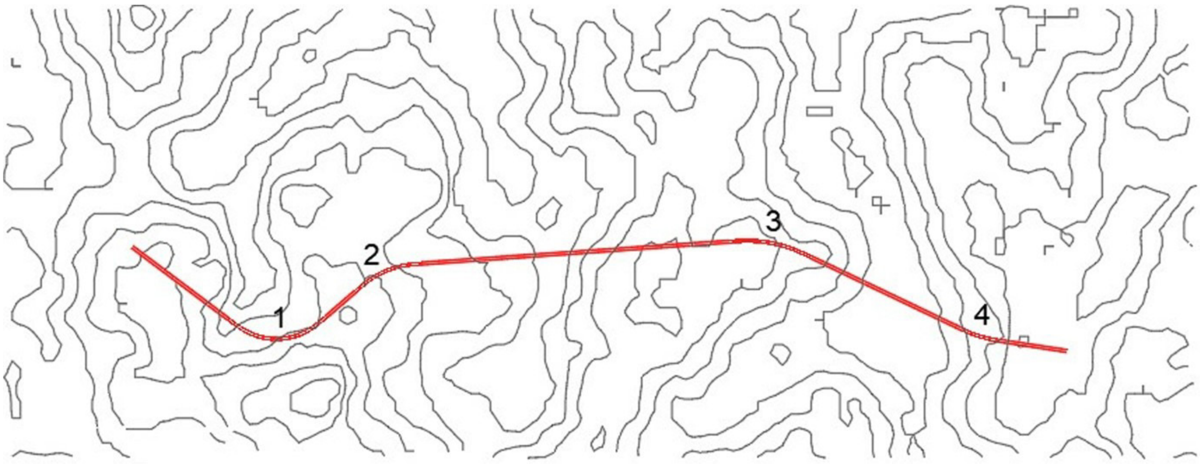

Figure 2. Geometric layout developed for the project

Table 1: Technical information of each curve

	AC	R (m)	Oc	T (m)	D (m)	Ls (m)
Curve 1	77°46’01”	220	54°54’19”	222.421	210.821	87.782
Curve 2	36°45’21”	300	23°50’31”	133.674	124.836	67.617
Curve 3	29°38’21”	450	22°03’53”	148.887	173.296	59.49
Curve 4	16°49’36”	450	-	66.557	132.157	-

At Curve 04, there is no need for a transition curve. For this reason, it is observed that there is no information on *Oc* and *Ls*.

2.2. 3D modeling

For the 3D modeling of the road, CLIP Tools® (CLIP, 2017) software was used. This software is for the conception of projects such as roads, highways, railways, canals, water mains, ports, airports, and urbanizations. In this software, it is possible to position the axis of the road on the topographic map (containing information about elevation and contour lines) according to the needs of the conceived project. The 3D visualization of the model allows analyzing the result and facilitating its understanding, offering a live view of the model generated three-dimensionally (images and even video generation according to a user-defined route). In addition, it is a valuable tool for the user to evaluate his project and detect possible inconsistencies in it, solving them in the early stages and reducing the cost that would entail the discovery of these problems in later stages of the project.

After placing the road axis on the topographical plane, information about image resolution and map scale can be specified and modified. Other measures can also be changed according to the project, such as maximum design speed, max cut and fill, length of the curve, and minimum radius of the curve. The gain of using 3D software for modeling a scenario is that the variables are changed in an approximation of the terrain topography generated through the contour lines. As the highway does not exist in the real world, only isolated elements of the vegetation and signaling (important for speed perception) are positioned along the route. The final scenario (environment and highway) was exported to the Unity 3D Game Engine® (Unity, 2016) with the modeled 3D objects, physics, virtual cameras, and controls to create an immersive realistic environment. In this environment, it was possible to develop a simulation on screen and in an immersive environment.

2.3. Application of the method

The methodology of the present study included an analysis of the results through a questionnaire applied to undergraduate students in Civil Engineering. The students used the two types of simulators (3D on-screen and 3D immersive visualization) and visualized the printed 2D project, where they answered questions related to the geometric design for the three cases. For the immersive visualization, the tests used a driving simulator connected to a computer mounted in a cockpit and a Head Mounted Display (HMD) - Oculus Rift® (Rift, 2017) that provided the user with 360º visualization of the virtual car and the road. Figure 3 shows a student using the simulator through immersive visualization and the image he is observing. In the on-screen view, the same scene was projected onto the screen, but without the use of the Head Mounted Display (HMD) - Oculus Rift® (Rift, 2017).

