SMART MATURE RESILIENCE

D3.3 RISK SYSTEMICITY QUESTIONNAIRE

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SUMMARY

This deliverable reports on the construction of the Risk Systemicity Questionnaire (RSQ) which is one of five tools that shall form new European Management Guideline developed as part of the Smart Mature Resilience (SMR) project. The RSQ contributes to building city resilience through a focus on risk assessment and preparedness for future risks. The originality of the RSQ is in its attention to risk systemicity. Risk systemicity takes account of how risks form dynamic networks and emphasises that risks should be considered as affecting one another, rather than being seen as independent and isolated from one another. As a result, the RSQ offers an important contribution to research and practice with respect to risk assessment and building city resilience, as well as to the EU Guidelines with respect to Risk Assessment and Mapping for Disaster Management.

This deliverable describes how the RSQ fits into the overall aims of the SMR project, how it was constructed through an iterative process engaging city stakeholders, what features it comprises of, and how it is expected to be used in cities. The RSQ is positioned as a tool for facilitating group discussion focussing on the interactions between risks that come from different risk areas, and so this tool is particularly well suited for interdisciplinary collaboration. Consequently, this deliverable, by offering a comprehensive report on the RSQ, may be helpful for anyone wishing to enhance their cities' risk assessment processes by thinking more intentionally about risk systemicity.

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1. INTRODUCTION

1.1. KEY CONTRIBUTIONS OF THE RISK SYSTEMICITY QUESTIONNAIRE

This deliverable reports on the development of the Risk Systemicity Questionnaire (RSQ) which is one of the tools developed as part of Workpackage 3 (WP3) of the Smart Mature Resilience (SMR) project. The RSQ is intended to form, along with four other tools (Figure 1), the new European Management Guideline that is intended to support cities in improving their resilience. The definition of city resilience followed in this report is based on the definition constructed in the SMR project, which is:

> "… The ability of a CITY or region to resist, absorb, adapt to and recover from acute shocks and chronic stresses to keep critical services functioning, and to monitor and learn from on-going processes through city and cross-regional collaboration, to increase adaptive abilities and strengthen preparedness by anticipating and appropriately responding to future challenges."

As evidenced in this report, the RSQ addresses various elements of the SMR definition of resilience. Primarily the RSQ is designed to "strengthen preparedness by anticipating and appropriately responding to future challenges". The RSQ is intended to help improve understanding of the dynamic interactions between risks (acute shocks and chronic stresses) and so help a city prepare for their combined impacts and unintended consequences. Also, the RSQ facilitates focussed communication and collaboration between different City teams and departments, and NGO's, with respect to a variety of risks, and therefore supports cities in anticipating and responding appropriately to "future challenges". Thus, the RSQ compliments the other four SMR tools in 1) its ability to assess the CITIES' risk through the generation of a risk level, and 2) by supporting CITIES when they are assessing their resilience maturity level. This is achieved through enabling CITIES to consider how prepared they are based on the policies they already have in place to deal with identified risks. In addition, the risk awareness score generated by the RSQ provides an indication of the city's knowledge with respect to risks, with increased knowledge indicating higher maturity of a city in the specific risk area.

As a result, the development of the RSQ has been designed to meet the following objectives of the SMR project:

SMR Objective 4: Develop and validate a Systemic Risk Assessment Questionnaire (now called the Risk Systemicity Questionnaire) which – beyond the capacity to assess the CITIES's risk – also can assist in determining the CITIES's resilience maturity level.

- WP3 Objective 3.2. Development of a systemic risk assessment questionnaire which identifies maturity state and key mitigation focus.
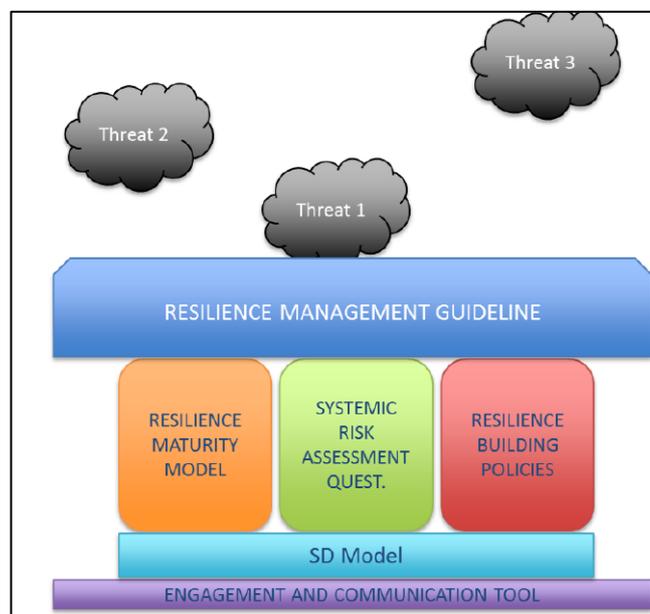

Figure 1: The five tools forming the SMR European Management Guideline

Overall, the following are the main advantages for cities of using the RSQ, which are elaborated in more detail in this report (Table 1):

Table 1: Key advantages of using the RSQ in cities

Key advantages of using the RSQ in cities
Have an easy to use tool which can be used to facilitate group conversation and reflection which promotes a focussed discussion about risks amongst local teams and a variety of stakeholders.
Appreciate risk systemicity: dynamic interactions between risks, vicious feedback loops, combined effects of risks, and non-obvious ramifications of risks.
Understand better the relationships between risks from different areas (e.g. how risks from flooding creates risks for health).
Compare risk level and city's preparedness with respect to different areas of risk.
Consider how the negative dynamic interactions between risks, such as vicious feedback loops, can be disabled through the implementation of appropriate policies.
For the reasons listed above, the RSQ supplements the European Risk Assessment and Mapping Guidelines for Disaster Management.

1.2. FULFILMENT OF THE CITIES' REQUIREMENTS

Deliverable 2.5 reported on the requirements gathered from cities which each of the five SMR tools should fulfil. Those requirements were gathered during the WP2 workshops organised in Riga, Bristol, Rome, and Vejle. Table 2 below describes how the general requirements which are applicable to all tools have been met by the RSQ.

Table 2: Fulfilment of the cities' requirements

Requirement	How the requirement was met
Useful friendly tools tailored to relevant stakeholders.	The RSQ was designed to be intuitive to use and is equipped with a built-in introduction which guides the user through its features. Most of the risk scenarios can be accessed both as text and as pictures.
Tools developed should complement the tools, indicators, policies, methods and procedures that are currently being used in cities.	The RSQ offers cities a supplementary perspective on risks through consideration of risk scenarios that result from the interdependence of risks. Thus, the RSQ extends existing tools, methods and procedures used in cities, by acknowledging risk *systemicity*. It also includes policies that have been tried and tested in cities around Europe and extends this by including further suggested policies.
Guideline to enable prioritisation of resilience building policies for CITY with respect to infrastructure resilience, climate adaptation and social issues.	The risk scores generated by the RSQ helps cities focus on high priority areas for which policies could be implemented. The RSQ then provides a range of tried and tested policy suggestions for each risk scenario.
Need to standardize the resilience building process.	The RSQ is designed for use in regular facilitated meetings which can become a part of a standard procedure for building city resilience. These meetings may involve i) the resilience team, ii) city wide project teams, or iii) external focus groups including critical NGOs.

1.3. STRUCTURE OF THIS REPORT

Having outlined the main purpose and contribution of the RSQ, as well as how it meets the general user requirements as expressed by the participating cites, the construction and the characteristics of the RSQ are described in more detail. Firstly, a literature review is presented which introduces the conceptual underpinnings of this tool, and explores how the RSQ contributes to the existing literature on city resilience and risk assessment. Secondly, the methodological approach towards constructing the RSQ is explained, including a description of the iterative process of drawing on the city participants' feedback to continually test, experiment, and so improve the RSQ. Thirdly, the key features of the RSQ are described. Fourthly, we explain how the RSQ integrates with the remaining four RSQ tools. Finally, the anticipated future uses of the RSQ in cities are presented, including guidelines for RSQ facilitators. We then end the report by summarising how the RSQ meets the objectives of the SMR project, and how it contributes to cities' everyday practice in developing resilience.

2. CONCEPTUAL UNDERPININGS OF THE RSQ

2.1. CITY RESILIENCE AND RISK ASSESSMENT

As modern societies advance further through the 21st century, it is becoming increasingly recognized that they need to be resilient with respect to different kinds of crisis and disasters, as evidenced by such efforts as the Rockefeller Foundation's 100 Resilient Cities Network (100 Resilient Cities, 2016a) and the growing resilience literature (Aldunce et al., 2014; Boin and McConnell, 2007; Labaka et al., 2015; Manyena, 2006). Effective risk assessment can be considered as an essential element in developing city resilience, as highlighted in the definition of resilience published in the Academy of Management Review journal: "… The ability of systems to absorb and recover from shocks, while transforming their structures and means for functioning in the face of long-term stresses, change, and uncertainty. This requires *actively understanding the risk landscape*, determining where those risks are best owned and managed, strengthening the components of the system that helps to face those risks, and understanding how the interrelatedness of these components affects system functioning" (emphasis not in original, van der Vegt et al., 2015: 972). An ability to assess and manage risks effectively in the context of developing city resilience is particularly relevant for cities of various sizes which provide homes for the majority of the world's population (The Economist, 2015). According to Arup's report which officially informs the Rockefeller Foundation's 100 Cities Network (100 Resilient Cities, 2016a, 2016b), whereas cities provide people with opportunities for economic activity, they "are (...) places where stresses accumulate or sudden shocks occur that may result in social breakdown, physical collapse or economic deprivation." Moreover, "risk is also increasingly unpredictable due to the complexity of city systems and the uncertainty associated with many hazards – notably climate change."

The recognition of the significance of effective risk assessment in developing city resilience means that risk assessment needs to account for certain concepts that are characteristic to the studies of city

resilience. Examples of such city resilience concepts is the differentiation between chronic stresses, which are gradually developing risks such as ageing of the population in the city, and acute shocks, that is sudden risk events affecting the city (100 Resilient Cities, 2016a, 2016b). While the EU-funded project the European Multiple Environmental Threats Emergency Network (EMETNET) addresses mainly acute shocks through the rapid risk assessment methodology (European Commission, 2016), the SMR project addresses both acute shocks and chronic stresses. Therefore, as explained in this report, such concepts have been used to inform the construction of the RSQ. In addition, the appreciation of the role of risk assessment in the context of city resilience also calls for a need to consider good approaches for risk assessment, and how such approaches can be operationalised effectively in practice.

2.2. RISK SYSTEMICITY

Typically organisations are encouraged to undertake risk assessment using a risk register (Chapman and Ward, 1997; Hull, 1990; Project Management Institute, 2013; Simon et al., 1997; Thompson and Perry, 1986; Williams, 1993) that lists the risks and makes a judgment about their potential impact and the probability of their occurrence. Indeed, the EU guidelines with respect to Risk Assessment and Mapping Guidelines for Disaster (European Commission, 2010) recommend that cities, regions and governments use the risk register as an approach to risk assessment. While such a register provides a structure for consideration of the risks that may be faced, it suffers from a number of other limitations (Ackermann et al., 2007). Firstly, the preparation of risk registers can become a bureaucratic routine 'in its own right' rather than informing the everyday work of practitioners. Secondly, risk registers typically focus on risks of engineering or technical nature, and so they cover only a small segment of possible risks. As evidenced by Eden (2001) and Eden et al. (2005), there are, particularly in the business world of project management, other significant categories of risks which do not tend to be covered by risk registers, such as: political, people, or financial risks. In the work we discuss here city resilience calls for attention to a very broad array of risks, including, for example, risks related to critical infrastructure, social issues or climate change. Moreover, as explained by the 100 Resilient Cities Network (2016a, 2016b) not only can these risks take the form of (sudden) acute shocks, but also gradually evolving chronic stresses. This means that cities which wish to become more resilient may

need to pay attention to a broad range of risks which not necessarily tend to be recorded in traditional risk registers.

