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Evaluation of Vehicle Tyre Aging Awareness as a Potential Hazard to Road Users in Ghana

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ABSTRACT

This study aimed to investigate tyre aging awareness level among various tyre users and determine their abilities to decode the date of manufacture (DOM) from Department of Transport (DOT) tyre identification number (TIN) printed on tyre's sidewall. The study was carried out within the Accra Metropolitan and Ho Municipal Assemblies in Ghana. Data was obtained through the administration of 1191 questionnaires using simple random sampling technique to tyre consumers consisting of drivers (1021), vulcanizers (120) and tyre dealers (50). Analyses of the results showed that majority of participants (77.5%) were aware of aging occurring in vehicle tyres but only 7.5% identified it as potential hazard to road users. The results also showed that participants had difficulty in decoding and interpreting information from the DOT's TIN. Majority of the participants (over 60%) were able to interpret the numeric denoting rim sizes correctly yet only 16.8% construed "R" as radial ply type of tyre construction. Furthermore, most participants were not able to determine the DOM accurately in the week/year format from other tyre markings. There was negative correlation between gender and educational levels of participants and their ability to decode DOM in the various formats from other tyre markings. The implication from the study suggest that most Ghanaian tyre consumers cannot decode very vital tyre information from DOT's TIN, thus training and education is recommended for various stakeholders in the tyre industry.

Keywords– Vehicle Tyre Aging, Date of Manufacture (DOM), Department of Transport (DOT), Tyre Identification Number (TIN), Ghana

I. INTRODUCTION

In the world, about 60 % of human beings and goods are transported on vehicles that use rubber tyres [1]. Thus, tyres are very important components of vehicle composition and their safety must be assured and not neglected. This is because tyres are the only part of a vehicle that have direct contact with the roadway and expected to be robust enough to bear both the weight of the vehicle and its cargo through many thousands of miles of travel, while staying pliant enough to ensure passenger comfort [2]. Tyres are also expected to be durable and versatile enough. This is because they are involved in many other important operations such as maintaining friction in the course of steering, accelerating and braking or negotiation of a curve under varying weather conditions such as snow and rain [3].

Disastrous road accidents can result from tyre failures such as blowouts and tread separations [4]. For instance, in the United State of America (USA), it was estimated that from 1994 to 2004, 400 fatalities occurred each year and may have been related to tire failures [5]. According to another study carried out in the Kingdom of Saudi Arabia, it was revealed that 624 traffic accidents emanated from tyre failure in the year 2001[6, 7]. Vehicle stoppage on road side due to tyre failures is a very familiar scene on roads. This implies that good maintenance of tyres is very crucial in road safety and reducing road accidents from tyre failures.

Literature search indicates that some vehicle users do not have adequate knowledge in essential basic motor vehicle maintenance such as appropriate tyre inflation pressure, minimum levels of engine oil, brake fluid, transmission fluid and fuels as well as the required Society of Automotive Engineers (SAE) grades, radiator coolant level, inspection of indicator lamps, brake effectiveness and minimum tyre tread depth [8-10]. Tyre maintenance is one of the basic motor vehicle maintenance practices that is identified that drivers do not practice as recommended. For instance, according to [2], many drivers do not inflate tyres at the recommended pressure. This can result in tyre failure and loss of vehicle control and other side effects such as poor fuel economy [11].

In addition, NHTSA and many tyre manufacturers recommended that tyre inflation pressure should be checked at least once a month [2]. All tyre manufacturers communicate to tyre consumers the characteristics and conditions (i.e. maintenance guidelines) of their tyres. These maintenance guidelines mostly are in the vehicle user or owner's manual and also placed as a sticker placard located on the driver's side door jam or on the glove box door [2]. However, many tyre consumers are unaware

about the location of tyre maintenance guidelines leading to the use of un-recommended standards of tyre characteristics.