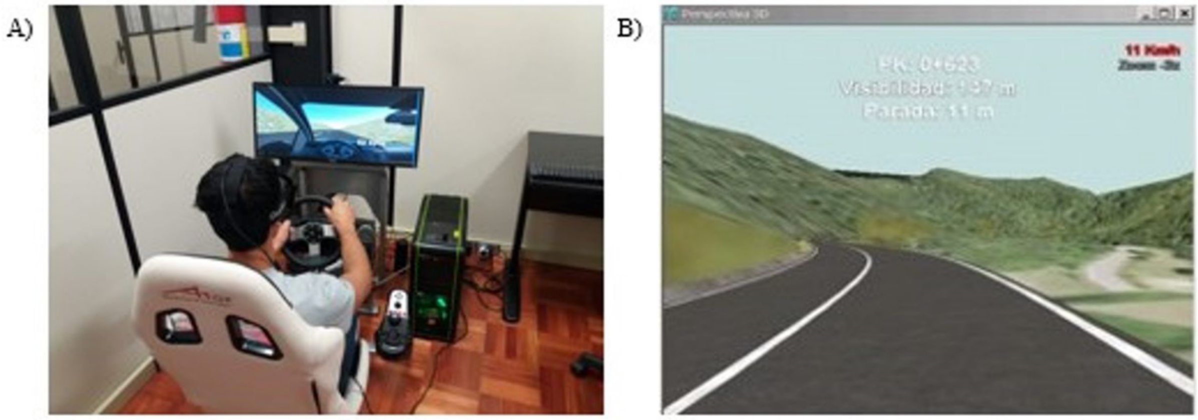

Figure 3. A) Driver using simulator. B) Driver view in an immersive environment

Seven students completed the questionnaire in the class, evaluating the items mentioned in this study. In this questionnaire, three aspects of the analysis of the three types of visualization were addressed, covering most of the qualities and defects that differ from each other. This questionnaire was developed based on the particularities of this specific project. First, students evaluated the 2D design and answered the questions, and then used 3D on-screen viewing and a 3D immersive environment applied to the same road project design.

2.4. Analytic hierarchy process-AHP

The Analytic Hierarchy Process (AHP) was used to evaluate the best way to identify errors in a geometric route of highways. This method (Saaty, 1977) is one of the principal mathematical models to support the decision where from an adopted objective, it makes comparisons between the proposed criteria and selects the best alternative to be adopted (Ruiz Bargueño et al., 2021).

The method compares pairs of alternatives, considering the user's priority judgment. The AHP identifies the best option among the possible options and assists in determining the priorities of the variables to determine the most important for a final objective, considering quantitative and qualitative aspects. This method seeks to reduce complex decisions to compare variables according to the established goal. The proposed model for the methodology is in Figure 4. In this way, it is possible to show the difference between the different levels of choices for the hierarchical structure of decision making (Saaty, 1977).

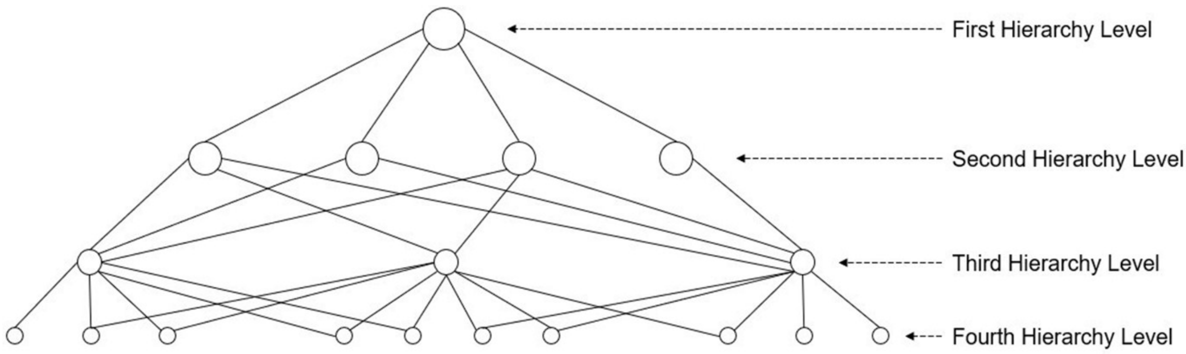

Figure 4. Hierarchical structures (adapted from Saaty (1977))