In addition to this, the EU guidelines with respect to Risk Assessment and Mapping Guidelines for Disaster (European Commission, 2010) suggest drafting possible *risk scenarios* as a way of preparing for risks, and to consider possible knock-on effects deriving from such scenarios. Indeed, the risks which cities face are usually the consequence of complex interactions between many factors which can often reinforce one another. These interactions can lead to non-obvious, and counter-intuitive, unintended consequences that may be difficult for cities to anticipate (Eusgeld et al., 2011; Rinaldi et al., 2001). In other words, for practitioners in the public sector it is limiting to view risks as being independent, instead it is essential to understand risks as forming complex networks, which in practice is a non-trivial endeavour (Ackermann et al., 2007; Ackermann et al., 2014). Therefore, suitable tools are required that can enable a city to identify, explore, understand, and present in a clear way how risks interact with one another.

2.3. THE CONTRIBUTION OF THE RSQ TO THEORY AND PRACTICE

The RSQ has been designed to contribute to research and practice of risk assessment with respect to city resilience by emphasising the interactions between risks of interdisciplinary nature. The RSQ contributes to existing literature by providing insights on how risks can be understood. Risks do not exist independently, but form systemic networks of mutual dynamics. This means that cities which want to be resilient, and more specifically, which want to *strengthen their preparedness by anticipating and appropriately responding to future challenges,* need to appreciate and respond to the systemic nature of risks which they are likely to face. Such a perspective on risks, however, adds more complexity to the portrayal of risks, and therefore suitable tools and methods are required to support the operationalization of risk systemicity.

With respect to the practice of risk assessment, it is important to note that important sources such as the European Commission's Risk Assessment and Mapping Guidelines for Disaster (European Commission, 2010) and the Project Management Institute Guidelines (Project Management Institute, 2013) do not cover risk systemicity. The RSQ therefore compliments and updates these sources, and it

offers a practical tool which any city could use to improve their thinking about the dynamics between risks. With the use of the RSQ, cities are encouraged to invite different stakeholders, with expertise in various risk areas, to collectively talk about the interactions of risks, and thereby develop crucial working relationships. It is expected that by taking a holistic view on risks, in which the knowledge of various practitioners is pooled together to prevent undesirable dynamics such as vicious loops and the combined effects of risks, cities can become more potent in their preparedness with respect to future risks.

The aims and the contribution of the RSQ shall be described in more detail in sections 4 and 5 of this report. In the next section, we present the methodological approach which underpinned the construction of the RSQ.

3. METHODOLOGICAL APPROACH

This section describes the process of developing the RSQ. It should be noted that the description has been limited to avoid duplication of content with regards to the WP2 deliverables (D2.1, D2.2, D2.3, D2.4), which report on the Group Explorer workshops that were organised to collect data to inform the RSQ. This section will then end with a discussion on the validation of the RSQ, and cities' involvement in updating regularly the RSQ during the course of its construction.

In principle, the RSQ was designed as an interactive questionnaire which city stakeholders can complete individually or as a group. The RSQ focuses on a number of different risk areas. As it is explained in more detail in this section, for each of these areas, users are presented with a number of risk scenarios which they need to provide an answer to with respect to the likelihood of occurrence of the given scenario in their own city. As each scenario carries a different weight (risk impact), the likelihood of occurrence and impact of the risk scenarios are combined so that, upon completion of the RSQ, the user is given a risk score for each risk area and an awareness score that indicates the level of knowledge about the likelihood of risk scenarios. The RSQ is dominated and focused on causal chains and vicious cycle scenarios because the participating cities regarded these as least understood and thought about. The initial design of the RSQ builds upon previous attempts at operationalising risk systemicity in an industry context (Ackermann et al., 2007), however, in this research the existing ideas are developed and translated into the context of city resilience.

3.1. TIMEPLAN OF THE RSQ DEVELOPMENT

Below in Table 3, Figure 2, and Figure 3, are listed the main milestones and tasks which were involved in the RSQ construction. The initial data collection and analysis began with the WP2 workshop in Riga (October 2015), and continued with the workshops in Bristol (January 2016), Rome (February 2016) and Vejle (May 2016). This included gathering data in the workshops, and subsequently analysing that data between the workshops in order to tidy the collected data and to identify interesting patterns in

the systemicity of risks. In addition to this, the initial work on the conceptualization of the RSQ as part of WP3 began shortly after the workshop in Rome, and this allowed the preparation of the early draft of the RSQ which was successfully presented during the WP5 kick-off event in Donostia (April 2016). That early draft was already fully programmed, it comprised of interactive risk scenarios, and it was used by a small group of project partners. Whilst WP3 had been originally scheduled to start in the second year of the project, we found it essential to begin the work on this work package in year 1 of the project. The reason for this is that WP3 was considered a highly technical work package due to its critical role in the project through the construction of city resilience tools, and therefore an initial planning of the tools needed to be commenced.

Building on the first test of the RSQ draft in Donostia, the work on the RSQ continued, which included improving the user interface and expanding the range of programmed risk systemicity scenarios, and which then prepared the ground for the second test of the RSQ in the WP2 workshop in Vejle. The feedback received in Vejle from the cities, which was generally very positive, reinforced the initial conceptualisation of the RSQ as being mainly a tool for facilitating focussed discussion between groups of practitioners, rather than necessarily being a diagnostic tool whose main purpose is to generate an objective and universal risk level. Based on that feedback, during the summer of 2016, in addition to creating new RSQ content, attention was paid towards developing the RSQ for use with groups, which involved adding pictures of the risk scenarios, vicious loops, and policies, which can be displayed to support group discussion.

The next important milestone in the construction of the RSQ was the WP5 workshop in Kristiansand (September 2016) where two new scenarios were tested with city participants (as described in more detail in the forthcoming D3.2), and the additional policies were gathered for including in the RSQ. The period after the workshop in Kristiansand was used to prepare the RSQ for the WP5 implementation, which involved adding new features (facility to capture comments, a sheet to summarise the RSQ output), and an expansion of the policy suggestions based on the material gathered in Kristiansand. Moreover, another round of validation of the existing scenarios by asking city participants for their judgment during the RSQ test runs listed below, based on the literature, and by three researchers inspecting the validity of the causal relationships contained in the causal maps produced from the WP2

workshops. During that period the RSQ was also tested in Bristol (November 2016), Glasgow (December 2016), and during a project meeting in Amsterdam (December 2016).

The final stage in the preparation of the RSQ was the WP5 implementation which took place in Donostia (January 2017), Kristiansand (February 2017), Glasgow (February 2017), and also in an additional RSQ session run by the initiative of the city of Rome (February 2017). The main outcome of the WP5 implementation was that it reassured the researchers that 1) the RSQ is fully ready to be used in cities from a technical and design perspective, and 2) the RSQ has the potential to become an effective tool for facilitating discussion and building relationships amongst city stakeholders with respect to consideration of risk systemicity in cities. On the basis of these reflections, the final version of the RSQ was prepared for submission at the end of March 2017.

Whilst the tables on the next pages provide a clear outline of the key milestones and tasks which led to the construction of the RSQ, these tasks are described in more detail throughout the rest of this report. However, the presented time plan of the RSQ development can be used as a point of reference whilst reading the following sections.

Table 3: Key milestones and tasks as part of the RSQ development

Key milestones and tasks as part of the RSQ development	Start date	Duration in days
WP2 workshop in Riga	26/10/2015	4
Initial data collection and analysis	26/10/2015	150
WP2 workshop in Bristol	25/01/2016	4
WP2 workshop in Rome	22/02/2016	4
Working on the initial conceptualisation of the RSQ on the basis of collected data	22/02/2016	150

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WP5 kick-off event in Donostia	12/04/2016	1
WP2 workshop in Vejle	12/05/2016	5
Further development of the RSQ - expanding the scenarios, new features (e.g. pictures)	12/05/2016	150
WP5 workshop in Kristiansand	19/09/2016	4
Preparation of the RSQ for WP5 implementation	19/09/2016	150
Test of the RSQ with the Bristol City Council	21/11/2016	1
Test of the RSQ with the Glasgow City Council	05/12/2016	1
Project meeting in Amsterdam - demonstrating the RSQ	12/12/2016	2
WP5 RSQ implementation in Donostia	24/01/2017	1
WP5 RSQ implementation in Kristiansand	09/02/2017	1
WP5 RSQ implementation in Glasgow	21/02/2017	1
RSQ test in Rome (organised from the initiative of the city)	21/02/2017	1
Preparation of the RSQ for final submission	24/01/2017	66
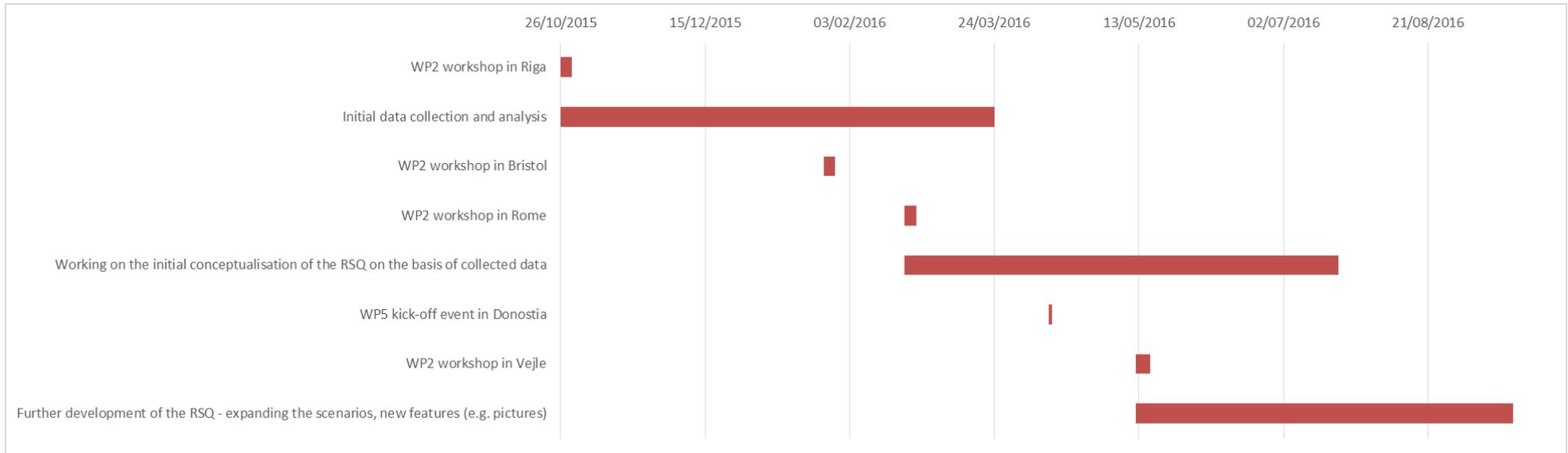
Figure 2: RSQ development timeplan – part 1
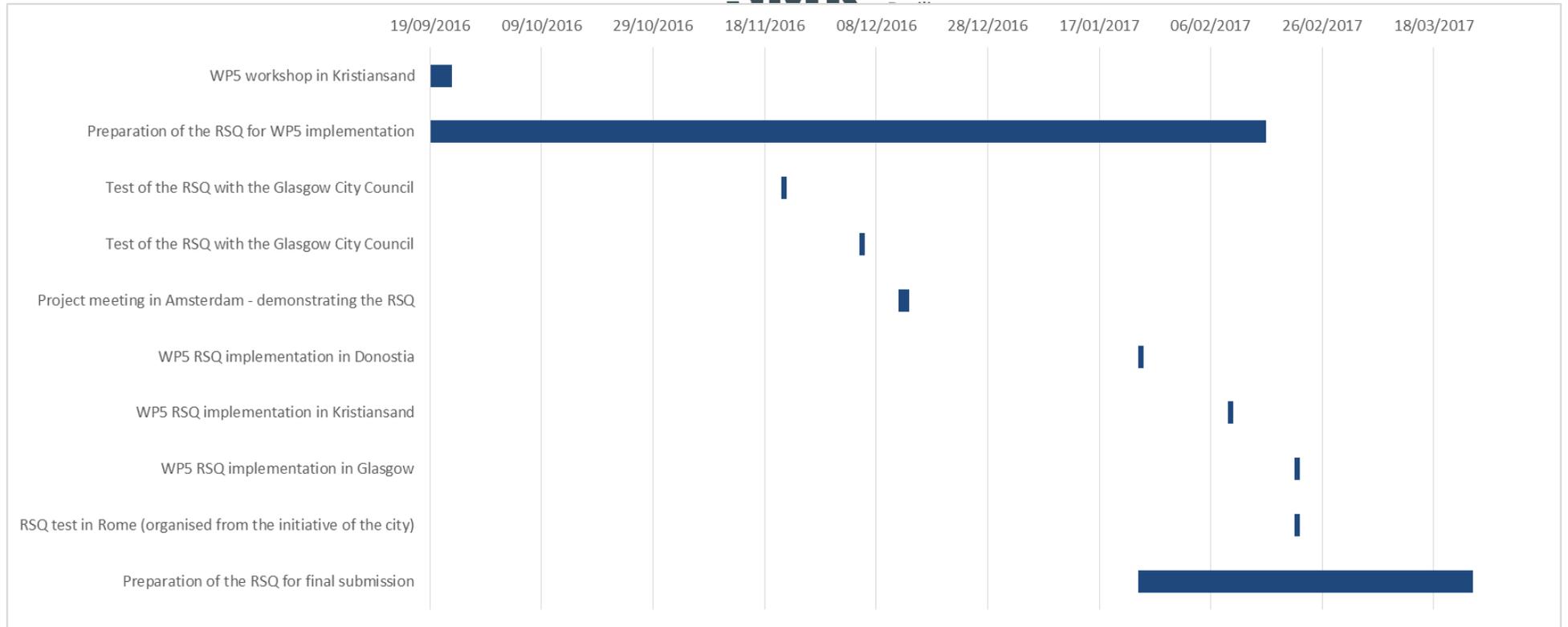
Figure 3: RSQ development timeplan – part 2

