

Introduction

There is an **essential need for the improvement of road safety prediction tools** through the assessment of established and proven traffic simulation tools and road safety assessment methods. Within the 'Predictive Approaches for Safer Urban Environment' (PHOEBE) project, which aims to increase road safety of vulnerable road users, the interdisciplinary power of traffic simulation and road safety assessment will be achieved (see Figure 1).



Figure 1 PHOEBE project ambition

In addition, PHOEBE project will draw inspirations from real-world scenarios in three pilot cities of:



Figure 2 PHOEBE pilot cities

Enhancing these tools with innovative data sources and methods can significantly **reduce urban crashes and their impact**. To achieve this, it is imperative to identify the requirements and gaps of relevant stakeholders in terms of professional road safety analysis tools.

The present study aims to utilize association rule mining to **determine underlying profiles of local stakeholders** who are identified as hands-on practitioners.

Stakeholder Questionnaire

In order to capture needs and gaps from the perspective of transport managers and municipalities, an **online stakeholder survey** was designed. The survey included questions related to several new metrics, models and techniques integration considering factors such as human behavior, modal shift, and improved data exploitation through machine learning methodologies.

The total number of complete **responses received was 50**, while the distribution of respondents covered **36 different cities**.

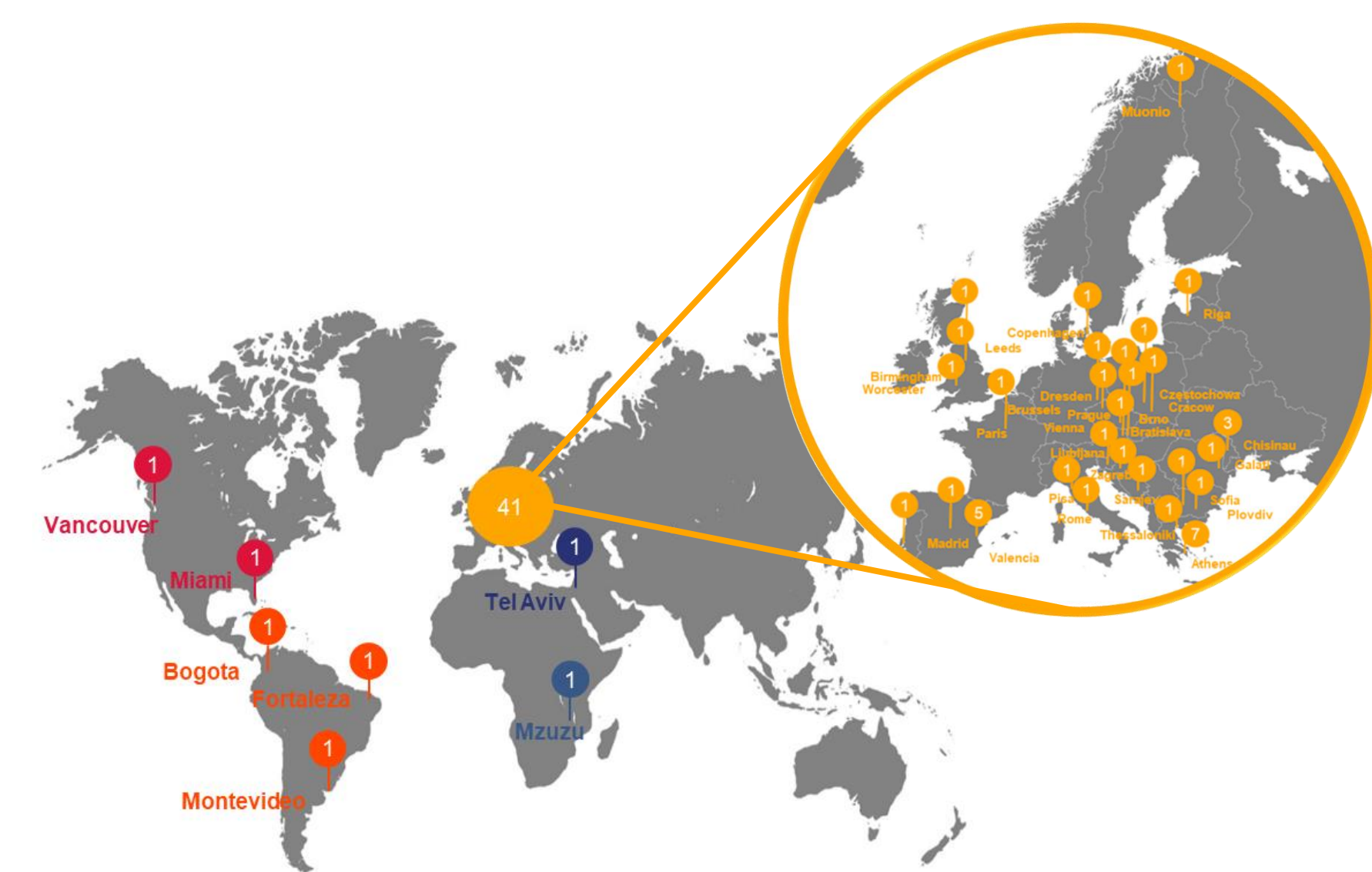


Figure 3 Distribution of stakeholder city coverage

Within this study the **answers analyzed** concerned:

