

Ergonomic investigation on pedestrian crossing with traffic light signalization

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Abstract. This article is about the risk behavior adopted by pedestrians at crosswalks with traffic light equipment. It was observed that many pedestrians take risk to cross the Presidente Vargas Avenue. This avenue is located in downtown in Rio de Janeiro city, Brazil, and has a heavy vehicular traffic and intense pedestrian flow. Many pedestrians cross the four lanes of avenue dangerously disobeying the traffic light indications. To conduct this research about pedestrian's behavior at crosswalks, a model known as Communication-Human Information Processing Model - C-HIP Model was used. Investigating the stages by C-HIP model perspective, using methods and techniques for each stage, enabled to identify which factors can contribute to pedestrians to disobey traffic signs and adopt a risky behavior in pedestrian crossing.

Keywords: C-HIP model, crosswalk, pedestrian, traffic light, urban space

1. Introduction

When pedestrians walk in an avenue with traffic lights they find a set of urban equipments in the street. These equipments can facilitate or impede a quiet walk. Because the pedestrians' boundaries are well defined the pedestrian are able to recognize the area where is possible to walk in safety. Usually, there is a center lanes for motor vehicles, traveling at high speed. In parallel, along the road, the sidewalks are arranged for pedestrians' circulation.

Immediately, the pedestrians realize that can be seriously hurt if they try to confront the cars. It is important to remember the vehicles' dimensions and speed are noticeably larger and faster compared to the human scale. The risk of fatality or injuries are concentrated on pedestrians. On the sidewalks, in addition to the pavement and people walking the streets, the pedestrians identify others urban facilities: public telephones, kiosks, bus shelters and benches. There-

fore, the pedestrian can feel safer to walk in an well equipped sidewalk.

However, not all the sidewalks of a city are so friendly and safe for pedestrians. There are places with pedestrians x vehicles conflicts. Especially in large urban centers, where the severity of these conflicts are intensified by the amount of intersections between streets and avenues. For this reason a very common type of accident occurs in these areas: the running over. The existence of pedestrians and vehicles on the same avenue leads to an increase in number of accidents involving pedestrians.

An organized pedestrian crossing environment minimizes the conflict between human and vehicles and increase the human safety at sidewalks. The appropriate signalized environment helps the pedestrian with information about where and when to cross the street.

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2. C-HIP Model as investigation tool

This study is about interaction between pedestrian and traffic light signals environment. The act of crossing streets is part of anyone task in an urban center. However, it is important to know that the actions of pedestrians on a crossing are not influenced solely by an information system. The pedestrians have their beliefs and motivations. These human internal factors can contribute to pedestrians' unsafe actions. For example, when someone thinks about go through the passing cars because he do not believe any kind of threat for himself (belief) and, at same time, this person is in a hurry (motivation). These two internal factors can lead the pedestrian to an unsecure act during crossing process.

To conduct this research about pedestrian's behavior at crosswalks, it was used a model developed by American researchers - Wogalter, Dejoy and Laughery (1999) [5] - known as Communication-Human Information Processing Model - C-HIP Model. This model is organized sequentially in seven stages. The initial stages are about how information are transmitted by a source. The intermediary and final stages allow to investigate how a person receives and processes the message in order to be committed to adopt a compliance behavior.

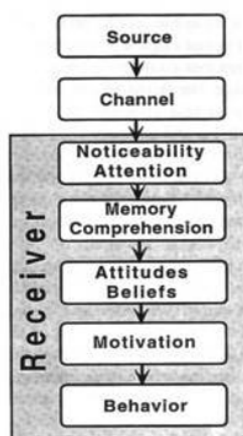


Fig. 1 – The C-HIP Model (Wogalter, Dejoy & Laughery, 1999) [5].

Through the C-HIP model, the systematic analysis of pedestrian crossing process helped the selection of research tools to investigate the pedestrians' non-compliance behavior reasons. All the seven stages can be realized in the process.

The Municipal Traffic Department is the source of information about the pedestrian crossing conditions

in the road environment. These informations are transmitted through a channel, which in this case are the several types of indications - signs, paintings on the pavement, lights, etc., which reach the receiver (the pedestrian). Also there are other information sources, using different channels to transmit a message. For example, government agencies or civil society organizations (source) inform the campaigns against violence in transit through the print and electronic media (channel), parents and teachers (source) teach children to cross the street by oral communication (channel), etc.

