

## Augmented Reality and Zenú Ethnicity: A Futuristic Look

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**ABSTRACT:** Museums are an inexhaustible source of knowledge of past and present cultures; thereby, they can be considered to be a source of information to strengthen the cultural identity of a region. This research aimed to make the archaeological pieces of the Zenú community visible, through the means of augmented reality with the support of a web platform to enrich the experience of the visitors of the museum. This ethnographic research was framed within qualitative and descriptive paradigms, where the sample is intentional. From software engineering it was applied the process model based on prototypes for the construction of the Web platform. On the other hand, the final work for Master's concludes with the design of the web platform, QR codes, augmented reality, marked tags, and the evaluation of the web platform going from the validation of HTML and CSS code to the application of a metric for the integral accessibility and usability analysis.

**Keywords:** marking labels, Zenú Ethnicity, archaeological pieces, augmented reality (AR), quick response code (QR).

### I. INTRODUCTION

In the department of Sucre, specifically in its capital city: Sincelejo, is located the Zenú Museum: Manuel Huertas Vergara, which preserves important archaeological pieces of the Zenú ethnicity. But, it is observed that the influx of visitor is very low, and the knowledge about the existence of this museum is almost null. One of the possible causes could be the little interest of the society about the cultural identity of the Savannah region.

Therefore, the Ministry of Culture of Colombia has created programs that achieves to preserve the cultural heritage, for that it has been arranged the creation of museums that displays the archaeological and anthropological heritage of the different indigenous cultures of the country. Nowadays, museums are considered as places for knowledge creation, for this reason technological advance contribute to the immersive interaction between the spectators and the exhibited pieces.

The National Administrative Department of Statistics (its acronym in Spanish, DANE) conducted a survey of Cultural Consumption in 2014, it yielded that the percentage of no assistance to museums is 86.5 percent, and the main reasons why people do not visit museums is due lack of interest, time or the distance factors. People have the belief that museum "are old spaces and they showed just one truth. Museums are places where you must be in silent. But now, they are spaces of dialogue" [1]. Also, it indicates that one of the factors to assist to museums is that "It perpetuates the idea that they are places that harbor treasures and they only serve for the contemplation and not for enjoyment, and it makes public to feel them far"[2].

Likewise, the nature of museums from XXI century must be different, they do not wait to be visited, but inside them are developed new ways to interact with people. [3]That is how it can be seen the importance of the entailment of schools and museums, in order to educate children about the significance that museums have in their integral formation and the new knowledge acquired, being participants in the proposed events in these scenarios.

Of the above it derives why Colombian people do not visit museums, and it highlights the next statement given by the Ministry of Culture: Mariana Garcés, she said "With the participation of the National Council of Museums and the interdisciplinary group, the public politics about museums are being updated with the purpose to establish the priorities of the existent museums in the country and to establish strategies for their strengthening".[4]

This research aims to make visible the Zenú Museum Manuel HuertasVergara through innovative technology like augmented reality, to awaken the interest of the citizens to visits this museum and to know about their ethnic ancestors.

One of the resources that have been used to give the museum a vision, is using Augmented Reality (AR), this technology enriches the consultation experience since it offers a more visual and wide information

about the archaeological pieces observed. It is of great value to show visitors the archaeological and anthropological heritage of the Zenú placed in the museum facilities, which will help to keep alive this important Indigenous cultural and ancestral manifestation.

For the visibility of the samples outside the museum, it was designed a web platform in which it will be recorded the data related to the museum and the archaeological pieces of the Zenú. Each patterned piece counts with its respective label marks that allow visitors to visualize the different archaeological pieces of in an o the Zenú Museum Manuel HuertasVergara and in this way to create a scenario where the citizenship appropriates the Zenú ethno-identity.

## II. THEORETICAL FRAMEWORK

The development of Information and Communications Technologies (ICTs) has revolutionized each sector of this world. The scenario that has been involved the most with ICTs is schools and recently museums. In this way “The multimedia convergence has opened new and impressive possibilities for cultural diffusion (...) the new museum has as main objective spread it, being exposed or not to the facilities” [5], therefore it can be seen that the culture gap must be lessened. With a view to achieve this, it is proposed augmented reality as a technology that can help to make more attractive for visitors (locals, tourists, student communities) the presentation of information of the different samples shown at Zenú Museum Manuel HuertasVergara.