- Work area (Figure 3)
- Education level (Figure 4)
- Working experience (Figure 5)
- Needs related to traffic microsimulation
- Needs on road safety assessment methods
- Expected frequency of using an integrated analytic tool
- Evaluation of how much an integrated analytic tool could impact real-crash numbers

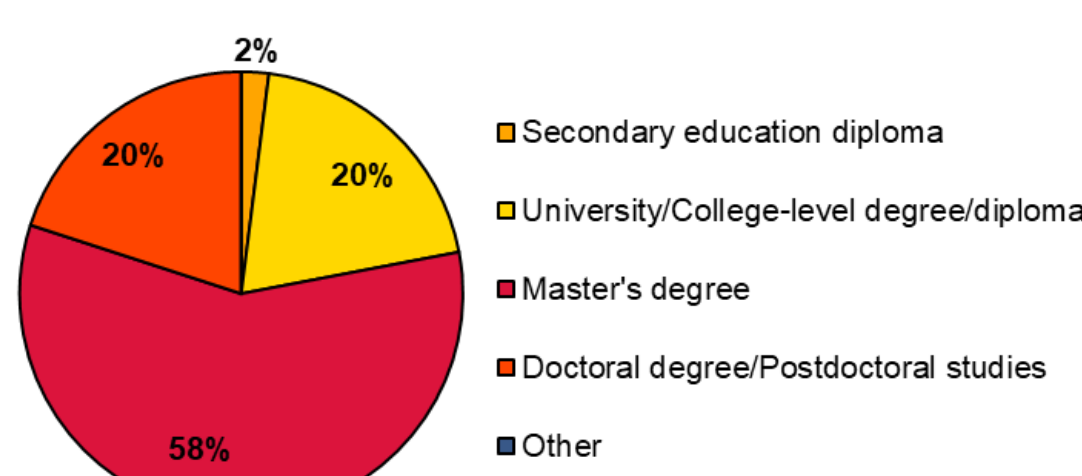


Figure 4 Stakeholder education level

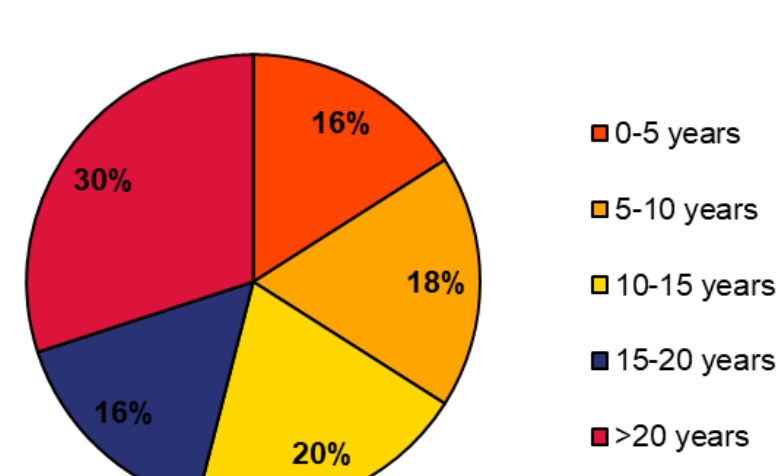


Figure 5 Stakeholder working experience

Apriori Algorithm

In order to analyze the survey data and discover meaningful links of stakeholder characteristics, **association rule mining** was implemented with the Apriori algorithm. Its primary purpose is to identify common item-sets within transactional datasets, which then facilitates the discovery of association rules.

Association rules, characterized by an **antecedent** part (e.g., "if X occurs") and a **consequent** part (e.g., "...then Y occurs as well"). The rules are assessed based on three key parameters:

- **Support** measures the probability that both X and Y occur together.
- **Confidence** expresses the conditional probability that Y occurs given that X has occurred.
- **Lift** measures the ratio between support and confidence.

Traffic Simulation User Profiles

The resulting top 5 association rules of stakeholder characteristics related to their **opinions on the requirements of traffic simulation** are presented in Table 1.