Later, the information transmitted by traffic lights, traffic agent and other signalization must be noticed by pedestrians (attention). After the pedestrians extract the necessary information, they should understand the message. The pedestrian must also believe the information content in order to adopts a positive attitude of caution and safety.

The motivation of obeying the traffic light orientation should be in accordance with their beliefs and attitudes. This stage the pedestrians evaluate whether it is better to wait their turn to cross safely or attempt a risky crossing. So, there is a balance between the costs of following the indications or benefits of non-complying with existing rules.

3. Problem and hypothesis

The casual observations showed that a lot of pedestrians had risky behavior when they disrespected the traffic lights indications. The pedestrians' possibility to be severed injured is enormous, because the high-speed traffic is intense. This phenomenon leads the question why people cross the lanes and put their lives in risk if the signalization oriented them to wait the right time to go through the avenue.

The hypothesis states that the traffic education influences pedestrians' internal factors and these factors stimulate their behavior during the crossing process in an avenue with traffic light. The independent variable is the pedestrians' internal factors like motivations and beliefs and the dependent variable is the type of behavior (safe or unsafe crossing).

So, this hypothesis allows to investigate the relation among four C-HIP Model stages: font, beliefs, motivation and behavior. Investigating the crossing process through C-HIP model perspective, using methods and techniques for each stage, enabled to identify which factors can contribute to a non-compliance pedestrians behavior before a traffic light indication.

4. The Presidente Vargas Avenue

The Presidente Vargas Avenue was chosen to be investigated based on the statistics related the number of pedestrian accidents occurred in Rio de Janeiro city. According to Rio de Janeiro's Municipal Traffic Department the number of pedestrians accident is more than two hundred per year [3].

The Presidente Vargas Avenue is one of the most important avenues of Rio de Janeiro. It is located in downtown and its length is 3.5 km. The avenue is 80 meters width and the daily traffic can reach 191.000 vehicles. Along its length there are important government buildings, headquarters companies, train and bus terminal, subway stations and intense vehicle traffic. These features indicate the number of pedestrians who frequent the region should be significant. Consequently, there is a intense conflict between pedestrians and vehicles. The avenue has four lanes for vehicles, separated by three traffic islands. These islands serve as security area for pedestrians to wait the right time to cross through lanes. It is always impossible to cross all four lanes on a single occasion.

5. Method

The main methods applied were observation and inquiry techniques. Systematic observations were made to investigate the pedestrians' behavior. Rating Scale were applied to investigate how are related the pedestrians' traffic education to their beliefs, motivations and behavior.

The observation allowed to survey the amount of sources on Presidente Vargas Avenue (traffic signal, crosswalk painting, road sign, traffic agent, etc.). It was noticed also others features that could assist the pedestrian (affordances): ramps from the sidewalk to the lanes, for example. Even with all urban equipment for pedestrian crossing working very well, it was observed that a lot of pedestrians desobey the traffic light indications.

The inquiry techniques were the main methods to investigate the relation among the four C-HIP model stages: font, beliefs, motivation and behavior.

Fifteen pedestrians were interviewed. This non-structured interviews allowed to know the pedestrians' point of view about their crossing process in the Presidente Vargas Avenue. The interviews were made in very informal way, almost like a chat. The questions were about the time they wait on the sidewalk, if they need to run to cross the lanes, running over witnesses, etc. The conversations took no more than five minutes. Notes were made in a small block

with the impressions of the casual observations and respondents statements. The pedestrians responses were important to help in structuring the rating scale.

The rating scale was an essential instrument because it enabled a single tool to investigate four stages of the C-HIP model. Tiwari et al.(2007)[2] and Hamed (2001)[4] had used a rating scale to research issues related to beliefs, motivation and behavior of pedestrians. However, these studies did not address specifically the relationship between the steps of the C-HIP model.

The rating scale goal was to investigate the four stages of the C-HIP model and the relation among them. Hence, it was needed to make many statements on a rating scale. In order to apply the scale to respondents was let a printed form for later recall. The form had thirty eight assertives about the four stages of C-HIP Model and the respondent filled all form in fifteen minutes approximately.

The thirty eight assertives were divided in five groups: 1) pedestrian's profile – gender, age, education level, frequency on the region, etc; 2) Channel – contact's type with traffic education in all life long; 3) Beliefs and attitudes – respondents' auto-perception about their physical conditions to cross running through the lanes, possible consequences in case of accident, eventual constraints to desobey the traffic rules; 4) Motivation – the respondents answered about themes like cross the avenue when they are in a hurry or to be delayed to get the office. It was asked if the others pedestrians behavior influenced their; 5) Behavior – It was included three assertives about the way the respondents cross the avenue.