Augmented reality is a variation of virtual environments, or virtual reality as it is more commonly called (...) AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world” [6]. In addition, AR is also considered as: “Resources in otherwise which the visualization of a real environment is augmented by means of virtual objects” [7] These authors converge in the aspect that augmented reality is a model of the real world which is designed through computer attaching images, animations, audio and video. By last, it is considered of great relevance the definition of augmented reality established by David Ruiz, “Augmented reality is a tool with great projection for the valuation of the heritage, which is adapted to the necessities of this kind of environment, facilitating the task of disseminating content through a didactic and attractive experience that is inserted in the dynamics of our society (...) the use of augmented reality is projected as pioneering technology of the wide range of museum-graphic resources based on new technologies, And that pretend to offer an image in which there are several speeches and interpretations to express the contents of this type of scope” [8]. The above mentioned shows the importance that augmented reality has as an strategy to strengthen the approach of people to the museum.

### 2.1.1. Technologies in augmented reality

Technology in augmented reality has two main characteristics, they are: hardware and software. Inside the hardware is valuable the display device, that is considered an essential element because it allows the interaction person – computer, these two elements are fundamental for the construction of systems of augmented reality is how to carry out the combination between the virtual image and the real image [9]. It is important to contemplate the type of device being used as these allow the visualization of the real world image and at the same time the image superimposed.

Nowadays, it is being used locating sensors and tracking systems based on vision techniques, also it can be found apps that combine both. Locating sensors are used in hardware such as smartphones and tablets. Tracking systems are based on vision techniques which operate with fiducial marks or by the recognition of natural features or patterns, “the last ones are the most suitable to use for digital techniques of the real environment” [9].

Beneficial to the completion of the interaction with each device, it has been implemented a series of software that helps the reproduction of augmented reality; this is conceived under the GPL license (General Public License). The first specific software for augmented reality was called ARToolKit, to which has preceded MXRToolKit, FLARManager, ARTag or Studierstube

At the same time they have developed APIs (Application programming Interface) that act as platforms for software component search engines like Wikitude, Layar or Junaio. From these programming interfaces can be developed based on augmented reality applications to be implemented in devices like Smartphone and tablets [9].

Other useful software tools for the construction of applications of augmented reality are those that allow performing the modeling of virtual objects that will be superimposed on the actual image of the video, the most well-known are: OpenGL, Papervision3D, Studio3DMax, AutoCad3D, Sketchup, Blender, etc.

### 2.1.2. Types of augmented reality

Augmented reality has four different forms, depending on the platform on which it runs.

**Table 1.** Types of augmented reality[10]

Types of augmented reality	Description
Augmented reality from smartphones	To carry out this kind of experience, the user must have a smartphone like iPhone, Blackberry, Android or similar; it needs a digital rear camera, in which it is downloaded a program that allows to execute augmented reality. Usually it is used with a global positioner by satellite, or GPS, to perform a geo-localization of the device in real time, and be capable to interpret the position of the camera in the moment that it is placed in front of the user in movement.
Augmented reality from special glasses	The user must have, as sensor, translucent glasses that are connected (wired or wireless) to a PC or a smartphone, in which is executed the program that enables the experience with AR.
Augmented reality OFF-line from a PC	It can be used a conventional personal computer, connected to a web camera of medium resolution that serves as sensor, an elaborated program to be executed from the PC, and a printed marker that represents the way in which the event is played for the visualization of the object on the computer screen
Augmented reality ON-line from a PC	It requires a wired or wireless connection to Internet, in which it is executed the program that read the virtual models; It only needs the Flash display, usually, available on computers for the display of these format

For this research, the perspective of augmented reality is using smartphones, since the users will have access to the application that will allow them to scan the augmented reality code and have access to the information.

