H2020 Project: Smart Resilience Indicators for Smart Critical Infrastructure
D6.5 - SmartResilience e-learning platform

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SmartResilience e-Learning platform

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## Release History

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Modern critical infrastructures are becoming increasingly smarter (e.g. the smart cities). Making the infrastructures smarter usually means making them smarter in the normal operation and use: more adaptive, more intelligent etc. But will these smart critical infrastructures (SCIs) behave smartly and be smartly resilient also when exposed to extreme threats, such as extreme weather disasters or terrorist attacks? If making existing infrastructure smarter is achieved by making it more complex, would it also make it more vulnerable? Would this affect resilience of an SCI as its ability to anticipate, prepare for, adapt and withstand, respond to, and recover? What are the resilience indicators (RIs) which one has to look at?

These are the main questions tackled by SmartResilience project.

The project envisages answering the above questions in several steps (#1) By identifying existing indicators suitable for assessing resilience of SCIs (#2) By identifying new smart resilience indicators including those from Big Data (#3) By developing, a new advanced resilience assessment methodology based on smart RIs and the resilience indicators cube, including the resilience matrix (#4) By developing the interactive SCI Dashboard tool (#5) By applying the methodology/tools in 8 case studies, integrated under one virtual, smart-city-like, European case study. The SCIs considered (in 8 European countries!) deal with energy, transportation, health, and water.

This approach will allow benchmarking the best-practice solutions and identifying the early warnings, improving resilience of SCIs against new threats and cascading and ripple effects. The benefits/savings to be achieved by the project will be assessed by the reinsurance company participant. The consortium involves seven leading end-users/industries in the area, seven leading research organizations, supported by academia and lead by a dedicated European organization. External world leading resilience experts will be included in the Advisory Board.
Executive Summary

The key objective of Task 6.1 of the SmartResilience project was to develop and provide an e-Learning platform to share the project results with the relevant stakeholder communities and supplement the “ResilienceTool”. To this end, Moodle – an open-source learning management system (LMS) written in PHP and distributed under the General Public License (GNU) – was chosen as the online platform for the support of the SmartResilience specific courses: “Indicator-based resilience assessment for CIs - the SmartResilience methodology and tools” and “Resilience Assessment of Critical Infrastructures.”

The courses were developed and lectured as part of the Joint Workshop DRS-7&14 “Aligning the resilience-related research efforts in the EU-DRS projects” (participating projects: RESOLUTE, DARWIN, RESILENS, SmartResilience, OECD, IMPROVER, SMR), organized from September 13-14, 2017, in Brussels, Belgium.

In addition to the project-specific courses, other courses in risk-related topics, such as occupational safety and the associated standards, etc., have been developed and made available in the e-Learning platform.

The provision of these courses in the e-Learning platform facilitated access to the materials during the project as well as after the end of the project, as the platform will be kept alive after the project ends.

The three primary research outcomes related to the project’s e-Learning platform are that it:

1) is open and freely accessible to any interested user,
2) can continue to be extended to include additional courses, and
3) can be customized for each user based on their educational needs.
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<td>CI</td>
<td>Critical Infrastructure</td>
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<td>DCL</td>
<td>Dynamic Checklist</td>
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<td>RL</td>
<td>Resilience Level</td>
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<td>FL</td>
<td>Functionality Level</td>
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<td>GA</td>
<td>Grant Agreement</td>
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<td>GDPR</td>
<td>General Data Protection Regulation</td>
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<tr>
<td>LMS</td>
<td>Learning Management System</td>
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<tr>
<td>PHP</td>
<td>Hypertext Preprocessor (a general-purpose programming language)</td>
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<td>REM</td>
<td>Risk Engineering and Management</td>
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<td>REWI</td>
<td>Resilience based Early Warning Indicators</td>
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<td>SCI</td>
<td>Smart Critical Infrastructure</td>
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<td>SHB</td>
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<td>SME</td>
<td>Subject Matter Expert</td>
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<td>SPO</td>
<td>Studien- und Prüfungsordnung (SPO); also referred to as Study and Examination Regulations (SER)</td>
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<td>WP</td>
<td>Work Package</td>
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<td>GNU</td>
<td>General Public License</td>
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1 Introduction

As part of the SmartResilience project’s work package 6 (WP6): Dissemination and Exploitation, task 6.1’s objective is to “use [a] e-learning platform as a tool to outreach the project results focusing the identified stakeholder communities by means of training and education”\(^1\). Therefore, the objective of this deliverable was to develop a particular course to introduce the project results to the expected audience – the SMEs or users who are responsible for the resilience assessments within a critical infrastructure’s organization, at the competent authority, the insurer or any other stakeholder, including carrying out the necessary calculations using the ResilienceTool or its alternatives. As such, this person can be an in-house person performing self-assessment, or it may be an external assessor performing assessments on behalf of for example infrastructure owners/operators, city officers/planners, regional authorities, or national agencies.

