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Behavioral dynamics of pedestrian's movements: Theoretical aspects of commercial arterial road frontage activities

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Abstract

The common scientific approaches to the reasoning of problems are mathematical reasoning or statistical reasoning. Mathematical or formal reasoning is usually deductive, therein one reason from general assumptions to specifics using symbolic logic and axioms for multi criteria decision-making. Mathematical probability, which is the basis of all statistical theories, had its beginning in the past. The aim of this paper is to explore a number of the mathematical and statistical aspects of the disposition and behavior of road frontage activities, which are of importance in pedestrian behavior as considered. It's shown that number of crossings from right to left is proportional to the pedestrian on the right ($PXRL \propto NR$) and therefore, the number of crossings left to right is proportional to the pedestrians on the left ($PXLR \propto NL$). Frequency distributions of the pedestrians generated for a given shopping string arterial were of 4 kinds, one related to pedestrians passing through not crossing the road, not going into and out of outlets. The second kind related to pedestrians crossing the road for the aim of going into and out of outlets, etc. the third kind related to pedestrian going into shops and eventually, the fourth kind related to others, e.g. Pedestrians generated from parking vehicles, buses, etc. A formula is given for the frequency with crossing from left to right and right to left based on the land-use activities on the left and right. In considering the capacity of road systems it should be remembered that increases in traffic flow generally produce corresponding decreases in speed. However, it's an assumption that a rise in population generated along the footpath can cause the crossing the road, and usually produce corresponding decreases in vehicle speed. The paper concludes with a constatation of the pedestrian movements at a continuing rate that expressed in mathematical form.

Keywords: Roads; Traffic; Theoretical; Pedestrian movements; Behavior; Road frontage

1. Introduction

The common scientific approaches to the reasoning of problems are mathematical reasoning or statistical reasoning. Mathematical or formal reasoning is usually deductive, therein one reason from general assumptions to specifics using symbolic logic and axioms for multi-criteria decision-making. Mathematical probability, which is that the basis of all statistical theory, had its beginning in past. The aim of this paper is to explore a number of the mathematical and statistical aspects of the disposition and behavior of road frontage activities, which are of importance in pedestrian behavior as considered. it's shown that number of crossings from right to left is proportional to the pedestrian on the right ($PXRL \propto NR$) and therefore the number of crossings left to right is proportional to the pedestrians on the left ($PXLR \propto NL$).

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Since the rapid development of urbanization and industrialization, the increasing use of automobiles, bicycles, on urban road systems, also as other relevant problems, have made the road systems most of the developed and underdeveloped countries more crowded [1]. Within the Third World and fewer developed countries there are sections of the road, subjected to heavy traffic flow, aligned by poor building stock, containing mixed land-use, barren of landscaping, with discordant power poles and street structures. [2] reported that the broad nature of the road and therefore the road environment within the Third World countries are seen as: * Points of traffic jam where the road has insufficient capacity to deal with existing traffic volumes. * Pedestrian movements -- there's no provision for zebra crossings, no island or refuge, no sidewalk along the road. * Unpleasant living, shopping, and dealing environments thanks to noise and pollution. * Inadequate provision for off-street parking and loading facilities, largely caused by historical circumstances and lack of foresight and investment within the facilities. * Use of public streets for casual activities related to adjoining properties. * Placement of informal activities on the carriageway. * Parking of cars along the road obstructing pedestrians and resulting in a visually unpleasant environment, danger, and lack of visibility. * Reduced amenity of adjoining residential development in side streets thanks to on street parking and traffic movements. * Traffic conflicts/accidents and hazards created by having retail/commercial/industrial development ashore fronting commercial roads and requiring vehicle access thereto. Furthermore, most roads have movement and access functions. Conflicts arise where roads with heavy traffic penetrate areas intended to be precincts; this is often described within the paper because the problem of roads in environments. Conflicts also arise where traffic routes have active frontage activities: this is often seen because the problem of roads as environments. Notwithstanding, some researchers explained that when the footpath becomes crowded, people are more likely to steer within the carriageway [3][4][5]. Risk decreases with increase in density [6]; [7]. Another researcher explained pedestrian interference with traffic when leaving a cinema [8].