**2.2. Zenú Ethnicity**

In his book “En el país de los Zenúes”, Otálvaro narrates the legend of the Zenú in a rich way. Here it is highlighted the born of this ethnicity; When other gods were creating other worlds, the god of the Sinú was creating the Zenú world; he created the first beings and he called them Mexión and Menexca, parents of the Zenú people. They gave birth to Finzenú, Panzenú and Zenufaná, who were ordered by their father to spread by the extensive valley and they founded the three great populations that conformed the Zenú empire [11].

It can be appreciated the creation of the Zenú people, conformed by three great villages. FINZENÚ: It involved the área from the Sinú Valley and the Savannah (Sucre and Bolívar) to San Jacinto Serranía; the ceremonial, funeral, crafts (ceramics, wickerwork and yarn centers) abound in this area [12] “Located thirty leagues in southern Cartagena. In the valley of the Sinúriver, Zenufaná’s sister ruled, she wanted that all vassals paid her homage. For this reason, she ordered to the most important seniors from the three lordships to make their graves in Finzenú. In this way it was well-known as a ceremonial center” [13]. PANZENÚ: Its area was from San Jorge valley to Magdalena river mouth, this was an agricultural, artisanal, fishing and hunting area [14]. Its flooded area was adequated with extensive drainage systems in the first centuries of our era, which enabled the exploitation of soils for agriculture, as well as the survival of the aquatic fauna [13]. ZENUFANÁ: located in the valley of the low area of Cauca and Nechí. It was the gold region and seat of the government power. At the same time, Zenufaná had the control over the areas were Zaragosa was established and also from the banks of Cauca river to Aburra savannas that were the richest lands [13].

The cultural practices of the Zenú people focused on the commercial and economic exchange and the food, fabrics and goldsmith’s articles production between the settlements. Unfortunately, the cultural pattern for exchange did not exceed the subsistence expectations. The ancient organization of the Zenú had a highly structured level of power, each province granted its power under the figure of the cacique, who could be male or female, it permitted them to improve hydraulic works, which are evidenced in the construction of irrigation canal systems.



**Figure 1.** Village Zenú[15].

Now, the Zenú indigenous inhabit a little part of their ancestral territory. As it was presented in the Indigenous chronicles, their land was divided in three provinces: Finzenú, Panzenú and Zenufaná. Finzenú was located in the Savannah and the hills of the Sinú river, Panzenú was located between the foothills of the western mountain range and the Cauca river, and Zenufaná was located to the east of Panzenú to the other side of the Cauca river[15], Further, some archaeological studies carried out in the lower course of the Sinú and San Jorge river showed that not only how the Zenú ancestors were distributed in this region, but also how they controlled and managed the lacustrine and riparian environment.



Figure 2. Territory of the Zenú Ethnicity.[16]

### III. METHODOLOGY

The research is part of the qualitative paradigm which has as a main interest the cultural patterns of a particular group of people, which seeks to understand and deepen the phenomenon and exploring them from the perspective of the participants related to the context and natural environment. [17].

The type of study is ethnographic, since cultural patterns of a group of people in a given context were explained in detail. The research focuses on the display of the archeological pieces of the Zenu ethnicity which are in the museum Manuel HuertasVergara so that the community knows and also they will feel own their ethnic identity, this research is carried out by making use of the augmented reality (AR) as an emerging and innovative technology.

In terms of the population it was made up by members of the indigenous reservation from San Andrés de Sotavento among who will be indigenous chiefs, thematic experts, and directors of the different institutions of the indigenous reservation; in addition to this the visitors of the museum Manuel HuertasVergara will be taken into account. The sample will be obtained for convenience.