Furthermore, this course had to be designed for self-learning and available openly online for audience use. To accommodate this goal, Moodle, a widely accepted and convenient tool and an open source e-Learning platform, was selected in order to enable potential interested parties to acquire knowledge about the SmartResilience methodology and tools developed and used during the project. The courses were developed according to and by the authors of the guideline for the SmartResilience methodology provided in Deliverable 3.6.

This document first elaborates on the SmartResilience project and its dissemination efforts in order to frame the context for the deliverable. Then, it briefly introduces Moodle - the chosen platform for implementing the main and supplementary courses. The third chapter is dedicated to the workshop held in Brussels in 2017 in which the course material was validated in front of live audience as part of the project’s dissemination efforts. The fourth chapter discusses how the SmartResilience courses are being embedded into the (optional) programs of Steinbeis University Berlin, while the fifth chapter provides a walkthrough for how new users can create accounts in order to access the freely-available SmartResilience courses.

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\(^1\) SmartResilience Grant Agreement Grant Agreement No 700621 (2016-2019)
1.1 SmartResilience: A short overview

Modern society needs a system of resilience management going beyond conventional risk management in order to address the complex behavior of large integrated systems and critical infrastructure, in particular, that which is exposed to the uncertainty of possible current and future threats. As such, the term “resilience” has gained strong attention in the last years (in- and outside the EU) and has been used in several disciplines including ecology, psychology, social research, and sustainable science.

SmartResilience does not claim to provide a universal answer to the question of resilience but builds on definitions and concepts that are assumed to be most suitable for assessing smart critical infrastructure resilience, finally developing a suitable definition2 (see Box 1). SmartResilience therefore does not start from scratch in developing methodologies and tools but instead combines exploitation of established solutions with new developments. It strongly builds on previous work in different fields such as critical infrastructure protection (overall approaches as well as with regard to specific types of infrastructure and different types of threats), smart cities, resilience assessments, and agent-based models to assess interdependencies, ripple and cascading effects. In addition, it makes use of new possibilities arising from recent technical developments (such as big data, open data) to develop an advanced methodology for assessing smart critical infrastructure (SCI) resilience, especially focusing on interdependencies and cascading effects. Thus, recent technical developments are addressed on the challenges’ side (i.e. possible increased vulnerabilities due to “smartness” of critical infrastructures) as well as on the solutions’ side (e.g. inclusion of big and open data in resilience indicators, making previously business critical processes obsolete by smart solutions). The implementation of the project results practically means providing a basis for gaining crucial knowledge for further activities (i.e. decision support). The project’s results are expected to promote activities to enhance specific aspects of SCI resilience, thus improving societal security; these activities will therefore have a shortened path to implementation and further exploitation.

1.2 Context within the project’s dissemination efforts

The grant agreement (GA) asked to ensure wide communication of the project results to all potential interested parties and to the widest possible audience throughout the project lifecycle as well as after its completion. The project dissemination efforts include, among others, participation in conferences, professional workshops, and official publications, as well as the introduction of an e-Learning platform.

The goal of the e-Learning platform is to help consolidate, spread, and apply the knowledge needed to assess and improve resilience of critical infrastructures by presenting the main outcomes of the project, tackling the discrepancies about the resilience assessment approaches, methods, and tools and highlighting aspects of the practical quantitative assessment of resilience.

In its essence, the platform completes the set of tools that were developed in the project (ResilienceTool [www.resiliencetool.eu-vri.eu]) by providing further training in the areas of resilience. Due to the complexity of the matter, the training method offered by the e-Learning portion should be considered an integral part of the ResilienceTool.

Box 2: SmartResilience dissemination: The feedback from testing the e-Learning platform

As part of the project’s dissemination efforts within WP9, the e-Learning platform was presented within the context of the ResilienceTool to 27 international organizations (end-users) in order to gain their feedback and incorporate it into both the e-Learning platform and ResilienceTool. This feedback is available both at the individual course level and at the overall ResilienceTool level. The e-Learning has also been specifically tested with at least one end-user company through inclusion of the SmartResilience courses into the company’s “learning academy.”

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The initial platform created in the first phase of the work on the task was replaced by a new one, based on the GA amendment No.6 (Reference No AMD-700621-31) of November 2018. The main reason for this change was the wish to create a platform integrated with the SmartResilience Resilience Tool (see Figure 1). In order to gain end-user feedback, as part of the project’s dissemination efforts within WP9, the e-Learning platform was presented within the context of the Resilience Tool to 27 international organizations (end-users). Their feedback was collected and incorporated into both the e-Learning platform and the Resilience Tool. This dissemination is further described in SmartResilience deliverable D9.1: Disseminating project results to resilience-related organizations and exploring future applications.³

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³ SmartResilience deliverable D9.1 is available for download at http://www.smartresilience.eu-vri.eu/Results.
An e-Learning platform was required to create a bridge between the project results and acquired knowledge with the global parties interested in learning from these results and knowledge.

