# INTERTWINING ROAD USER BEHAVIOUR AND TRAFFIC PSYCHOLOGY WITH ITS TECHNOLOGY IN SOUTH AFRICA

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**Abstract**

Road safety is a core problem that the South African government battle with year-on year. One of the areas where South Africa has sadly been lacking behind is within the field of road and traffic psychology. This is despite the fact that presumably 90% of road and traffic crashes are considered to be due to human error. Approaches to address road user behaviour on South African roads are seemingly not tailored enough to address the problem on our roads. One of the reasons for this might be the serious lack of reliable scientifically sound data. Without adequate transport and traffic related data it becomes difficult to develop countermeasures or to influence policy and the effective formulation of strategies to curb the road safety problem in South Africa. The CSIR NyendaWeb aims to address this problem through the creation of an open platform, where data from a sensor web can be received, analysed and made accessible to researchers, practitioners and policy-makers. Interventions and strategies to reduce crashes in South Africa mainly revolve around engineering and enforcement with little or no real insight into the behaviour that these strategies aim to address. The field of Intelligent Transportation Systems is still fairly unexplored within either the ergonomics or traffic psychology domain in South Africa. The CSIR NyendaWeb platform for the first time provides an opportunity to collect road user behaviour data through the sensor web, which will make it possible to collate, analyse and interpret road user behaviour on a higher level. Most approaches in accident reduction revolve around (mostly unavailable) crash data and specific locations. By utilising the sensor web to collect different types of information from everyday road usage situations it becomes possible to better understand road user behaviour within the South African context. In order to interpret and understand what the specific road user behaviour is and how it fits within the South Africa context, one should first be able to classify that information. Currently no such a behavioural guideline or index for road users exists in South Africa. Only after road user behaviour has been classified and indexed can methods be developed to fully measure road user behaviour. This tool could be used to pinpoint specific and hazardous locations, as is currently being done, but will also give insight into general and "not at risk" road user behaviour.

## 1. The Context of South African Road Safety

Road traffic accidents are a global health problem killing approximately 1.2 million people per year worldwide and injuring between 20-50 million[1]. More than 85% of road deaths occur in low and middle income countries, such as South Africa. Africa has the highest road traffic accident death rate per population. Road safety in South Africa has a dismal track record. The number of fatalities sustained in crashes for the year 2007/2008 was 14,627[2]. Pedestrians accounted for the highest percentage of fatalities (36%), followed by passenger deaths (35%) and driver deaths (29%). The Commission for Global Road Safety 2008 reports that per 100 000 populations, 26 child deaths occur in South Africa, compared to 1.7 in the EU as a whole. In Africa the costs related to road traffic crashes constitute between 1-3% of the GNP. Road safety is still a core problem that the South African government battles with year-on-year. According to Botha[3], since 1903, when the first traffic crash occurred in Cape Town, up to the end of 2003, approximately 393 977 persons were killed in road traffic crashes on South African roads. This number is approximately 1.13% of the

total number of people killed world wide in traffic accidents. The Road Traffic Management Corporation, the public entity responsible for the recording of and reporting on accident statistics in South Africa, recently indicated that the annual cost of accidents in South Africa is conservatively estimated to be in the region of 56 billion Rand.

Botha points out that it is widely accepted that up to 90% of traffic accidents occur due to human error.

- Human factors are responsible for between 60%-90% of traffic accidents in South Africa
- Vehicle factors are responsible for between 15%-30% of traffic accidents in South Africa
- Road factors are responsible for 5%-20% of traffic accidents in South Africa
- Environmental factors are responsible for 3%-5% of traffic accidents in South Africa

Botha stipulates in his paper that except for the environment over which the driver has little control, the rest of the contributory factors all include some human involvement, either directly or indirectly. It is this human error of which so little is understood in South Africa. Despite the fact that between 60%-90% of crashes that take place on South African roads can be undeniably linked to the human factor, research in South Africa tend to focus on the other contributory causes namely the road, vehicle and environment. Psychological and behavioural aspects including consequences of specific road user actions are neglected fields in South Africa. While the rest of the world progressed towards greater knowledge, skill and capacity pertaining to better understanding the characteristics, factors and consequences that explains the complex interaction between the road, vehicles and humans, Africa sadly stayed behind. For decades, SA road safety research has been dedicated to the development of fields such as Construction, Enforcement and Engineering. Technology-related research gave little consideration to the complex human processes that play a role in the execution of road user tasks. In a country where people from different backgrounds are so different in their perceptions of road usage, it becomes essential to understand and elaborate on similarities, differences and everything else that makes the road safety situation in South Africa so unique. The need for tailor-made road safety interventions, informed by credible, reliable data becomes more evident every day.

