Mobile GIS based Traffic Count using AR-Traffic Count.

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Abstract
Traffic count plays a fundamental role in the planning of roads and management schemes, which rely heavily on existing traffic data such as average daily traffic, traffic flow patterns and economic traffic forecasting, to inform planning decisions. Most developing countries use the inefficient manual paper-based counting method which involves a tedious process of manually collecting and then entering of the data into a database or spreadsheet. It was therefore noted that improvements needed to be made to the current process and an efficient, cost-effective, user-friendly alternative to manual paper-based collection should be developed.
AR-Traffic Count, a mobile application, was developed to offer a solution to the inefficient, time-consuming, and error-prone manual paper-based method of Traffic Data Collection, recognizing the potential for traffic data to be collected in person and recorded directly into a mobile device as a classified vehicle count at the press of a button, with automatically georeferenced data (using GPS) and easily sharable and exportable to excel. It has been estimated that the use of AR-Traffic Count saved over 2hrs in total time compared to the use of the previous paper-based method for the Kiungani project road.
Keywords: Traffic Data, AR-Traffic Count, Data Collection, Mobile Application, Planning.

1.0 Introduction

Traffic data is required for the purposes of road network maintenance planning, which should be undertaken on an annual basis, with major roles in estimating traffic patterns and future traffic growth for road agencies and authorities.

Traffic Surveys are completed for different purposes, from determining vehicle speeds to traffic flow in categorized vehicle classes, to determining the current volume and type of traffic travelling on the road (ORN 40).

Traffic Count has the following advantages which are:

- Developing base year traffic data which includes ADT (Average Daily Traffic) and AADT (Annual Average Daily Traffic)
- Determining Traffic Movement patterns in different modes of transport, which can also include provide traffic diversion from existing routes with an advantage of reduced transport costs.
- Planning, prioritization and project initiation.
- To check efficiency of the road network by comparing current traffic volume with the level of service or the calculated traffic capacity.
- Traffic forecasting models with subsequent traffic projection on road sections.

To facilitate the assessment of present and future traffic demands, for the development of need-based infrastructure, accurate information, and continuous monitoring of traffic, using an appropriate method is necessary.

Implementing authorities must ensure that adequate and appropriate data is available in order to undertake necessary planning, design, construction and maintenance of the country's road network, which is aimed at meeting the significant traffic flow, future traffic growth and loading without considerable deterioration in the quality of service.

Mobile GPS based Apps have been acting as new discipline and as an intersection between science and technology for the past decade. As we can observe, technology has now moved to the palms of our hands, from the taxi service mobile applications such as Uber to food ordering mobile applications, this all suggests that it is high time to look at the options of integrating mobile apps for conducting Traffic Counts. The introduction of mobile based app like AR-Traffic Count aims to analyse the current road traffic data collection methods.

Types of Traffic Count

Briefly we will have a look at the types of traffic count which are available:

Manual Counts

Manual Counts are normally carried out by observers situated at a count point at the side of the road, while the most usual type of manual count survey is the classified count using a piece of paper.

Automatic Counts

These counts can record traffic data for 24 hrs a day, 365 days a year, in two-way traffic flow, which normally provides a higher accuracy compared to the Manual counts, such as pneumatic tubes and buried loop counting.

Pneumatic Tube systems

The counter measures two-way traffic flow as vehicle passes in which compressed tube releases pulse of air to make a vehicle count.

Buried Loop Systems

This involves an insulated wire loop buried below surface of the road, which when the vehicle passes over the loop, the metal of the vehicle causes the inductances of the loop to be sensed by the counter.

2.0 Methodology

How AR-Traffic Count Works.

This is a semi-automated mobile proprietary app which revolutionizes the paper-based traffic count to a Mobile based GPS with customized export to excel template. The app allows traffic data to be collected in person, but it is recorded directly onto a mobile device rather than on paper, thereby negating the need for the data to be typed up, or the location to be identified, since it can be automatically georeferenced, with the ability to export traffic data directly into Excel or other applications, including email, or social media platforms.

This App was developed by both Eng. *Arnold M Kilaini (from Tanzania)* and *Eng. Ram Gopal Kachhepati (from Nepal)*. The rights and source code are maintained by the developers.

AR-Traffic Count System Architecture

AR-Traffic count has been programmed using Java programming language under the umbrella of the android programming interface as shown in the figure below.

