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Spontaneous order of pedestrian and vehicle intersection conflicts in the Indian context

Nicholas N. Ferenchak *, Wesley E. Marshall

University of Colorado Denver, Civil Engineering Department, 1200 Larimer Street, Denver, CO, USA

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ABSTRACT

While transportation systems have traditionally been designed to isolate different modes of travel, another developing school of thought advocates removing space demarcations, abolishing rules, and encouraging interactions between different modes. As rules are lifted, road users must become more aware of the actions of those around them. In turn, spontaneous social order takes hold. This research explores the factors that influence when a pedestrian acquiesces to a vehicle within a space shared by both modes, or when a vehicle will yield to a pedestrian. Does the relative number of each mode make a difference? If so, will this shift take place when pedestrians outnumber vehicles by two, or at an even higher ratio?

Data collection took place at intersections in India due to their abundance of intermodal conflicts. The variables explored included the quantity of conflicts, the mode dominance – in terms of whether pedestrians acquiesced to vehicles or vice versa – of the conflicts, the number of vehicles, the number of pedestrians, design elements, and vehicle speeds. Multivariate linear regressions and graphical analysis suggest that while the number of pedestrians is significantly related to the number of conflicts, it is the number of vehicles that is significantly related to mode dominance. The results also suggest that mode dominance shifts from vehicles to pedestrians as pedestrians begin to outnumber vehicles.

1. Introduction

Traditional traffic design necessitates that different modes of transportation be segregated from one another. In this school of thought, conflicts and safety concerns arise when two or more different transportation modes share the same road space. Accordingly, designers attempt to minimize such conflicts in our everyday travel. In theory, pedestrians have certain places and times when they can cross a roadway, bicyclists must stay off the sidewalks, and vehicles cannot ride on sidewalks or in bike lanes. These lessons were cemented into our engineering and planning processes through seminal works such as Buchanan's *Traffic in Towns* and became the convention with respect to designing our transportation spaces (Buchanan, 1983).

This conventional mindset relies upon a rule-based method of controlling and bringing order into a system. As long as the rules are followed, issues and conflicts should theoretically be minimized. Nevertheless, a pedestrian is killed every two hours in the United States, on average (US DOT, 2014). While some pedestrian fatalities are not related to the rule-based system of control, more than 50% of urban pedestrian fatalities in France occur in a crosswalk when the pedestrian has

* Corresponding author.
E-mail addresses: Nicholas.Ferenchak@ucdenver.edu (N.N. Ferenchak), Wesley.Marshall@ucdenver.edu (W.E. Marshall).

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the right-of-way (ONISR., 2013). Based on such poor safety outcomes, it is clear that the rules are not always followed. In fact, traditional rule-based systems often give users a false sense of security, which could lead to worse safety outcomes. For instance, several studies found worse pedestrian safety outcomes when a crosswalk was present (Zegeer, Esse, Stewart, Huang, & Lagerwey, 2004). Moreover, 93% of respondents from one American survey report that running a red light in a car is unacceptable; yet, more than one-third report doing so in the last thirty days (AAA., 2010). While the traditional rule-based system would be more effective if rules were strictly followed, this does not always seem to be the case. Such behavior exacerbates safety issues and suggests the need for a better system of order.

Over the last few decades, some visionary transportation engineers and planners – such as Dutch traffic engineer Hans Monderman and British urban designer Ben Hamilton-Baillie – advocated *increasing* conflicts between modes as a way to regain order within transportation systems. This approach calls for physical separation to be removed, rules to be lifted, and behavior to rely on social cues instead of signs and signals. When road users enter this sort of unregulated situation, the theory is that they must orient themselves to the situation by observing and building upon the order established by fellow road users as opposed to that instituted by externally-created rules. The thinking is that the so-called chaos creates more awareness, and that this can lead to even greater 'order' in the transportation system. To picture this concept, imagine an ice-skating rink (Hamilton-Baillie, 2008a; Klein, 2006). On the rink, there are no demarcations, markings, or rules. The skaters, both individuals and groups, are going every which way, and at varying speeds. According to the traditional transportation school of thought – as well as the simple idea that you could have dozens of people interacting on ice with sharp blades attached to their feet – the situation should be total and utter chaos. But as you watch, an amazing thing happens: order takes hold. As the skaters move about, they are able to modify their paths and avoid collision with other users of the system. They are aware of their surroundings as well as fellow users and take cues in real-time from these other members to institute an order to the system. This structure, instituted from the unspoken cues of other users instead of rules, is referred to as spontaneous order (Hamilton-Baillie, 2008a; Klein, 2006). Although this spontaneous order may be expected to exert at least a small influence over nearly all multi-user situations in our transportation systems, its influence may not be as strong at very high or very low densities. However, it is worth noting that some well-regarded shared spaces are found at densities of over 20,000 vehicles per day, such as in Drachten, the Netherlands (Hamilton-Baillie, 2008b).

An environment that currently exhibits a high number of these intermodal interactions is the transportation systems of developing countries. For example, India maintains high mode shares of both pedestrians and motor vehicles with little segregation between the modes and few enforced rules. In this research, we collected data from dozens of intersections in India to better understand road user prioritization in these unregulated contexts. In other words, this research aims to better understand conflicts between vehicles and pedestrians and explore how spontaneous order is moderated within Indian intersections. More specifically, we address two primary research questions: (i) which factors influence the spontaneous order; and (ii) when does the dominance of the order switch between travel modes? With the world moving towards two-thirds urbanization and the accompanying increases in walking and bicycling mode shares, conflicts between vehicles and other modes are bound to increase. It is vital to understand how these conflicts take place and what factors influence the order and behavior. It is also important to understand this concept of spontaneous order because, even in conventional transportation systems, unwritten social cues influence the behavior of the users and should also influence design.

1.1. Background

The following sections explore the theory and literature behind spontaneous order. The discussion evolves from a general introduction of theory into a discussion of relevance to transportation conflicts. First, the general theory of spontaneous order, with a strong focus on the related economic theory, is explored. Next, literature related to spontaneous order in our conventional transportation systems is detailed. This section focuses specifically on the influence of spontaneous order on pedestrian/vehicle conflicts and primarily looks at factors that influence the number of conflicts. Finally, shared spaces are examined. Even though the intersections studied in this research are not what we might define as shared spaces, the shared space concept also relies on spontaneous order and is closely related to the study sites through functionality. Thus, it is worth looking at the literature regarding how shared spaces function. Most of the research in shared spaces examines factors related to the dominance of the spontaneous order. It is the goal of these sections to reveal factors worth exploring and discover the potential influence of such factors. A better understanding of these factors is crucial to determine the functionality of the underlying order behind the conflicts in this study.

1.2. Theory

Many fields have explored the implications of spontaneous order in unregulated systems. It has long been a favorite subject of economists, wishing to understand how actors behave in systems with few institutionalized rules or regulations. According to Sugden (1989), game theory predicts that people will start to follow conventions based on observed and social influences around them, assuming that a certain amount of knowledge has been obtained about the other users of the system. As the system becomes more utilized and more users pick up on the conventions, a pattern of behavior can transform into an informal, unstated rule. This is termed the "evolution of conventions" (Sugden, 1989). Economic behavior often relies on such contextual knowledge instead of abstract rule-based decisions. The objective is never order, but order is necessary to reach the objective (Boettke, 1990). In other words, although order is not formally instituted and is not the end goal of