In Dar es Salaam, July 2009, where the focus was on road safety in developing countries, the “Call for a Decade of Action” to “Make Roads Safe” was endorsed by the ministers of the countries attending[4]. The Make Roads Safe Campaign is a call for responsible building and investing in road infrastructure with at least 10% of funding for bigger projects being allocated to make the “road safe” for especially vulnerable road users. These include investment and provision of infrastructure that can separate vehicles and vulnerable road users by providing infrastructure such as walkways, pavements and cycle paths. This 10% investment can also be dedicated to public education and enforcement campaigns.

## 2. Traffic psychology research in South Africa

Lagarde’[5] rightly states that research into road safety in developing countries, especially in Africa, is scarce. This is even more so for research relevant to traffic psychology in South Africa. Most of the funding and resources dedicated to road safety in South Africa is aimed at pedestrians. The road safety campaigns, enforcement and education directed at drivers in South Africa is sporadic and tend to be focussed on specific times of the year such as during the Easter and Christmas

holidays. After these periods of increased activity on the South Africa roads, the RTMC[2] gives feedback with regard to road statistics for these periods. One possible answer to why only selected statistics are fed back to the nation or why driver education and communication campaigns are implemented in the way described above is that the authorities simply don't have the necessary information to develop and run focussed, sustainable campaigns directed at motor vehicles drivers of any sort in South Africa. An area in need of expanding research and development is that of road traffic psychology and the role it could play in informing unique approaches and interventions to road safety in South Africa. One possibility falls within the expansion of ITS technology into a behavioural study that will lead to the development of a road user behaviour classification and indexing tool. This tool would first aim to identify and understand road user behaviour unique to South Africans, and secondly aim to systematically classify road user behaviour within a South African culture. Further development of such a tool could entail to monitor behavioural parameters that would give insight into cognitive processes while using the road as well as exploring motivational issues that influence behaviour on the road. The development of a model, framework and finally the tools aims to highlight the need for a better and unique understanding of road safety in South Africa from a behavioural and psychological perspective. This would also lead to a different and new approach in the conceptualisation and development of road safety interventions in South Africa.

## 3. CSIR NyendaWeb programme

Labuschagne[6] states that in order to manage traffic and road safety effectively, one needs accurate, relevant timely information to guide and inform traffic management strategies, policies and actions at all levels of transportation/traffic planning, design, management and operations. Here the first problem arises, as South Africa does not have accurate data sources which can inform the development and implementation of road traffic management strategies to a level that is needed to curb the carnage on South African roads. Labuschagne[6] argues that good data, information or intelligence is the first step towards achieving success in planning road traffic management interventions in any of the four "E" disciplines.

The NyendaWeb programme was conceptualised and developed to assist in the facilitation of access to reliable and accurate road and traffic management data and thus to address the existing data need within the road and traffic management fraternity in South Africa. The NyendaWeb programme is specifically meant to utilise and apply ITS technologies to such an extent that the traffic management fraternity can put it to use in order to stop the carnage on South African roads[6]. NyendaWeb intends to change the face of traffic management in South Africa through the utilisation of Intelligent Transportation Systems (ITS) by providing an open platform for the facilitation and exchange of data accessible to all road and traffic management stakeholders, researchers and practitioners. NyendaWeb, as the name suggests, is a web or network of distributed ITS databases, which facilitates access to different types of data from various sources[6]. NyendaWeb is also an ideal integrative platform for the development of a data dictionary and standards for Intelligent Transportation Systems data in South Africa. Currently it is difficult firstly to access and secondly to consistently compare data across boundaries or levels as the data is not standardised. The development of the data dictionary will contribute to NyendaWeb's functionality as it will operationalise a database framework that links with various forms of ITS and other transport-relevant data sources. The improved standardisation of data definitions will then facilitate the development of advanced analyses and presentation tools that

can be transformed into more accurate information and also intelligence about road safety and other transport matters.

The NyendaWeb programme is still in its infant stage. NyendaWeb architecture has been developed and the next big step is the standardisation and setting of guidelines for electronic ITS data, which is envisaged to become the universal language for understanding, interpretation and application of road traffic management data in South Africa. These functions are dependent on the needs of end users. Labuschagne[6] indicates that the research will also ultimately entail the development of an "emulator" that will create a "bird's-eye view" - made possible through ITS technologies that provide continuous data streams create a data-rich study environment. This will thus enable researchers and academics to study road user behaviour and contribute information (ultimately intelligence) that will enable authorities to take appropriate action in terms the South African road safety situation. Provision is made for different types of data as well as methods and means to extract data from NyendaWeb for the analysis, interpretation and presentation of data by third parties.

