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Assessment of Awareness of Livestock-Vehicle Traffic Accidents in Dhofar Region, Oman

A. M. Abu Abdo
Associate Professor Department of Civil & Infrastructure Engineering American University of Ras Al Khaimah
PO Box 10021, Ras Al Khaimah, UAE, ahmed.abuabdo@aurak.ac.ae

A. A. Al-Ojaili
Research Assistant Department of Civil and Environmental Engineering, Dhofar University
PO Box 2509, Salalah, 211 Sultanate of Oman, a201200100@du.edu.om

Abstract
Due to the importance role of traffic regulations knowledge and awareness in the reduction of traffic accidents, especially livestock-vehicle accidents and their toll on the society, this study was initiated to assess the knowledge and awareness of road users and livestock owners in Dhofar region, Sultantate of Oman. To meet the objectives of this study, a questionnaire was designed, distributed, and collected. Data analysis showed that participants were knowledgeable of factors affecting livestock-vehicle accidents and their impact on Dhofari society. The majority of participants were involved in an accident with an animal crossing the road resulting in monetary damage and causing health problems. One of the most important findings of this study that there was a significant relationship between traffic accidents and road design. Even though it may be expensive and difficult to maintain, it is recommended to erect fences along all major highways in Dhofar region and construct pass ways for livestock to safely cross roads. Livestock owners should be held accountable for not monitoring and confinement of their livestock. Thus, the Municipality, livestock owners, and drivers are the key in eliminating livestock-vehicle accidents in Dhofar region.

Keywords: Traffic Awareness, Traffic Safety, Traffic Survey Traffic Accidents, Livestock Crossing, Dhofar Region, Oman.

Introduction

The Sultanate of Oman is located on southeastern coast of the Arabian Peninsula. Oman has an area of 309,501 km^2 and its population is about 3,632,000 [1]. Dhofar region is located in the south of Oman and has the largest area of the eleven Omani Governorates. Its area covers 99,300 km^2 and has a population of 250,000 as of the 2010. It is famous of its mountainous terrains, beaches, and desert and the highest numbers of livestock. TABLE 1 presents livestock numbers and percentages in Oman, Dhofar region has 60.0% Camels and 57.8% Cattle of the total livestock in all Oman [2]. Unfortunately and due to the vast area, the spread of grazing lands, and its mountainous terrains, the number of traffic accidents due to livestock crossing (Fig.1) is relatively high and mainly involves camels as shown in TABLE 2 [3].

TABLE.1. Number of Reported Livestock in Oman (After MoAF [2])

Governorate	Sheep		Camels		Cattle	
	%	Count	%	Count	%	Count
Muscat	3.9%	21423	0.2%	459	1.5%	5492
Dhofar	2.6%	14403	60.0%	145875	57.8%	207891
Musandam	2.3%	12818	0.0%	17	0.1%	333
Al-Buraimi	7.1%	38714	1.7%	4128	1.6%	5890
AL-Dakhiliya	10.0%	54967	4.2%	10118	5.0%	18063
Al-Batinah South	23.8%	130269	4.0%	9667	18.7%	67119
Al-Batinah North	8.9%	48956	3.6%	8762	6.4%	23113
Al-Sharqiyah South	13.3%	73101	7.2%	17463	2.6%	9260
Al-Sharqiyah North	12.9%	70870	8.9%	21577	2.3%	8431
Al-Dhahirah	11.2%	61518	2.5%	6006	3.9%	13914
Al-Wusta	3.9%	21192	7.9%	19251	0.0%	1
Total	**100%**	**548231**	**100%**	**243323**	**100%**	**359507**

Fig.1.a. Camels Crossing Salalah – Dalkout Road, Dhofar Region

Fig.1.b. Camels Crossing Salalah – Sahlnout Road, Dhofar Region

TABLE.2. Number of Reported Livestock in Oman (After MoAF [2])