Another important factor that can contribute to tyre failure is tyre aging. Tyre aging is associated with deterioration or drying out of tyre's internal components which weakens the adhesive holdings of the tyre [12]. The deterioration is enhanced by oxidation and heat. Even, tyres which are less used are vulnerable (i.e. spare and leisure vehicle tyres). This is because spare and recreational tyres are stored in extreme temperature conditions for longer period [13, 14] which can result in tread separation (i.e. tread detaches from rest of the tyre) and/or a tyre blowout [2].

The detection of tyre aging (i.e. tyres exceeding safe lifespan) by consumers cannot be carried out solely by visual inspection. This is because tyre may not show any visual signs of aging because degradation occurs within its internal structure [14]. Therefore, an aged tyre in appearance can be safe for usage even though it may not be safe chemically. Studies conducted shows that a lot of tyre consumers are not aware of tyre aging and its potential hazards to tyre consumers and other stakeholders. For instance, only 4% of 225 participants in the study reported that tyre aging is a potential tyre problem [15]. Furthermore, in another study conducted by [8], approximately 25% of participants in the study over estimated tyre life span by four years or more as well as duration of life span of spare tyres in vehicles.

Every tyre manufactured has a DOT tyre identification number (DOT TIN) on its sidewall which is made up of different codes of information (NHTSA Part 574 –Tire Identification Requirements, 2009), including the Date of Manufacture (DOM) [2]. The new format of DOM consists of the week (2-digits) and the year (2-digits) in which the tyre was made. DOM is part of serial numbers which does not show any significant characteristics of a date. Thus, the current DOM formats are confusing and not easily recognizable by consumers. However, some vehicle manufacturers such as Audi, Ford, Toyota, BMW, Mercedes-Benz, Porsche etc. and auto safety advocates endorse changing tyres after six years from the DOM. In addition, numerous tyre manufacturers (such as Goodyear, Dunlop, Hankook, Firestone, Continental) have opined that tyres should be detached from service ten years after the DOM; attributing it to the fact that aged tyres may fail even if there is sufficient tread [14].

A few studies carried out shows that majority of tyre consumers cannot decode the DOM from the DOT number which is a potential contributing factor to a catastrophic road accident since an expired tyre could easily blowout.

Most of the researches carried out on tyre aging and related problems were conducted in developed countries. In developing countries such as Ghana, there was little or no research in this direction. However, most Ghanaian drivers relied on imported "used tyres" from developed countries since they cannot afford brand-new ones. This practice of drivers commonly using imported "used tyres" is a potential hazard to vehicle users. Thus, it is very imperative to carry out a study to assess the knowledge level of product information on tyres and their accurate interpretation. The key objective of this research is to investigate tyre aging awareness level among various tyre consumer stakeholders. In addition, to determine tyre consumers' ability to interpret tyre information by providing them with DOT tyre identification number for them to decode the DOM.

II. LITERATURE REVIEW

2.1 Basic Components of Tyres

A tyre is in a ring shape, with covering fitted around a wheel rim to protect it. The tyre allow good vehicle performance by providing a flexible cushion to absorb the vibrations and ensure that the wheel is in close contact with the ground [16]. The essential materials of current tyres are natural rubber, synthetic rubber, wire and fabric alongside other chemical compounds. The tyre comprise of a body which provide support and the tread for traction. Tyres must transmit braking, driving and cornering forces to the road under all forms of weather conditions and simultaneously demonstrate the ability to resist wear and puncture. All forms of tyre construction must possess the following six major parts namely Tyre Beads, Body Plies, Tread, Sidewall, Belts and Liner. Tyre Beads are bands of high tensile strength, double steel rings covered in rubber compound clamping the tyre sidewalls against the wheel rim. The Body Plies are rubberized fabric and cords wrapped around the beads forming the tyre body given strength to the tyre structure. The Tread is a thick extruded outer profile surface of the tyre that interacts with the road and covers the tyre body. The tread compound includes additives to impart traction, environmental and wear resistance. The Sidewall is the exterior surface of the tyre which encompasses the bead and tread. It also comprises the tyre size and identification information. The Belts are sheet comprising of a rubber layer, diligently spaced with steel cords. The Liner is a thin layer of rubber bonded to the inner part of the plies which provides a leak of proof membrane for tubeless tyres to hold high air pressure inside [17].

