Final publishable summary report (Version 1_0 from 25/06/2014)

Executive summary

Increasing urbanisation drives the need for new solutions for security issues on all levels of urban planning. The development of a useful tool set of computer assisted tools that enables urban planners and associated parties, such as architects or engineers to make well-considered, systematic, qualitative and quantitative assessments of urban areas regarding security issues is the goal of this project. In the long-term this will contribute to more robust and resilient cities with a quantitative balance between costs and benefits.

A suite of computerized tools has been developed under the name VITRUV and is readily available for security considerations in urban planning. All the tools were intensively tested over a 12 month period in the project with representative users from urban areas in Bologna, Copenhagen, London and Waterford.

SecuRbAn (quick risk assessment tool: http://www.vitruv-project.eu/downloads.html) provides qualitative but well-structured decision support at the "concept level", before site maps are drawn. The tool assesses the potential relevance of security issues for (re)developed of urban areas based on a questionnaire. It allows the comparison with different configurations and similar situations. The support tool is linked with and supplemented by the online Urban Securipedia knowledge base (http://www.securipedia.eu) which provides a wider range of security relevant definitions, background and potential countermeasures to the user.

When maps are to be drawn, or partly exist for an area to be re-developed the "Plan and Detail level tools" allow quantitative risk analysis to be undertaken by none-specialist users. The 3D graphical user interface provides the choice of a wide range of pre-defined urban infrastructure types including their use and cost. First fast analysis on the "VITRUV plan level" is based on empirical data extracted from the Terrorist Event Database (an in-house but widely recognised database from the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut). Transfer of the methods to crime data from UK sources has been initiated in the project and initially tested. The software allows the evaluation of the susceptibility (empirical probability of an event) of urban objects and their users and the vulnerability (empirical consequences per event). The quantitative empirical risk can be computed and conveniently visualised as the product of both quantities.

An additional refinement step allows on the "VITRUV detail level" a more accurate but more time-consuming prediction using physical consequence models:

1) Explosive threats and effects, using empirical mass-distance relationships for the loading and simplified mechanical models (SDOF) for the damage to infrastructure and persons, together with enhancement products and their associated costs;
2) Engineering tables to evaluate progressive collapse, derived from linear dynamic in combination with non-linear static finite element analyses of the pre-defined building structures;
3) An engineering model for traffic disruption, calculating delay times and reconstruction costs;

4) Poisonous gas clouds (biological or chemical) in CFD calculations combined with threshold concentrations for damage to humans.

The project duration was 36 months from May 2011 until April 2014. The following partners participated in the VITRUV project: Fraunhofer EMI, Crabbe Consulting Ltd., Provincia di Bologna, West Yorkshire Police, Schüßler-Plan, DISSING+WEITLING architecture, TNO, Future Analytics Consulting Ltd (FAC), Sigmund Freud Private University Vienna, CEUSS | Center for European Security Studies, Decisio | Economic Consulting, THALES Security Solutions & Services SAS, London Borough of SOUTHWARK.

Summary description of project context and objectives

Project context

At this moment, more than half of the world population lives in urban environments. A rise to 80% by 2050 is predicted. This concentration of population increases associated security issues. As traditional mitigation measures prove to have limitations, cities are looking for new solutions. The VITRUV toolsuite offers such a solution in enabling urban planners to design security into their plans to:

- Make well-considered systematic qualitative analyses with decision support at the "concept level",
- Analyse quickly the susceptibility of urban spaces (e.g. building types, squares, private and public transport and their functionalities) with respect to new threats at the "plan level", and
- Perform a detailed vulnerability analyses by computing the likely damage to individuals, buildings, traffic infrastructure at the "detail level".

All levels contribute to enabling the development of more robust and resilient structures with respect to urban (re)planning, (re)design or (re)engineering.

