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A Proposal to Innovate the Design of the Sudanese Vehicle Number Plates

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ABSTRACT

Vehicle number plates display, and recognition have been a lawful concern in all countries. Research engages in improving the quality of plates has been an interesting and challenging task. It is shown that the plates have different shapes and sizes and have assorted colours in different countries. In Sudan, the recent plates in use are of a white background with black text and numbers written in English and Arabic languages. This study proposes an innovative design for the plates considering the regional and international standards. The attempt incorporated the Sudanese flag, reduced the letter crowding and noise, enlarged the font and improved contrast, and kept Arabic numbers, and excluded the Indian numbers and included a logo for branding the plate. The study has considered both theoretical mathematical and experimental approaches. However, it is commissioned to facilitate the electronic identification of the plate is an issue. The experimental component proved a sizable visual difference between the old design and the proposed innovative design. Mainly assembled on two steps; firstly, the plate is identifiable visually from longer distance compared to the existing plate; secondly the segmentation allowed a sustainable better electronic recognition.

Keywords- *Innovative vehicle number plate design, character distance identification. Electronic recognition.*

INTRODUCTION

Vehicle Number Plate (VNP) for cars is issued by a law approved by the legislative authority in Sudan [1-2]. The administrative authorities are trusted with implementing and ensuring the implementation of what is stated in the consignments of that law. The contents of the plate, including numbers and letters, and the way it is designed and displayed, are an important means of registering cars in the country [3]. The plate shall be owned by the state and under the direct supervision of The Sudanese Ministry of Interior Affairs and specifically the General Administration of Traffic Police [4]. The vehicle's owners will hire the number plate and will be responsible against the road regulations and beyond[4]. We point out that the plates currently used are in accordance with a specification, as they were preceded using a group of designs, the first of which was in the year 1950 in Sudan [5]. The VNP design currently in use was last implemented in 2009 [1]. At the micro level, the innovative design provides a good opportunity for a digital link to all relevant identities and security organizations, road users, and parking facilities agencies, improving their duties and services. When at the micro level, the implementation will secure an update and help in controlling the whole automobiles in Sudan [6-8].

The study aimed to update the design and upgrade the components of the plate to achieve a radical solution to the problems of irregularities and abuses in the use of the current plate design. The new proposed design will allow for the introduction of digital services and legal follow-up on vehicles in all the Sudanese territories and abroad. The proposed plates will support the genuine Sudanese Government Computerization inclinations and linking of all states digitally to control all vehicles in the country because of enormous increase in the number of cars, and the diversity and versatility of car use have necessitated a review to fit with the digital strategy's plans. The implementation of such a design reduces the opportunity for vulnerable people not to commit violations and not to escape if identified without being subject to legal accountability.

MATERIALS AND METHODS

The design of a plate according to the optical visual resolution mathematical equation as shown in Figures 1, 2, 3 & 4. Detailed visual resolution is achieved with the naked eye of the objects to be seen when they are at a distance and height that creates an angle of 5 minutes of space from the middle of the human eye. Thus, the height and distance of the object to be seen can be controlled using the tangent equation [9]:
Height (number or letter) = tangent x the distance it displays (number or letter).

The distance over which (the number or letter) is displayed = the height of (the number or letter) / the tangent of the angle. The plate is designed into a rectangular shape which divided into three segments. The first plate segment houses the numerical number, the middle segment accommodates the letter code in Arabic and English and the logo. The third segment houses the flag and the word Sudan in English and Arabic.

The drawing below shows the standard angle, height of the letter, and the distance from the eye to the detection panel in all visual acuity charts design (Figure No. 1) and then to the angle of 5 minutes would be adapted in each number used in the new designed plate (Figure No. 2).