The e-Learning platform is based on Moodle and designed to provide educators, administrators, and learners with a single robust, secure, and integrated system to create personalized learning environments. Steinbeis Transfer Institute Advanced Risk Technologies, as part of Steinbeis University Berlin, is administering this platform and has set a specific section within the platform for the SmartResilience project courses.

All course materials, as well as information about the lecturers, can be found on the platform. Participants are registered for the courses they attend and are able to see all course related information.

### 2.1 About Moodle

Moodle is a free and open-source learning management system (LMS) written in PHP and distributed under the General Public License (GNU). Moodle is a leading virtual learning environment and can be used for many applications, such as education, training and development. Moodle is used for blended learning, distance education, flipped classroom, and other e-Learning projects in schools, universities, workplaces and other sectors around the world.

Moodle’s basic structure is organized around courses. These are essentially pages or areas within Moodle where teachers can present their learning resources and activities to students.

Moodle’s plugins are a flexible tool set, allowing Moodle users to extend the features of the site, as has been done for the SmartResilience project (see Figure 2). For example, as shown in Figure 3, the e-Learning platform has been extended with modules that support gaming.

![Figure 2: The e-Learning platform for the SmartResilience project - landing page](https://moodle.org)
2.2 **SmartResilience specific courses**

The SmartResilience project created two specific courses on its methodology and results which were developed specifically to match and accompany its guideline (D3.6) and the dedicated tool “ResilienceTool” (D3.7), as well as to correspond with the results and requirements arising from the end-users (D1.3, D3.1, D4.4 and the Brussels workshop in 2017). These two courses are:

1. Resilience Assessment of Smart Critical Infrastructures
2. Indicator-based resilience assessment for CIs - the SmartResilience methodology and tools

In addition, complementary courses, provided by Steinbeis⁵, have also been added and put on offer. Several of these courses have first been offered in an in-person format before before being All available SmartResilience courses (see Figure 4) can be found listed at [http://moodle.risk-technologies.com/moodle/course/index.php?categoryid=34](http://moodle.risk-technologies.com/moodle/course/index.php?categoryid=34).

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⁵ Steinbeis University Berlin Transfer Institute Advanced Risk Technologies
2.2.1 Indicator-based resilience assessment for CIs - the SmartResilience methodology and tools

This course provides a lecture on indicator-based resilience assessment with a focus on the developments in the SmartResilience project, distinguishing the SmartResilience approach from already known risk management systems. The course describes step-by-step how to perform resilience assessments in a transparent and structured manner for one or more critical infrastructures within an area, e.g. a city. The most relevant threats, such as terrorist attacks and cyber-attacks, are assessed for each critical infrastructure (CI), focusing on the “issues” (factors, capacities, capabilities, etc.) that are most important to ensure resilience in each phase of the resilience cycle from understanding risk to adapt and learn.

The key concepts of the methodology are explained as well as how to define suitable sets of indicators for the selected critical infrastructures and relevant threats to generate "dynamic checklists" (DCL). This and the use of other supporting tools are all covered in the course. One key reference method forming the basis for the SmartResilience methodology (in addition to the REWI method) - the method developed by Argonne National Laboratories, which is widely used in the United States, is also covered.

This course is aimed at practitioners and anyone who is responsible for generating resilience assessments for their organization and/or checking those assessments. The expected outcome of the course is an improved understanding of resilience and its assessment through the use of the SmartResilience methodology, as well as a better grasp of the projects’ fundamentals.

2.2.2 Resilience Assessment of Smart Infrastructures

This course is the direct result of the SmartResilience project methodology, incorporated with the input provided by end-users in the various stages and deliverables of the project to create a full, stand-alone course that delivers the developed resilience assessment methodology, its various use cases, and an overview of the project ResilienceTool. It is aimed at professionals and assessors who seek to deepen their
knowledge in resilience assessment and the use of the integrated tool. The Table of Contents for this course, as offered within the e-Learning platform, is provided in Figure 5).

![Table of Contents](image)

**Figure 5:** Resilience assessment of critical infrastructures course’- course table of contents

### 2.3 Further courses currently on offer on the e-Learning platform

The offered courses are constantly being updated and maintained; new courses, resulting from new connected topics or being provided/offered by collaborating institutions and organizations, are being added, as needed. The current list of offered courses includes not only the formal training on the SmartResilience Methodology that has been offered as part of the SmartResilience Workshop in September 2017 but also additional training offers from Steinbeis University Berlin (see Chapter 4) as well as from other partners (see list of lecturers, Section 2.4). Examples of these further offered courses include:

#### 2.3.1 Regulatory framework for Critical Infrastructures

This is an introductory course on standards, international, European and national policies, legislation, soft laws and key ruling court cases for students at the Bachelor’s degree level.