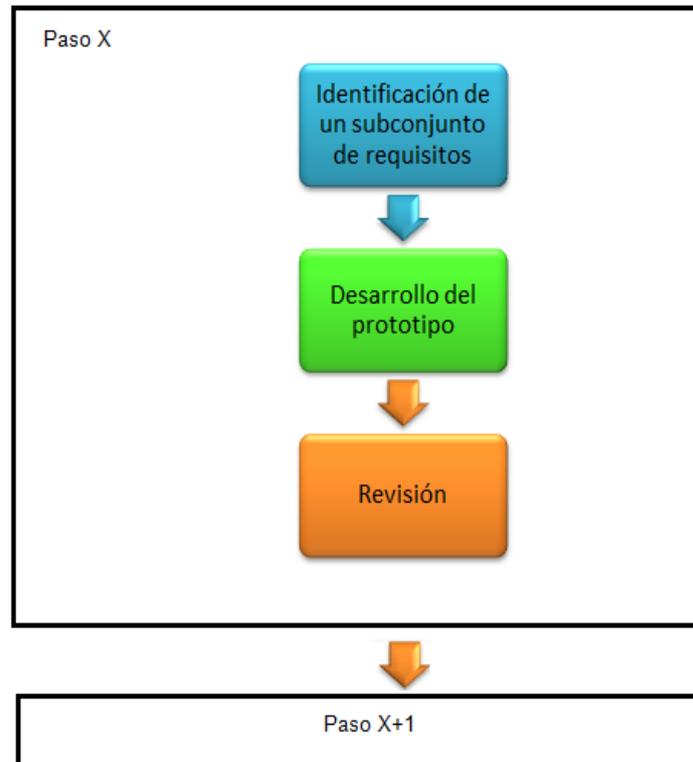
The research was carried out taking into account the following phases:

Table 2. Phases of the Research Project. Own Elaboration.

PHASES	DESCRIPTION
Phase 1: Characterization of the archaeological pieces.	Gathering, analysis and description of the information.
Phase 2: Modeling of the archaeological pieces.	Selection of the archaeological pieces and the design of the models in third dimension (3D)
Phase 3: Design of the web platform “Museum of ethnic augmented reality Zenú-TOTÓ “	Design of the web platform using framework, augmented web, programs for the design of the web pages such as HTML5, JQuery, JavaScript y CSS3.
Phase 4: Evaluation of the web platform.	Implementation of a metric for the evaluation of accessibility and usability of the web platform.

Regarding to the information gathering, a semi-structured interview was applied. For the modeling of the archaeological pieces of the Zenú ethnicity audiovisualequipment such as cameras and structure sensor 3D were used. Following with this, a perception survey was applied as a technique in order to inquire about the people’s knowledge on their identity cultural Zenú, museums and the technology integration about the information in the museums.

For the design of the web platform “Museum of ethnic augmented reality Zenú-TOTÓ”, the process of the software was taken into account, which is considered as the imposed structure by the software development. For this to be achieved, the model process based on prototypes was implemented, which allowed to develop a model of the product in order to verify its functionality and thus obtain an evaluation that enable to perform the relevant improvements of the web platform.



**Figure 3.** Prototype Model (Identification of a subset of requirements, Development of the prototype, Review)[18]

Finally, the evaluation of the web platform was conducted by using the web audit approach which “is a specialized technical consulting conducted by external technicians and commissioned by the address of company or organization” [19]. This method seeks to compare the quality of websites considering factors such as usability, accessibility, functionality, reliability and efficiency, these factors were studied through a metric for the master thesis.

To evaluate the accessibility to the page the tool TAW (Web accessibility Test) will be used which is hosted in the website <http://www.tawdis.net> that uses the pattern WCAG 2.0 and the code HTML (HyperText Markup Language) will be examined with the validator of the W3C Markup Validation Service to check the use of the standar for the Web established by the World Wide Web Consortium.

## IV. FINDINGS AND CONTRIBUTIONS

### 4.1. Characterization of the archeological objects.

It can be said that, one of the characteristics of the culture was the goldsmithing which shows an exquisite work in filigree melted accomplished through a modeling wax of bees which was replaced by the gold presenting the appearance of filigree [20]. This technique was also used to emphasize some striking features of birds and other animal species.

The described pieces are established based on the archaeological studies undertaken by Plazas, Flachetti, Sáenz& Archila in 1998 in the low area of Saint George. According to this, three ceramic traditions were established pertaining to different busy periods: incised, modeled-painted and isolated incised. Moreover, three types of ceramic are distinguished: Modeled, Incised and Rabon.