Years	Number of Accidents	Human		Animals		Types of Animals			
		Fatality	Injury	Death	Injury	Camels	Cows	Goats	Others
2004	220	17	133	238	133	133	14	21	70
2005	231	21	135	262	150	150	11	18	83
2006	191	14	120	196	122	122	14	23	37
2007	210	19	128	233	138	138	8	27	60
2008	234	20	149	195	82	147	5	61	64
2009	420	10	108	189	52	116	3	72	50
2010	261	10	127	219	78	149	4	86	58
2011	220	18	150	228	43	113	4	86	68
2012	258	17	164	231	71	151	0	82	69
2013	234	15	115	205	70	121	3	85	66

TABLE 3 presents number of accidents due to livestock crossings in main areas of Dhofar region reported in 2013 [3]. It is clearly shown that Mirbat and Almagseel areas had the highest accidents numbers, it is speculated that it was due to large numbers of camel daily migrating from livestock barns located in the mountains to nearby grazing lands across the main highways connecting Salalah (main city) to these areas.

TABLE.3. Number of Accidents due to Livestock Crossings in Dhofar Region in 2013 (After ROP [3])

State/City	Number of Accidents
Taqah	98
Ittin	88
Almagseel	113
Thamrit	46
Mirbat	116

Furthermore and due to the rainy (monsoon) season during the summer in Dhofar region, owners relocate their livestock from the surrounding mountains, especially camels, to the outskirts of Salalah near the main highways. The main reason for such action is to avoid injuries and possible financial loss of their livestock due to unstable wet lands and slides.

With the large number of livestock and the increasing numbers of vehicle, especially during the monsoon season that attracts many tourists, who are not familiar with the region and the hazards of livestock crossing, more accidents are likely to occur. Thus, this study was initiated to evaluate the awareness of livestock owners and road users of factors affecting such accidents.

Scope

The main purpose of this study was to investigate factors of livestock-vehicles accidents in Dhofar Region in the Sultanate of Oman main roads and to assess drivers and livestock owners' awareness of these factors. Furthermore the study reviewed adopted practices to reduce these accidents and their applicability to Dhofar's roads.

Survey and Data Collection

A questionnaire was designed to collect data, it covered awareness of participants and their knowledge of livestock behavior near roads and drives reactions. Participants included livestock owners, road users, and Dhofar Municipality staff.

To determine the sufficient sample to be evaluated, statistical analysis was used and deployed to determine the sufficient number of distributed questionnaire to have significant meaning. TABLE 4 shows samples numbers and level of confidence, and since Dhofar region, which was being evaluated, had a population of about +100,000 and to achieve a confidence level of 95% and margin of error 5%, the minimum sample number should be 384 [4].

TABLE.4. Sample Numbers and Confidence Levels

Population	Margin of Error			Confidence Level		
	10%	5%	1%	90%	95%	99%
100	50	80	99	74	80	88
500	81	218	476	176	218	286
1000	88	278	906	215	278	400
10000	96	370	4900	264	370	623
100000	96	383	8763	270	383	660
+100000	97	384	9513	271	384	664

To achieve a minimum level of confidence of 95%. A 405 questionnaires were distributed and collected successfully. In the process of data analysis 5 questionnaires were excluded because of incomplete data.

Data Analysis

Results showed that most participant 29.3% agreed on the fact that over speed and the use of phone while driving (23.8%) were the main causes for traffic accidents, while 19.5% stated that the traffic accidents could be attributed to road problems. While, 12.5% agreed that presence of livestock on the roads might be the main cause. An about 14.8% agreed that it could be contributed to vehicles' problems (Fig.2).

Fig.3 presents participants' opinions on the percentages of road accidents according to the time of day. The majority (66.3%) believed that traffic accidents due to livestock crossing were more likely to happen at night due to lack of visibility. Only 10.9% of the participants said that accidents take place in the morning and 15.7% indicated that road accidents happen in the evening and 7.1% stated that accidents happen in the afternoon more than other times of the day.