#### 2.3.2 Introduction to Risk Management

The course covers the main topics of industrial safety, starting with different aspects of risks and terminology used in the field. The main part of the course is dedicated to the related EU directives and their application in industry. The course outlines goals, scope, and required measures/obligations considering acute (e.g. accidents-related) and chronic (e.g. pollution-related) risks. Special attention is devoted to major accident prevention and related process safety risk assessment methodologies.
2.3.3 **Principles and Methods of ISO 31000**

The course covers the International Standard of ISO 31000:2009 highlighting the relationship between the risk management principles, framework and process as described in this International Standard. The course also highlights issues related to the applicability of the standard in industry and in general.

2.3.4 **Risk Governance Concepts and Practices**

The course explains principles of modern risk governance including its main elements as described in the IRGC framework:

- pre-assessment
- risk appraisal
- risk characterization and evaluation
- risk management and e-risk communication.

Apart from each of the elements (e.g. under “Risk Assessment”: hazard identification and estimation, exposure and vulnerability assessment, risk estimation, exposure and social concerns, socio-economic impacts) the examples from industrial practice will be shown and explained. A separate part of the course will be dedicated to the overview of specific methods and techniques (e.g. Delphi), as well as to the tools and instruments facilitating the application by industry, governments and public bodies.

2.3.5 **Risk Perception and Risk Communication**

This course presents theoretical backgrounds and state-of-the-art research issues on perception and communication of risk. It aims to provide a solid basis for further developments of such work tasks by including theoretical achievements in the related fields, various examples from field work, and an internal training exercise. The understanding of communication processes and the improving of information and communication techniques related to risk and hazards are central themes of the course. The course will also provide insight into selected historical aspects as well as current topics and literature.

In order to facilitate the bridge between theory and practice, a special attention will be given to two methodologies that enable the implementation of Risk Perception and Risk Communication concepts: The Delphi and the Focus Group. Beyond their description, this unit will be complemented with exercises based on experience of Focus & Delphi group work.

2.3.6 **Emerging Risks**

The course introduces and transfers knowledge on emerging risks and management of emerging risks. The risks considered as "emerging" are primarily the risks previously not recognized as such, e.g. the risks due to new processes, new technologies, new ways of working or risks due to social or organizational changes (the risks linked to nanotechnologies, bio-technology, new chemicals, outsourcing, globalization are practical examples tackled within the course). The risks due to the change in public perception or new scientific knowledge are considered as well.

2.3.7 **Business Continuity Risks & Insurance**

Complement other courses devoted to technical and engineering issues of risk management in industrial plants (petrochemical plants, process industry, power plants, etc.). Technical risks in the above plants can be a cause or a contributing factor in/for the business continuity and the final outcome of the technical/engineering activities is practically always to be seen on the background of business implications and implications/impacts to the business activities of a company. The insurance aspects are the most relevant practical aspect linking the engineering and business side of the company operation and asset management; therefore, these are tackled too.

2.4 **Lecturers from the SmartResilience project**

The following persons were appointed as lecturers of the SmartResilience courses currently in the e-Learning platform – all of them having actively participated in the SmartResilience project and being renowned in their specific course-related area:
2.4.1 Lecturers outside the project

The following persons were appointed as lecturers of the further courses currently in the e-Learning platform – all being renowned in their specific course-related areas and being registered lectures through SHB:

- Prof. Orwin Renn
- Prof. Dirk Linowski
- Dr. Jörg Bareiß
- Dr. Marko Gerbec
- Dr. Reto Schneider
- Dr. Frederick Petit
- Dr. József Balla
- Ms. Vanessa Pfau

2.5 Future Development

In the future, additional courses will be added to the curriculum of the e-Learning platform of SmartResilience. It is planned to maintain the platform after the project ends in order for it to be accessible and maintain its relevance for stakeholder groups. In addition, it is envisaged to include the platform in any other upcoming EU projects in the area of risk and resilience.
3 Formal Training within the SmartResilience project

3.1 General

As part of the dissemination activities of SmartResilience and in order to “test” the educational material with a live, professional audience, a training course on “Indicator-based resilience assessment for CIs - the SmartResilience methodology and tools” was developed and lectured as part of the Joint Workshop DRS-7&14 “Aligning the resilience-related research efforts in the EU-DRS projects” (participating projects: RESOLUTE, DARWIN, RESILENS, SmartResilience, OECD, IMPROVER, SMR) organized in September 13-14, 2017 in Brussels, Belgium. The agenda from this course is provided in Figure 6.

Feedback from the course was incorporated along with results arising from D1.3, D3.1 and D4.4 into the complementary course “Resilience Assessment of Critical Infrastructure” which together deliver the project’s methodology within its own context as well as a stand-alone educational course. The Joint Workshop DRS-7&14 projects in 2017 gathered 160 leaders from the government, industry, research and technology organizations (RTOs) and academia around the world. 28 countries were represented in the workshop, and most of the participants came from Germany, Italy and United Kingdom. In addition, even though the primary focus was the EU-funded projects, other international bodies were present in this workshop, namely the Organization for Economic Co-operation and Development (OECD), the United States Department of Homeland Security (DHS), and the Argonne National Laboratory (ANL).