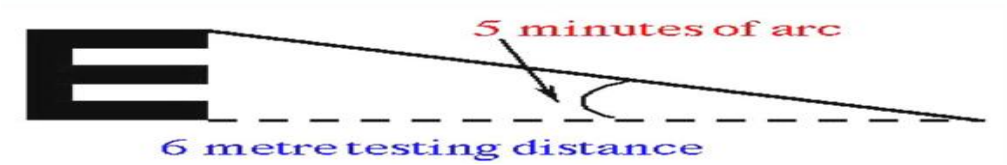


Figure No. 1 Minimum angle of resolution

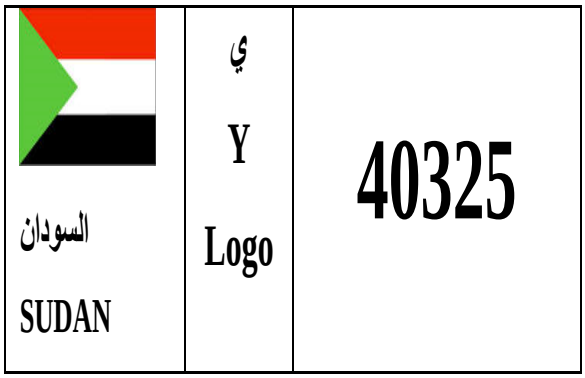


Figure No. 2 Sudanese Vehicle Number Plates - 1

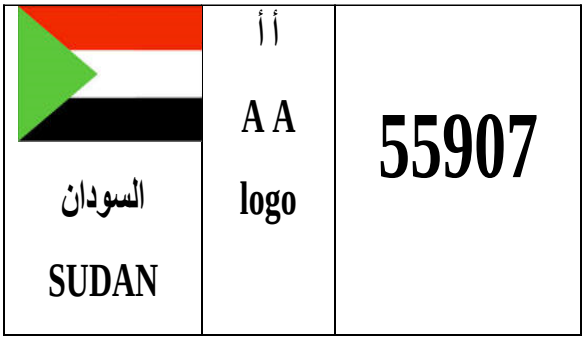


Figure No. 3 Sudanese Vehicle Number Plates – 2

The designed plate has the following parameters: the panel shall be 500 mm long and 110 mm height (S_1 200 mm, S_2 120 mm, and S_3 is 180 mm) (Figure 3), or 240 mm long and 410 mm height (S_1 = 120 mm S_3 120 mm each and S_2 200 mm) (Figure 4). The maximum distance at which a single number or letter written at a height of 60 - 80 mm can be seen on average is forty-eight meters for a person with a visual acuity of 6/6 on the detection plate or its equivalent. This is mathematically as follows:

1. Distance = height of number or letter / tangent of the angle
2. Distance = 60 ÷ 0.001454 = 27510 mm = 41.27 meters
3. Distance = 70 ÷ 0.001454 = 30949 mm = 48.14 meters
4. Distance = 80 ÷ 0.001454 = 34387 mm = 55.02 meters

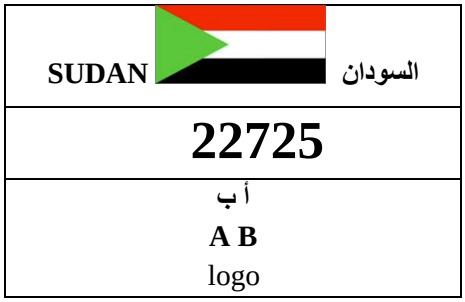


Figure No. 4 proposed Sudanese Vehicle Number Plates

The letter grouping mode will contain selected matching Arabic and English Alphabets. The Letters Grouping selected are displayed in the table below as shown in table 1. Number plates generated from the table above computed to be. 1 X 99999 X 10 X 12 = 11,999,880 car plates