Interestingly, collected data showed that there was a high percentage of participants (40.6%) who had an accidents involving animals crossing (Fig.4). Furthermore, Fig.5 presents participants' opinions on type of damages that may

result from this type of accidents. Monetary damage and health damage were the most types of damages stated by the participants; 37.8% and 33.9%, respectively. 14.2% indicated that accidents caused psychological damages. However, a similar percentage stated that they were affected by monetary, health, and psychological damages after their accidents.

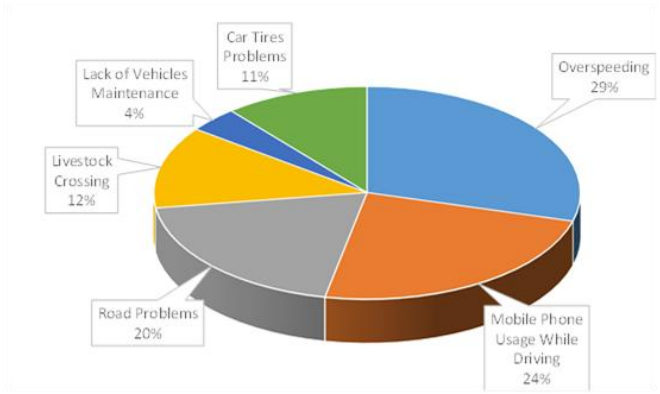

Fig.2. Participants' Opinions on Main Causes of Traffic Accidents

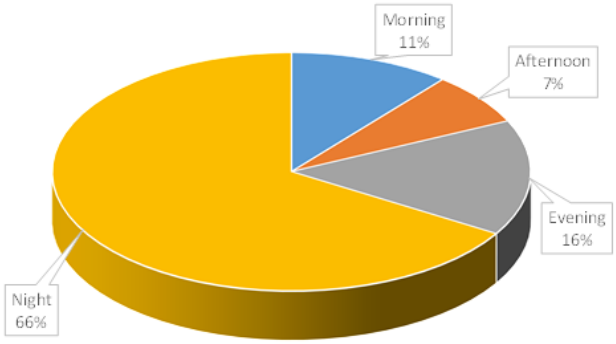

Fig.3. Participants' Opinions on Livestock-Vehicle Accidents According to the Time of Day

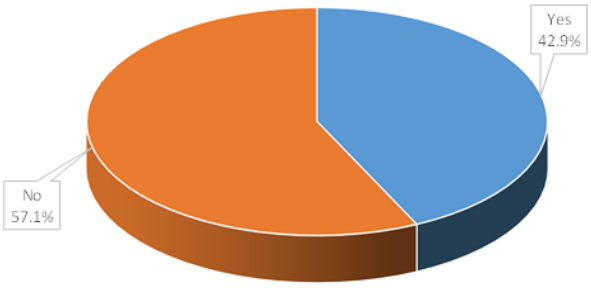

Fig.4. Participants' Involvement in Traffic Accidents with Livestock

Fig.6 presents the percentages of livestock-vehicle accidents on main roads connecting Dhofar region based on collected data. About 25% stated that Salalah - Taqah road, Taqah - Mirbat Street and Salalah - Thumrait roads were the most dangerous roads, where accidents basically happen due to the presence of livestock. However, accidents caused by animals on roads like Salalah - lttin and Salalah - Magseel roads were not very common; 17. 1% and 9.1%, respectively. It is believed that the main reason for that these roads are located on the paths of camels' daily trips to and from grazing lands.