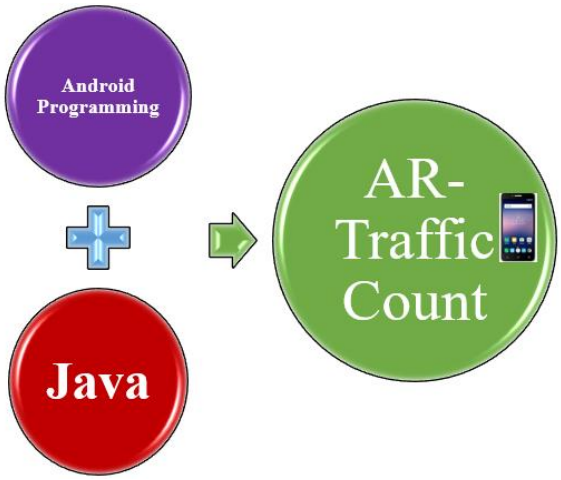
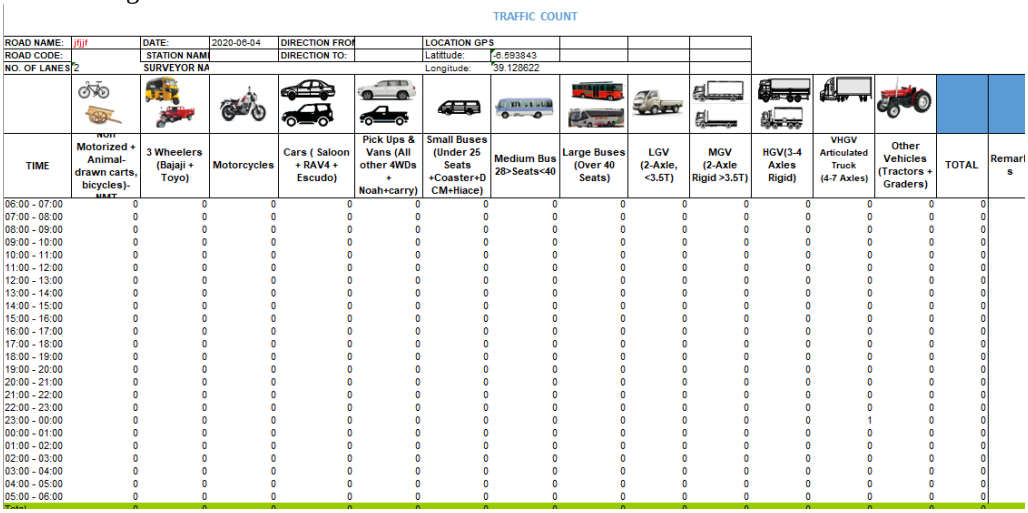


Figure 1:AR-Traffic count system Architecture

Vehicle Classifications

The application has customized general purpose standard general format which covers almost all vehicle categories as shown in the figure.



TRAFFIC COUNT

ROAD NAME:	jfjf	DATE:	2020-06-04	DIRECTION FROM		LOCATION GPS									
ROAD CODE:		STATION NAME		DIRECTION TO:		Latitude:	-6.593843								
NO. OF LANES	2	SURVEYOR NA				Longitude:	39.128622								

TIME	Motorized + Animal-drawn carts, bicycles)-	3 Wheelers (Bajaji + Toyo)	Motorcycles	Cars (Saloon + RAV4 + Escudo)	Pick Ups & Vans (All other 4WDs + Noah+carry)	Small Buses (Under 25 Seats +Coaster+DCM+Hiace)	Medium Bus 28>Seats<40	Large Buses (Over 40 Seats)	LGV (2-Axle, <3.5T)	MGV (2-Axle Rigid >3.5T)	HGV(3-4 Axles Rigid)	VHGV Articulated Truck (4-7 Axles)	Other Vehicles (Tractors + Graders)	TOTAL	Remarks
06:00 - 07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
07:00 - 08:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
08:00 - 09:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
09:00 - 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10:00 - 11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11:00 - 12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12:00 - 13:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13:00 - 14:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14:00 - 15:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15:00 - 16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
16:00 - 17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
17:00 - 18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
18:00 - 19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
19:00 - 20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
20:00 - 21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
21:00 - 22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
22:00 - 23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
23:00 - 00:00	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
00:00 - 01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
01:00 - 02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
02:00 - 03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
03:00 - 04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
04:00 - 05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
05:00 - 06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Figure 2: Vehicle Classification (Source: produced by the Author)

How AR-Traffic Count Works

This mobile traffic count application works by utilizing GPS allowing for a traffic count to be undertaken at a road section.

Main Menu

The Main Menu page gives you options to select “Road Info” (Road Information), “Traffic Count” process and “Reporting”.