As indicated earlier in this paper there is a huge need for reliable and accurate data which can be fused, mined and interpreted into meaningful strategies for addressing road safety in South Africa. Two particular applications or "spin-offs" developed on the NyendaWeb platform are briefly discussed below. The critical missing element in both these applications is the underlying understanding of human behaviour on the road. Ribbens and Pillay[8] illustrated how the NyendaWeb platform could be utilised to develop an integrated information system that that could be used to identify ward based road safety problems in the City of Johannesburg. This initial rudimentary integrated information system was used to capture details and dynamics of each of the city's wards and to lay the foundation for the development of scientific decision making tools with a multi-disciplinary approach to the planning, implementation and evaluation of road safety problems experienced in communities. The NyendaWeb served as platform for the collation, analysis and ultimately presentation of the research findings to the City of Johannesburg. The whole NyendaWeb concept revolves around the sensor networks[9] from which data is derived, at first from the road and the environment and at a later more advanced stage from the road users themselves. It is stated that by developing new sensors the NyendaWeb will "add" contribute to the characterisation of the built environment, which includes traffic and transport. This data to be collected is envisaged to at first be primary data that will constitute an accurate portrayal of the status quo of road safety within a particular road environment. From many of the sensors it will be possible to obtain primary data that will for the most part remain static and it will be fairly easy to monitor changes in the road environment. On the other hand, road user behaviour in particular settings or environments are more difficult to assess and monitor within a particular area or road environment depending on the constants and the variables within that particular environment. The KRONOS application[10] is an example of how the NyendaWeb platform was used to simulate a particular road safety situation on a problematic road, namely the R573 in Moloto, Gauteng, South Africa. KRONOS is an agent based Computational Building Simulation tool, used to work on advanced research within the built environment, particularly with regards to road traffic safety and user behaviour within buildings. Conradie et al[10]. indicate that in order to study traffic in this manner both static and dynamic capabilities are required. Although utmost care was taken to develop the simulation to be as representative of the situation on R573 as possible, it only included basic and generalised behavioural characteristics of agents

representing the road users. This agent based Computer Building Simulation tool was proved to be successful for use in for example an automated road safety assessment scenario.

## 4. Towards a South African road user behavioural index

As much as we may try to adapt international approaches towards better road safety in South Africa, we need to face the fact that we have a unique first and third world outlook that influence South Africans in unique ways. The history and legacy of cultural, educational and socio-economic differences all culminates in the way that South Africans behave on the road. The only way to understand the behaviour is to understand the rest of the context in which SA operates. In 1985 Michon[11] indicated that driver psychology research should be heading for an "intelligent, knowledge and rule-based model" which will explain driver behaviour within the context of a wide array of realistic and complex situations. Road user behaviour classification is by no means a new concept and both subjective and objective methodologies have been utilised to develop road safety, risk and individual road safety risk behaviour indexes[11;12;13;14]. It soon becomes impractical to make use of labour intensive methods such as human observers, as it becomes too costly. The only way to get around this problem is to start automating the collection of information.

The problem with conventional approaches to road safety risk and behavioural indexes is firstly that these approaches tend to focus on specific data: known or presumed hazardous locations or particular at-risk behaviour such as driving too fast; dangerously overtaking and so forth. Traditionally researchers resorted to the use of well designed subjective measures such as self-reporting behaviour questionnaires to better understand a particular behaviour in traffic over time, or the use of more objective techniques such as traffic conflict measuring techniques, or the analysis of video footage (DVR).

The analysis of the sample material is based on predetermined or known indicators such as location, performance measures such as speeding, or particular behaviour that is deemed incorrect such as dangerous overtaking or lane-changing. It is the view of the author that the only way to approach the human element on the road is to understand the problem bottom-up and not the other way around. For the first time the NyendaWeb platform provides South Africa, along with the rest of developing Africa, with the opportunity to develop a framework, model and system which will be uniquely positioned to identify, classify, index, and at a later stage measure and quantify SA road user behaviour. A road user behavioural index will need to take into account characteristics such as the engineering and enforcement environment from where the information is originating as well as the risk profiles and road user characteristics. This behavioural indexing will however not be based on hazardous locations or only focuses on expected actions at specific locations, but rather on the road user behaviour itself. Since road traffic crashes are considered to be random events, enormous amounts of energy, time and resources are spent on preventing these random events that cause such havoc when they occur. Research focuses on the identification of hazardous locations, making use of crash data in an attempt to understand the behaviour that lead to a crash at a specific place and point in time. The classification and indexing of "normal" road user behaviour will enable researchers to better understand the motivation for road user behaviour in all contexts and circumstances, not only in those circumstance that lead to a random event such as a road traffic crash.