A pilot form was applied among thirty respondents and served to test if it was possible to apply the form without presence of inquirer, if the questions would be understood and estimate how long a respondent answer all the assertives.

6. Results

All areas studied have three refuge islands to divide four lanes for vehicles. However, there are areas with fewer pedestrians walking than other regions. There are some specific places with heavy vehicle traffic and concentration of people on the road. These places are more uncomfortable to cross the avenue because the vehicles-pedestrians conflict and due the discomfort when walking through a tumultuous is always present.

A full list of components and environment features in the pedestrian crossings were made. It was prepared a table with ten items to check the presence of

traffic light system components. Thus, it was possible to make a simple comparison between the crossings. This systematic observation helped to know the numbers of urban components and to compare the amount of traffic lights devices presents in each crossing point.

It was noticed that all basic components for a pedestrian crossing were presents. It is true that there were some peculiarities in some crossings. However, it was considered that the basic equipment needed for crossing was working well, despite the obvious lack of maintenance in some places. The presence of these basic components was identified through the systematic observation.

The rating scale was applied to 65 respondents. The respondents work in offices or study in university located in downtown. The form were applied in five different companies (public and private) and an university. Only responded to the rating scale who reported that walked through Presidente Vargas Avenue at least once in three months.

Among the 65 informants interviewed 46.2% were female and 53.8% male. Most of the informants were considered young (80,1% were under forty years old). Most respondents frequents the Rio de Janeiro downtown to their daily activities: work or study (90.7%) and most of them use public transport to get the neighborhood (89.2%). These two factors are important reasons why the respondents (87.7%) needs to cross the Avenida Presidente Vargas at least two to three times a week.

The main contact with traffic education was through family life. It was found that 90.8% of respondents agreed that parents guided the informants about how they must cross a street. Seventy percent of the informants agreed also that the news is an important way to know about accidents with pedestrians. Questions about traffic campaigns appear to be less present in everyday life of the informant. Most of them disagreed on the assertion that there are many campaigns related to pedestrians (69.2%).

Questions about pedestrians beliefs were made. It is possible to verify some importants pedestrians beliefs that will influence their behavior when they cross the avenue.

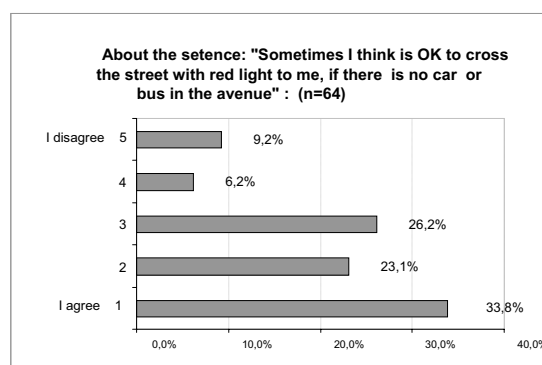


Fig. 2 – This question shows that only 15.4% disagree about if they should to disobey the traffic light orientation when there is no vehicle traffic.

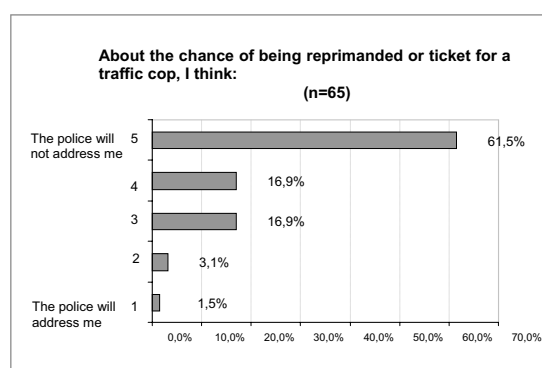


Fig. 3 – This question shows the conviction of respondents that can hardly be approached in case of an improper crossing. The informants (78,4%) do not believe they can be called by a traffic agent if they disrespect the orientations for pedestrians.

It was also made questions about pedestrians motivations. These motivations shows gains and losses that pedestrians has when they are in a crossing avenue situation.