The user with knowledge of the priorities for the specific study performs the scale of priorities to assign weights between the analysis criterion, as shown in Table 2. Therefore, it is up to the user to transpose the comparisons into quantitative values, avoiding inconsistencies. The fundamental Saaty scale is absolute and assigns ranges of values from 1 to 9, representing the prevalence among the elements (Saaty, 1977). After creating the comparative matrix between the variables, which can range from 1/9 to 9, the priority vector was calculated. This vector presents the relative weights between each variable and is obtained through the arithmetic mean of the value of each criterion, whose sum results in 1.

Table 2: Saaty's fundamental scale (adapted from Saaty (1977))

Intensity of importance	Definition	Explanation
1	Equal importance.	Two activities equally to the objective.
3	Weak importance of one over another.	Experience and judgment slightly favor one activity to another.
5	Essential or Strong importance.	Experience and judgment strongly favor one activity to another.
7	Demonstrated importance.	The activity is strongly favored, and its dominance is demonstrated in practice.
9	Absolute importance.	The evidence favoring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate values between the two adjacent judgments.	When compromise is needed.

For our study, three criteria were chosen to evaluate the best way to identify inconsistencies: technical inconsistencies identified (most important criterion); changes users would make (second most important criterion); and simulation visualization evaluation (third most important criterion). These criteria were chosen because they are important in identifying the best way to visualize inconsistencies in the geometric design.

3. RESULTS

As previously shown, the choice of undergraduate students from the Civil Engineering course aimed to select users with knowledge of a geometric road project. Due to this, students can identify technical errors which lay users could not observe.

3.1. Results from the three criteria

The choice of variables for the first two criteria is related, as the identification of inconsistencies is directly related to the changes that users would make. In this way, the error identified as 1A (Inconsistent radius horizontal/vertical curves) is related to 2A (Change the road's geometric route to improve visibility) and 2D (Increase bend radii). Variable 1B (Unsuitable superelevation) is related to 2B (Optimize terrain cuts) and 2C (Scale superelevation). The geometric inconsistency identified as 1C (Low visibility) is related to 2A (Change the road's geometric route to improve visibility) and 2E (Add vegetation/signage to the terrain), and the geometric inconsistency 1D (Very steep slopes) is related to 2A (Change the road's geometric route to improve visibility) and 2B (Optimize terrain cuts).

In the first criterion, the students answered about the perception of specific errors for this road project (Table 3). In this assessment, users could identify the errors found in each form of visualization. In the questionnaire, the main perceptible errors in geometric projects were included. The students could choose more than one error, not limited to a single selection. In this way, the number of errors found between the different forms of visualization is not the same.

Table 3: Criterion 1 (Technical inconsistencies identified)

Variable	Perceived errors	2D printed design project	On-screen simulation	Immersive simulation
1A	Inconsistent radius horizontal/vertical curves	1	2	3
1B	Unsuitable superelevation	0	2	1
1C	Low visibility	2	4	4
1D	Very steep slopes	1	1	0
1E	No errors detected	4	1	1

The second criterion for assessing inconsistencies between the three ways of visualizing considered what students would change in the geometric layout (Table 4). It also left options for students to mark, and students could choose more than one option to check.

Table 4: Criterion 2 (Changes users would make)

Variable	Changes	2D printed design project	On-screen simulation	Immersive simulation
2A	Change the road's geometric route to improve visibility	3	4	3
2B	Optimize terrain cuts	2	1	0
2C	Scale superelevation	2	1	1
2D	Increase bend radii	1	2	3
2E	Add vegetation/signage to the terrain	1	3	2
2F	No changes	2	0	1

In the third most important criterion, it is possible to observe that most users (86%) believe that the simulator in a virtual environment is better for evaluating errors in the geometric layout of a road project, and 14% believe that the simulator with screen projection is better to assessment this (Table 5). This fact highlights that the immersive environment brings the user closer to reality, as it interacts more with the simulated environment than the on-screen simulator and 2D printed design project. The on-screen simulator presents a projection considered realistic but not as significant as the immersive visualization. In Table 5, five users believe that the immersive environment integrates the driver more with reality. This is because it works predominantly in more dimensions than the on-screen simulator and 2D printed design project.