3.1. USING CAUSAL MAPPING IN THE CONTEXT OF THE RSQ

In the previous sections of this report it was noted that not only can risks take the form of (sudden) acute shocks, but also gradually evolving chronic stresses (100 Resilient Cities, 2016a, 2016b). This means that cities which wish to become more resilient may need to pay attention to a broad range of risks. Moreover, in line with the EU Guidelines discussed in section 2 of the report, it is also important that cities consider the risk scenarios and knock-on effects of the different types of risks that they face. Therefore, in order to capture the systemicity of risks, it is important to apply suitable methods for that purpose.

The method used in this research is causal mapping (Huff, 1990; Jenkins, 2002; Laukkanen, 1994) which represents peoples' thinking about unfolding risk scenarios using directed graphs (a network of nodes – events, linked through assumed causality). The constructed graphs, causal maps, thus consist of short statements connected with unidirectional arrows signifying 'may lead to' relationships. Causal mapping is governed by a set of formalisms (Bryson et al., 2004) which make the resulting maps amenable to analysis, and which differentiate them from 'word and arrow' diagrams. As different 'expert' views are added to the same map, which often takes place concurrently during a risk workshop, their understandings of potential risk scenarios are surfaced in one place and so participants can debate and negotiate their respective understandings, effectively co-creating a shared causal map (Eden, 1992; Eden et al., 1992). These features of causal mapping make it a flexible method which is effective in managing the complexity and richness of gathered content, especially when supported by dedicated group support software (Ackermann and Eden, 2011b; Ackermann et al., 2016).

With respect to risk systemicity, causal mapping is designed to capture how risks affect one another. For example, increasing air pollution may be argued to lead to a higher number of respiratory illnesses in the city, which then can lead to an increasing pressure on healthcare, which in turn may lead to a worsening quality of healthcare delivery to citizens. It is therefore worth noting that, from the city's perspective, there can be risk interactions between different categories of risks, such as when human activity affects the environment, which then affects social issues and populations' health. Furthermore, various risks (both acute shocks and chronic stresses) may occur concurrently rather

than sequentially, and so they can form *portfolios of risks* where the *combined* impact of risks is greater than the sum of them all (see also Ackermann et al., 2007). An example of a portfolio of risks is depicted in Figure 4 where the city is affected by riots, leading to a number of consequences: city traffic is blocked, railway structures become permanently damaged, and the harbour is shut down. This portfolio of risks then leads to the disruption of critical infrastructure, which in turn means that public and private transport in the wider region could become overwhelmed.
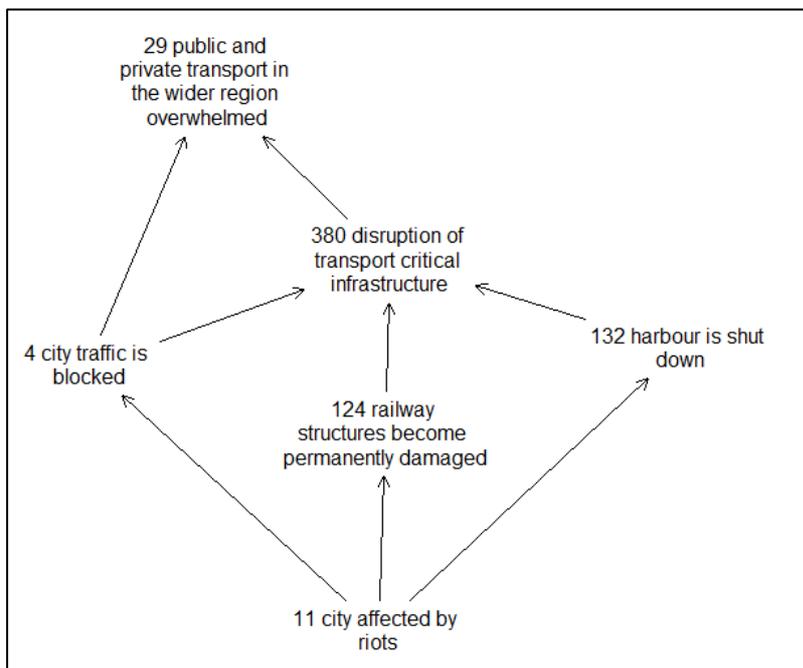

Figure 4: Example of a small part of a risk scenario

Numbers before statements are reference numbers and reflect the order in which the statements were added on the map. Links signify 'may lead to' relationships.

A causal map such as that depicted in Figure 4, especially if developed with contributions from different experts, can also help participants to appreciate the knock-on events and non-obvious consequences of risk events as well as identify the risks themselves. Importantly, such interactions can identify links between risk categories (these categories are discussed in chapter 4). For example the statement 'public and private transport in the wider region overwhelmed' could possibly continue into health risks (people suffering injuries from road accidents) and economic risks (city economy damaged by the

disruption of local transport). Such interdisciplinary interactions between risks encourages mutual engagement between different project teams or city organisations who possess expertise and have a stake in the given risk domains. Importantly, during such interdisciplinary conversations causal maps can play an important role as a 'boundary object' (Carlile, 2002, 2004; Winnicott, 1953), which is a point of reference that helps people share their views rooted in diverse disciplines.

One aspect of risk systemicity which is of particular interest are vicious cycles as they mutually drive self-reinforcing, non-desirable outcomes. An example of a vicious loop is illustrated in Figure 5: increasing citizens' loneliness means that poor citizens' quality of life is getting worse, which leads to increasing issues related to mental health, which then leads back again to increasing citizens' loneliness. It is worth noting that the risks depicted in a loop are all chronic stresses (they gradually develop over time rather than occur suddenly) which highlights that cities need to pay as much attention to these chronic stresses as they do to acute shocks, which are risk events that occur suddenly (for example, a flood). Also, due to their self-reinforcing nature, vicious loops can lead to considerable escalating undesirable consequences for the cities, and for this reason vicious loops need to be attended to carefully. A visual representation of a risk scenario that is a causal loop can be helpful in inviting groups of city experts to devise bundles of policies that can be used by the city to break the identified vicious cycle or switch it from being vicious to virtuous (where the self-reinforcing nature of the loop leads to a desirable outcome). For example, with respect to Figure 5, city stakeholders might want to find ways of preventing citizens from becoming lonelier, which could include such policies as introducing more community centres and social activities, and thereby disable the threatening loop.
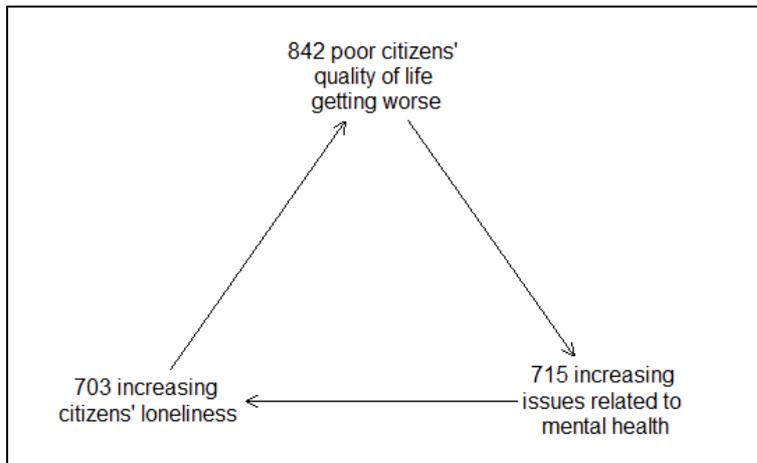
Figure 5: Example of a simple vicious loop

3.2. COLLECTING DATA IN GROUP EXPLORER WORKSHOPS

Group Explorer [1], a group decision support system, and causal mapping were the primary methods used to gather data required for the development of the RSQ, as well as for using that data to generate risk scenarios which formed the different RSQ topics. The Group Explorer interactive workshops were discussed in detail in the WP2 deliverables (and will also be the main subject of D3.2 which will be published after this deliverable) and therefore, to avoid duplication, this section only presents a summary of the results of these workshops. Five workshops, all in different locations, took place over the course of one year: Riga, Latvia; Bristol, UK; Rome, Italy; Vejle, Denmark; and Kristiansand, Norway. Representatives of each of the seven SMR partner cities actively participated in the workshops. Most of the representatives were employees of the respective city councils working in the departments related to strategy and resilience. From the perspective of data collection the participants, in most cases, can be regarded as generalists with a broad view of the discussed risks and policies rather than

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[1] *Group Explorer* is a Group Support System (GSS): specially developed software and a networked computer system that facilitates high productivity in collecting multiple perspectives as a group perspective represented as a causal map. The system permits establishing the degree of consensus about view, identifying causal loops, and a variety of other supporting analyses. The software is in the public domain and is open source.

specific subject experts, although subject experts were involved in some of the workshops. Data collection regarding risk events facing cities took place during the first three workshops (in Riga, Bristol, and Rome), during which three broad themes related to city resilience were explored: critical infrastructure, climate change, and social issues. The remaining two workshops (in Vejle and Kristiansand) were used to test the initial prototype of the RSQ and to expand on the policy suggestions gathered in previous sessions.