Figure 3: Showing Main Menu

Road Traffic Information

The Road Traffic Information (Road Info on Main Menu) asks you to provide road information such as road name, road code, number of lanes, and weather. The GPS position is automatically filled in based on your current location.

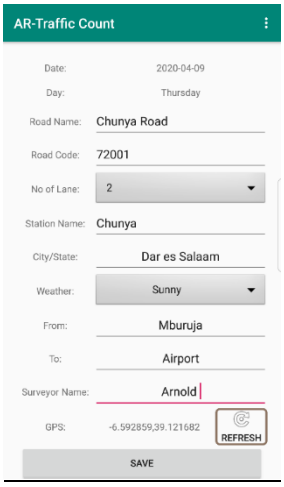


Figure 4: Showing Road Info attribute.

Traffic Count

The next step is to select "Traffic Count" from the Main Menu, and this is where the actual Traffic count is completed, after filling in the Road info. The below figure shows the Traffic Count Interface.

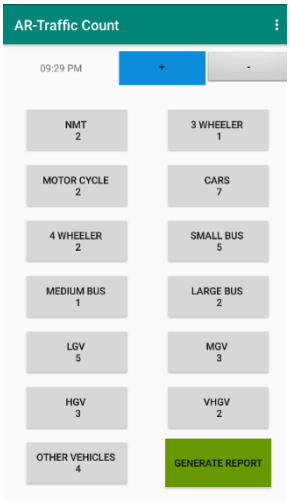


Figure 5: Showing Traffic Count Form

There are 13 Vehicle Categories in the AR-Traffic Count Application which can be selected during the Traffic Count exercise and should be selected after clicking the Plus or Minus Sign.

N.B

The Positive and Negative buttons shown above are for addition or omission of vehicle count during data collection. After finishing the Count, you can click the "Generate Report" button for Excel Report Generation.

Report Generation

This option is where the reports are generated and are ready to be shared either via email, WhatsApp or Bluetooth.

The figure below shows an example of Reports saved from the AR-Traffic Count App.

Figure 6: Showing Reports saved

Testing of the AR-Traffic Count App

The Government of the Republic of Kenya (GoK) intends to upgrade the Kiungani Road to bitumen standard. A preliminary traffic count was intended to be undertaken to understand the traffic flow and patterns of the project road. The Design Team of the project road was appointed by the Director (Urban Roads Planning & Design). The Design team was mandated to carry out detailed topographical survey, detailed geometric design and pavement design.
The design team constituted of the following:

Design Engineers Team

1. Eng. Doreen K. Kirima - Team Leader
2. Eng. Abdiaziz Abdullahi - Senior Engineer
3. Victoria Gakii - Engineer

Survey Team

1. Patrick Gitile - Surveyor

Kiungani Road is located within Syokimau area in Machakos County which is a heavily built up settlement with most roads in Earth or Gravel conditions. The project road measures approximately 4.0 km in total and the road reserve is of 8 – 11 m approximately. There is minimal encroachment along the road.
Upgrading of the above-mentioned road will improve access to important institutions in the area such as the Notre Dame School, as well as residential and other commercial properties and spur business opportunities and development of area.
The road location map is attached:

Figure 7: road location map (Source: developed by the Author)

Traffic Count data collection was done for Kiungani Road with both Paper based and Mobile GIS based application at a count station of location latitude -1.371808 and longitude 36.920448 recorded by the application.

Traffic count was done for 2 days whereby the first day on 6th November 2020, the count was done from 6pm to 9pm and the other count was on 7th November 2020 from 6am to 9pm.

Figure 8: showing observers doing both paper based, and Mobile GIS based AR-Traffic Count app.

3.0 Results

AR-Traffic Count has been used to collect Traffic Count Data for Kiungani Road and has enormously saved Time as the app generates report in excel per click of the button.