Table 5: Criterion 3 (Simulation visualization evaluation)

	Variable	2D printed design project	On-screen simulation	Immersive simulation
3A	Best method for evaluating inconsistencies in the geometric layout of a road project	0	1 (14%)	6 (86%)
3B	Simulator where the user felt more integrated into the simulated environment	0	2 (29%)	5 (71%)

3.2. Results from analytic hierarchy process-AHP

After defining the three variables used, weights were assigned to each one according to studies that indicate the number of accidents selected for each variable (Hammad et al., 2019) (Limpert, 2021). The application of the AHP method was chosen to evaluate the results to form a vector of priorities where it quantifies the importance of each variable of each criterion adopted to determine the best method for identifying inconsistencies in geometric road layouts.

For Criterion 1, the variables 1A (Inconsistent radius horizontal/vertical curves), 1C (Low visibility), and 1E (No errors detected) are the ones with the higher importance for the objective, receiving equal maximum weights. Variable 1B (Unsuitable superelevation) has a little less importance, receiving median weight and variable 1D (Very steep slopes) has less importance, receiving the lowest weight (Table 6).

Table 6: Comparative matrix of variables (Criterion 1)

Variables	1A	1B	1C	1D	1E
1A	1	5	1	3	1
1B	0.2	1	0.2	0.5	0.2
1C	1	5	1	3	1
1D	0.333	2	0.333	1	0.333
1E	1	5	1	3	1

For Criterion 2, the variables 2A (Change the road's geometric route to improve visibility), 2D (Increase bend radii), and 2F (No changes) have greater importance – maximum weight. Variables 2B (Optimize terrain cuts) and 2C (Scale superelevation) have medium importance – medium weight, and variable 2E has less importance – lower weight (Table 7).

Table 7: Comparative matrix of variables (Criterion 2)

Variables	2A	2B	2C	2D	2E	2F
2A	1	3	3	1	5	1
2B	0.333	1	1	0.333	3	0.333
2C	0.333	1	1	0.333	3	0.333
2D	1	3	3	1	5	1
2E	0.2	0.333	0.333	0.2	1	0.2
2F	1	3	3	1	5	1

Criterion 3 has two variables. Variable 3A (The best method for evaluating inconsistencies in the geometric layout of a road project) has greater importance and therefore received the maximum weight. Variable 3B (Simulator where the user felt more integrated into the simulated environment) has less importance (Table 8).

Table 8: Comparative matrix of variables (Criterion 3)

Variables	3A	3B
3A	1	3
3B	0.333	1

The priority vector for each variable is in Table 9.

Table 9: Priority vector for each criterion

Criterion 1		Criterion 2		Criterion 3	
Variables	Priority vector	Variables	Priority vector	Variables	Priority vector
1A	0.28251	2A	0.255424	3A	0.75
1B	0.054597	2B	0.095242		
1C	0.28251	2C	0.095242		
1D	0.097874	2D	0.255424	3B	0.25
1E	0.28251	2E	0.043242		
		2F	0.255424		

The priority vector of each criterion was multiplied by the number of answers corresponding to each alternative shown in Table 3, Table 4 and Table 5, and then the results were added. This mathematical process was carried out to quantify the best method for identifying inconsistencies in geometric road designs. Table 10 shows the results for the three criteria adopted.

Table 10: Comparison the methods to identify inconsistencies in highway geometric designs

Criterion	2D printed design project	On-screen simulation	Immersive simulation
1	2.075442	2.184636	2.314675
2	1.956758	1.852757	1.969697
3	0	1.25	5.75

4. DISCUSSION

The main factor for choosing the students was the knowledge of a discipline in the traffic area that produced their geometric layout to be analyzed by the research. This choice of sampling is based on existing research in this area, which shows that for technical evaluations of a geometric layout, the participants must know the area (Liu and Xu, 2019; Jeong and Liu, 2019). In addition, the research focused on the academic environment and chose a Transport Infrastructure subject of Civil Engineering graduation for the answers. For this reason, the number of samples was limited to students enrolled in this subject. In this way, seven answers were counted to the questionnaires.