Group Explorer was selected to support the workshops as it has been used extensively and successfully, with a variety of organisations and distinct settings, to facilitate productive meetings when working with groups of practitioners (Ackermann and Eden, 2011a). During the course of a session the facilitator encourages users to consider a number of questions to be addressed. Participants then use individual laptops to respond to the question by entering their contributions in the form of short statements or causal links which connect the previously added statements on a shared public map displayed on a large screen. In this research participants worked in city pairs, with participants from the same city normally working together using the same laptop. Moreover, Group Explorer enabled participants to express their preference with respect to, for example, the significance of statements on the shared causal map by engaging in a voting exercise. Group Explorer offers a number of advantages over traditional meetings (Ackermann et al., 2016) such as: full anonymity of contributions, ability for all participants to express their views at the same time (rather than only one person talking), and presentation of everyone's' views in a visual form which can be inspected, compared, and explored at each user's convenience during the course of the session. Each session also concluded with a tangible outcome – a co-created shared causal map (Figure 6) which was subsequently analysed.
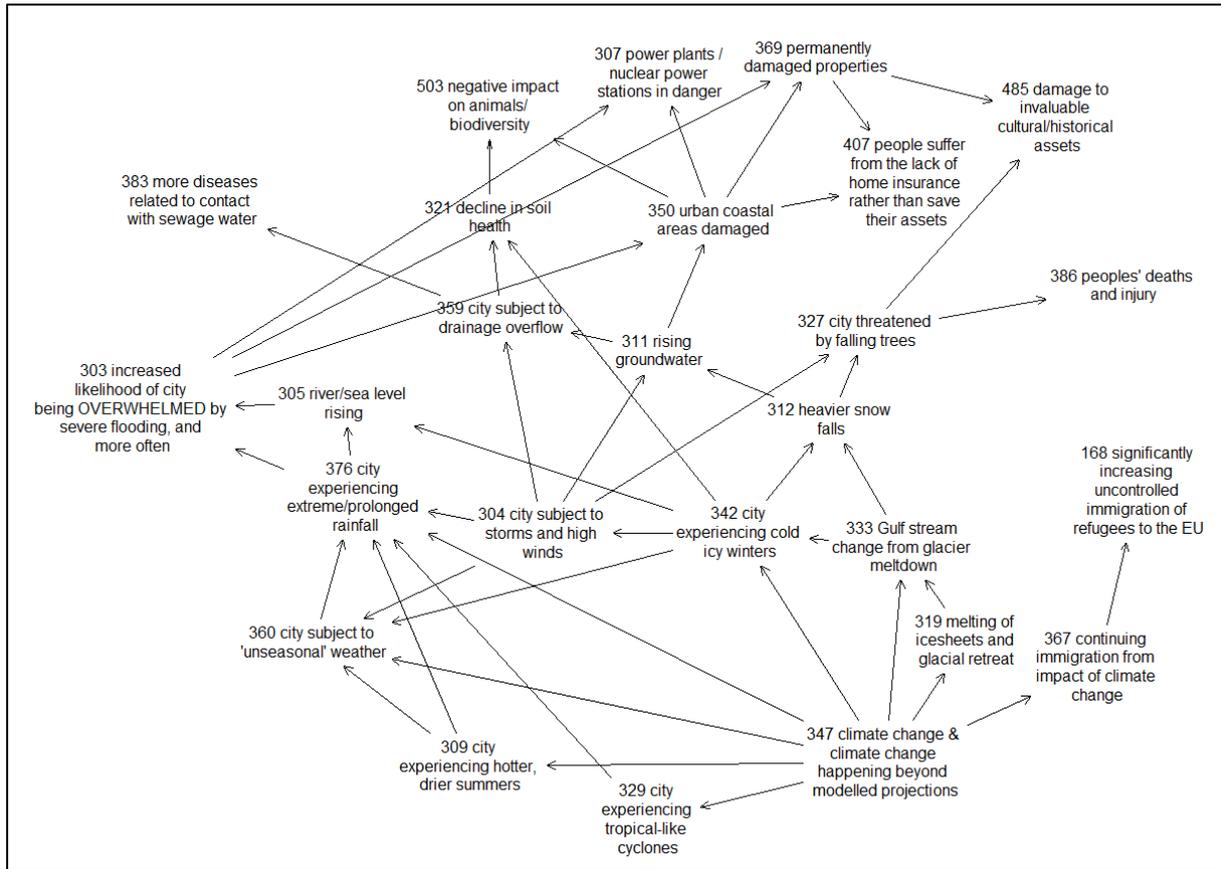
Figure 6: A small segment of the tidied causal map from the WP2 workshops

Numbers before statements signify the order in which the statements were added on the map. Links signify 'may lead to' relationships.

During the sessions, and based on feedback from city representatives, there was a high level of continuous engagement by all city participants who produced a high number of contributions in a relatively short amount of time. Thus, the three causal maps resulting from the first three workshops were large and messy. The first 'critical infrastructure' workshop ended with 183 statements and 339 causal links, the second 'climate change' workshop ended with 339 statements and 515 links, and the third 'social issues' workshop ended with 427 statements and 764 links. The three causal maps were subsequently merged together by identifying shared patterns and commonalities between the maps.

3.3. DEVELOPING RISK SCENARIOS

The merged maps were 'tided': correcting the directions of causal links, editing wording to increase clarity, and adding obvious or well validated links and statements to complete the existing chains of arguments on the map. It must be stressed that care was taken to ensure that all changes to the model were made i) 'in the spirit' of the participants' original contributions, which means that the modifications were not aimed to change the meaning of the original content of the map, but instead to fill the missing gaps in the maps and to clarify partially vague statements; or ii) on the basis of additional material from research. The available data was also cross-validated by the three researchers, and the constructed maps were then fed back for validation to city participants and academic partners within the broader project consortium during subsequent workshops.

The analytical functions of the mapping software were applied to identify key themes and patterns in the data, which included loop analysis (identification of self-sustaining loops), cluster analysis (the software partitions the data into segments based on the density of causal links between statements), and analysis of centrality (identification of those statements which exercise the strongest influence in the model based on their causal links with the rest of the map). This analysis has been covered in the WP2 deliverables.

The analysis of the data led to the recognition of 17 key themes which cut across the three original main topics of the conducted workshops, that is: critical infrastructure, climate change, and social dynamics. These 17 main topics were identified based on i) their centrality within the model (that is the extent to which that topic is interrelated with the rest of the map), ii) their differentiation from each other, and iii) the results of evaluations of importance, impact and probability during the workshops. These 17 topics were used to inform the structure of the next draft of the RSQ. Some of these topics were grouped together based on the degree of their immediate interlinkages, which means that not all of these topics were presented as separate RSQ sheets (for example ageing population and digital marginalization were presented on one RSQ sheet as they were strongly interlinked). Those topics were as follows (Table 4):

Table 4: Key topics identified in the causal maps obtained fro mthe WP2 workshops

Key topics identified in the causal maps obtained from the WP2 workshops
1. Violent riots
2. Public and private transport
3. Business infrastructure
4. City reputation
5. Health services under pressure
6. Immigration
7. Flooding
8. Air pollution
9. Media sensationalism
10. Digital marginalization
11. Fear of crime
12. Ageing population
13. Social inequalities
14. Social cohesion
15. Individual productivity
16. Extremism
17. Political instability

Interestingly, the theme which turned out to be particularly significant within the network of risk systemicity was 'social cohesion'. The causal map revealed that social cohesion and social alienation underpinned numerous aspects of risk mitigation. This result was of particular interest because social cohesion is a dominant aspect of a resilient city (Cagney et al., 2016; Hickman and Mai, 2015; Poortinga, 2012; Townshend et al., 2015). Overall, the identified themes and patterns from the analysis

subsequently provided foundation for the construction of the RSQ so that the tool could reflect city participants' views and contributions gathered during the Group Explorer workshops.

Moreover, as explained in the WP2 deliverables, the WP2 workshops also allowed a range of risk-specific policies to be gathered that have been implemented by cities to address the risk systemicity scenarios. As shown in section 4 of this report, these policies are detailed alongside the RSQ scenarios.

3.4. PROGRAMMING IN VISUAL BASIC FOR APPLICATIONS

The RSQ was programmed in Excel using Visual Basic for Applications (VBA) programming language. Excel and VBA were used as the basis for the RSQ because 1) future users are likely to be familiar with Excel and have it installed on their machines and this prevents the need for specialised software, 2) the clarity of Excel and the use of built-in formulae which support the RSQ features, 3) the high degree of flexibility in creating new customised features. The main disadvantage of using VBA is that it requires macros (that is the programmed content) to be enabled in the user's copy of Excel, which could be prevented by organisational security settings – and in such cases the user would require support from their IT department to enable this facility.

3.5. VALIDATING THE RISK SYSTEMICITY SCENARIOS

Validation of the risk systemicity scenarios occurred through an iterative process during the development of the RSQ development. Firstly, the RSQ was validated through regular engagement with the participating cities, and as outlined in the RSQ time plan in Table 3 above, it involved various workshop, test and implementation sessions. Secondly, all elements of the risk systemicity scenarios (that is all risks and their relationships) were carefully inspected by the three researchers, involving a significant amount of focussed discussion and reflection. The researchers used the causal mapping software to inspect whether the wording of statements fit the logic of causal relationships (the causal chains) constructed by the city participants during the workshop. This exercise involved the inspection of every link and statement in the causal map model. Thirdly, the RSQ was validated by drawing on relevant risk assessment and city resilience literature, which led to changing elements in the risk systemicity scenarios, as well as adding new elements (such as risk triggers and policy suggestions).

Information gained from academic articles and governmental reports helped to verify the statements and causal links. It should also be noted that users of the RSQ are able to capture comments during the course of completing the RSQ, and so express their degree of agreement with respect to the validity of the presented risk scenarios. Capturing the discussion of a group is encouraged as the main purpose of the RSQ is to prompt such discussion amongst participants.

Due to the iterative nature of the RSQ construction, participants' feedback was used not only to validate the RSQ but also to continuously change and improve it so that it meets the cities' requirements. All RSQ tests and events were used as an opportunity for cities to contribute to improvement of the content of scenarios, which included correcting the wording, the direction of causality, and expanding the range of available policies. The early tests (in WP5 Donostia kick-off event and WP2 workshop in Vejle) showed that cities found it very important to talk about the notion of vicious loops (described in more detail below) which therefore became one focus of the RSQ. Those initial tests also helped to improve the visual interface so that the RSQ could become more attractive and easier to use - for example by replacing the need to write an 'X' to select a response with the ability to simply double click a response. Further tests of the RSQ in the second half of year 2016 (Table 3) showed the importance of tailoring the RSQ to be used as a tool for facilitating discussion, and so more emphasis was placed on adding pictures of risks scenarios and policies so that the users can understand better the causality chains and use the pictures as a shared point of reference. The WP5 implementation sessions at the beginning of 2017 allowed the researchers to also develop facilitation guidelines with respect to the different uses of the RSQ (explained in section 5), and to add new features which were found to be of particular use to groups (capturing comments from group discussion, sheet summarising the RSQ output).

It can be concluded that the co-creation element of the RSQ was very strong, and that the cities' feedback played an important role in the development of the various features of the RSQ. Whilst this section described the process of developing and validating the RSQ, in the next two sections the features of the RSQ and its potential uses are described in more detail.

4. DESCRIPTION OF THE RSQ

In this chapter are described the features of the RSQ, including the risk systemicity scenarios, the RSQ policies, and the summary sheet. In addition to this, selected RSQ topics are presented. The chapter ends with a discussion with respect to the integration of the RSQ with the four other SMR tools.