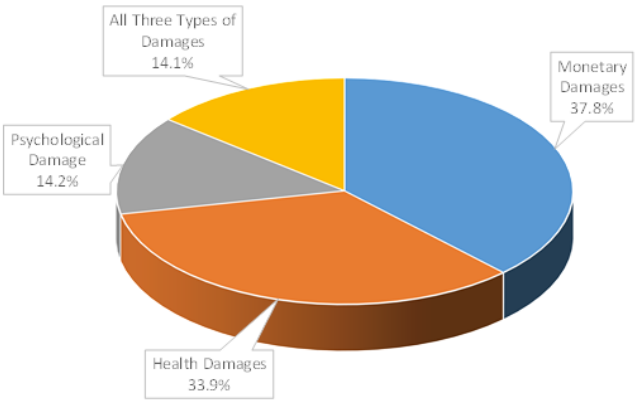

Fig.5. Type of Damages Due to Traffic Accidents with Livestock

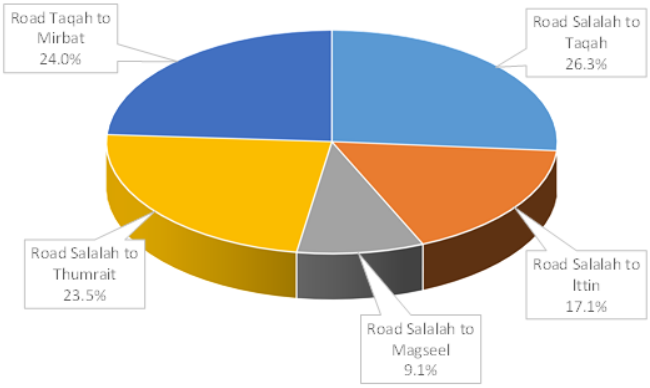

Fig.6. Participants' Feedback on Main Roads with Most Accidents due to Livestock Crossings

When asked about their opinion on the role of Dhofar Municipality in eliminating road accidents caused by livestock crossings. The majority (85.3%) indicated that the Municipality should have an important role and exert strong measures to reduce the number of this type of accidents. When questioned whether livestock owners had a role in eliminating these type of traffic accidents, 87.1% of participants agreed and only 12.9% had negative feedback and due to the fact the livestock owners are no longer liable for their stray livestock increases the chances of the occurrence of such accidents.

Countermeasures

The importance of protecting road users and animals in Oman from serious injuries and possible death due to road accidents cannot be overstated, thus finding preventive solutions are essential. Many studies [5-12] have conducted studies in search and evaluation of the most effective method to prevent animals crossing, they covered Fencing, Passage Structures Underpass and Overpass Structures, Warning Signs, Reflectors, Biological and Chemical Repellent, Animal Detection Systems that uses radio frequencies, infrared sensors or collars on animals to detect the presence of large animals on public roadways, Vehicle Detection, detect the presence of approaching vehicles and send a signal to remote units strategically placed further down the road that uses sound, light and/or scent to repel wildlife, Highway Lighting, Lower Speed Limits, Public Information and Education Programs.

In a study by Hedlund et al. [13], they evaluated the above methods and concluded that effective methods with solid scientific evidence is Fencing along the roads, combined with underpasses and overpasses as appropriate, is the only broadly accepted method that was theoretically sound and proven to be effective. Fencing is expensive to construct and maintain. They concluded that general education, passive signs, and lower speed limits appeared ineffective in influencing driver behavior and reducing animal-vehicle accidents.

In Saudi Arabia, camel crossing accidents are of a big concern [9,10], fencing of main highways and the construction of overpasses can be clearly seen on these highways. Unfortunately, these measures are only deployed on major highways due to economic reasons, leaving other roads unprotected. Ragab [9] presented a high-level design of a deployable and intelligent Camel-Vehicle Accident Avoidance System (CVAAS) that utilized global positioning system (GPS). CVAAS utilized programmable GPS device to detect camel position, direction and movement. Furthermore, CVAAS categorizes the dangerous zones that enable the warning system to adapt the alarming period. This method utilized satellite monitoring system, which may considered expensive, especially to livestock owners with low financial means and small herd.