This international perspective provided the workshop participants a broader view of resilience assessment methods and tools, as well as a deeper understanding of how application cases from different projects might yield valuable lessons for international...
cooperation in the area of resilience. As part of the workshop, a course was developed and offered about the “Indicator-based resilience assessment for CIs - the SmartResilience methodology and tools”. The goal of the course was to present the methodology and resilience related information to a broad range of experts with different backgrounds. The exploitation of the project results and further activities in the area of resilience is based on developing a common understanding about the need for resilience assessments and monitoring within the EU but also worldwide. This is why expert communication, skill development and knowledge-transfer through training are of enormous importance during the SmartResilience project and after its end.

The developed course material was transferred to the SmartResilience Moodle platform and an online-course was created out of the developed materials, too, and is accessible for both, persons within and outside the project.

### 3.2 Launching the e-Learning platform: SmartResilience Course, September 2017 - Brussels

The course “Indicator-based resilience assessment for CIs - the SmartResilience methodology and tools” (also now available as online-course in the e-Learning platform) presented the main outcomes of the project, tackling the discrepancies about the resilience assessment approaches, methods and tools and highlighting aspects of the practical quantitative assessment of resilience. It included 4 units (also see Figure 7):

- Unit 1: State-of-the-art, basic principles, approaches
- Unit 2: Theoretical background, methods & tools
- Unit 3: Practical application: Industry
- Unit 4: Practical application: civil structures

“The course provides a lecture on indicator-based resilience assessment with focus on the developments in the SmartResilience project. The course describes step-by-step how to perform resilience assessments in a transparent and structured manner for one or more critical infrastructures within an area, e.g. a city. The most relevant threats, such as terrorist attacks and cyber-attacks, are assessed for each critical infrastructure focusing on the "issues" (factors, capacities, capabilities, etc.) that are most important to ensure resilience in each phase of the resilience cycle from understanding risk to adapt and learn. The issues are measured by resilience indicators, and any type or form of indicators are considered appropriate, meaning that it can be yes/no questions, numbers, percentages, portions, or some other type. Proposals for issues and indicators, i.e. "candidate" issues and indicators have been collected throughout the SmartResilience project and stored in a database. Suitable sets of indicators for selected critical infrastructures and relevant threats are generated as "dynamic checklists" from the database. This and other supporting tools will be explained in the course. One key reference method forming the basis for the SmartResilience methodology (in addition to the REWI method) is the method developed by ANL and extensively used in the US. The ANL method will be presented by one of its core developers.”
INDICATOR-BASED RESILIENCE ASSESSMENT FOR CIS - THE SMARTRESILIENCE METHODOLOGY AND TOOLS

COURSE SUMMARY

The context of the course has been developed within research done in the EU funded project SmartResilience (Grant Agreement no. 700621) and is part of the SmartResilience e-learning platform (http://www.smartresilience.eu/vrl.eu/sup/).

This course provides a lecture on indicator-based resilience assessment with focus on the developments in the SmartResilience project. The course describes step-by-step how to perform resilience assessments in a transparent and structured manner for one or more critical infrastructures within an area, e.g. a city. The most relevant threats, such as terrorist attacks and cyber-attacks, are assessed for each critical infrastructure focusing on the “issuies” factors, capacities, capabilities, etc.) that are most important to ensure resilience in each phase of the resilience cycle from understanding risk to adapt and learn. The issues are measured by resilience indicators, and any type or form of indicators are considered appropriate, meaning that it can be yes/no questions, numbers, percentages, points, or some other type. Proposals for issues and indicators, i.e. “candidate” issues and indicators, have been collected throughout the SmartResilience project and stored in a database. Suitable sets of indicators for selected critical infrastructures and relevant threats are generated in a “dynamic checklist” from the database. This and other supporting tools will be explained in the course. One key reference method forming the basis for the SmartResilience methodology (in addition to the KRISP method) is the method developed by Argonne National Laboratory (ANL) and extensively used in the U.S. The ANL method will be presented by one of its core developers.

SMARTRESILIENCE METHODOLOGY FOR RESILIENCE ASSESSMENT

This course materials consist of the following items:

1. Introduction
   - What is resilience?
   - State-of-the-art: basic principles, approaches
   - What can we measure?

2. Method for defining functionality/performance vs. resilience level
   - Overview
   - Examples

3. Tools

4. Conclusions for the 1st part

5. SmartResilience methodology short course
   - Introduction
   - Method development
     - Six-level model
   - Issues and resilience levels
   - Method steps
     - Overview
     - Steps 1-10 (including examples)
     - Demonstrate transparent calculations
     - Conclusions for the 2nd part

6. Argonne National Laboratory: Methodology and its application in the U.S
   - United States Context
   - Rail, Resilience and Interdependencies
   - Infrastructure Protection and Resilience Indicators
   - Infrastructure Interdependencies
   - Infrastructure Protection and Resilience Assessments

The course materials are available here.