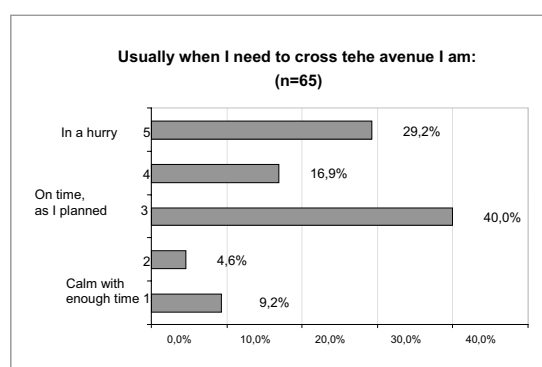


Fig. 4 – This question exposes that few respondents are quiet and go with sufficient time transiting at Presidente Vargas Avenue (13.8%). Most of them has no time left.

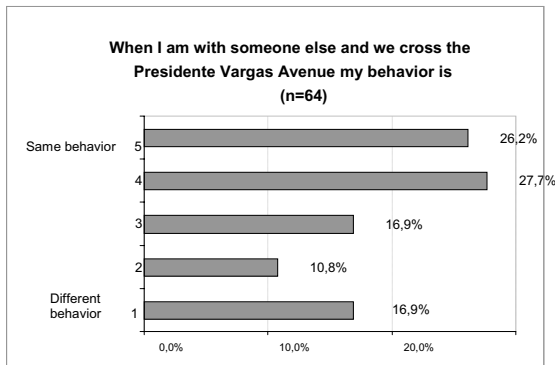


Fig. 5 – The question reveals that the someone company does not motivate the informants to change their behavior in crossing the avenue. Most participants cross the avenue in the same way they do(53.4%).

Finally, it was asked about how the informants cross the avenue.

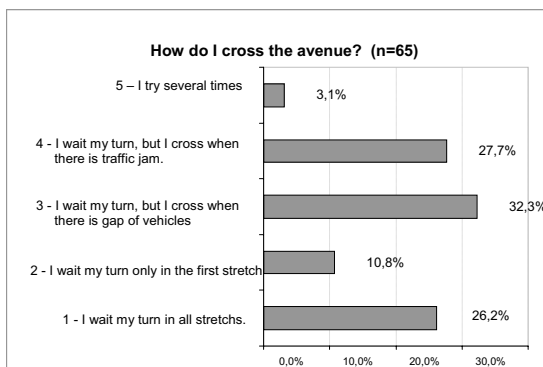


Fig. 6 – The question shows that only a minority states to comply fully with the traffic light orientation (26.2%). The rest of the respondents (73.8%), somehow violates the traffic rules and simultaneously exposed themselves to the pedestrian accident risk.

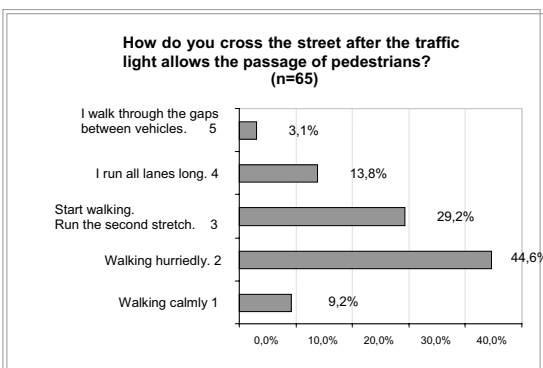


Fig. 7 – The question reveals that less than 10% cross the avenue quietly. Certainly these respondents need more than one cycle to get across four lanes of the avenue. The vast majority (90.8%) needs to take some extra effort to complete the crossing.

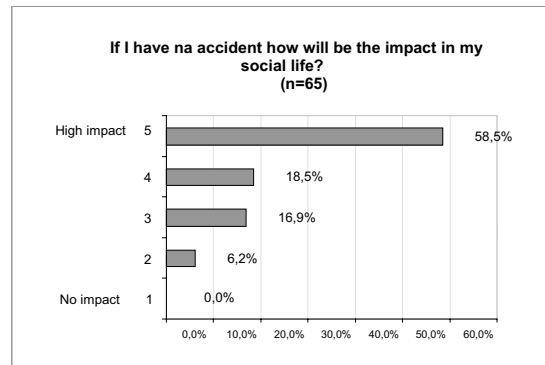


Fig. 8 – In this question it is clear that the informants are aware about the impact that can cause in the transit victim’s life. All responses show a tendency to be a life dramatically affected by an accident.