4.1. DESIGN OF THE RSQ

RSQ TOPICS

The RSQ consists of 9 risk systemicity topics which can be explored as separate sheets in Excel. As part of preparing these 9 topics, some of the 17 key themes identified in the analysis of data (as listed in Figure 4) were grouped together. It was necessary to group the 17 key themes into more general topics becasue 1) some of the 17 key themes were not rich enough in terms of the available data to serve as standalone topics, and 2) the grouping of 17 key themes accounted for the close interlinkaged between some of the themes.The grouping of the 17 key themes resulted in 9 risk systemicitytopics as shown in Table 5.

Table 5: Topics in the RSQ

Topics in the RSQ
Climate change – air pollution
Climate change – flooding
Health
Ageing population
Immigration
Riots

Social alienation
Social cohesion
Social inequalities

Each RSQ topic comprises between 6 to 12 risk systemicity scenarios which describe a chain of events that may occur in the user's city. Whereas it was not possible to cover all possible risk scenarios, the researchers focussed on those risk scenarios that were deemed by the participating ciites to be of most importance to the three main area of the SMR, namely: critical infrastructure, climate change, and social issues. All elements of risk systemicity scenarios are linked causally, for example a risk scenario that is included in the air pollution topic is as follows: changes to urban microclimate resulting from air pollution leads to increasing levels of smog, and so people spend less time outdoors on physical activity in social setting, causing citizens are subject to higher rates of obesity. Each scenario describes a chain of risk events and some of these chains of events form feedback loops as described in section 2. For example, Figure 7 presents a risk scenario which appears under the 'social alienation' topic of the RSQ. In this risk scenario, a user is asked to consider whether it is likely that in their city the following chain of arguments may occur: social alienation in the city increases, leads to decreasing trust between citizens, leads to increasing citizens' loneliness, which reinforces increased social alienation within the city. Users would be asked to consider the occurrence of such a scenario over a set timeframe. Although this can be determined based on the specific context for which the RSQ is being used, during this work cities have found a period of 3-5 years a usual timeframe to consider. At the end of this risk scenario the chain of arguments returns to, and thus reinforces, the initial starting statement (increased social alienation). As the described scenario is undesirable, this is an example of a vicious loop. The RSQ therefore plays an important role in helping users appreciate the nature of various types of vicious loops which may target their city.

"PEOPLE BEGIN TO TRUST EACH OTHER LESS" - causal loop				
Increased social alienation within the city				View as picture
LEADS TO decreasing trust between citizens				
AND SO increasing citizens' loneliness				Comment
WHICH REINFORCES increased social alienation within the city				
HOW LIKELY DO YOU THINK THIS SCENARIO WILL DEVELOP IN YOUR CITY/REGION?				
Likely	Possibly	Unlikely	We don't know	I don't know - someone else does

Figure 7: A vicious loop scenario in the RSQ

*Statements in black font represent statements which users will have already seen in previous risk scenarios (as a reminder for user), whereas statements in blue font represent statements which have not appeared yet in any previous risk scenario (and so a user is encouraged to pay particular attention to those new statements).

WEIGHTS AND CALCULATIONS OF SCORES

Ror each scenario, a user is asked to consider the likelihood of the scenario happening in their city by selecting from one of five responses: 'likely' (to occur), 'possible', 'unlikely', 'we don't know but someone else (e.g. in my organisation or project team) knows (if the risk event is likely to occur)', and 'I don't know'. Depending on the response, a risk score (an estimated risk level for the city) and an awareness score (the level of knowledge the city has about the possible risks) for individual risk scenarios are calculated according to the formulae given in Table 6. For overall risk topics, the risk score is higher when the user finds the scenario likely to happen, whilst the awareness score is lower when the user does not know an answer to the question. Low awareness can be seen as a form of risk for the city in itself. The overall risk score for the topic is calculated as a sum of risk scores for the individual scenarios divided by the sum of risk weights for the individual scenarios. The overall awareness score for the topic is calculated as 100% minus the sum of awareness scores for the individual scenarios divided by the sum of risk awareness weights for the individual scenarios.

Table 6: How the RSQ risk score and the awareness score are caluclated for individual risk scenarios

Calculation of RSQ risk score and awareness score for individual risk scenarios[2]		
Answer	**Risk score**	**Awareness score**
Likely	= Wr	= 0
Possibly	= Wr/2	= Wa/2
Unlikely	= 0	= 0
We don't know	= Wr	= Wa
I don't know, but someone else in my organisation knows	= Wr/4	= Wa

It should be noted that the RSQ was not designed as a technical risk diagnostic tool, but as a tool for facilitating group discussion, and therefore the calculation of the risk score and awareness score are only intended to allow for relative comparison between the RSQ topics, as well as to encourage furher discussion. On that basis the calculations are not intended to provide objective risk scores that could be applied to anything beyond facilitating group discussion.

Also, the risk scenarios in the RSQ are of general rather than city-specific character so that they may be applicable to a broad range of cities. As a result, users need to be able to attend to those scenarios which are of particular interest to their local setting. Thus, users can select between those RSQ topics that they wish to consider, and still receive an overall risk score. Furthermore, during the course of completing the RSQ, if user finds certain risk scenarios are unlikely to happen in their cities, then their

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[2] Wr = risk weight assigned to the given risk systemicity scenario, and Wa = awareness weight assigned to the given risk systemicity scenario.

answer will automatically disable other risk scenarios which are related to the initial risk scenarios. Consequently, by implementing these features, it was possible to balance the requirement to appeal to a broader audience whilst simultaneously provide users with options to make the experience of using the RSQ more relevant to their cities.

RISK SYSTEMICITY SCENARIOS

Furthermore, it became evident in feedback from city representatives that for individuals who are not familiar with the notion of vicious loops it is not easy to understand the nature of vicious loops simply by reading the content of risk scenarios. Therefore every vicious loop in the RSQ (as well as any other risk systemicity scenario) has the option of being displayed as a picture in addtion to being displayed as text (see Figure 8). City representatives found the inclusion of pictures an important addition to the RSQ as they enabled the user to clearly differentiate between risk scenarios that are vicious loops and those that are linear chains of arguments. Also, during testing of the RSQ with cities it was observed that some users preferred to complete the RSQ by reading the scenarios exclusively as pictures rather than in the form of text, whilst others preferred to resort to reading text only – and so it was useful for users to have an ability to choose between these two modes of presentation.
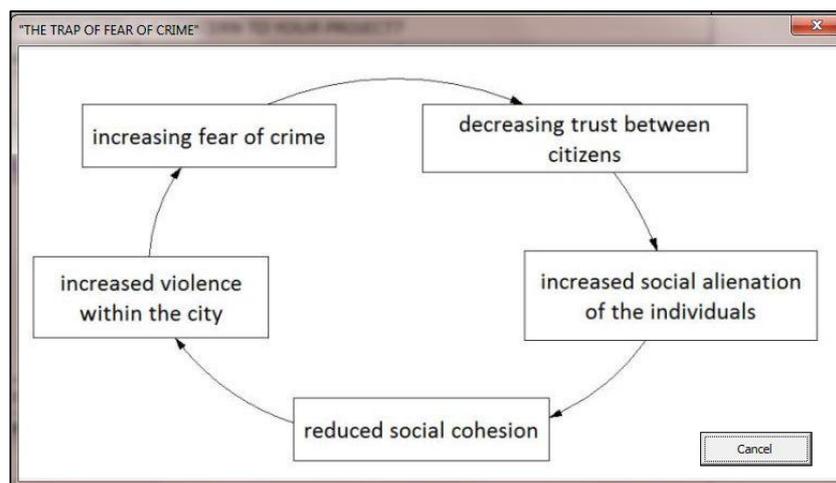

Figure 8: A picture of a vicious loop from the RSQ

In order to introduce the concepts of risk systemicity and vicious loops, a description of these concepts are also included in an introductory overview to the RSQ which can be accessed on its front page (see Figure 9).
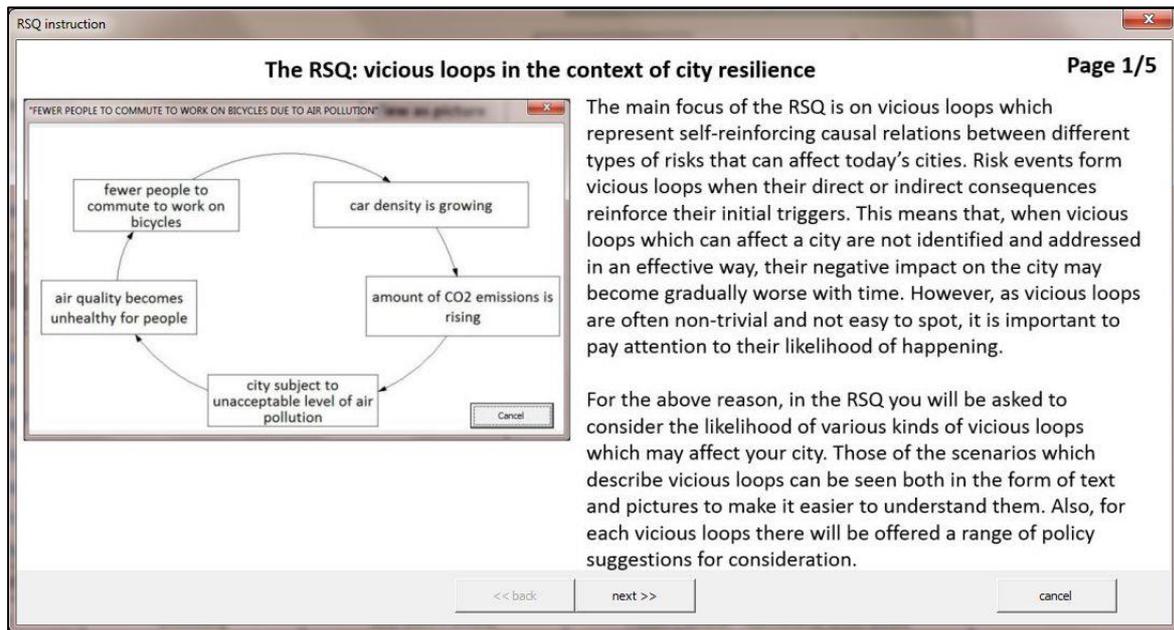