2. Conceptual Theory of Arterial Road Frontage Activities

The theory developed in this paper as follows:

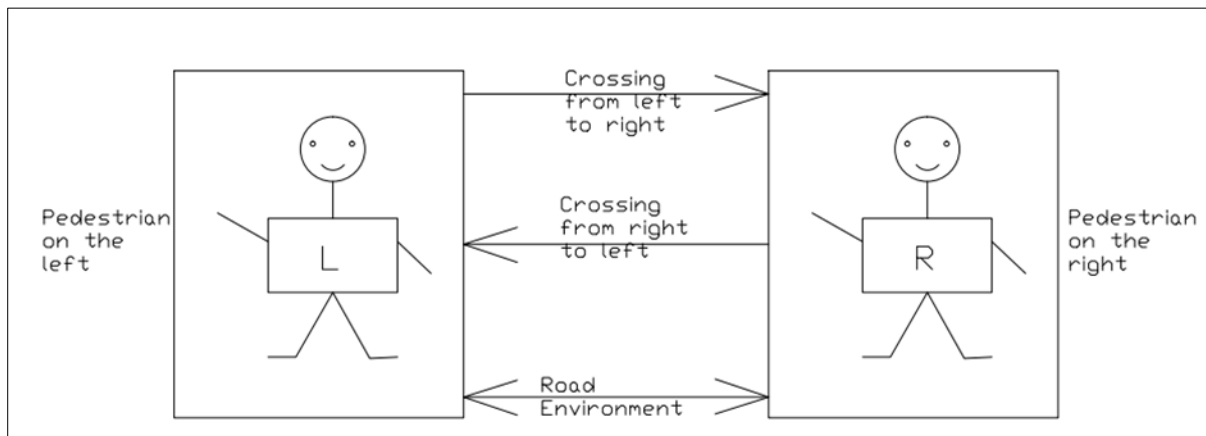


Figure 1a A mode of containing three objects, and two binary relations on road space (Ped_s from left to right)

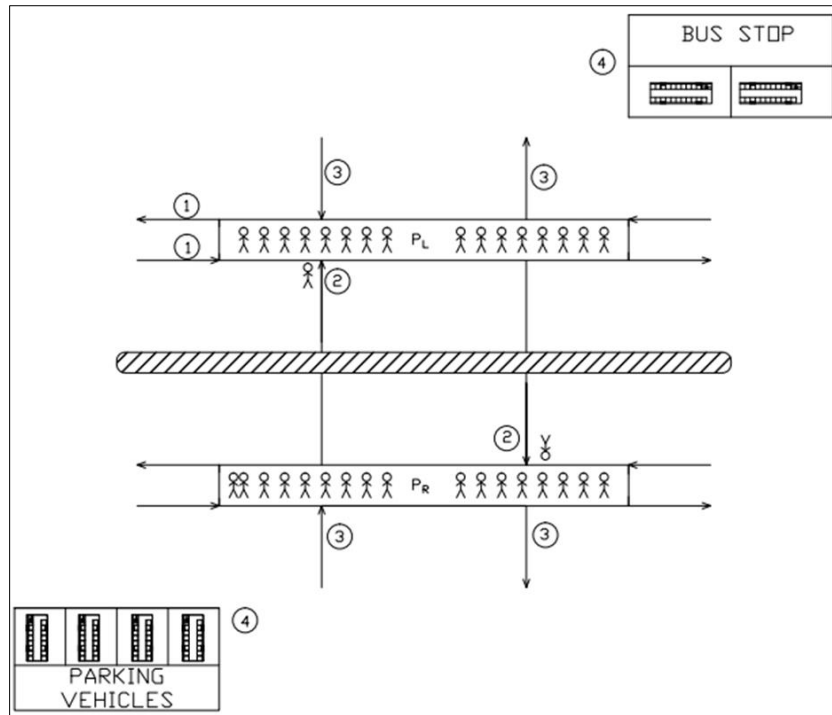


Figure 1b Conceptual Framework of Birth and Death of Roads and Road Environment Research

3. Analysis of Framework

HL Westerman [5] reported that most roads have movement and access functions. Conflicts arise where roads with heavy traffic penetrate into areas intended to be precincts; this is described in the paper as the problem of roads in environments. Conflicts also arise where traffic routes have active frontage development: this is seen as the problem of roads as environments.