The next question that arises is how one should analyse and interpret the raw behavioural data that will contribute to the development of meaningful strategies, policies and so forth in order to make the particular road environment safer for road users. Currently no specific road user behavioural index or classification system exists in South Africa. Through the years researchers and engineers utilised existing and internationally renowned methods such as traffic counts and observations as well as the Swedish traffic conflict measuring technique. In-vehicle technologies such as the tachograph monitor speed behaviour when driving a company vehicle, and some countries even employ the use of video data. All of the existing technologies that are used to monitor behaviour on the road are aimed at the identification of specific at-risk or potentially dangerous behaviour. This makes it possible to comment on road user behaviour such as speeding, lane-changing and so forth. Attempts that have been made to summarise or automate the processes of understanding road user behaviour are limited, and such data is normally restricted for use internally in companies either to improve performance or for commercial purposes.

This brings us back to the problem of accessible and standardised data that can be compared across different levels and boundaries. A road user behavioural index as described above should incorporate and include all different types of road user behaviours and should ensure that the information is captured and analysed simultaneously. As the next step behaviour can then be classified according to risk or type of behaviour, predicting or discarding specific actions at specific locations. This will serve to adequately inform and contribute to the development of meaningful strategies, policies and procedures that can address the at-risk behaviour at specific or selected locations.

Earlier in the paper it was indicated that the CSIR NyendaWeb is envisaged to integrate conventional transport/traffic data, to unlock data sources currently not accessible and to create new sources of data through the development and expansion of the sensor web. It was stated [9] that the creation of new data sources will "appreciably add to improved characterisation of the built environment" which includes the traffic and road domain. The envisaged sensor web will be able to collect the information from the road in different formats and types, at high rates, in large volumes and even in "near real time" where appropriate and practical. It becomes difficult and time consuming to repeatedly filter through large quantities of digital data in order to extract information (or intelligence) for research, development or policy-making purposes[9]. It would therefore be sensible if this data is processed and classified on an already developed road user classification and index system. This leads to the next step, which lies within the definition and description of the data obtained from the sensor webs and lying within the domain of transport-relevant ontology and the development of a data dictionary for transport. It is within this data dictionary that the road user behaviour classification process starts. This means that NyendaWeb should have the capability to translate raw road user behaviour information in such a way that it can automatically assign meaning to the data through ascribing different values and attributes to the information streaming in via the sensor networks. The value assigned to a specific type of behaviour becomes meaningful when it is considered in the prevailing context. This meaning can only be assigned to the raw data once a proper behaviour classification system is in place, with an appropriate scale and index onto which the particular road user behaviour can be plotted. It is envisaged that this enriched road user behaviour data set will provide meaningful insights into specific road user behaviour not only at specific selected locations but at any point of the road network. It will also be made possible to

interpret and translate the data into meaningful information that could be used on greater scale, in association with other environmental and road related data received from the sensors.

Then a similar way as for DSMIV in psychology, where abnormal behaviour is classified and indexed, a system of classification should exist for road user behaviour, which can be used to describe road user behaviour not only in "random crash events" but for normal road usage as well. By assigning a specific value or behavioural attribute to a specific stretch of road or a location on a road, it will become possible to elaborate on the character of the road and its environment, not only in engineering terms but in a holistic manner that incorporates the human element. This will make it possible to predict and prevent certain types of road user behaviour. As part of a bigger traffic management system it will also be possible to monitor and evaluate how changes over time impact on the character of the road, by making the road, the environment and the associated behaviour and human reaction to the road even more dynamic in understanding what why and how crashes occur. In order to develop this behavioural classification system data from many diverse environments will be needed and definitions to classify and describe the particular and precise behaviour will have to be developed. The CSIR is currently exploring the possibility of being included in the Naturalistic Driving Study (NDS) in which the rest of the developed world (including at this stage Germany and Canada) will take part. South Africa will be in a position to contribute to this dynamic driver behaviour database by generating specific data pertaining to driver behaviour within a developing country. This study will present the opportunity to collect sufficient driver and more general road user data to enable South African researchers to build capacity in terms of driver behaviour studies. The NDS study is also seen as a possible source of information to further develop the envisaged road user behaviour classification tool.

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