2.2 Type of Tyres

There are two types of tyres depending on their air holding ability and constructions namely the tubed and tubeless tyre.

2.2.1 Tube Tyres

In construction, the tubed tyres are made up of peripheral concealment which interacts with the road. Tube tyres engaged wear and weight of the vehicle. It has a thin interior tube which keeps the air and inflates the tyre [16]. The interior tube then forms a separate air bag which is protected by the peripheral concealment of textile material and rubber. The sole purposes of this inner tube are to take up the shape of the tyre cover when inflated with compressed air and to contain this trapped air over long periods [3].

2.2.2 Tubeless Tyres

The tubeless tyres have the inner part of the casing and outer surface having the bead lined with a soft rubber forming an air tight seal with the rim. This removes the need for a separate tube [16]. The initial sealing between the bead and wheel rim when inflating the tyre is aided by the taper rim seat on each side of the well base and adjacent to the rim flanges. Car and commercial vehicle rims tend to have taper angles of 5º and 15º respectively [18]. This design has merited the tubeless tyre with better air sealing qualities provided the concealment is sealed properly to the rim. The soft interior liner of the concealment provides a puncture sealing arrangement over the tubed tyre. The soft inner liner of the tubeless tyre seals around the object of puncture thereby slowing down the escape of air, especially if the puncture occurs at high speed [17].

2.3 Tyre Markings

It communicates certain important information about the tyre to users or consumers. It includes tyre size, wheel diameter, aspect ratio, load index, manufactures logo, speed rating among others. It also indicates the tyre classification for various vehicle usage such as Light Truck (LT), Temporary Spare (T), Special Trailer (ST), and Commercial (C). The sequence of numbers which define the tyres specifications are found on the sidewall and it is expected of a tyre consumer to match it to the car stated by the car manufacturer [19]. There are numerous kinds (i.e. other classifications) of tyres available for vehicle usage. However, the choice of selection is dependent on the usage, location, ride preference, nature of road and other significant factors. The classifications of the tyres are performance tyres, all season tyres, wet-weather tyres, snow or ice and mud tyres and all-terrain tyres [20].

2.4 Date of Manufacture (DOM) Text Format for Tyres

In addition to the tyre markings, tyres are also printed with information regarding when and where the tyre was manufactured on the sidewall. In the United States, every tyre has a Department of Transport (DOT) Tyre Identification Number (TIN) on its sidewall. Information such as the Manufacturers Identity Number, Plant Code as well as the Date of Manufacture (DOM) among others constitutes the DOT's TIN [2].

The first eight characters that follow DOT are essentially a serial number used by the vehicle manufacturer to identify the tyre and in which production facility it was made. For tyres manufactured in the year 2000 till now, the present DOM requirement consist of four digits at the tail end of the DOT number such as "0709" indicating that, the tyre was manufactured in the 07^{th} week of the year 2009 or in February 2009. However, for tyres manufactured before the year 2000, it is the last three digits of the code. The first two digits refer to the week within that year. Such as "022", it means that the tyre was produced in the second week of the year, and the year is the second year of the decade. This is the stage it gets more confusing since there is no universal identifier that signifies which decade, either in 1982 or 1992 although some tyres have a small triangle following the DOT code to indicate the 1990s [19].

As a matter of fact, it is tedious and perplexing as expected of a consumer to locate and decode this DOM. This is because the date is not having any notable characteristics signifying that it is a date. People who have an idea for tyres manufactured in the year 2000 to present might even guess "0709" to be July 2009. A study by [2] showed that the current format in which the United States DOT tyre's DOM is represented is not consumer friendly as only a diminutive fraction of the participants less than 20% were able to identify and convert a given code "2205" into week/year using the U.S. DOT's DOM rule correctly.