For the analysis of results, three criteria were chosen: 1) Technical inconsistencies identified (most important criteria), 2) Changes users would make (second most important criteria), and 3) Simulation visualization evaluation (third most important criteria). These three criteria cover the essential elements for choosing the best method of visualization and identification of errors in geometric tracings.

After applying the AHP for the three criteria, the best form to identify inconsistencies in a geometric layout is through immersive simulation visualization. For criteria 1 and 3, the second-best way of identifying geometric inconsistencies is through simulation visualized on screen, and for criterion 2, the second-best way is through a 2D printed project. This fact reinforces the other research that sought to show the limitations of analyzing geometric designs through 2D printed designs (Bella, 2009). The perception of elements outside the geometric layout, like vegetation and signaling is more perceptible in the 3D driving simulator. This is observed in studies carried out previously that evaluated these external conditions in the trafficability of a road (Zolali et al., 2021; Hussain et al., 2020; Chang et al., 2019; Babic and Brijs, 2021).

Regarding the technical inconsistencies identified through each form of visualization of the geometric trace, shown in Table 3, there is a significant difference in the errors found. In the 2D printed geometric design, most students did not detect errors. In the other two visualization forms (on-screen and immersive environment), only one user responded that he did not find any design errors. In the on-screen visualization and an immersive environment, the more errors found were low visibility and curves with inconsistent radii. This difference reinforces the importance of technology to detect inconsistencies that would not be perceived through a printed geometric design. In the printed project, curve radius, visibility, superelevation, and slope may not be identified due to the limitations of this analysis.

Students also requested what they would change in the project after each form of visualization, presented in Table 4. As in the first question, the visualization through a printed project had a superior number of students who would not change anything in the geometric design. This fact reinforces and complements the importance of using driving simulators for geometric projects, as it shows that students would change more elements after visualization using the simulator. In these two forms of visualization (on screen and in an immersive environment), the radius of the curve and the geometry are the elements most changed by the students. Another factor frequently addressed by students was the lack of signage and vegetation elements in the simulator. It is relevant as these elements guarantee the feeling of immersion and the correct perception of speed for the simulation (Bassani et al., 2019). Nevertheless, in the 2D printed view of the project, it was better to observe the cut/fill volumes, as this information is presented to the student in the project.

These results are consistent with the ones found by Walch et al. (2017), although according to these authors, users felt more uncomfortable with the use of the immersive environment. (Blissing, Bruzelius and Eriksson, 2022) and (Weidner et al., 2017) found no significant differences between the two 3D forms of visualization, despite having a minor advantage in using the immersive environment. Although our research shows better results when using the immersive environment, it is also possible to observe a good assessment of the items mentioned above in the on-screen view, depending on the characteristic that will be analyzed.

Thus, the immersive environment is the best way to assess inconsistencies in the geometric layout of a road design. Furthermore, it is the form of visualization in which the user felt more integrated into the simulated environment and was less affected by distractions. Based on these results, it was possible to evaluate that the immersive simulator has a higher level of realism than the simulated projection on the screen. Thus, the reliability level of the simulator in an immersive environment is higher than in the on-screen simulator.

5. CONCLUSION

The present study sought to compare three methods of visualizing a geometric design (one through the 2D visualization of a printed road project and two using a 3D driving simulator - on screen and in an immersive environment) to identify the best method for visualization of inconsistencies in geometric tracings. The main contribution of this study to the literature is the use of the driving simulator in the project of geometric design and not just as a form of final visualization. For this, a questionnaire was answered by students of a discipline of Civil Engineering graduation after visualizing their road project in the three forms.

With the AHP method to assess the results, it was observed that the use of driving simulators (both on-screen and in an immersive environment) facilitates the identification of geometric errors in the road project that would be imperceptible in a printed project. It is also important to highlight that the amount of cut/fill was more noticeable with the use of the 2D printed project, not highlighted in the simulator.

Based on these results, it is possible to observe that the three visualization forms presented their characteristics and satisfactory results. Despite this, it is evident that using driving simulator technology in an immersive environment can contribute to the correct conception of a road project when used in conjunction with traditional tools. It is essential to point out that the printed project cannot be discarded, as it is the most technical, cheap, and functional way to prepare projects. The future scope of work foresees the use with the largest number of professionals who carry out geometric designs professionally.

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