Figure 9: The first page of the RSQ instruction

RSQ POLICIES

In order to be able to mitigate against the imposed threats policy suggestions, which had been collected during the Group Explorer sessions, were included in the RSQ. The policy suggestions are accessible upon completion of each of the 9 topics in the RSQ and can be explored through use of an interactive menu (see Figure 10 and Figure 11). On viewing a policy suggestion, a distinction is made between those policies which have already been successfully implemented in the participating cities, and policies which have been offered as suggestions from city representatives, but not declared as already having been implemented by any of the 7 cities that participated in the research, and thus might require more testing in practice. For example, under the 'rising social alienation' topic, users can learn about tested policies such as 'use city parks as places for community engagement' as well as policy suggestions such as 'create shared spaces within the city for growing vegetables where people can foster social relationships'. Thus, not only does the RSQ promote an awareness of vicious loops,

but it also gives cities an opportunity to consider strategies for improving their resilience through policy implementation.
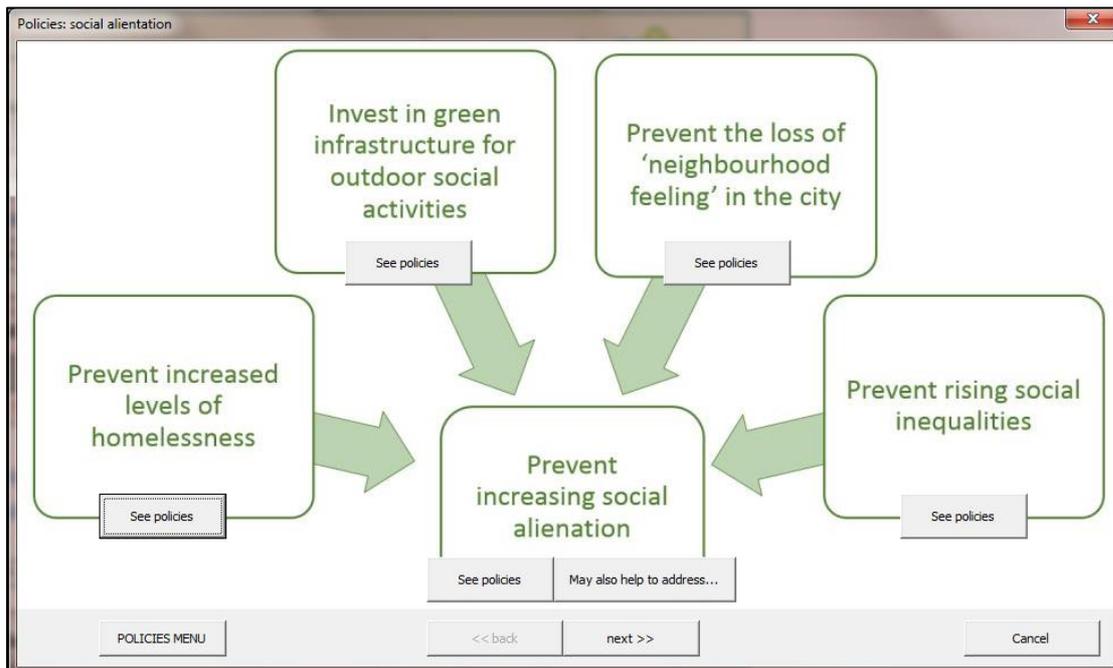

Figure 10: Exploring policy suggestions in the RSQ
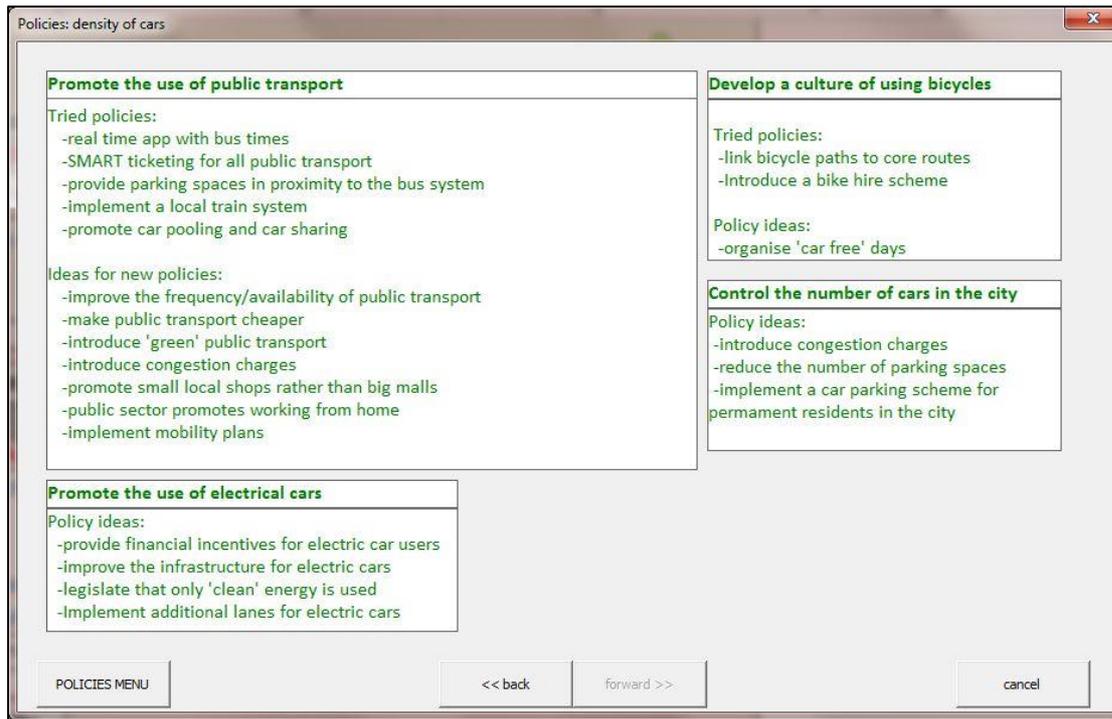
Figure 11: Exploring policy suggestions in the RSQ - detailed view

INTERACTIONS BETWEEN SCENARIOS

Intertaction between risk scenarios also occurs across risk topics. Such interactions result in some scenarios appearing in mulitple RSQ topics (for example a scenario may appear both under 'health' and 'air pollution'). However, the user is only asked to provide an answer to that scenario once – the same scenario which also appears in a different RSQ topic will then be completed automatically. Thus, the interacting scenarios allow chains of arguments which cross between different RSQ topics to be captured. This feature of the RSQ emphasises the importance of considering the interdependencies between risks traditionally associated with different risk areas.

In addition to this, some scenarios act as triggers for other scenarios. When a trigger scenario is answered as being 'unlikely', then the scenarios which would otherwise follow from that 'unlikely' scenario are disabled and effectively hidden from the RSQ.

COMMENT BOX

Finally, the RSQ comprises of two features, which were inspired by cities feedback. These two features were designed particularly for use with groups, but they can also be helpful when completing the RSQ individually. The first of these two features are comment boxes, which can be displayed for each risk systemicity scenario (see Figure 12). The user can save comments, which can be a summary of the group discussion, and can be later accessed and edited. Also, saved comments are automatically transferred to a separate comments sheet where the user can easily navigate between the previously added comments. This feature enables a summary of any discussion that occurred when completing the RSQ to be captured alongside the scenarios, which prompted the discussion, providing a record of the most important aspects of the discussion.
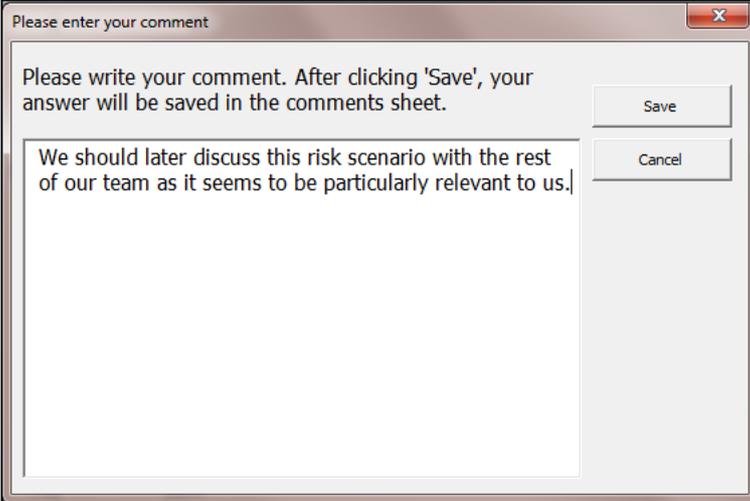
Figure 12: Comment box

SUMMARY SHEET

The second feature inspired by cities feedback is the summary sheet (see Figure 13). The summary sheet allows the user to see the ranking of the scores, which they have received for each topic, as well as a summary of each of their answers for every RSQ scenario. This feature allows for a convenient comparison of results, which highlights those that may require further attention. In Figure 12, in the top half of the screen are listed the overall scores for each RSQ topic, with a green coloured score

signifying a positive outcome, and red colour signifying a negative outcome (for the city). In the bottom half of the screen are the listed the user's answers provided for the scenarios for each topic, with each different type of response highlighted by a different colour.

Risk Systemicity Questionnaire

Risk Systemicity	Risk Level	Awareness Level		
			Rank by risk	
Air Pollution	100%	100%	Rank by awareness level	
Inequalities	75%	75%		
Social Alienation	50%	50%		
Social Cohesion	50%	50%		
Flooding	43%	61%		
Immigration	0%	100%		
Health	0%	100%		
Riots	no score yet	no score yet		
Ageing	no score yet	no score yet		

List of your answers to the RSQ topics

Climate change - flooding	Hide/unhide	
FLOODING		I don't know-someone else does
INFORMAL SETTLEMENT IN FLOOD-PRONE AREAS		Likely
CITY WITHOUT SUSTAINABLE DRAINAGE SYSTEMS		Unlikely
DISRUPTION OF PUBLIC AND PRIVATE TRANSPORT IN THE FACE OF FLOODING		Unlikely
CITIZENS LOSE THEIR HOMES		Possible
SKILLED WORKERS LEAVE THE CITY		Likely
ELECTRICAL NETWORK OVERWHELMED		I don't know-someone else does
LOCAL BUSINESSES SUFFER FROM LACK OF ELECTRICAL POWER		Likely
LONG-TERM DECLINE IN SOIL HEALTH MEANS LESS LAND FOR FARMING IN THE REGION		I don't know-someone else does
LONG-TERM DECLINE IN SOIL HEALTH PUTS URBAN GREEN SPACE UNDER PRESSURE		I don't know-someone else does
EMERGENCE OF DISEASES RELATED TO INCREASED AMOUNTS OF STAGNANT WATER		We don't know
FLOODING LEADS TO NEW STRAINS OF DISEASES IN THE CITY		Unlikely
Climate change - air pollution	Hide/unhide	
Health	Hide/unhide	

Figure 13: Summary sheet

4.2. EXAMPLES OF THE RSQ TOPICS

The previous sub-section provided a detailed description of the features of the RSQ. This sub-section provides examples of two RSQ topics; social alienation and air pollution, as they are presented in the RSQ in text format. For each of the scenarios below, the user would be asked to consider that scenario with respect to its probability of occurrence in their city. In the title of each scenario there is a distinction whether this scenario is a causal loop, or a causal chain. Each scenario is essentially a causal

chain (as it depicts causal relationships), but only some scenarios are self-reinforcing feedback loops (the characteristics of feedback loops are described in chapter 2).

TOPIC: SOCIAL ALIENATION

Scenario 1: "SOCIAL ALIENATION" – causal chain

- Is your city likely to be subject to increasing social alienation?

For each scenario, the user is asked to consider the likelihood of occurrence of the given scenario in their city. The first scenario is usually formulated as a question so that it may allow the user to decide whether the given RSQ topic is of relevance to them. The following scenarios which then follow this initial question include a chain of events that present a potential scenario that may be of a risk to the city.