2.5 Tyre Aging

Tyre aging occurs over a period of time when the rubber and other constituents in the tyre deteriorates due to service, poor storage and environmental conditions. This is because tyres are mostly made up of rubber which loses its chemical properties with time. Tyre aging is a naturally occurring process on either used, reserved spare tyres or shelved tyres yet to be purchased [21]. Despite the fact that, the average tread life of a passenger vehicle tyre was around 24,000 miles in 1973, it has quadrupled over the last forty years making manufactures promise 100,000 miles of tread life. The tread life becomes less of a factor in the service life of a tyre as oxidation becomes a more serious concern particularly in hotter climates [22]. A study by [15] on humans' understanding of tyre aging and other tyre associated complications found out that, only nine out of two hundred and twenty five participants stated tyre aging as a possible tyre problem. Another research also indicated that nearly twenty five percent of the participants overestimated the recommended tyre life span by four years or more [8] although there has been some media publicity on hazards associated with aged tyres [23]. It has also been shown that numerous tyre users are ignorant of tyre aging and its dangers [9].

As tyre age, they are more prone to failure. In ensuring roadworthiness of vehicles, some automakers (i.e.

Audi, Ford, Toyota, BMW, Mercedes-Benz, and Porsche) and auto safety advocates endorse changing tyres after six years. It has been opined numerous tyre manufacturers such as Goodyear, Dunlop, Hankook, Firestone and Continental that tyres detached absolutely from service ten years after the DOM regardless of tread wear [24]. Aging in tyre causes decrease in tyre mobility [25]. In addition, empirical study indicated that aged tyre (i.e. four or more years old) with B" or "C" temperature rating being used in high ambient temperature countries are causes of road traffic accidents [26]. Therefore, apart from worn tread and improper tyre pressure, tyre can become unsafe due to their age. As tyre aged, their inner constituents dehydrate and the bond holding the constituents together weakens. Heat and oxidation fast track the deterioration process [5].

III. METHODS

3.1 Participants

One thousand one hundred and ninety one (1191) vehicle tyre consumers consisting of drivers (both private and commercial vehicle drivers), tyre dealers and vulcanizers participated in the study. Both genders (83% males and 17% females) were involved in the study. The dominance of males in the study was attributed to the fact that driving and automobile related issues are masculine dominated activity in developing countries such as Ghana. Majority of the participants (24%) who partook in the study were between the ages of 36 and 40 years, another (29%) had up to secondary school education level and (59%) were married. Most of the participants (25%) had driving experience or have been working in vehicle tyre related environment between 1-5 years. This working experiences in the vehicle tyre industries of which knowledge the researchers believed had provided exposure and equipped the participants for the provision of relevant information for the study.

3.2 Data Collection Instruments

The data collection instrument used in this study was questionnaires. Questionnaire was used because it is a perfect instrument to collect descriptive information from a large sample and extensive contents in a short time [27]. In addition, the questionnaires can be distributed and allow the respondents have sufficient time for filling and handpicked at a later time. Further, it gives a sense of anonymity to the respondents and it is an impartial way hence no researcher as in the case of an interview [28]. Structured questionnaire was used in the study, which contained both open and closed ended questions. A section of the questionnaire has pictures of tyre markings (i.e. DOT TIN) including the DOM in the current and five other formats for participants to decode and interpret. Participants were asked they could use either of the month or week format in their response as answers. In addition, there were questions on a seven-point Likert-scale that participants were tasked to rate how easy it was in determining the DOM from the DOTs markings on tyre. The scale consists of 1 = Not extremely easy, 2 = not very easy, 3= not easy, 4 = neutral, 5= easy, 6 =very Easy, 7= extremely easy.

Other items on the questionnaire were questions on awareness of tyre aging and related factors. They included previous knowledge of recommended years of tyre replacement and unused tyres after certain period by vehicle manufactures. They were also asked if they have looked at DOM from DOT TIN printed on sidewall of tyres.

Simple random sampling technique was used to administer the questionnaires to tyre consumers. The questionnaires were administered to the 1268 participants out of which 1191 were retrieved given a 94% retrieval rate. The sampling consists of drivers (1021), vulcanizers (120) and tyre dealers (50).

