EXCASAFEZONE
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DOI
10.7480/spool.2019.2.4368

Publication date
2019

Published in
Spool

Citation (APA)
Scholtenhuis, L. O., Vahdatikhaki, F., Zlatanova, S., Beetz, J., & Pauwels, P. (2019). EXCASAFEZONE: Synthesizing expert based ‘on-the-fly’ safety risk heat maps. *Spool*, *6*(2 #5), 17-20. https://doi.org/10.7480/spool.2019.2.4368

EXCASAFEZONE

Synthesizing Expert Based 'On-The-Fly' Safety Risk Heat Maps

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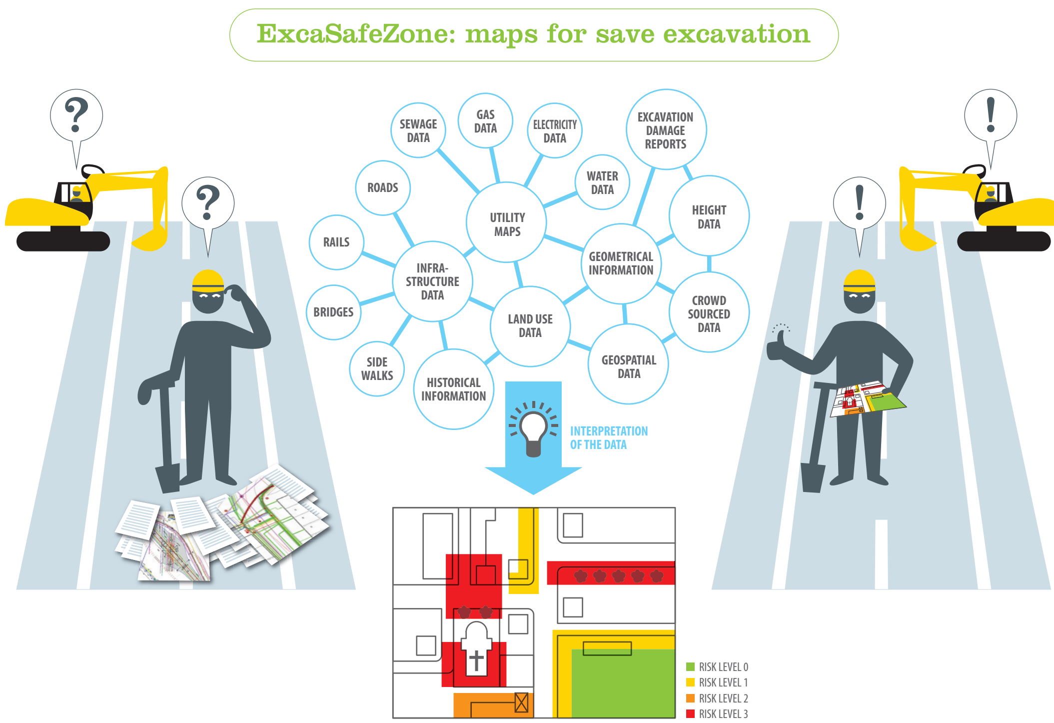
Abstract

Excavation work takes place almost continually in most cities around the Western hemisphere. Many cities are already full of infrastructures, buried networks, and street furniture, so excavation work is not without any thread to the operator and surrounding environment. Small construction sites, for example, are often constrained by operating infrastructure on surface level and underground. Although different agencies and network owners have information about the location of the objects that put excavation work at risk, this information is not centralized. Different organizations manage location information of buried cables, unexploded ordnance, and pollution, for example. This significantly complicates the early-stage planning and last minute risk assessment processes because professionals need to manually collect, assess, and integrate data about subsurface objects into a comprehensive risk assessment. To smoothen this process, ExcaSafeZone project, therefore, develops a system that collects location data, defines expert-based rules for safety risk assessment, and that synthesizes this into an open source prototype that visualized safety risks on a heat map.