Table 1 Top 5 association rules for stakeholder needs related to traffic simulation

Antecedent	Consequent	Support	Confidence	Lift
5/10 importance of traffic simulation enhancement	Master's degree	0.06	0.750	1.293
8/10 importance of traffic simulation enhancement	Master's degree	0.10	0.833	1.437
Western Europe	10/10 importance of traffic simulation enhancement	0.08	0.667	1.961
<5 years working experience	10/10 importance of traffic simulation enhancement	0.08	0.500	1.471
7/10 importance of traffic simulation enhancement	University/College-level degree/diploma	0.08	0.500	1.471

Based on the above results the following are concluded:

- Stakeholders who present a moderate or an adequate need of simulation tool enhancement hold a master degree title.
- A stakeholder who works in Western Europe has a highly need of simulation tool enhancement.
- Stakeholders who have under 5 years working experience have a highly need of a traffic simulation enhancement.
- Stakeholders stated that there is a 7 out of 10 need of the enhancement hold a University or College-level degree or diploma title.

Safety Assessment User Profiles

The resulting top 5 significant associations among stakeholder characteristics regarding **safety impact assessment methodologies** are detailed in Table 2.

Table 2 Top 5 association rules for stakeholder needs related to road safety assessment

Antecedent	Consequent	Support	Confidence	Lift
7/10 importance of safety assessment enhancement	Southern Europe	0.06	0.500	1.471
7/10 importance of safety assessment enhancement	Master's degree	0.08	0.667	1.149
Western Europe	10/10 importance of safety assessment enhancement	0.10	0.833	2.604
5/10 importance of safety assessment enhancement	5-10 years working experience	0.06	0.500	2.778
5/10 importance of safety assessment enhancement	Master's degree	0.08	0.667	1.149

Based on the above results the following are concluded:

- Stakeholders who state that there is a 7 out of 10 need of road safety assessment methodologies enhancement, they work in Southern Europe and hold a master degree title.
- A stakeholder who works in Western Europe believes that there is a highly need of safety assessment enhancement.
- Stakeholders who believe that is a moderate need of this enhancement, have an experience between 5 to 10 years in their role and hold a master degree title.

Integrated Analytic Tool Expected Usage

The resulting top 5 noteworthy links among stakeholder attributes concerning the **expected usage of an integrated analytic tool** can be found in Table 3.

Table 3 Top 5 association rules for stakeholder expectation to use an integrated analytic tool

Antecedent	Consequent	Support	Confidence	Lift
6/10 expected usage of an integrated analytic tool	Master's degree	0.06	0.750	1.293
9/10 expected usage of an integrated analytic tool	15-20 years working experience	0.06	0.100	2.308
9/10 expected usage of an integrated analytic tool	Master's degree	0.06	0.600	1.034
10/10 expected usage of an integrated analytic tool	Western Europe	0.06	0.500	4.167
Western Europe	10/10 expected usage of an integrated analytic tool	0.06	0.500	4.167

Based on Table 3 the following are concluded:

- It seems that stakeholders who claim there is a moderate possibility of using an integrated analytic tool hold a master's degree title.
- On the other hand, those who state that it is very likely to use this kind of tool have between 15 to 20 years of experience in their roles and also hold a master's degree title.
- A stakeholder who is certain they will use a tool like this works in Western Europe, and conversely, a stakeholder working in Western Europe will use the tool.

Integrated Analytic Tool Expected Impact on Safety

The resulting top 5 significant associations of stakeholder characteristics related to the **expected impact of an integrated analytic tool on safety** are presented in Table 4.

Table 4 Top 5 association rules for stakeholder expectation of an integrated tool impact

Antecedent1	Consequent	Support	Confidence	Lift
8/10 expected impact of an integrated tool on real crashes	Master's degree	0.06	0.500	0.862
Western Europe	7/10 expected impact of an integrated tool on real crashes	0.06	0.500	3.125
9/10 expected impact of an integrated tool on real crashes	10-15 years working experience	0.08	0.667	3.333
10-15 years working experience	9/10 expected impact of an integrated tool on real crashes	0.08	0.400	3.333
9/10 expected impact of an integrated tool on real crashes	Central or Eastern Europe	0.06	0.500	1.563

Based on the above results the following are concluded:

- Stakeholders who believe that an integrated analytic tool will possibly impact real-crash numbers, they hold a master degree title.
- A stakeholder who works in Western Europe believes that there is a moderate possibility of this kind of tool to impact crashes.
- Stakeholders who state that is very likely for a tool to impact crash numbers have experience between 10 to 15 years and they work in Central or Eastern Europe.

Conclusion

Findings offer a quantitative perspective on the interconnections and dependencies among different stakeholder attributes, shedding light on **potential patterns and preferences** that can guide decision-making in the context of road safety improvement.

This study also serves as a crucial resource for **crafting more effective, data-driven road safety strategies** that can ultimately improve safety and make roadways safer for all.

This profiling is not a mandate to exclude stakeholders with different characteristics from using analytic tools. Rather, it is a way to:

- Measure the most likely stakeholder audiences.
- Tailor the developed tools to their needs but also their capacities.
- Develop additional venues, re-sources and tools to reach different stakeholder profiles.

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