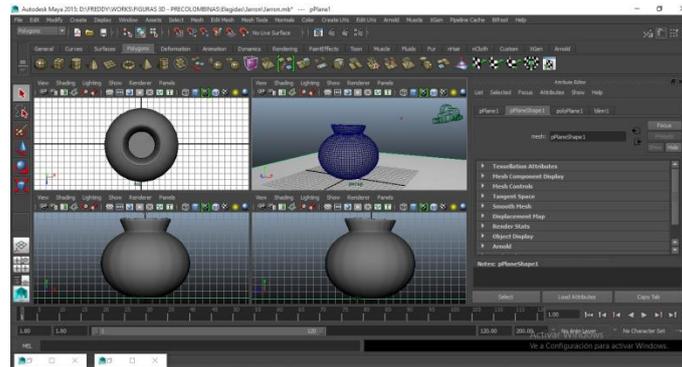
The described collection corresponds to the archaeological pieces of the Manuel HuertasVergara Museum in Sincelejo, city in which are 226 pieces registered before the Anthropology and History Colombian Institute in agreement to the filing number N° 3509. Then, some of the archaeological pieces of the Zenú ethnicity are related.

**Tabla 1.** Archaeological Collection in the Zenú Museum Manuel HuertasVergara– MUSEMAHVE

DESCRIPTIVE NAME	CHRONOLOGY	PHOTOGRAPHIC RECORD
VESSEL	Century XII a.C. to Century XVII a.C.	
POT	Century II a.C. to Century XII a.C. – Century XII a.C. to Century XVII d.C.	
OTHER	Century XII a.C. to Century XVII a.C.	
CUP	Century XII a.C. to Century XVII a.C.	
BOWL	Century XII a.C. to Century XVII a.C.	
MOCCASIN	Century XII a.C. to Century XVII a.C	
URN	Century XII a.C. to Century XVII a.C	

**4.2. Modelingpieces and augmented reality**

Autodesk mayal 2015 was used for modeling of the pieces which is “A computer program dedicated to the development of 3D graphics for computer, special effects and animation. (...) Maya is characterized by its power and the possibilities for expansion and customization of its interface and tools. MEL (Maya Embedded Language) is the code that forms the core of Maya and thanks to which it is possible to create scripts and customize the package. The program has different tools: for modeling, animation, rendering, simulation of clothing and hair, dynamics (simulation of fluids), etc.[21]. Then, the interface of the software used and the process for modeling of one of the pieces belonging to the Zenú ethnicity are presented.

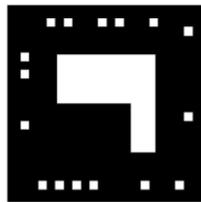


**Figure 4.**Interface and process for modeling.

The modeled piece corresponds to a vessel that dates between the century II a.C. and the century XII a.C., designed in ceramic and the state of conservation of the piece is good. This corresponds to the incised flattened ceramic tradition whose form is noted for being globular with neck, its function could be to contain liquids.

#### 4.2.1. Design of pieces in augmented reality

For the generation of the RA content of the archaeological pieces of the Zenú ethnicity, the Aumentaty software was implemented which offers a range of tools to make use of the augmented reality. One of these products is Aumentaty Author that allows the generation of augmented reality contents and comes with a suite of tools that enables the design of marking tags to create and visualize 3D models. This software is freely distributed. Another tool is Aumentaty Viewer that permits the view of the scene at the moment to scan the designed marks with Aumentaty Author.



**Figure 5.**Pieces archaeological marking of the Zenú ethnicity. OwnElaboration

The design of the web platform “Museum of ethnic augmented reality Zenú -TOTÓ”, is supported in the software process “Prototype-based process model” which enables the creation of prototypes for testing and at the same time for obtaining an evaluation of the platform, allowing the refining of this, until reach into the final result. As a first instance, a subset of requirements was taken into account for the design of the platform, which began with the definition of the global objectives for the platform, then, the known requirements and the areas of the diagram where is required more definition were identified, and finally, an iteration of the prototype design was stated to verify the appearance and organization of the context. Following with this, the first prototype of the platform is developed making use of the system of the content management WORDPRESS, that allowed through its administration interface, handle the content in a simple form and perform the web layout. It is possible to observe this first draft by entering the following URL <https://realidadaumentadamuseoetniazenu.wordpress.com/>



**Figure 6.** Code QR. Prototype web platform. Own Content.

The last phase was checking, in which, users participated who also interact with the prototype and they give their opinions making reference to the design, content and accessibility to the information. The following figures show the things observed by the end-users.