3.3 Piloting of Questionnaire

To achieve validity and reliability of the research instrument, a pilot survey was carried out in another city which has identical characteristics as the study areas. Pre-testing of the questionnaire was done to identify any ambiguous questions, unclear instructions in the research instruments and to determine the duration for the response to the questionnaire. The suggestions and comments in the pre-testing process were incorporated in the revised questionnaire to improve on the efficiency of the instrument.

3.4 Data Analysis

The data collected was edited, coded and entered into the Statistical Package for Social Science (SPSS) version 22 for analysis. The data was subjected to frequency analysis of measured items represented in percentage tables and means. Pearson correlation analysis carried out to describe the strength and direction of the linear relationship between participants' demographic characteristics and ability to decode DOM from other tyre markings.

IV. RESULTS AND DISCUSSION

4.1 Tyre Aging Awareness among Vehicle Tyre Users

The result from the study indicates that half (50.3%) of the participants owned their vehicle(s) while other participants have regular access to vehicles. The drivers who took part in the study had valid driver's licence but never read vehicle's owner's manual. This finding agreed well with other studies that indicate that people who purchased their own vehicle even lack the ability to read their vehicle's owner's manual [15, 29, 30].

A scenario of question was created for participants "*Assuming you owned a 12-year-old vehicle,*

please describe in as much details as you can by listing all the types of problems that you envisage could occur with the vehicle's tyres". Participants enumerated 481 potential tyre problems as shown in Table 1. Majority (23.9%) of the respondents mentioned "flat & tyre blowout" as the main potential tyre problem. Small proportion of participants (7.5%) also identified "aging" as potential problem. This result is confirmed in another study which shows that only a small number (i.e. 9 out of 225 participants) recognised aged tyres as a possible cause of tyre failure [15]. Although very small percentage of participants mentioned tyre aging as a potential problem, majority of participants (77.5%) were aware that aging occurs in vehicle tyres.

Table 1: Frequency Analysis of Potential Tyre Problems

Response	Frequency	Percentage (%)
Flat & tyre blowout	115	23.9
Worn out thread	107	22.2
Misalignment & balancing problems	54	11.2
Damage valve & leakages	38	7.9
Aging (expired)	36	7.5
Puncture	35	7.3
Others (ball joint, noise, increased stopping distance etc.)	34	7.1
Cracking	18	3.7
Pressure & inflation problems	15	3.1
Bulging & deformation	13	2.7
Tyre detachment from rim	11	2.3
Over heating	5	1.0
Total	**481**	**100**

Source: Field Study

The study also indicated that 89% of the participants used spare tyres because of tyre blowouts, punctures and flat tyres. The tyre replacement was carried out by participant's themselves (58.6%), vulcanizers (27.6%) and service of someone (13.8%). In addition, the results indicated that regardless of gender of a vehicle driver or user there can be flat tyres which need replacement (i.e. both male and female drivers' experienced flat tyres). More commercial drivers (82 %) have ever experienced a flat tyre than private vehicle driver. This is not surprising since tyre failure is prone to commercial vehicles because of high and extensive patronage of services rendered by them.

The study also shows that 67.0% of the participants were aware of the recommended six years replacement of either used or unused tyre by automobile manufactures. However, they mentioned that they do not check the DOM on spare tyres to assess their suitability before replacement.

4.2 Tyre Markings

Tyre marking is a very important aspect of vehicle tyres. It contains all the essential information about the tyre. In this study, participants were asked some vital questions relating to tyre markings. Participants were instructed to assume **185 / 65 R 15 88T M+S** as being printed on actual tyres as shown in Figure 1.

Figure 1: Tyre Image Showing Tyre Markings

Participants were asked to interpret the meaning of the markings on the tyre. The result shows that out of the 1191 participants, only 20.9% explained **185** as the tyre sectional width which is the correct meaning, (27.7%) described **65** as aspect ratio or the sidewall height which is a perfect answer, only (16.8%) could correctly clarify **"R"** as radial ply construction with majority of participants (83.2%) describing **R** as rim which is not an appropriate interpretation. This implies that participants interchange R which is radial ply construction for rim.