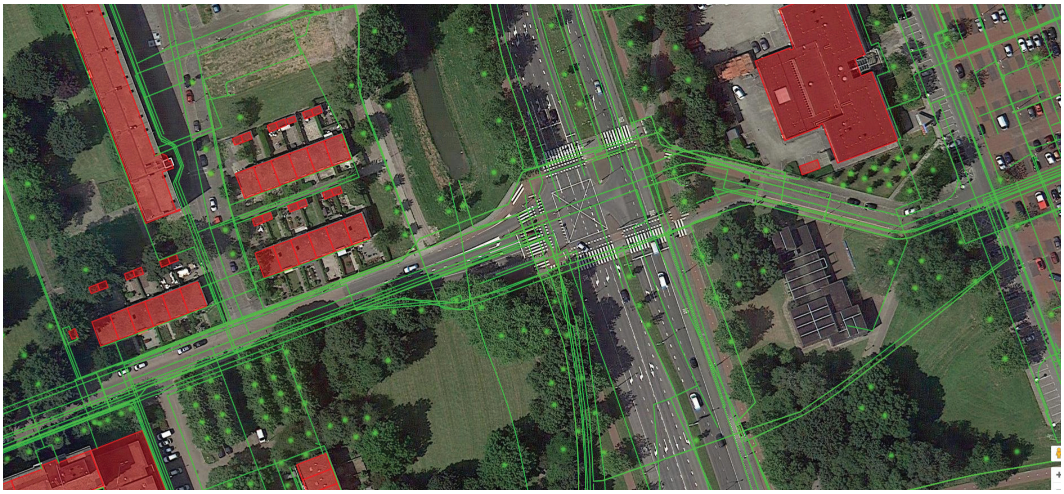
Keywords

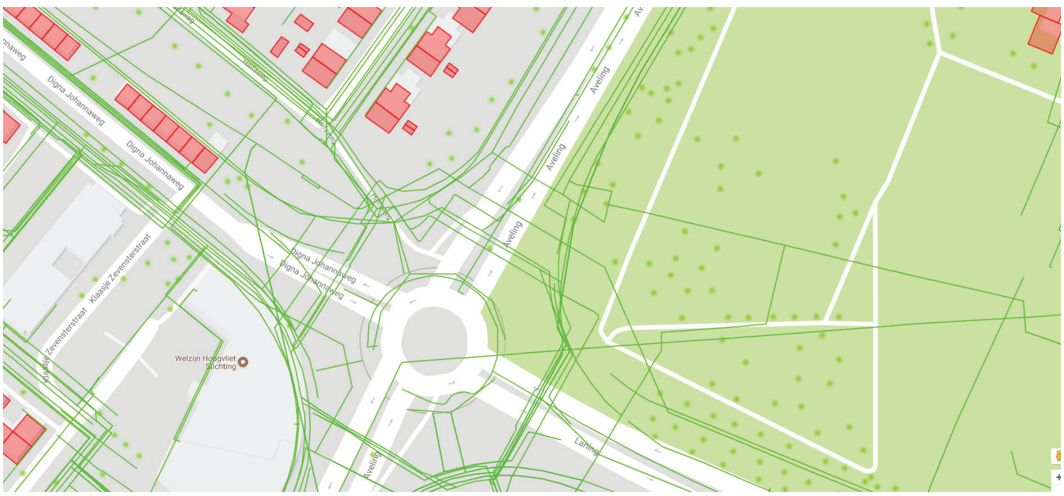
excavation, data, risk, information system, construction, objects

To build a Safety Risk Heat Map system, the research team first gained knowledge about the safety hazards existing on the excavation site. To truly understand these risks, the research team conducted four workshops with excavator operators and work planners from the Dutch excavator operator school SOMA and professional association Het Zwarte Corps (HZC). In the first workshop, the researchers interviewed five respondents that have extensive experience in the various domains of excavation (e.g., waterworks construction, gas pipeline excavation, and road construction). They were asked to individually list sources of risk and to draw a situation that describes a hazardous situation that they remember from a project in the past. The three subsequent workshops presented various different scenarios to 12 professionals. For three different infrastructure configurations (streets, intersections, and areas without buildings or infrastructure), the professionals indicated how the presence of the abovementioned objects creates a risk to onsite safety and project continuity.



As a next step, the researchers analyzed the empirically derived risk scores. This not only allowed the team to better understand how practitioners perceive risks on the construction site, but also helped them to derive the first set of rules that relate the presence of an object onsite to risk. As a next step, the team further consulted what existing open data sources could be used to gain a rich set of information about the objects on the excavation site. Next, they analyzed the content, native format, granularity, and resolution of available data sources to better understand how the various data structures can be integrated into one information system. By using real data from the Hoogvliet district in the city of Rotterdam, the researchers finally developed and tested a prototype that integrates geo-referenced information from different open data sources on a heat map that displays safety risk levels.





The workshops revealed that practitioners judge about safety and project risks by using objects on various levels of granularity. Risk-related objects are, for example, cables and pipelines, older neighborhoods, fiber optic networks, trees, overhead railway power lines, ammunition and explosives, and polluted soil. Risk perception (scaled from 0 to 10 - highest risk) in relation to the identified objects varied between professionals. On average, for example, the 10 excavator operators rate the threats caused by the objects as high (scores ~ 7-8), while two job planners see much less risk (scores ~ 3-4). The average scores of the perceived risk for each object show that professionals agree mostly that explosives, soil, buried objects cause most risk (scores 9, 7 and 8 respectively). In addition, there was a consensus that archeological findings are the least risky with only 4 points.

The scores from the workshop were used to define three risk levels ranging from low risk (e.g. only one risk object with severity <5 points), medium risk (one risk with more than 5 points, or at least two risks with <5 points), and high risk (more than one associated risk with > 5points). We visualized these risks in our web-based heat map prototype. To identify the presence of the risk-related objects on the selected construction site cadaster data, topography data, cable and pipeline maps, ground pollution, land use maps, and road network data were collected, amongst others.

The final step to be taken in this project is the validation of the system with practitioners. The plan is to demonstrate the system to SOMA and members from HCZ and apply it during last minute risk analysis in a hypothetical project to see if the system enables the practitioners in their risk analysis and decision-making on site. Ultimately, the development of the Safety Risk Heat Map may help construction professionals to integrate risk data from open data sources on the fly, generate safety maps, and make informed go-no go decisions for performing excavation work on a particular site. The further development of the prototype for applications in real-life would require, as next steps, a development of user-friendly interfaces on portable devices, as well as the development of a more complete data set of infrastructure data.