Figure 7: SmartResilience e-Learning platform: Course Description & Agenda for the “Indicator-based resilience assessment for CIS - the SmartResilience methodology and tools” course (expanded from the in-person course curriculum offered in September 2017)
3.2.1 Participants

In total 36 persons registered and attended this formal training on the SmartResilience methodology offered on September 14, 2017.

![Pie chart showing participants' distribution by type.](image1)

Figure 8: SmartResilience course participants: Profession

The background of participants was mostly from Research and Industry, with fewer persons coming from Government/Politics and other areas. In total, 16 countries were represented through the course participants, including 1 representative from the United States (other participants were from EU countries).

![Pie chart showing participants' distribution by country.](image2)

Figure 9: SmartResilience course participants: Nationalities
3.2.2 **Venue**

The workshop and the course on SmartResilience methodology were hosted at the BAO Congress Centre, rue Félix Hap 11, 1040 Brussels, Belgium.

3.2.3 **Lecturers**

The following persons lectured of the course in Brussels and have been included into the list of lecturers of the e-Learning platform (see section 2.4) – all of them having actively participated in the SmartResilience project and/or being renowned in the specific courses related area:

- Prof. Aleksandar Jovanovic
- Dr. Knut Øien
- Frederick Petit

3.3 **Implementing/using the platform at project partner (end-user) sites**

As part of end-user testing of the e-Learning platform, the platform was used to support in-person courses offered at SmartResilience partner project sites. For example, three in-person courses, supported by material in the e-Learning platform, were offered between November and December 2018 to participants from SmartResilience project partner NIS. These three courses can be found on the e-Learning platform under “Industrial Projects: PSMS courses” as shown in Figure 10.

![Industrial Courses in the e-Learning platform: PSMS courses offered to SmartResilience project partner NIS](image)

During the in-person offerings of these courses, feedback was collected in order to improve the content of the courses uploaded into the e-Learning platform. A sample of this feedback is shown in Figure 11, with full course evaluation data for one offering of each of these three courses shown in Annex 3.
Figure 11: Feedback collected on the quality of course material for an in-person offering of the PSMS course Element 10: Asset (offered in December 2018)
4 Embedding the SmartResilience Courses in the Master and Certification Program of Steinbeis University Berlin (SHB)

The European Master and Certification Program in Risk Engineering and Management (REM) has been based on several international as well as EU industrial projects, and its curriculum design is compatible with several educational projects. Moreover, in these industrial projects there are a number of companies that are involved, among others Slovnaft, Shell, NIS, Gazprom, Petronas, Sinopec etc. Universities, educational and other institutions are also involved in the program.

The Master and Professional Certification program is state-acknowledged and accredited in Germany, as part of Steinbeis University Berlin (SHB). The updated curriculum, which is including the SmartResilience courses will be accredited as part of the program, too.

The professional Certification program is envisaged as unique professional qualification scheme, which will allow building and setting up a standard for experts dealing with risk management and engineering in different fields on a global level.

In addition, special about the Certification program is the fact, that it can be also aligned with the Master’s. That means the courses/modules taken in the Certification program can be added into the structure of Master’s in case someone wishes to enroll as a Master student.

Box 3: SmartResilience e-Learning platform: Embedded in the accredited programs of Steinbeis University Berlin (SHB)

The e-learning platform applied in the SmartResilience project is an extension of the platform used by SHB, particularly through the Steinbeis Transfer Institute Advanced Risk Technologies (R-Tech). The courses developed in SmartResilience are included in the activities of the Institute and its programs, such as the Master of Risk Engineering and Management (see Annex 2).

Incorporating the SmartResilience courses into SHB programs has multiple benefits, including:

1) increasing sustainability of the courses being updated and maintained following completion of the project, and
2) increasing credibility of the SmartResilience courses by including them in an accredited program, thereby also increasing the attractiveness of the courses for potential students.

Figure 12: Master of Risk Engineering and Management facts
Master of Risk Engineering and Management Factsheet

The master program in Risk Engineering and Management of Steinbeis University Berlin is designed for graduates and professionals who wish to develop their knowledge, skills and competences in the field of modeling, formulation, analysis and implementation of simulations in the area of risk and resilience as well as for understanding these approaches in the broader context.

Figure 13: Master of Risk Engineering and Management Curriculum

The e-Learning platform applied in the SmartResilience project is an extension of the platform used by SHB, particularly through the Steinbeis Transfer Institute Advanced Risk Technologies (R-Tech); the courses developed in SmartResilience are included into the activities of the Institute and its programs, such as the Master of Risk Engineering and Management (see Annex 2). The “SmartResilience Tutorial” (i.e. the course “Resilience Assessment of Smart Critical Infrastructures”) incorporated within the SHB programs can be found at: http://moodle.risk-technologies.com/moodle/course/view.php?id=25.

Box 4: SmartResilience e-Learning courses: always free, with the opportunity to pursue optional fee-based study programs

- **Always free and openly-accessible:**
  Access specifically to the SmartResilience courses is, and will remain, free for any interested user. Users simply need to register for a free account in order to access the courses, as described in Chapter 5.