Recently in Oman and in an effort to reduce livestock-vehicle accidents, the installation of phosphorous bands on the necks and bodies of camels (Fig.7) has been initiated [14]. In an effort to make camels visible in the dark, so that road users can spot them from a distance and can avoid a collision. As per surveyed livestock owners when asked about the effectiveness of the phosphorous bands, the majority (92.2%) expressed their concerns, since these bands might be effective in open spaces (northern regions of Oman), however in Dhofar region, where there are vegetation and trees, these bands could be easily removed due to brushing with vegetation and anchoring wires of utility poles, which camels utilize as a rubbing medium.

As per collected data, Fig.8 illustrates participants' feedback on the effectiveness of applied methods, which could be implemented by Dhofar Municipality to reduce traffic accidents involving livestock crossings. Preventing animals from entering the road was ranked number one with 27.9% of participants. While construction livestock passages and roadblocks and were suggested by 18.5% and 16.3% of participants, respectively. Other activities like roadway lighting, financial support to livestock owners, material support to the owners and installing warning signs were each stated by less than 13%. Livestock owners commented that if the municipality provided material support such as protected grazing lands and/or animal feed would reduce the number of livestock crossing and straying.

Fig.7. Camels with Phosphorous Bands (After Almnatiq [14])

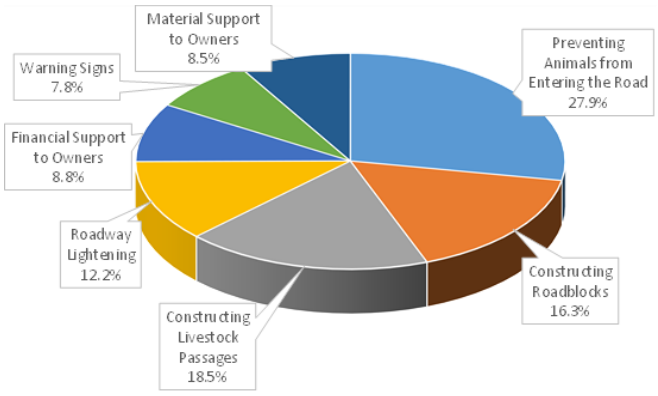

Fig.8. Participants' Feedback on Effectiveness of Applied Methods to Reduce Accidents

Conclusions and Recommendations

Dhofar region, which is located in the south of Sultanate of Oman, is well known for its vast area and various terrain. The number of livestock is the highest when compared to other regions in Oman. Recently, attention was directed toward the increase in traffic accidents, especially livestock-vehicle accidents. In light of this, this study was conducted to

investigate the awareness of livestock owners and road users of factors causing these accidents.

As per the collected data, it was found that most of traffic accidents in Dhofar region occur mostly at night and mainly involve livestock crossings. Salalah-Taqah, Salalah-Thumrait and Taqah-Mirbat roads were reported as the highest potential locations for livestock-vehicle accidents. It is believed that this is due to the daily migration of camels from-to grazing lands alongside these roads.

Surprisingly, data showed that 40.6% of participants had an accidents where animals were involved resulting in monetary damages and causing health problems with percentages of 37.8% and 33.9%, respectively.

The role of Dhofar Municipality in eliminating livestock-vehicle accidents was emphasized by the majority of participants (85.3%). However, 87.1% of participants agreed that livestock owners had a role in eliminating these type of traffic accidents as well, and only 12.9% did not agree. One of the most important findings of this study that there was a significant relationship between traffic accidents and road design.

Based on the finding and even though it may be expensive and difficult to maintain, it is recommended to erect fences along all major highways in Dhofar region and construct pass ways for livestock to safely cross roads. Livestock owners should be held liable for not monitoring and confinement of their livestock. Thus, the Municipality, livestock owners, and drivers could play a very important role in eliminating livestock-vehicle accidents in Dhofar region.

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