It was found important correlations between assertives about beliefs and behaviors’ intention: informants that are used to cross the avenue in unsafe way answered more positively with the affirmation about disrespect the traffic light orientation sometimes – correlation between questions of Figure 2 and Figure 6 ($r=0,48$). Those less respectful with traffic light signalization were more unbelievers about traffic cop coercions – correlation between questions of Figure 3 and Figure 7 ($r=0,46$). Significant correlations between motivation and behaviors’ intention were found: the informants that affirmed they had no enough time for their daily activities tend to cross the avenue more dangerously – correlation between questions of Figure 4 and Figure 7 ($r=0,41$). The interesting is that the respondents are more positive to change their behavior when they are accompanied by someone else – correlation between questions of Figure 5 and Figure 6 ($r=-0,41$). The t-test showed that the male respondents tended to think in more drastic accident occurrence, if it would happen, than female informants - Figure 8 - ($p<=0,05$).

7. Discussions

It is assumed that the informants were qualified to answer questions about the crossings of Presidente Vargas Avenue, as 75.4% cross the avenue at least once a day. It is important to remember that 89.2% said they use public transport to get downtown. Due to the Presidente Vargas Avenue configuration it easy to realize that anyone uses public transportation can give up to cross the avenue. Probably, the passengers must walk down the sidewalk and cross the avenue to reach the destination or return home. It is important to remember the thinking of Reed & Sen

(2005)[6] on the pedestrians who depends on public transportation: this type of transient is that is more exposed to accidents in the street, because they always walk on sidewalks.

After reading the charts, it became clear that parental guidance is the main form of access to information about traffic education. 90.8% informants responded that the guidance on how they should conduct as a pedestrian came from the parents. Among the questions related to the stage Channel, no one else has reached such a high degree of agreement on this subject.

Currently, the main contact information on the pedestrians conduct in traffic is disclosed through the news media. Unfortunately, these reports are related to accidents and many of them fatal. Informants agree that they are impressed with the consequences of traffic accidents. While the respondents has these informs from the newspapers, traffic campaigns seem to be missing in their everyday life.

The rush was one of the most present factor in this study as a motivating force for pedestrians cross the avenue before the time indicated by the traffic light. In the rating scale, the rush was identified as a important component when only 13.8% of respondents said they had enough time when walking along Presidente Vargas Avenue. It was concluded that the pedestrian in a hurry has a tendency to take risk while crossing the avenue. Some of the results were very similar to others researches about pedestrians behavior. Mostly, those studies that demonstrated differences between genders related how people behave before a pedestrian crossing - Hamed (2001) [4], Diaz (2002) [1] e Tiwari (2007) [2].

The pedestrians that take more risk crossing the Presidente Vargas Avenue are more motivated to try a chance crossing the road when there is gap between vehicles or if the traffic is jammed. Simultaneously, it was found that dared pedestrians cross tend to modify their behavior when they are accompanied.

Therefore, we found moderate associations between factors internal pedestrian (Attitudes / Beliefs and Motivation) and behavior in crossing avenue with traffic light signals.

8. Conclusion

The human information processing modeling helped to organize this research steps on pedestrian crossing in avenue with traffic light. Several issues were raised which could result in future studies. These issues can be summarized in two aspects: a) new questions about the influence of internal factors in

the behavior of pedestrians and b) how to use the C-HIP model in studies on other information design topics.

The first aspect, the question arose whether the pedestrians behavior at Presidente Vargas Avenue was associated with cultural issues. One of the respondent mentioned about this possibility - that the lack of respect for the signalizations is "a thing of the Rio people." It would be interesting to apply the same tools to pedestrians from other cities (national or international) with a avenue with a similar feature of Presidente Vargas Avenue.

The second aspect questioned if it is possible to use the C-HIP model in graphic design research. Researches about Attention, Memory and Comprehension stages are quite common in design. There is an intense curiosity of the design researcher to know why certain logo, sign, symbol or pictogram works well or fails to call attention and if the users understand the meaning of the message. However, there has quite a few literature on the design that would address the other stages that here were linked to the pedestrians internal factors.

Therefore, it is encouraged to design research from similar models because it will lead to the investigation of other factors related to human nature that are not always included in the bibliography of industrial design. There are already models in design studies that take account other factors that deal with internal user, such as emotional and cultural. Research several internal factors is welcome, it adds more knowledge and helps to expand the design scope. Finally, it is believed that the design and ergonomics can contribute effectively to the issues relating to transport and built environment. The design approach, from ergonomics informational certainly provides a solid theoretical foundation studies in this area.

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