TRAFFIC COUNT

ROAD NAME:	Kiungani	DATE:	2020-11-07	DIRECTION FROM	6.00am	LOCATION GPS									
ROAD CODE:	01	STATION NAME	Stn 1	DIRECTION TO:	9.00	Latitude:	-1.371808								
NO. OF LANES:	2	SURVEYOR N	Claire			Longitude:	36.920448								
TIME	Non Motorized + Animal-drawn carts, bicycles)-	3 Wheelers (Bajaji + Toyo)	Motorcycles	Cars (Saloon + RAV4 + Escudo)	Pick Ups & Vans (All other 4WDs + Noah+carry)	Small Buses (Under 25 Seats +Coaster+DCM+Hiace)	Medium Bus 26>Seats<40	Large Buses (Over 40 Seats)	LGV (2-Axle, <3.5T)	MGV (2-Axle Rigid >3.5T)	HGV(3-4 Axles Rigid)	VHGV Articulated Truck (4-7 Axles)	Other Vehicles (Tractors + Graders)	TOTAL	Remarks
06:00 - 07:00	0	0	31	10	7	0	0	0	0	2	2	2	0	54	
07:00 - 08:00	0	1	82	33	20	0	0	0	5	8	4	4	0	157	
08:00 - 09:00	0	1	90	42	24	0	0	0	1	9	6	13	0	186	
09:00 - 10:00	0	1	102	39	26	0	0	0	1	10	8	2	1	190	
10:00 - 11:00	0	1	75	46	43	0	0	0	4	11	16	7	0	203	
11:00 - 12:00	0	1	70	58	27	0	0	0	5	15	10	7	0	193	
12:00 - 13:00	0	2	58	52	42	1	0	0	6	10	10	12	0	193	
13:00 - 14:00	0	0	43	44	40	0	0	0	1	2	5	12	0	147	
14:00 - 15:00	0	0	58	39	32	0	0	0	4	4	7	10	0	154	
15:00 - 16:00	0	1	74	67	47	0	0	0	0	5	4	13	0	211	
16:00 - 17:00	0	1	42	43	15	0	0	0	0	2	3	9	0	115	
17:00 - 18:00	0	0	55	42	38	1	0	0	2	3	0	3	2	146	
18:00 - 19:00	0	1	63	35	26	0	0	0	2	1	1	3	0	132	
19:00 - 20:00	0	0	0	0	0	0	0	0	0	0	0	1	0	1	
20:00 - 21:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
21:00 - 22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
22:00 - 23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
23:00 - 00:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
00:00 - 01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
01:00 - 02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
02:00 - 03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
03:00 - 04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
04:00 - 05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
05:00 - 06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Not Surveyed
Total	0	10	843	550	387	2	0	0	31	82	76	98	3	2082	

Figure 9: showing excel report generated for Kiungani road

AR-Traffic Count saves time in comparison with the paper-based method which requires tallying and entering data into excel. It also allows for synchronization of data between field and office and there is room to add more Traffic count data options such as peak hour traffic count in the application. Paper based Traffic count needs data to be punched and tallied in excel, which for our case there were more than 2 hours lost during the entire process of entering data in to excel.

AR-Traffic Count is a cost-effective proprietary mobile application which can work in offline mode, with internet connection required only during the sharing of the report.

The following shows the cutting-edge merits over the paper-based method

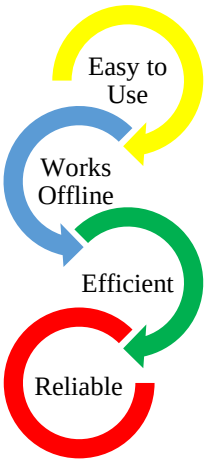


Figure 10: Advantages of AR-Traffic Count (Source: produced by the Author)

3.1 Analysis of Traffic Data collected by AR-Traffic Count

Traffic Data is reliable as the exported data in excel can be easily analysed. For example, data was collected for 3 hours, between 6pm to 9pm for Kiungani road on 6th November 2020 and during this time 143 motorcycles were counted, accounting for 47% of all vehicle categories, while Medium buses had the least number of vehicles accounting for 0.3% of all vehicle categories.

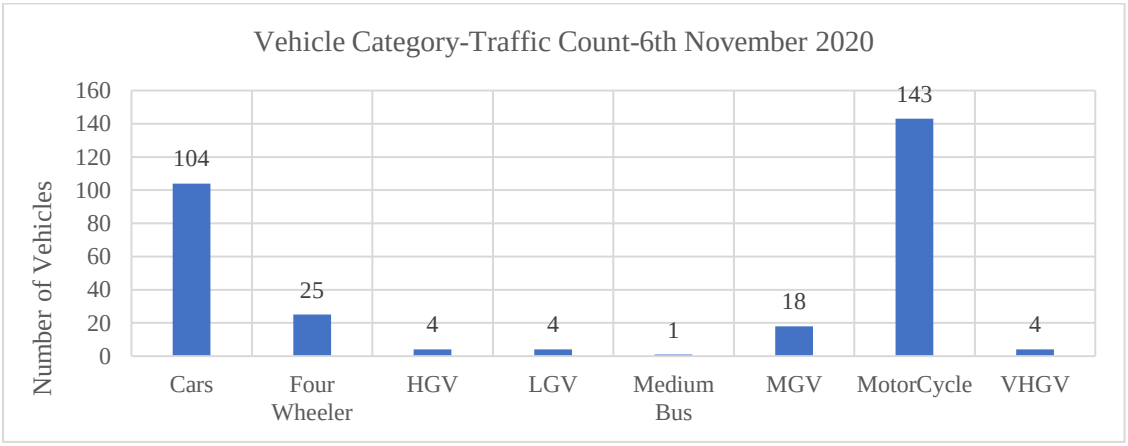


Figure 11: A graph showing Vehicle categories of Kiungani road on 6th November 2020.