Scenario 2: "PEOPLE GETTING DISCONNECTED IN THE LIGHT OF PROGRESSING URBANISATION" – causal chain

- Increasing urbanisation and population growth
- LEADS TO citizens experience continuing loss of neighbourhood feeling
- WHICH TRANSLATES INTO increasing citizens' loneliness
- WHICH LEADS TO increasing social alienation
- LEADING TO reduced social cohesion

Scenario 3: "THE TRAP OF LONELINESS" - causal loop

- Level of loneliness in the city is rising
- CAUSING peoples' quality of life getting worse
- LEADING TO citizens' mental health problems increasing
- WHICH REINFORCES level of loneliness in the city rising

Scenario 4: "PENSION AGE" - causal chain

- Pension rights come later in life (later retirement age with possibly lower pensions)
- MEANS THAT ageing citizens working longer
- LEADS TO role strain between caring for aged friends and partners, and the need to remain in employment
- CAUSING increasing work-related stress for aged citizens
- LEADS TO increase in breakdown of the family structure AND poorer quality of life for the aged poor
- WHICH MEANS increased social alienation and loneliness for the aged citizens
- LEADING TO reducing social cohesion in the city

Scenario 5: "DISINTEGRATING FAMILIES" - causal chain

- Families are living far away from one another
- LEADS TO isolation risks of the elderly AND breakdown of the family structure
- CAUSING increased social alienation
- LEADING TO reducing social cohesion in the city

Scenario 6: "INDIVIDUALISATION OF THE SOCIETY" - causal chain

- Family members increasingly living far away from one another
- CAUSES personalisation and individualisation of people's lifestyles in the modern age
- LEAD TO continued increase in single households
- CAUSING isolation of working age people from their communities
- MEANS a continuing loss of neighbourhood feeling
- AND SO increasing loneliness of the aged

Scenario 7: "ISOLATION OF DISADVANTAGED PEOPLE TRANSLATES INTO MORE CASES OF EXPLOITATION" - causal loop

- Loneliness and isolation among disadvantaged people is rising
- LEADS TO social stigma associated with isolated and lonely people
- WHICH CAUSES increasing cases of exploitation of the disadvantaged people
- AND SO REINFORCING loneliness and isolation among disadvantaged people is rising

Scenario 8: "DIGITAL MARGINALISATION" - causal chain

- Ageing population in the city is increasing
- LEADS TO increasing number of elderly citizens experience problems with little understanding digital technologies and social media
- MEANS THAT elderly people feel, and become, excluded from the online networks and communities
- CAUSING isolation risks of the elderly
- AND SO increased social alienation
- LEADING TO reducing social cohesion in the city

Scenario 9: "PEOPLE BEGIN TO TRUST EACH OTHER LESS" - causal loop

- Increased social alienation within the city
- LEADS TO decreasing trust between citizens
- AND SO increasing citizens' loneliness
- WHICH REINFORCES increased social alienation within the city

Scenario 10: "THE TRAP OF FEAR OF CRIME" - causal loop

- Reduced social cohesion
- LEADS TO increased violence within the city
- CAUSING increasing fear of crime

- WHICH LEADS TO decreasing trust between citizens

- AND SO increased social alienation of the individuals

- WHICH REINFORCES reduced social cohesion

Scenario 11: "CITIZENS SPEND LESS TIME OUTDOORS ON TRAINING/PHYSICIAL ACTIVITY" - causal loop

- Urban green space in the city is becoming less

- AND SO green space absorbs less carbon dioxide

- LEADING TO city is subject to unacceptable level of air pollution

- AND SO people spend less time outdoors on training/physical activity in social setting

- CAUSING citizens are subject to higher rates of obesity

- WHICH LEADS TO social alienation through bias and stigma

- WHICH MEANS reduction of social cohesion in the city

- CAUSING less motivation among citizens for green solutions

- WHICH REINFORCES urban green space in the city continues to become less

Scenario 12: "INSUFFICIENT NUMBER OF GOOD QUALITY COMMUNITY SPACES" - causal chain

- Lack of attention to recreational areas in urban development planning

- LEADS TO the gradual decline of communal spaces

- WHICH THEN CAUSES neighbourhood decline

- AND SO continued loss of neighbourhood feeling and increasing citizens' loneliness

- CAUSING increased social alienation within the city

- LEADING TO reduced social cohesion

Scenario 13: "VULNERABLE GROUPS SUFFER FROM LACK OF ACCESS TO SOCIAL ACTIVITIES" - causal chain

- Lack of meeting points for social activities

- MEANS fewer opportunities for vulnerable groups to develop social relations

- WHICH CAUSES continued loss of neighbourhood feeling and increasing citizens' loneliness

- CAUSING increased social alienation within the city

- LEADING TO reduced social cohesion

Scenario 14: "WORKERS' RIGHTS BECOME ERODED" - causal chain

- Unemployment, underemployment and short term contracts (especially among young people)

- LEADS TO eroded worker rights

- WHICH MEANS current economic system works for some but not others

- LEADING TO rising social inequalities

- CAUSING increased social alienation within the city

Scenario 15: "THE DISENGAGEMENT OF CITIZENS" - causal chain

- Increasing social and economic problems (unemployment, reduced social welfare)

- LEADS TO loss of trust in the national government and public/social services

- WHICH LEADS TO decreased participation in civil society (e.g. civil initiatives, voting, joining political parties)

- CAUSING increasing citizens' loneliness

- WHICH CAUSES increased social alienation within the city

- AND SO reduced social cohesion in the city

TOPIC: CLIMATE CHANGE – AIR POLLUTION

Scenario 1: "RISING CO2 EMISSIONS" - causal chain

- City is faced with increasing CO_2 emissions as a result of human population growth, car density, increased demand for power, and increased demand for goods

- LEADS TO rising CO_2 emissions

Scenario 2: "COLDER ICY WINTERS AS A RESULT OF CLIMATE CHANGE" - causal chain

- Climate change is happening beyond modelled projections
- AND SO city experiencing colder icy winters
- AND SO city more frequently subject to freezing fog
- LEADING TO the use of winter tyres growing with associated growth in fine particles of rubber
- WHICH CAUSES city is subject to unacceptable level of air pollution

Scenario 3: "HOTTER, DRIER SUMMERS AS A RESULT OF CLIMATE CHANGE" - causal chain

- Climate change is happening beyond modelled projections
- AND SO city experiencing hot, drier summers
- LEADS TO city being increasingly exposed to frequent heatwaves
- CAUSING increased demand for air conditioning AND changes to the city's microclimate and topography
- WHICH CAUSES city is subject to unacceptable level of air pollution

Scenario 4: "CITIZENS SUFFER FROM RESPIRATORY DISEASES" - causal chain

- City is subject to unacceptable level of air pollution
- LEADS TO increasing number of citizens suffer from respiratory diseases
- CAUSES increasing number of citizens suffer from breathing difficulties
- AND SO citizens suffer from increasing health problems

Scenario 5: "FEWER PEOPLE TO COMMUTE TO WORK ON BICYCLES DUE TO AIR POLLUTION" - causal loop

- City is subject to unacceptable level of air pollution
- WHICH LEADS TO air quality becomes unhealthy for people
- CAUSING fewer people to commute to work on their bicycles
- WHICH CAUSES the car density is growing

- LEADING TO the amount of CO_2 emissions is rising
- WHICH REINFORCES city subject to unacceptable air pollution

Scenario 6: "CITIZENS SPEND LESS TIME OUTDOORS ON TRAINING/PHYSICIAL ACTIVITY" - causal loop

- Urban green space in the city is becoming less
- AND SO green space absorbs less carbon dioxide
- LEADING TO city is subject to unacceptable level of air pollution
- AND SO people spend less time outdoors on training/physical activity in social setting
- CAUSING citizens are subject to higher rates of obesity
- WHICH LEADS TO social alienation through bias and stigma
- WHICH MEANS reduction of social cohesion in the city
- CAUSING less motivation among citizens for green solutions
- WHICH REINFORCES urban green space in the city continues to become less

Scenario 7: "SKILLED WORKERS LEAVE THE CITY DUE TO AIR POLLUTION" - causal chain

- City is subject to unacceptable level of air pollution
- WHICH MEANS THAT city is less attractive to work in
- CAUSING skilled workers leave the city
- WHICH MEANS THAT city suffers from decreasing numbers of skilled workforce
- LEADING TO longterm damage to the local economy
- AND SO loss of taxes to the city
- AND SO local authority budget under pressure

Scenario 8: "CITY EXPORTING ITS POLLUTING ACTIVITIES TO OTHER CITIES" - causal chain

- City is subject to unacceptable level of air pollution
- CAUSES local factories are increasingly being shut down and moved to other cities
- LEADS TO city purposively exporting its air polluting activities to other cities

- CAUSING loss of jobs in the city

- LEADING TO rising unemployment

Scenario 9: "AIR QUALITY INEQUALITIES" - causal chain

- City is subject to unacceptable level of air pollution

- WHICH LEADS TO air quality becomes unhealthy for people

- LEADS TO city purposively exporting its air polluting activities to other cities

- CAUSING air quality inequalities between cities

- LEADING TO rising health inequalities between cities

- AND SO rising social inequalities between cities

Scenario 10: "AIR POLLUTION LEADS TO DECREASED WATER QUALITY" - causal chain

- City is subject to unacceptable level of air pollution

- LEADS TO declining water quality in the city/region

- CAUSING more diseases (previously reduced) related to contact with sewage water in the city/region

- LEADING TO new strains of pandemic diseases and sanitation problems in the city/region

- WHICH CAUSES increase of people's health problems in the city/region

- WHICH LEADS TO life expectancy reduced in most affected areas

- AND SO rising health inequalities

Scenario 11: "LESS LAND FOR FARMING" - causal chain

- City is subject to unacceptable level of air pollution

- LEADS TO soil health declining significantly

- TRANSLATES INTO less land for farming

- AND SO reduced local food production in the region

4.3. INTEGRATION OF THE RSQ WITH OTHER SMR TOOLS

The previous sub-sections described the features and the content of the RSQ. This sub-section addresses how the RSQ integrates with four other tools so that it can form new European Management Guidelines. It should be noted that tool integration is subject to ongoing work in the SMR project and therefore the ideas presented in this section are expected to be developed further.

The RSQ supports the use of the SMR Maturity Model in a number of ways. Firstly, the use of the RSQ is explicitly mentioned in the Maturity Model. The use of the RSQ reflects a more sophisticated approach to risk assessment and thus indicates that a city is more mature when considering the 'preparedness' dimension of maturity. Secondly, the degree of risk awareness score, which is generated by the RSQ in addition to the risk score, helps cities to consider their knowledge of the risks that their city may face. Low risk awareness scores may indicate lower maturity in the risk topic area being considered. And thirdly, the sets of policies that are built into the RSQ assist cities in determining their preparedness with respect to mitigating risk systemicity, enabling them to assess their level of maturity in this context.

In addition to the integration with the Maturity Model, the RSQ is also integrated with the other SMR tools as follows:

Resilience Building Policies Tool: Although this tool has yet to be developed, it is anticipated that this tool will capture the relationships between the risk mitigation policies included in the RSQ. Some of the RSQ policies also support the development of maturity and these will feed into the part of the Policy Tool that covers policies associated with maturity development.

System Dynamics model: The maturity development policies mentioned directly above, link into the System Dynamics Model where the dynamics between the Maturity Model policies are explored.

Community Engagement Portal: this tool captures the integration between the tools by providing a platform where the users of these tools can mutually engage on aregular basis.

5. APPLICATION OF THE RSQ

Following the description of the features of the RSQ in the previous section, this section of the report will describe how the RSQ can be used by cities. Firstly, three potential uses for the RSQ are presented. Secondly, a typical facilitation process that can be followed in a RSQ workshop is described. This process has evolved during the WP5 implementation sessions. The suggested facilitation process can be applied to all three uses of the RSQ conceptualised in this section.

5.1. THE THREE USES OF THE RSQ

Following experiments and testing of the RSQ with cities, three potential uses of the RSQ were highlited by city representatives. It was recognised that the RSQ would be the basis for promoting and facilitating a designed and structured discussion about risk assessment and risk mitigation and thus support resource prioritistion. The discussion would be across a small group responsible for assessing risk and its mitigation with respect to the city overall or with respect to a particular project. The process might be expected to help develop consensus and to flush out different perspectives on resilience.

Use 1 - Resilience Office Team: The RSQ could be used regularly by the resilience office team to monitor the changing impact of risk scenarios on the city's resilience strategy. The RSQ could help to identify those areas of the city that require most attention with respect to resilience and thus help the team prioritise limited resources.