In analysing urban areas at the conceptual level a broad approach has been followed to identify urban security risks generally but also comprehensively. Security related issues are placed in relationship with the other aspects within urban planners' decision spaces, such as economic, ethical, social, safety and mobility dimensions. Following the identification of risks, mitigation strategies are presented, including for example which tools, methods or best practices to consider introducing before a further conceptual assessment or during the development of plans and in the detailed design stages. At the plan and detail level quantitative empirical and physical algorithms are applied to identify specific urban security vulnerabilities and to consider specific mitigation options. Plan and detail level are more focussed on threats from the use of explosives or biological and chemical agents. Moreover, the same risk assessment methodology has been applied to general crime in a research version of the tools.

Objectives

The specific overall objectives were:

1) Development of a computer assisted tool that enables city administrators to make well considered systematic, qualitative decisions with regard to the security of cities while developing their overall planning concept.

2) Development of a computer-based tool with:
    a. automated empirical and semi-quantitative risk analysis (ERA) based on database analysis and expert judgment of urban "spaces" using their actual or planned location, design, building types and function for susceptibility analysis (SA); and

b. automated quantitative risk analysis (QRA) of "spaces" based on the detailed characteristics of individual urban spaces, in terms of: location, building types, their structural members, load bearing concepts and function for vulnerability analysis(VA).

3) Integration of the SA and VA functionalities in an urban planner three dimensional Graphical User Interface (3D GUI) which includes guidance on resilience enhancement measures and their costs. The 3D GUI is a graphical user interface (GUI) allowing three-dimensional visualization of urban planning scenarios, analysis input and results.

4) Test and evaluation of the developed computer tools by a range of public and private end users in different urban contexts.

Description of the main S&T results/foregrounds

The main results identified in the project which can be exploited are:

- **VITRUV software**

  The purpose of the software is to support urban planners to better consider urban security within their work and decisions. The software will support urban planners at different stages of their work and levels of decision making. It consists of, or provides access to, all of the foreground results described below apart from the CPD module. The software provides on three levels advice on security aspects to urban planners. The Strategic Concept Urban Planning Tools (STCUP, described below) constitutes the most generic level, early in the planning process. It provides through the decision support tool SecuRbAN (Excel-based) and the connected database of knowledge Urban Securipedia (web-based) advice and structure during general consideration of security as part of the urban concept in mind. The plan and detail level tool software allows generation or import of 3D models of the urban area described. The in-built modules allow then a fast and rough empirical based risk assessment (plan level) or physics based quantitative risk assessment (detail level) without expert knowledge on the methods by the user.

- **Strategic Concept Urban Planning Tool (STCUP)**

  The purpose of the tool is to enable urban planners to systematically integrate security in the conceptual stages of their planning process. It consists of the "SecuRbAN" (risk assessment) and "Urban Securipedia" (knowledge base) foreground results. The SecuRbAn and Urban Securipedia tools are designed to complement each other and to be used in tandem. The combination of the risk assessment and consolidated background information base represents a tangible opportunity for urban planners to ensure that security (and connected safety) aspects are considered during the urban planning process. Although the tool specifically focuses on issues of security, it recognises the fact that urban planners work in a holistic environment, i.e. that they have to consider a widely varied range of aspects and interests from a multitude of parties. Security information and advice within the tool are placed in this context. The Urban Securipedia also serves as an 'inspiration' prompt, allowing the urban planner to identify topics from a perspective that differs from their traditional focus. In a way, it represents an advocacy means to incorporate security and connected safety in the urban environment.

- **SecuRbAn tool**

  The purpose of the SecuRbAn tool is to provide a quick risk assessment to urban planners at the conceptual level of planning. The basis for the SecuRbAn quick risk assessment is an interactive questionnaire that poses a maximum of 76 questions to the urban planners concerning the characteristics or properties of the intended urban development. These questions survey the presence of indicators for the occurrence of a total of 13 crime types. The indicators have been compiled from a literature study and contain both positive and negative indicators for the occurrence of particular types of crime. The answers given are interpreted by a scoring mechanism to represent a measure for the level of attention still required to solve potential security issues. A particularly important feature of SecuRbAn is that it fits into the practical work practices of urban planners, where they have a specific project deadline and need an efficient and effective risk assessment to direct their next steps. The VITRUV consortium end user partners have validated the tool in their own work practices.