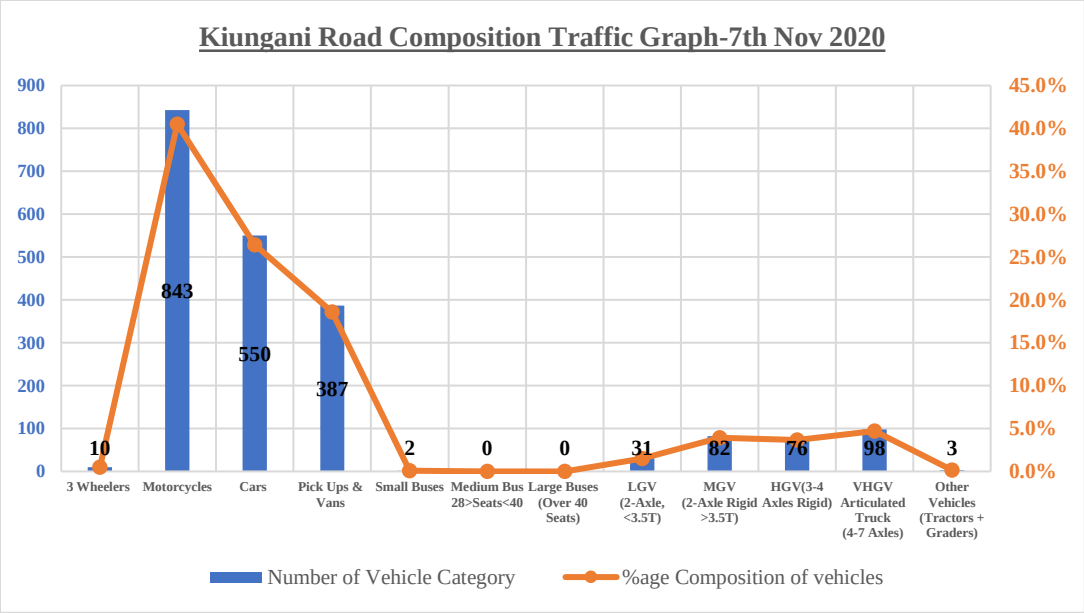


Figure 12: A graph showing Vehicle categories and road composition of Kiungani road on 7th November 2020.

Traffic Data for Kiungani road was collected on 7th November 2020 between 6am and 9pm. During this period 843 motorcycles were counted, making up 40.5% of all vehicle categories, with Heavy Good Vehicles contributing to less than 5% and Large and Medium buses accounting for 0%. This therefore demonstrates the road has few Very Heavy Good Vehicles, which could be an effect of axle loading for the road.

4.0 Discussions

As with all mobile apps, their continuous use can result in the draining of the phone battery upon using GPS position services and Traffic count button clicks, therefore the phone battery needs to be sufficient during data collection, and portable charging facilities made available.

As Traffic count data is collected using mobile app, customized pdf encrypted report formats can be generated depending on the user specifications with additional Peak hour-15 mins traffic generation to be programmed from the application to acquire such information.

5.0 Conclusions

Traffic Data Collection plays a fundamental role in planning of road development and management schemes and can also enhance benefits to the society by comparing traffic volume and the number of accidents of the road sections.

As we are implementing the Third Mid Term Plan (MTP III) of Vision 2030, aiming to transform Kenya into a newly industrializing, Middle-Income Country by 2030, it is high time we adopt new mobile smart technologies for Traffic data collection such as AR-Traffic Count in a clean and secure environment with a focus for Traffic Management Planning.

Acknowledgement

Completion of this paper would not have been possible without the support of Eng. Doreen Kirima Kago of KURA (Kenya Urban Roads Authority), who provided me the opportunity, ushered and helped me in to the basics of Traffic management plan for the Mobile Based AR-Traffic Count Application. I would also like to express my thanks to Ellen Rogan of Cardno IT Transport for reviewing the paper and other anonymous reviewers who pointed out key issues for clarification.

References

1. Rolt, J et al, Overseas road note 40, A guide to axle load surveys and traffic counts for determining traffic loading on pavements, TRL Limited, United Kingdom (1 999)