Use 2 - Project Teams: The RSQ may prove useful for teams that are working on city projects that bring together a range of stakeholders from across the city.The RSQ could be used at the beginning of a project in order for the team to think differently about risks that may impact the success of their project.

Use 3 - Engagement with City stakeholders: the RSQ can be used as a way of consciousness raising among a wide set of city stakeholders. The RSQ would be the basis for focus group meetings involving, for example, pressure and voluntary groups seeking to help the city become more resilient. In

particular, given the significance of social cohesion as a force for making a city more resilient, the RSQ could be used to promote discussion about the potential risks to social cohesion.

In each of these uses, participants can gain an appreciation of a range of perspectives with rescpet to risk, explore risk systemicity in the context of their own city and/or project and use the final evaluations as a basis for prioritizing resources for risk mitigation.

5.2. FACILITATION PROCESS OF THE RSQ SESSION

For all three uses of the RSQ, the following four-stage facilitation process may be followed:

STAGE 1: GENERAL INTRODUCTION

The RSQ sessions do not require any special facilitation skills different to the skills that would be typically required for managing a multi-stakeholder meeting. The standard requirements for each session are:

- Computer with the RSQ loaded onto it (the computer needs to be able to run macros in Excel).
- Data projector.
- Room with U-shaped seating for participants.
- Facilitator sitting at front so he/she can see all participants and the screen.

The introduction to the session should involve:

- Round-robin introduction of all participants.
- Introduction by a lead participant regarding the issue/project that brings the group together.
- Introduction to the objective of the RSQ (which can be informed by this report). It is crucial to emphasise that the aim of the session is to understand better, as a group, the dynamic relationships between the risks that the individual participants may already be aware of. This means that **the session is not intended to give new information about types of risks, but how**

these risks interact with one another. This introduction provides a very important scene setting.

- Introduction to the objectives for the session (depending on the group(s) and the organisation(s) involved).

- Emphasise that group discussion about the risk systemicity scenarios is an important objective.

- Emphasise that the group does not have to agree – it is helpful to capture different perspectives and opinions.

STAGE 2: SELECTING THE TOPICS TO WORK WITH IN THE SESSION

After the introduction, the following actions are recommended:

- The group considers the available risk topics (for example health, inequalities, flooding) and suggests those that appear to be of most interest to them. The facilitator may have suggestions based on participants' interests and expertise.

- The group chooses the topic (RSQ tab) to start with.

- The facilitator shows the initial summary question (to which the answer should be 'likely' or 'possible' given the topic has been chosen due to its interest to the group). This is typically the first question in the given RSQ topic, and upon selecting 'unlikely' it often disables the rest of the topic.

- Typically the initial summary question prompts discussion that will be relevant to scenarios that appear later in the topic, and so the facilitator can point this out and move the group to the first scenario in the topic.

STAGE 3: COMPLETING THE SCENARIOS

Having selected the first set of topics to work with, the group can continue to the following actions:

- The facilitator reads the scenario from the text view and then shows the scenario in diagram view (by clicking the 'View as picture' button).
  - A response to the scenario is invited from the group.

- This prompts discussion.
  - The facilitator listens to the discussion and proposes a response for the RSQ scenario if one is not proposed by a participant (e.g. likely, unlikely, possibly etc.)
  - When a rough consensus appears the answer is 'fixed' by the facilitator clicking on the relevant response in the RSQ and the group moves to the next scenario (to keep the pace going).
- The facilitator moves to another scenario and might suggest an answer to the scenario, based on earlier discussion, by clicking on a proposed answer to prompt disagreement/response.
- The facilitator uses the comment box to summarise the key points of the discussion and get agreement from the group regarding the comments.
- Move steadily through the scenarios related to the topic, keeping reasonable pace that reflects the number of topics planned to get through and the time available.
- On average, a topic may take 30mins to complete.

When all scenarios in a topic are complete, the following actions can be taken:

- Review the risk and awareness scores (pointing out that awareness is lowered by 'possible' answers).
- Check whether this 'makes sense' to the group.
  - If not, then discuss with respect to the responses provided to each of the scenarios.
- If appropriate, at the end of each topic the group can view the policy suggestions with respect to those scenarios deemed by the group of most risk to them. This enables the participants to discuss policies that have already been implemented in their own city and those suggested by other cities.
- Agree next topic – this is often a prompt from the RSQ, but, if not, it is usually obvious given the nature of the discussion, otherwise can refer back to list suggested from group at beginning of the session regarding topics of interest to them.

STAGE 4: SUMMARISING THE RESULTS

Once all the relevant topics have been completed by the group, they can proceed to the following:

- Display the summary sheet with the risk topics that have been considered set out in order of risk level and then in order of awareness.
- Display the scenarios and their responses in the summary sheet.
- Highlight, in particular, those risk topics that are ranked as highest risk and lowest awareness and the risk scenarios which are 'likely'.
- Discuss the above results.
- At the end of the session, thank participants for their contributions to the 'thinking' of the City/project.

6. CONCLUSION

Based on engagement with the cities actively participating in the SMR project, and based on the risk assessment literature, it is clear that having a good understanding of risk systemicity in the context of developing resilience is of high priority for today's cities. However, risk systemicity is not easy to understand due to the complexity that can result when considering the interactions between many risks. The RSQ offers an innovative tool which allows cities to operationalise risk systemicity in their own settings, and thereby make risk systemicity an integral part of their everyday risk assessment. Moreover, beyond risk assessment, the RSQ also serves as a group facilitation tool which invites practitioners from different teams and risk areas to build potentially productive working relationships through multidisciplinary discussion and collaboration with regards to the interactions between risks. Indeed, the numerous tests of the RSQ carried out with cities as part of the SMR project have demonstrated that cities are very enthusiastic about using the RSQ, and they see it is as being complementary to the existing resilience tools and methods which they already use.

As evidenced in this report, the RSQ meets its original objectives by enabling cities to "strengthen preparedness by anticipating and appropriately responding to future challenges". On that basis, there is a clear integration between the RSQ and four other SMR tools, which includes supporting the evaluation of the city's current maturity level. Another crucial impact of the RSQ is that it updates and compliments the existing EU guidelines with respect to Risk Assessment and Disaster Management (European Commission, 2010) through its practical and conceptual contribution. It is therefore expected that the RSQ will play an important role in improving the current theory and practice of risk assessment and city resilience at the European level and beyond.

7. REFERENCES

100 Resilient Cities (2016a) About Us. (accessed 05.01.2017).

100 Resilient Cities (2016b) What is Urban Resilience? (accessed 05.01.2017).

Ackermann F and Eden C (2011a) *Making Strategy: Mapping Out Strategic Success,* London, UK: Sage.

Ackermann F and Eden C (2011b) Negotiation in Strategy Making Teams: Group Support Systems and the Process of Cognitive Change. *Group Decision and Negotiation* 20(3): 293-314.

Ackermann F, Eden C and Pyrko I (2016) Accelerated Multi-Organization Conflict Resolution. *Group Decision and Negotiation* 25(5): 901-922.

Ackermann F, Eden C, Williams T, et al. (2007) Systemic Risk Assessment: A Case Study. *The Journal of the Operational Research Society* 58(1): 39-51.

Ackermann F, Howick S, Quigley J, et al. (2014) Systemic risk elicitation: Using causal maps to engage stakeholders and build a comprehensive view of risks. *European Journal of Operational Research* 238(1): 290-299.

Aldunce P, Beilin R, Handmer J, et al. (2014) Framing disaster resilience: The implications of the diverse conceptualisations of "bouncing back". *Disaster Prevention and Management* 23(3): 252-270.

Boin A and McConnell A (2007) Preparing for Critical Infrastructure Breakdowns: The Limits of Crisis Management and the Need for Resilience. *Journal of Contingencies and Crisis Management* 15(1): 50-59.

Bryson JM, Ackermann F, Eden C, et al. (2004) *Visible Thinking - Unlocking Causal Mapping for Practical Results,* Chichester, UK: John Wiley & Sons.

Cagney KA, Sterrett D, Benz J, et al. (2016) Social Resources and Community Resilience in the Wake of Superstorm Sandy. *PLoS ONE* 11(8): e0160824.

Carlile PR (2002) A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development. *Organization Science* 13(4): 442-455.

Carlile PR (2004) Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries. *Organization Science* 15(5): 555-568.

Chapman C and Ward S (1997) *Project Risk Management: Processes, Techniques and Insights,* Chichester, UK: Wiley.

Eden C (1992) One the nature of cognitive maps. *Journal of Management Studies* 29(3): 261-265.

Eden C (2001) Coping with strategic risk. In: Crainer S and Dearlove D (eds) *Financial Times Management Handbook* London, UK: Financial Times, 286-291.

Eden C, Ackermann F and Cropper S (1992) The analysis of cause maps. *Journal of Management Studies* 29(3): 309-324.

Eden C, Ackermann F and Williams T (2005) THE AMOEBIC GROWTH OF PROJECT COSTS. *Project Management Journal* 36(2): 15-27.

European Commission (2010) Commission Staff Working Paper: Risk Assessment and Mapping Guidelines for Disaster Management. (accessed 05.01.2017).

European Commission (2016) European Multiple Environmental Threats Emergency Network (EMETNET). (accessed 10.03.2017).

Eusgeld I, Nan C and Dietz S (2011) "System-of-systems" approach for interdependent critical infrastructures. *Reliability Engineering & System Safety* 96(6): 679-686.

Hickman MJ and Mai N (2015) Migration and Social Cohesion: Appraising the Resilience of Place in London. *Population, Space and Place* 21(5): 421-432.

Huff AS (1990) *Mapping Strategic Thought,* New York, NY, USA: Wiley.

Hull JK (1990) Application of risk analysis techniques in proposal assessment. *International Journal of Project Management* 8(3): 152-157.

Jenkins M (2002) Cognitive Mapping. In: Partington D (ed) *Essential Skills for Management Research.* London, UK: SAGE, 254-271.

Labaka L, Hernantes J and Sarriegi JM (2015) Resilience framework for critical infrastructures: An empirical study in a nuclear plant. *Reliability Engineering & System Safety* 141: 92-105.

Laukkanen M (1994) Comparative Cause Mapping of Organizational Cognitions. *Organization Science* 5(3): 322-343.

Manyena SB (2006) The concept of resilience revisited. *Disasters* 30(4): 434-450.

Poortinga W (2012) Community resilience and health: The role of bonding, bridging, and linking aspects of social capital. *Health & Place* 18(2): 286-295.

Project Management Institute (2013) *A Guide to the Project Management Body of Knowledge (PMBOK Guide),* Newtown Square, Pennsylvania, USA.

Rinaldi SM, Peerenboom JP and Kelly TK (2001) Identifying, understanding, and analyzing critical infrastructure interdependencies. *IEEE Control Systems* 21(6): 11-25.

Simon P, Hillson D and Newland K (1997) *PRAM: Project Risk Analysis and Management Guide,* Norwich, UK: APM Group Ltd.

The Economist (2015) Bright lights, big cities: Urbanisation and the rise of the megacity. (accessed 06.01.2017).

Thompson PA and Perry JG (1986) *Risk Management in Engineering Construction,* London, UK: Thomas Telford Services

Townshend I, Awosoga O, Kulig J, et al. (2015) Social cohesion and resilience across communities that have experienced a disaster. *Natural Hazards* 76(2): 913-938.

van der Vegt GS, Essens P, Wahlström M, et al. (2015) Managing Risk and Resilience. *Academy of Management Journal* 58(4): 971-980.

Williams TM (1993) Risk-management infrastructures. *International Journal of Project Management* 11(1): 5-10.

Winnicott DW (1953) Transitional objects and transitional phenomena; a study of the first not-me possession. *The International Journal of Psych-Analysis* 34(2): 89-97.