In addition, majority of the participants (62.8%) correctly described **15** as rim size, (16.2%) defined **88** as load index, (4.2%) explained the **T** as speed rating and finally (8.4%) were able to explain **M+S** as mud and snow**.** It can be observed that most of the participants were only able to explain the rim size correctly. Furthermore, **T** which is the speed rating was the least identified among all the tyre marking characters. However, speed rating

stipulates the maximum speed at which a tyre is designed to carry its maximum load. It ranges from "A" as the lowest to "Z" the highest even though some tyres also carry extra specific ratings known as secondary ratings. This clearly shows that majority of drivers do not adhere to the maximum load for a tyre and also do not understanding tyre markings and their implications. Thus, the applicability of the information in tyre markings in relation to driving cannot be followed which is a potential hazard to road users.

Table 2: Tyre Markings Answered Correctly

Tyre Markings	Description	A*	Frequency of correct responses	Percentage (%) of correct responses
185	Sectional width	910	249	20.9
65	Aspect ratio	842	330	27.7
R	Radial ply construction	993	200	16.8
15	Rim size	898	748	62.8
88	Load index	480	193	16.2
T	Speed rating	368	50	4.2
M + S	Mud and Snow	355	100	8.4

A* = Column of participants who attempted the interpretation of the DOT tyre identification number (TIN) out of the 1191 participants.
Frequency and Percentage (%) of correct responses out of the 1191 participants

4.3 Text Format of Tyre's Date of Manufacture

The Date of Manufacture (DOM) of a tyre is an important information about the tyre. It indicates the date the tyre was manufactured at the factory. The current DOM comprised of the number of weeks (2-digits) and the year (2-digits) in which the tyre was made, yet there is no distinguishable characteristic signifying that it is the date [2]. The result from the study shows that majority of the participants (87.4%) were much informed about the DOM of vehicles tyres as any other product. About 60% of the participants stated that they always looked for where actually the DOM of tyres are printed but was not able to locate it.

To determine if participants could truly identify tyre's DOM and interpret it correctly, they were presented with six tyres' DOM markings or formats assumed to be on the sidewall of vehicle tyres and instructed to write the appropriate dates. Tyre pictures with these DOMs were shown on the questionnaire to give clearer and pictorial views to the participants. Accurate interpretation and answering for the DOM markings were scored for one point for a participant and no points for incorrect date. The scoring scheme was based on the present DOT's tyre DOM rule such as 1102 and 2205 where the first two characters refer to the number of weeks and last two being the year [2].

In addition, the date markings 12/05/07 and 03/06/09 used common U.S. date abbreviations: month/day/year. Date marking 12/05/07 indicates the 12th month (December) of 2007 or could be correctly translated to the 48th week in 2007. Marking 03/06/09 corresponds to the 3rd month (March) of 2009 or translates to the 9th week of 2009.

The result from the study as shown in Table 3 indicated that maximum precision of 38.7% (for 03/06/09) and 39.9% (for 12/05/07) were obtained for month/year format. With the exception of 03/01 date marking that had 20.4% accuracy; the remaining markings (i.e. 2205, 41/07, and 1102) had no accuracy (0%). Participants were able to explain 03/01 as March, 2001 but could not do the same for 41/07 since we have only 12 months. It was observed that for the week and year marking format, 3.7%, 18.8%, 15.2% and 16.8% of participants had the dates markings for 03/01, 2205, 41/07 and 1102 respectively accurate.

Table 3: Frequencies of Accurate Responses of Date Format and Date Markings

	FORMAT					
	Month/year			Week/year		
Date marking	**A***	**Freq.**	**Prop (%)**	**A***	**Freq.**	**Prop (%)**
03/01	596	246	21.0	62	44	3.7
12/05/07	689	469	40.0	87	0	0.00
2205	218	0	0.00	368	224	18.8
41/07	200	0	0.00	619	180	15.1
03/06/09	642	466	39.0	87	0	0.00
1102	280	0	0.00	299	200	16.8

A* = Column of participants who attempted the interpretation of the DOM of tyres out of the 1191 participants.
Frequency and Percentage (%) of correct responses over the 1191 participants

It can be seen that most participants were not able to interpret date markings in week and year format more accurately compared to the month and year format. Specifically, tyres DOM designated in day/month/year format had the highest accurate interpretation. This could be attributed to the fact that the common international date of abbreviation used in Ghana is in this format. Hence based on their previous experiences with other products DOM markings, they could easily identify these formats.