The relevant changes were made, once the evaluated aspects were analyzed in order to go with the design of the platform making use of the language HTML 5 (HyperText Markup Language, version 5). With a view to carry out a good design the following scheme is proposed:

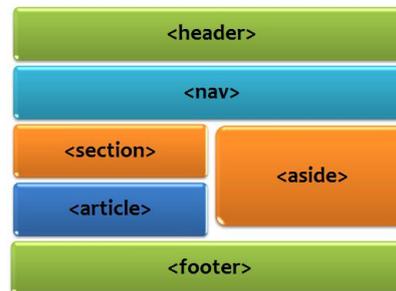


Figure 7. Development Scheme. Own Elaboration

Adicional al Lenguaje HTML5, se incorpora el uso de CSS 3 (hoja de estilo en su versión 3), esta permite definir y crear la presentación del documento de forma estructurada. Para la plataforma web, se estructura un CSS agradable y funcional que permita la accesibilidad y funcionalidad del mismo. Para darle mayor interacción a la plataforma web se hace uso de JQUERY framework de JavaScript, este es un software libre y de código abierto.



Figure 8. Museum of ethnic augmented reality Zenú – TOTÓ<sup>1</sup>. Own Content.

#### 4.3. Evaluation and validation of the web platform.

##### 4.3.1. Validation of the platforms through W3C Markup Validation Service

For the validation of the code it was necessary to use The W3C Markup Validation Service, this service tests the validity of the web documents made in HTML, XHTML, SMIL languages among others. For the validation of the CSS, the CSS W3C validation service was used, which is free useful software to execute the results to styleaplicacion1.css.

Figure 9. Validation HTML y CSS

<sup>1</sup><http://otssincelejo.com/museoratoto/Index.html>

#### 4.3.2. Evaluation of the platform since its usability and accessibility

##### 4.3.2.1. Analysis with TAWDIS (perceivable, operable, understandable y robust)

According to the validation carried out through the TAW tool, four relevant aspects are highlighted in order to achieve an accessible web page and these are:

- The information and the components of the user interface must be presented to the users, so that they can perceive them.
- The components of the user interface and the web surfing must be operable.
- The information and the management of the user interface must be understandable.
- The content must be robust enough to be reliably interpreted by a wide variety of user agents, including technical aids.

The results show that the platform has three problems from the robust, thirty nine warnings, which were checked manually, and eighteen unverified that were also checked manually. In a detailed way, these results were found: 0 problems from the perceptible, and 16 warnings in this item, 0 errors in the operable and 7 warnings; 0 problems in the understandable and 0 warnings and 3 problems in the robust and 16 warnings. With the given results the verification and correction of the warnings were made.

##### 4.3.2.2. Application of the metric to evaluate the web platform

To carry out this analysis the following aspects for the evaluation were taken into account: usability, accessibility, functionality and content. The aspects evaluated are described below:

##### 4.3.2.3. Aspect of evaluate the web platforms

*Scheme of the web platform*, is well structured, and for this reason it guarantees a good observation and safe web surfing.

*Labels*, the web platform has text labels, but in the images there are not presented the corresponding labels, that indicate their usefulness.

*Web surfing*, it is good and it has identifiers of the page.

*Consistency of web surfing*, the page shows coherence and it is understandable according to the objective of this.

*Feedback from the website*, according to the items to evaluate the platform has all of these things, the only problem is that for this prototype version and the characteristics of the platform there is no a link to the most frequently questions.

*Stethic Design of the web page*, the page has a good design that makes intuitive the usability of this.

*Classification of the data*, the information is classified, which allows to see an organization of the information and at the same time it enables to have to the hand what is needed.