Table 1. The letter grouping mode

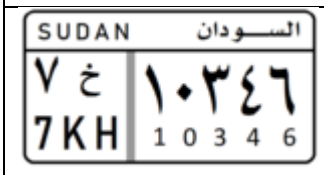
Letter Grouping	**أ A**	**ب B**	**د D**	**ر R**	**س S**	**ك K**	**م M**	**و W**	**ي Y**
أ A	أ أ A A	أ ب A B	أ د A D	أ ر A R	أ س A S	أ ك A K	أ م A M	أ و A W	أ ي A Y
ب B	ب أ B A	ب ب B B	ب س B D	ب د B R	ب ر B S	ب ت B K	ب ك B M	ب و B W	ب ي B Y
ت T	ت أ T A	ت ب T B	ت د T D	ت ر T R	ت س T S	ت ك T K	ت م T M	ت و T W	ت ي T Y
ح H	ح أ H A	ح ب H B	ح د H D	ح ر H R	ح س H S	ح ك H K	ح م H M	ح و H W	ح ي H Y
د D	د أ D A	د أ D B	د س D D	د د D R	د ر D S	د ت D K	د م D M	د و D W	د ي D Y
ر R	ر أ R A	ر أ R B	ر س R D	ردR R	ر ر R H	ر ت R K	ر م R M	ر و R W	ر ي R Y
س S	س أ S A	س ب S B	س د S D	س ر S R	س س S S	س ك S K	س م S M	س و S W	س ي S Y
ك K	ك أ K A	ك ب K B	ك د K D	ك ر K R	ك س K S	ك ك K K	ك م K M	ك و K W	ك ي K Y
ل L	ل أ L A	ل ب L B	ل د L D	ل ر L R	ل س L S	ل ك L K	ل م L M	ل و L W	ل ي L Y
م M	م أ M A	م ب M B	م د M D	م ر M R	م س M S	م ك M K	م م M M	م و M W	م ي M Y
و W	و أ W A	و ب W B	و د W D	و ر W R	و س W S	و ك W K	و م W M	و و W W	و ي W Y
ي Y	ي أ Y A	ي ب Y B	ي د Y D	ي ر Y R	ي ر Y S	ي ك Y K	ي م Y M	ي و Y W	ي ي Y Y

<u>Illustration of the existing plate and the newly suggested plate.</u>

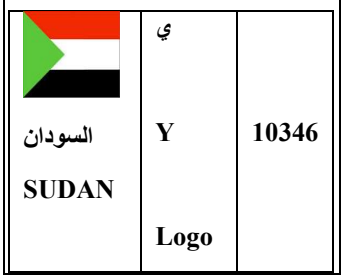
In figure 5 & 6 illustrated the plate image, date of issue, design dimensions, serial format, and explanation to the letter coding for the existing plate and the newly suggested plate, respectively.

The existing plate has a height of 160 mm and a width of 320 mm. The plate divided into three segments; one segment in the upper part, which contains the name of the country (SUDAN) which was in English and Arabic. The other two regions in the lower part, which divided by a silver metallic bar written on it Republic of Sudan, the segment to the right contains digits (1 to 5 numbers) written in Hindi and Arabic, and the other region on the left side contains characters and number written in English and Arabic, the characters are an abbreviation of Sudan states name, and the number to keep the sequence of the numbering. The maximum distance at which a single number or letter used in current car plates can be seen by a healthy or visually corrected eye with a visual acuity of 6/6 or its equivalent is on average thirty-one metres. The distance between the numbers is in the range of 5 – 10 mm, which increases the problem of literal crowding in vision, which reduces the ability to detail or distinguish between digits and reduces visual acuity. The whole characters in the plate are black on a white background and have a contrast intensity 90-80% that gradually decreases with time of use, which reduces visual acuity.

Similarly Figure 6 showed the new suggested plate image, design dimensions, serial format, and explanation to the letter coding. The newly designed plate digits were chosen to be written in Arabic instead of the two languages (Hindi and Arabic) as in the existing plate, and here authors point out the common confusion between Hindi and Arabic numbers. Therefore, we point out that the proposal stated the matter and used Arabic numbers only. In addition, it was suggested that car registration should centralized. The distance between the digits is in the range of 10 – 15 mm, which reduces the problem of literal crowding in vision and improves visual acuity. The width of the letter is 6 - 8 mm gives a greater opportunity and space that helps in detail and distinctive ability.