In addition to the decoding of the tyres' DOMs, participants rated how easily it was in identifying the dates associated with each DOM. The result indicated in Table 4 (i.e. means and standard deviations arranged in order from highest rated to lowest rated) shows that 03/06/09 date marking format was easily identified (mean = 5.40) out of the six date format markings presented. This was followed by 12/05/07 format which looks similar to the first one. However, this 41/07 format was perceived to be difficult (mean = 3.40) in identification because it was designated in week/year which participants were not conversant with.

Table 4: Mean Ratings for Perceive Ease of Identifying DOM

Date Marking	A*	Mean	Std. Dev.
03/06/09	811	5.400	1.833
12/05/07	817	5.120	2.008
1102	804	3.783	2.194
03/01	798	3.680	1.923
2205	804	3.535	2.165
41/07	760	3.402	1.879

A* = Column of participants who attempted rating the easiness of identifying DOM of tyres out of the 1191 participants.
1 = Not extremely easy, 2 = not very easy, 3= not easy, 4 = neutral, 5= easy, 6 =very Easy, 7= extremely easy

4.4 Correlation Analysis

Correlation analysis was carried out to determine the strength and direction of the relationship between demographic characteristics of participants and the easy of determination of DOM from the tyre markings. A significant positive correlation between demographic characteristics and DOM formats indicates that drivers can easily decode the DOM from other tyre markings. From Table 5, the result shows that gender negatively correlated with 12/05/07 (i.e. day/month/year) DOM format marking ($r = -0.214$; $p<0.01$). This implies that gender has some level of influence on the easy of identification of DOM formats of tyre. The age of participants was not significantly related to any of DOM of tyre formats. However, significant negative correlation was observed between educational level of participants and these DOM format types 12/05/07 ($r = -0.198$; $p<0.01$) and 03/06/09 ($r = -0.218$; $p<0.01$) respectively. This result indicates that the educational level of participants could enhance vehicle tyre consumer's ability to decode DOM of tyre (i.e. day/month/year) format from other tyre markings.

The working experiences do not show any relationship between the formats of DOM on tyres. This explain the fact that the work experience of tyre consumers do not have any influence on decoding of DOM of tyre from other tyre marking. Similar trend was obtained for the marital status of participants in relation to their ability to decode DOM from other tyre markings.

Table 5: Correlation Analysis between Demographic Characteristics of Participants and DOM formats on Tyres

DOM format	Demographic Characteristics of Participants					
	Gender	Age	Education	Vehicle Category	Working Experience	Marital status
03/01	0.039	0.022	0.004	0.102	-0.094	0.098
12/05/07	-0.214*	0.138	-0.198*	-0.121	0.153	0.041
2205	0.024	-0.107	0.193*	0.190*	-0.172	-0.002
41/07	0.114	-0.008	0.156	0.262**	-0.053	0.092
03/06/09	-0.115	0.136	-0.218*	-0.159	0.138	0.035
1102	-0.035	-0.137	0.096	0.129	-0.023	-0.109

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

V. CONCLUSION

Tyre deterioration and aging awareness level among Ghanaian tyre consumers is very high. However, most participants had difficulty in decoding and interpreting information from the DOT tyre identification number, which are very important for tyre maintenance. Significant proportion of the participants (60%) was able to interpret rim sizes correctly. The current DOM formats are not consumer friendly since most of the participants were not able to determine the date of manufacturing accurately. The DOM in the month/year format was rated easily for identification and comprehensible to participants. Therefore, for quality decision making and information regarding tyres, tyre DOM should be provided in ways various consumers can easily identify and understand.

In addition, the Government of Ghana should formulate a policy that potential drivers must be tested on vehicle tyre information before acquiring driving license.

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