- **Fee-based programs:**
  The SmartResilience courses have also been incorporated as course options for SHB’s master and certification programs. Those choosing to pursue a paid “full track” program through SHB would fulfill the additional courses (i.e. those developed by SHB beyond the SmartResilience courses) in accordance with SHB standard conditions, which includes course fees.
5 How to register for the SmartResilience e-Learning platform

This chapter demonstrates how to create a new account and register on the e-Learning platform in order to access the free SmartResilience courses. First, there are three methods for users to arrive at the e-Learning platform, in an effort to provide intuitive pathways to access the courses:

2. Via the “Toolbox” tab at the top of the main SmartResilience webpage (http://www.smartresilience.eu-vri.eu/) that opens the ResilienceTool (which includes the link to the e-Learning platform, as shown in Figure 2), or
3. Directly via the ResilienceTool webpage, and then following the e-Learning link as described in pathway 2 (http://resiliencetool.eu-vri.eu).

Once a user is on the webpage for the e-Learning platform (see Figure 14), in order to access the free SmartResilience Courses the interested user needs to register on the platform. To do so, the user needs to click the “Create new account” button in the upper right corner of the page (also shown in Figure 14). Alternatively, clicking on any of the course titles will prompt a login page where one can either enter existing credentials or register for a new account (as shown in Figure 15).

Figure 14: Creating a new account on the e-Learning platform (pathway 1)
Via either pathway, once a user clicks “Create new account,” a new page will open and prompt the user to choose a username and password and provide additional data, as shown in Figure 16. The only required fields are for Username, Password, Email Address, and Name, with other fields as optional survey data. Data collected from users will be processed and handled legally, ethically, and transparently in agreement with the EU General Data Protection Regulation (GDPR). This is explained in the site policy agreement which all new users are requested to agree to at the bottom of the sign-up page.

Once the new account has been created, the user will receive a notification by email and will be able to manage their account (activate it, change password or mail properties, register for courses, etc.).

---

7 Direct link to the site policy agreement: https://www.risk-technologies.com/home.aspx?lan=230&tab=705&itm=707&pag=694
NEW ACCOUNT

Choose your username and password

Username
The password must have at least 8 characters, at least 1 digit(s), at least 1 lower case letter(s), at least 1 upper case letter(s), at least 1 non-alphanumeric character(s) such as @, _, or #

Password

More details

Email address

Email (again)

First name

Surname

City/town

Country
Select a country

Other fields

To which gender identity do you most identify?
Select a gender identity

Site policy agreement

Link to site policy agreement

I understand and agree

Create my new account
Cancel

There are required fields in this form marked •.
6 Conclusions

Across all topic areas, knowledge is the basis for any further and future development and (cross-border) cooperation. In particular, the critical topic of resilience is a very complex topic, which is why a common knowledge base is even more important for future development. This includes the definition and common understanding of concepts, as well as the possibility of being able to apply the methods of resilience evaluation and assessment. For this reason, it was of particular interest for the SmartResilience project to develop and provide educational content and courses as a method to share the results of the project with different stakeholder groups.

Therefore, the objective of Task 6.1 of the SmartResilience project was to develop and provide an e-Learning platform to share the project results with various stakeholder communities. For this reason, a Moodle-based platform has been set up and the contents of the SmartResilience-specific courses (offered first in-person) were uploaded and made accessible to the general public.

The provision of these courses in the e-Learning platform facilitates access to the materials during the project as well as after the end of the project, as the platform will be a sustainable result living after the project ends. In addition, it is planned to include the courses and the platform in future projects.

In addition to the publicly-available courses developed with content directly related to the project, related publicly-accessible courses were also developed and provided within the e-Learning platform free of cost; these additional courses are related to areas such as risk-related topics, occupational safety and the associated standards, etc.

One future goal for the e-Learning platform is to develop more courses and to continue to make them openly-accessible for the public. For this reason, lecturers have been committed from different related fields. These individuals are both lecturers from the pool of SmartResilience experts as well as from the pool of lecturers of the Steinbeis University Berlin (SHB). These successful collaborations are another success of the fruitful joint work in the SmartResilience project that are foreseen to continue beyond the project’s lifetime.
# ANNEXES

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Annex 1  Review process

The Content of this Annex has been submitted as part of the periodic review report to the PO/EU/ Reviewers.

An additional review table has been provided to accompany the revised deliverable that addresses the comments made by the PO/EU/ Reviewers.
Annex 2  Curriculum: Master of Risk Engineering and Management

The courses developed in SmartResilience are being included into the activities of R-Tech and its SHB programs, such as the Master of Risk Engineering and Management (REM).