##### 4.3.2.4. Aspect of evaluation Accessibility

*Images*, inclusion of alternative text of the pictures used in the web platform.

*Use of display attributes*, the page has contrast, and in this version of the platform a wizard for disabled users is not included.

*Events with the keyboard*, it has a consistent movement through the different parts of the web platform.

*Labels*, the platform use tagline to have more information in the web page, and also this have not alterations using the modification of the Font size.

*Adaptability*, the platform is adaptable to mobile devices such as Tablet, Smartphone and others.

##### 4.3.2.5. Aspect of evaluation Functionality

*Aspects of search*, in this version of the web platform is not included the sections of searching, which is one of the improvements that will be carried out in the following prototype.

*Aspect of exploration*, the page offers a simple and fluid surfing; it has a map of the site that allows visualizing the organization of the web platform.

##### 4.3.2.6. Aspect of evaluation Content

*General information*, the platform has an impeccable display; the information about the content is coherent.

*Explorability*, the titles and subtitles are significant, it has a legible text, and it is suitable for the web, the phrases used have simple structure for the reader, the information contains relevance and is free from grammatical and spelling errors.

*Use of the content*, the information presented in the web platform is optimal, the given texts are of the pedagogical nature. The images used are appropriate and consistent with the information shown. It presents homogeneity in the texts of the surfing menu. Finally, has all the content of the topics raised, spelling, presentation and development of the content.

*Other information*, the platform includes references and links to sources of information, also the inclusion of the author and the content adjusted to the pedagogical level are evidenced.

#### 4.3.2.7. Aspect of evaluation Reliability

*Absence of errors*, the platform does not have neither invalid nor broken links in the web page.

*External links*, the reviewed version has privacy policies, copyright to all the information that is not self-created.

*Standard*, the platform has validation with W3C.

*Updating*, the platform possesses updated.

According to the evaluation carried out in the web page, it established that the range of assessment reached is good, the obtained result was 8,87 in the weighing, which indicates that this is accessible but it must be improved on some items in order to achieve a one hundred percent of accessibility and usability..

## V. CONCLUSION

It is important to promote the ancestral culture through the use of ICTs in order to reach different types of population, especially in vulnerable areas caused by violence as the case of the department of Sucre and its capital Sincelejo, that receives multiple surrounding populations that fled their violent past caused by illegal armed groups. The indigenous settlements have not been the exception and they are one of the most affected populations in Colombia. Every day, they have to bear with the cultural alienation, losing their ancestral roots due to the interaction with the Anglo-Saxon, cosmopolitan and consumerist culture.

This research has contributed to make visible and recreate a portion of the Zenú ethno-identity, showing its archeology and anthropology through the web platform "Museorealidadaumentada de la Etnia Zenú – TOTO". For different schools of the indigenous, this platform made easy the access to some ancestral pieces. It is significant to stand out that one of the most avant-garde aspects was the use of augmented reality (AR) which exhibited the pieces in a realistic way. At the same time, it enhanced the interaction with the pieces since valuable information could be found in each marking label.

Web engineering was taken into account when checking that HTML5 and CSS3 codes meet the standards established by the World Wide Web Consortium (W3C), in order to guarantee the proper operation of the web platform. Subsequently, the access to the platform was tested through the use of a tool named TAWDIS, there were no perceptible problems and just 16 advertencies associated to techniques alluding to the positioning of elements and structure of the labels headers. Regarding to the operable part, it was no evidenced errors and just seven advertencies related on the content descriptors and the positioning of the elements. On the understandable part there was no a problem nor advertencies. And on the robust part, three problems and 16 advertencies were found; the advertencies were due to ambiguities that could be inside the code used in CSS.

Finally, a metric to perform the audit was applied, and five aspects were observed: usability 20%, accessibility 15%, functionality 15%, content 40% and reliability 10%. Some indicators were linked to evaluated items, and they were assigned a percentage and a value from 1 to 10, being number one the lowest score and the maximum score was ten. At the end of the metric, the percentage of the evaluation and the weighted total of the platform was a total of 8,87 highlighting that it is accessible and functional according to the standards proposed by Nielsen.

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