- **Urban Securipedia**

  The purpose of Urban Securipedia is to provide a wide range of information about security and everything that is associated with security in the context of the urban planner in the form of a knowledge base. This knowledge is presented in the well-known platform of MediaWiki (the Wikipedia platform). This allows the knowledge to be internally linked, structured and at the same time approachable in a flexible way.

- **Empirical risk modules**

  The purpose of the modules is to provide urban planners with an empirical risk assessment of an urban area in dependency of usage to indicate critical areas. Empirical data, i.e. data based on past events, for terrorist threats (The TED - Terrorist Event Database - is a private in-house database from the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institute) and crime (beta version, recorded offences from the United Kingdom's West Yorkshire police force area) are available. They are handled as data on frequencies per event type, consequences per event and the resulting product as risk per urban objects. The results from the assessment enable urban planners to decide whether further risk assessments, for example with other functions within the "VITRUV software" are necessary.

- **Injury models (inside / outside buildings) applicable to urban planning**

  The purpose of the foreground is to provide urban planners with a quantitative risk assessment of the damage to humans in a defined urban area as a consequence of explosions based on averaged values from multiple (timely disconnected) terrorist attack scenarios. While the empirical frequencies per event type are statistically well-based, the result and statistical reliability of empirical consequences strongly depend on the focus of the considered area. Locally focussed data will be more interesting for the considered case, but less statistically reliable. Therefore, replacing empirical by quantitative consequence (or hazard and damage) models allows much more detailed and physically based risk calculation. Furthermore, they open the option for protection measures and cost benefit analysis. Providing quantitative consequence data has been achieved through the application of injury models for explosive threats. The results from the assessment enable urban planners to decide whether further mitigation or resilient measures should be implemented and how large will be the quantitative benefit.

- **Blast load models for glazing and bearing elements applicable to urban planning**

  The purpose of the foreground is to provide urban planners with a quantitative risk assessment of the initial damage to glazing and bearing elements in a defined urban area as a consequence

of an explosion based on averaged values from various terrorist attack scenarios (i.e. location and size of charge). This has been achieved through the application of engineering injury models for explosive threats. The results from the assessment enable urban planners to decide whether further mitigation or resilient measures should be implemented, how big will be the progress compared to the costs.

- **Progressive collapse models**
  The purpose of the models is to provide urban planners with further quantitative risk assessment of structural damage to urban objects in a defined urban area as a consequence of an explosion based on averaged values from various terrorist attack scenarios (i.e. location and size of charge.). A link is made between the direct consequences of a blast wave to load bearing structures and the follow-up consequences due to possible progressive collapse. This has been implemented for ten types of exemplary building structures. The results from the assessment enable urban planners to decide whether further mitigation or resilient measures should be implemented.

- **B & C module (injury model for outside of buildings) applicable to urban planning**
  The purpose of the module is to provide urban planners with a quantitative risk assessment of Biological and Chemical (B&C) threats outside buildings based on averaged values from various dispersion scenarios (i.e. location and amount of dispersion). The results from the assessment enable urban planners to decide whether further mitigation or resilient measures should be implemented.

- **Vulnerability analysis module (Automated generation of multiple attacks)**
  The purpose of this result is to automatically determine where possible threats can be positioned in the considered urban area (without identifying them to the user). The visualised results of the various quantitative risk assessments described above show an average of all possible threat positions. The ability for a user to obtain a quantitative risk assessment for a specific location and threat quantity are disabled within the “VITRUV software” to avoid the provision of security critical information. This functionality is seen as the only responsible way to make quantitative risk assessment accessible to a wider user community without security concerns.

- **Traffic network analysis**
  The purpose of this result is to provide urban planners with a quantitative risk assessment of the damage to the functionality of traffic nets from direct and indirect threats. Damage has been considered in terms of rebuilding cost and delays to travel time. A software-based traffic model of a generic city was used. The number of trips, the total travel distance and total travel time within this generic city were calculated for different scenarios (unaffected traffic net, affected traffic net). The results of the calculations are factors of prolongation of travel time for different scenarios which have been integrated as tabulated engineering data into the “VITRUV software”. The results from the assessment enable urban planners to decide whether further mitigation or resilient measures should be implemented.