Image	First issued	Design	Serial format	Serials issued	Notes
	2009	30 cm x15 cm Bilingual Arabic and English	1**L**-2345	1-99999	The Letter **L** indicates the State The letter **خ/KH** indicates Khartoum State for example

(Figure No. 5)

Image	First issued	Design	Serial format	Serials issued	Notes
	After approval	30 cm x15 cm Bilingual Arabic and English	Alphabet bilingual letters	1-99999 Arabic Numbers	The Letter/s indicate the serial numbers as the registration will be central

(Figure No. 6)

Design currently used:

The mathematical maximum distances for seeing numbers and letters are as follows:

Distance = height of number or letter / tangent of the angle.

Distance = 40 ÷ 0.001454 = 27510 mm = 27.51 meters

Distance = 45 ÷ 0.001454 = 30949 mm = 30.95 meters

Distance = 50 ÷ 0.001454 = 34387 mm = 34.49 meters

The experimental method employed was a setup of the newly designed plate compared against a setup of existing plate in use. The experimental method employed was a set of the newly proposed designed plate with its optimum parameters located in a car plate carrier. Hence, the experiment set up adopted from the method of examining the letters and numbers legibility test for designing the visual acuity charts [10-11]. Group of 55 Volunteers recruited in the study, thirty-two males and thirty-three females aged between 19 - 66 years of age (mean was 30.8 years). Each volunteer was assessed for Visual Acuity in the clinic monocular binocularly initially. The main test conducted with both eyes open were the volunteer asked to read the plate numbers and walk back gradually till the

numbers were unreadable to them. The plate treated similarly to the Snellen's and LogMAR visual acuity charts. Volunteers were verbally consented with the right to leave the participation without giving reasons. Volunteers have binocular visual acuity between 6/5 – 6/6. Volunteers with visual acuity less than 6/6 excluded and ametropias were wearing their full refractive correction, spectacles or contact lenses. The distance a volunteer reported he/she was just unable to read the plate was recorded and with a rest of 3-5 minutes, the volunteer asked to walk towards the plate from where 2 meters from the point he failed to call the numbers till he/she enabled to see and call the plate number clearly and loudly. The new distance recorded and the average of the two recorded distances tabled for the analysis. The experiment repeated with the existing plate located in the car plate carrier. The same way experiment setup was followed, walk away and walk towards distances from the plate when the average distant was recorded to maintain validity. Study conducted within the framework of reviewing and improving the existing vehicle number plate in use in Sudan. It is approved by the research committee of the Faculty of Optometry and Visual Sciences, University of Al Neelain, Sudan.The experiment took place at Al Neelain University, Khartoum, Sudan car park and the ground plotted in meters gabs and the time was 04:00pm the sun light was full. The recorded distances appeared in table 2.

RESULTS

A total of 55 participants their age ranged between 19 and 66 years with mean 30.8±13.1. Most participants were male 58.2% and female 41.8% as shown in table 2.

Table 2. Demographic data

Age group (years)	Gender	
	Male	Female
From 19 to 30	52.6%	47.4%
From 31 to 40	50.0%	50.0%
From 41 to 50	50.0%	50.0%
From 51 to 60	100.0%	0.0%
From 61 to 70	100.0%	0.0%
Total	58.2%	41.8%

New Designed Car Plate outcomes

The newly designed car plates showed high visibility in meters with mean 54.6± 4.6 compared with existing one 40.2±5.4. There appears to be a nonsignificant difference between the two plates *P>0.05*. as shown in table 3. The correlation between New Designed Car Plate and Existing Car Plate is shown in both a scatter plot. The *line* in graphs is the linear regression ($r^2 = 0.17$, $P < 0.001$). are showed in Figure 7.