The curriculum of previously existing courses for this program, i.e. beyond the SmartResilience courses, is available at: http://sti.risk-technologies.com/Events.aspx?crs=3&lan=230&tab=2833&itm=2988&pvw=1&ftr=1&pst=1&sle=0&scp=0&sta=7

Figure 17: SHB Master of Risk Engineering and Management (REM)
Annex 3  Testing the SmartResilience courses and e-Learning platform

In addition to the testing the SmartResilience courses as part of the in-person SmartResilience course offered in September 2017 (refer to Section 3.2), the SmartResilience e-Learning platform has been repeatedly tested within the broader SmartResilience ResilienceTool; the WP9 deliverables further describe this testing with end-users.

Single courses, offered in-person with support by the e-Learning platform, have been evaluated in accordance with the Steinbeis Quality Objectives (https://www.risk-technologies.com/home.aspx?lan=230&tab=2950&itm=2958&pag=3018&nr=11%23bl5649), which state that for training services, customer satisfaction should be kept on the level of "2/3 of 2/3"; meaning: 2/3 of customers/trainees should evaluate the training and 2/3 of them should evaluate the training as "good" or higher.

Examples of single course evaluations for three courses (provided within the e-Learning platform and offered in-person to SmartResilience partner NIS) are provided in Figure 18 to Figure 20. These in-person courses were supported by the e-Learning platform and are listed on the platform under Industrial Projects: PSMS Courses.

Figure 18: Example of single course evaluations for course “Element 7: Hazard Identification and Risk Analysis” offered at SmartResilience partner NIS in December 2018
Figure 19: Example of single course evaluations for course “Element 10: Asset” offered at SmartResilience partner NIS in December 2018
Figure 20: Example of single course evaluations for course “Element 13: Management of Change” offered at SmartResilience partner NIS in November 2018.
Annex 4  SPO document

The SmartResilience courses were designed in alignment with the Studien- und Prüfungsordnung (SPO)/Study and Examination Regulations (SER) document of SHB for the Master of Risk Engineering and Management (M.Eng.) program (see Annex 2). This document provides the framework (strategy) for the courses as required by the statute of SHB. The main document and its Annex 1 are provided in Figure 21 and Figure 22.

![Figure 21: SHB Master of Engineering SPO](image-url)
Annex I:

SER M.Eng II-1
Area: Advanced Risk Technologies
Major subject: Risk Engineering & Management
Accreditation: -

Determined by University Council and confirmed by the authorised administration of the Senate of Berlin the following specifications shall apply:

1. **Duration**
The programme takes 24 months, which students normally pass consecutively.

2. **Structure**

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<th>min.-</th>
<th>days</th>
<th>hours/h</th>
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<tr>
<td>c Project work and thesis</td>
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<td><strong>Total study time</strong></td>
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3. **Special Admissions Requirements**

3.1 Program

3.1a Applicants must be able to present a qualifying university degree (Bachelor) in the area of Engineering, Business Administration, Science or Industrial Engineering with a final grade of at least 2.4.

3.1b Admission requires no special language skills that would go beyond the English B2 level of the “Common European Framework of Reference for Languages”.

3.1c Admission requires professional experience. For the recognition of the necessary professional/management experience (minimum: 1 year) please refer to the examination committee decision.

4. **Modules: Definitions and Annotations**

4.1 **Transfer**: -

4.2 **Basics**: -

4.3 **Focus**: -

4.4 Optional compulsory:

4.4a Optional compulsory - basics modules (OC-1): three modules to be selected.

4.4b The module „J0 BC: Risk Based Inspection – Advanced“ can only be selected in combination with the Module „J0a BC: Risk Based Inspection – Basics“.

4.4c Optional compulsory - specialization modules (OC-2): one module to be selected.

4.4d PSA within an optional compulsory module (one of OC-1 or OC-2).

4.5 **Supplementation compulsion**: -

4.5a In case admission levels document a lack of prior education that potentially could lead to study failure SHB reserves the right to prescribe individual study plans that would include supplementary courses. During the time of individual prestudies and additional courses, students are admitted to the program.

4.5b In case a lack of Credit Points at admission time that may affect the completion of the study, SHB reserves the right to prescribe individual study plans that would include supplementary courses. During the time of additional courses, students are admitted to the program.

4.6 **General annotations**:

AI Annex I
All Annex II
AP Oral master thesis defence (final exam)
C Case
CP Credit Point according to ECTS = 30h/CP
ECTS European Credit Transfer and Accumulation System
F Foundation
Gew. Weighting
h Hour (basic 9h/Tag day)
K Written examination
LNV Examination
M Oral examination
MT Master Thesis
P Presentation
PA Project work
PK Project
PSA Project study paper
S Seminar (also as lecture/blended learning/units/tutorial/workshops/colloquia/lectures etc. [cf. study plan])
SA Study paper
SL Self-study
SPO Study and examination regulations
TA Transfer work
TDR Transfer documentation report
TR Transfer
VT Major subject

5. **Modules and Load**

See Annex II.

136197-2015-11.1.10-M.Eng-II-1-C+H2 / SPO Studium- und Prüfungsordnung / Study and Examination Regulations Steinbeis University Berlin / C+H2 2/2

Figure 22: SHB Master of Engineering SPO – Annex I

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