



Validity of traffic conflict-based road safety analysis

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Introduction

Limitation of crash-based safety assessment such as data unavailability, imprecision, misclassification, underreporting, and a reactive nature, raising ethical concerns, has led to the introduction of alternative and proactive approach, based on analysing safety using non analysing road safety by studying non-crashes events called traffic conflicts and usually quantified by the means of surrogate safety measures (SSM).

Numerous promising applications of Traffic conflict method for general safety assessment exist. There is an ever-growing interest in these methods, however, their wide application as a complete alternate to crash based analysis still require proper reliability and validity. The validity of conflict has been a hot topic of discussion since its introduction in the in the '70s with several studies attempting to validate well know conflict technique or surrogate safety measures till nowadays. The validity of conflict-based analysis has often been overlooked (or partly addressed) in review studies, despite the relevance of this topic.

The objective of this paper is to provide a comprehensive overview of the validity methods used in conflict-based analysis studies. Typically, how does studies have assessed the consistency of the relationship between conflict and crashes. The paper intends to present the concept of validity, how it has been addressed by existing conflict studies, and some insights into challenges and future research avenues.

Research methodology.

This research followed the PIRISMA guidelines to search and review relevant literature. Databases such as Scopus and Web of Science were used alongside the snowballing method to collect studies using various synonyms for traffic conflict like surrogate safety measures, near misses, safety critical events, in combination with keywords related to validity, like validation, product validity, relative validity, process validity. The initial search of peer-reviewed articles, resulted in 813 responses as of October 6, 2023, narrowed down to 650 after removing duplicates and non-English papers. In addition, several relevant studies were also found via the data base of the ICTCT website. Screening for relevance to traffic conflict-based safety analysis further reduced the pool to 347. After assessing clarity in validation technique employed, 85 studies were retained for review . The goal was not to retrieve the exhaustive studies of traffic conflict, but those relevant enough to help discussing the focus of this paper.



Results

The following provide a glimpse of some of the findings.

- **Validation of conflict-based safety results.** From the 320 traffic conflict studies obtained, only 25% (85) included a validation aspect either directly or indirectly. Those were the studies considered for review. But overall, this shows how often validation is overlooked in conflict-based studies, despite its relevance. One potential reason for this is the insufficiency or lack of crash data as highlighted by several studies.
- **Validation method.** There are three main types of validity including process validity, relative validity, and product validity. Out of the 85 studies reviewed, 98% employed absolute and relative validity. The limited presence of process validity is explained by the fact this method requires detailed data of the crash and conflict mechanism prior to the occurrence of the incident, which are usually not available or too difficult to obtain. No study employed more than one validation method.
- **Product validation.** It was the predominant (58%) validation technique and included Correlation between observed conflict from field (or simulation) and historical recorded crashes, Correlation between the expected number of crashes from a conflict-based safety performance functions and the historical crashes, and Comparison of the expected number of crashes calculated from an extreme value theory approach using conflict with the historical crash records.
- **Relative validation.** It was the second most (30%) employed method and included identifying and ranking high risk location, predicting unsafe situation in the following interval, comparing the effectiveness of countermeasures. The methods were particularly insightful as they allowed a comparison between conflict based and crash based analysis. It is relevant to point out that some marginal studies employed relative validation without using crash data, by describing the direction in change and not the magnitude.
- **Validated methods/measures.** Temporal proximity measure as time to collision, post encroachment, were by far the most validated among the reviewed studies. In addition, there were also several studies, especially the oldest one, attempting to validate traditional conflict methods such as the Swedish Traffic Conflict Technique (STCT), the Dutch traffic conflict technique (DOCTOR).
- **Validation results.** Mixed results among studies about the validity of conflict-based safety analysis. While some found consistency in conflict-based results compared to crash-based results, others did not find similar performance. However, it is difficult to make a conclusion, as the findings of each study are strongly correlated with the conflict method used, the conflict measures chosen, and the study design.



- **Thresholds selection.** Selection of thresholds is crucial to effectively define and separate conflict from non-conflict event. However, most studies (>75%) used predefined thresholds from literature to distinguish conflicts from non-conflicts and very few employed empirical approach like correlation or extreme value theory to quantitatively find the most suitable thresholds. With this approach, several thresholds are considered and the most suitable is defined for instance as the one returning the highest correlation between the recorded conflict and historical crashes.

Discussion and conclusions

Key areas for further research and discussion include:

- Conduction of further validation study to see if old findings still apply. Because traffic environment has changed since (higher, safer vehicle, etc)
- Conduction of further validation study using advance technology (e.g computer vision) to see if finding obtained from previous old studies (using mainly field observation with traffic conflict technique) still applies.
- Conduction of further validation studies considering more than dimension of validity to see if results are consistent.
- Conduct direct comparison between conflict-based study and crash based study and eventually also in-built safety studies to see if the three methods generate coherent results.