	Minimum	Maximum	Mean	Std. Deviation	P value
New Designed Car Plate	45	64	54.6	4.6	P>0.05
Existing Car Plate	24	48	40.2	5.4	

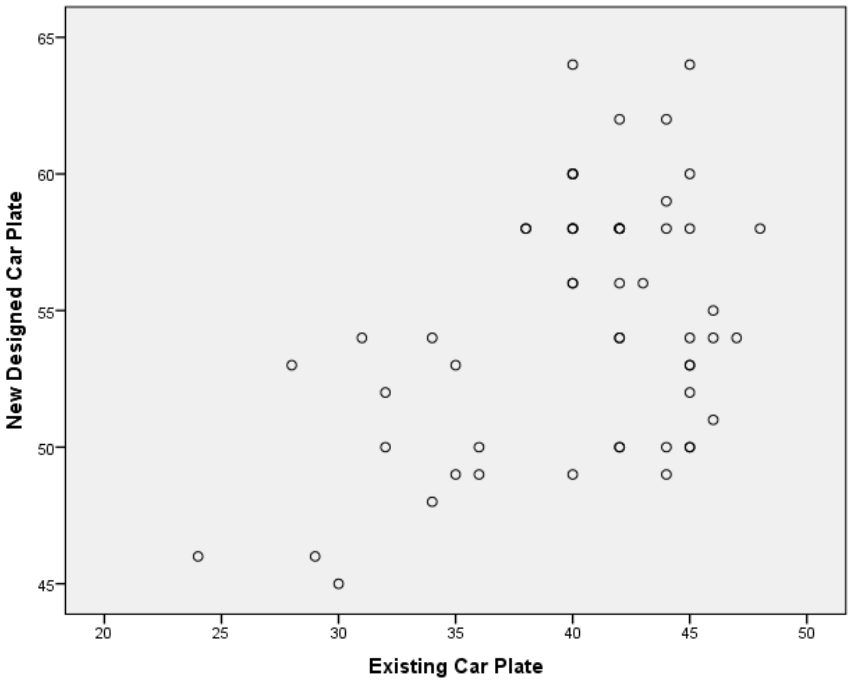


Figure 7. Scatter Plot between the two plates

DISCUSSION

Sudanese Car plate literature refers to the various texts, sources, and documents related to car plates in Sudan. These texts may include laws, regulations, guidelines, and historical information regarding the design, format, and usage of car plates in Sudan. They provide valuable insight into the legal requirements, specifications, and standards that must be followed when it comes to Sudanese car plates [4]. The vehicles registered on or after September 1, 2001, must have car plates that can be shown in no more than three lines and must comply with specific height and size requirements [12] .

Comparing the proposed design with the design used with the mathematical data, the result is an improvement and preference in performance by 21.52% for the proposed design. The plate must be made of engraved characters in metal sheet and to include a hologram on it, thus fulfilling the security condition that prevents imitation and forgery. The background of the plate to use assorted colours to consider the Private vehicles, commercial vehicles carrying passengers, commercial for goods, Police, army vehicles, diplomats, and government vehicles. The plate made of engraved metal and does not contain a hologram. The machines that are currently used in extracting plates can still be used to produce the new designed plates; however, it might need some adjustments.

In addition, it was suggested that car registration be centralized, thus supporting government computerization trends, and linking all states digitally to control all vehicles in the country. Many electronic theories and software are available for the detection the plate [7-8]. Our finding consistent with different studies in different countries [12-14].

CONCLUSION

The experimental component proved a sizable visual difference between the old design and the proposed innovative design. Mainly assembled on two steps; firstly, the plate is identifiable visually from longer distance compared to the existing plate; secondly the segmentation allowed a sustainable better electronic recognition. The study findings created a strategic necessity for the adaptation of the new car number plates. Overall, the new design and system of Sudanese car plates are tailored to meet the administrative and regulatory needs of the country, ensuring proper identification and management of vehicles.

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