- **Cost benefit analysis of enhancement measures**
  The purpose of this result is to provide urban planners with an estimation of the additional costs of enhancement measures to minimize the consequences concerning explosive threats in urban areas to enable them to carry out a cost-benefit analysis. Testing of security products at EMI can be enriched by integrating the tested product directly into an urban security assessment software.

- **Import feature of dxf data (3D modelling)**
  The purpose of this feature is to enable an urban planner to create an urban area in the "VITRUV software" by importing 3D Computer Aided Design (CAD) designs. This is a basis for the risk and mitigation assessments in the software.

- **2D plan import applicable to urban planning**
  The purpose of this feature is to enable an urban planner to create an urban area in the "VITRUV software" by importing 2D images saved .jpg or .gif and the manual generation of urban objects using the "VITRUV software" tools. This is a basis for the risk and mitigation assessments in the software, as an alternative to importing the dxf files (mentioned above).

- **Continual Professional Development (CPD) module**
  The purpose of the CPD is to provide urban planners and future security & safety engineers with training on the consideration of security issues and how they should consider them in their planning. Results from the project are used to demonstrate how security issues can be recognised, assessed and development plans enhanced to mitigate risk. In this way the module informs urban planners about security issues and also the benefits of the use of the tools.

- **Assessment of developed systems**
  This result consists in an evaluation of the performance of the technology developed in the project, particularly with regards to the requirements of end users. This knowledge will be input into the re-engineering and/or further development following the end of the project.

- **VITRUV as reference project**
  This result consists in being a member of a successful international collaborative research and technological development (RTD) project and specifically in the area of the Framework 7 programme, Security and Urban security.

Potential impact and the main dissemination activities and exploitation of results

The project has provided research and development results targeted towards the project objectives listed above. The expected use and impact of the results are:

The "STCUP Tool" (consisting of of "SecuRbAN" + "Urban Securipedia") have been publicly available on-line and free-of-charge since January 2014. Securipedia was on-line during its whole development. The tool has been made available free of charge in order to try and attract as many potential users as possible and to receive their feedback. The partners also see this as a way to become even more established as experts and reference points for urban security questions.

The "VITRUV software" will be offered for sale visa licence. In the first stage the licenced software will contain, or provide access, to all elements of the foreground apart from the "B&C module" (and the CPD module because of its nature). The "VITRUV software" will not directly contain the "STCUP" but will provide direct access to it through its Graphical User Interface (GUI). In a further stage the "B&C module" could be included in the "VITRUV software" made commercially available.

The Partners of this project can utilise the experience demonstrated and gained as a reference for obtaining future customer, support, development and consulting contracts.

Knowledge and experience gathered during the project has been used to develop content for a Continuous Professional Development (CPD) module. The purpose of the CPD is to provide urban planners and security & safety engineers with training on the consideration of security issues and how they should consider them in their planning. Results from the project are used to demonstrate how security issues can be recognised, assessed and plan enhanced to mitigate risk. In this way the module inform urban planners about security issues and also the benefits of the use of the tools.

Nearly 100 dissemination activities were achieved during the project period, targeting audiences around the world. The audiences included the scientific community, industry, civil society, policy makers and the media. The activities varied from presentations, publications, flyers, posters and websites to interviews as well as contributions to conferences, workshops and specialised journals.

A project webpage was launched (http://www.vitruv-project.eu/) which includes besides project related information also a direct link to the free-of-charge concept level tools. The project has also been published on third party websites such as the European Crime Prevention Network: http://www.eucpn.org/research/projects.asp

An information leaflet/flyer has been produced for distribution at suitable events. It is available in Danish, Dutch, English, French, German and Italian.

Benefits: Greater awareness of security within urban planning with tools offering a consistent approach to integrate security and safety which in turn will improve policy decisions and accountability. The tools will contribute to enabling the development of more robust and resilient areas in the field of urban (re)planning, (re)design and (re)engineering. Planners using VITRUV's tools will be able to deliver urban areas less prone to and affected by terrorist attacks, general.

Project public website

http://www.vitruv-project.eu/

http://www.securipedia.eu