For each of the PL and PR there are several inputs and outputs. e.g.

- EW, WE: Pedestrian passing through, not crossing road and not going into and out of shops
- NS, SN: Pedestrian crossing road
- NS, SN: Pedestrians going into and out of shops etc.
- EW, WE pedestrian going into shops
- Others: Pedestrians generated from parking vehicles, buses etc.

By looking at set-down and pick up (#4 and #5), probably time-dependent ie. Peak/non-peak

By looking at in/out for shops, etc office-like Bank, Educational offices and probably time-dependent – again peak/non-peak shops probably have a very small net influence on (#3).

The flows in the EW and WE direction may depend on things like location of bus stops and market area during market day. These may be a small tidal effect on (#1) crossing and through pedestrian.

Assumption – A basic assumption of the above problem is that pedestrian movements at constant rate and can be expressed in mathematical form.

$$P_L(t + \delta t) = P_L(t) + P_{XRL}(\delta t) - P_{XLR}(\delta t)$$

$$N_L(t + \delta t) = N_L(t) + \lambda_{RL}\delta t N_R(t) - \lambda_{LR}\delta t N_L(t) \dots \dots \dots (1)$$

$$N_R(t + \delta t) = N_R(t) + \lambda_{LR}\delta t N_L(t) - \lambda_{RL}\delta t N_R(t) \dots \dots \dots (2)$$

$$N^1_L(t) = \lambda_{RL}N_R(t) - \lambda_{LR}N_L(t)$$

$$N^1_R(t) = \lambda_{LR}N_L(t) - \lambda_{RL}N_R(t)$$

Adding complies $N_L(t) + N_R(t) = N$

$$N''_L(t) = \lambda_{RL}N'_R(t) - \lambda_{LR}N'_L(t) = \lambda_{RL}$$

$$N'_L(t) = \lambda_{RL}(N - N_L(t)) - \lambda_{LR}N_L(t)$$

$$= N\lambda_{RL} - (\lambda_{RL} + \lambda_{LR})N_L(t)$$

$$N'_L(t) + \lambda N_L(t) = 0$$

$$A + Be^{-(\lambda_{RL} + \lambda_{LR})t} = A + Be^{-\lambda t}$$

$$-\lambda Be^{-\lambda t} = N\lambda_{RL} - \lambda(A + Be^{-\lambda t})$$

$$A = \frac{\lambda_{RL}}{\lambda_{RL} + \lambda_{LR}}$$

$$N_L(t) = N \frac{\lambda_{RL}}{\lambda_{RL} + \lambda_{LR}} + B e^{-(\lambda_{RL} + \lambda_{LR})t}$$

$$N_L(0) = N \frac{\lambda_{RL}}{\lambda_{RL} + \lambda_{LR}} + B$$

$$\therefore B = N_L(0) - N \frac{\lambda_{RL}}{\lambda_{RL} + \lambda_{LR}}$$

$$N_L(t) = N \frac{\lambda_{RL}}{\lambda_{RL} + \lambda_{LR}} + \left(N_L(0) - N \frac{\lambda_{RL}}{\lambda_{RL} + \lambda_{LR}} \right) e^{-(\lambda_{RL} + \lambda_{LR})t}$$

The point is $N_L(t) = A + Be^{-\lambda t}$ have assumed number of crossing right to left is proportional to pedestrian on the right.

$$P_{XLR} \propto N_R$$

Number of crossing left to right is proportional to pedestrian on the left

$$P_{XLR} \propto N_L$$

$$\therefore \text{Number crossing LR} = C(A + B e^{-\lambda t})$$

$$= (A^I + B^I e^{-\lambda t})$$

$$\text{Number crossing RL} = (A^{II} + B^{II} e^{-\lambda t})$$

$$\text{Number crossing total} = (\bar{A} + \bar{B} e^{-\lambda t})$$

4. Conclusion

In conclusion, the above analysis applies to steady state only. However, the of conflict observations is to determine the critical situations in traffic. This means that one seeks to obtain an insight into the probability of an accident as well as

the seriousness of it. The question is how great the risk is and which elements are the most relevant from the above conceptual framework. Thus, there is a need for minimum vehicular and pedestrian volume warrants for the installation of pedestrian movement and crossings among commercial Arteria roads.

Compliance with ethical standards

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