Risk systemicity and city resilience

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Abstract

The resilience of cities has become a matter of concern across the world. The Rockefeller Foundation has sponsored resilience development in 100 cities across the world and the project discussed in this paper follows from EU interest in the topic. Resilience is dependent, at least in part, on effective risk assessment. However, most risk assessment follows the creation of the traditional risk register that list risks, their probability and their impact. In this paper we describe the development of a risk systemicity questionnaire (RSQ) that recognises risk scenarios as complex networks of risk consequences, and has embedded in it background programming that recognises the interaction between risk scenarios represented in the questionnaire. The research represents an attempt to operationalise theoretical perspectives on risk systemicity through work with seven European cities. The RSQ was co-produced with these cities to help European cities in their consideration of risk systemicity with respect to their local contexts.

Keywords: risk systemicity, resilience, risk assessment, causal mapping

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Risk Systemicity and City Resilience

Introduction

As modern societies advance further through the 21st century, it is becoming increasingly recognized that they need to be resilient with respect to an array of different kinds of crisis and disasters, as evidenced by such efforts as the Rockefeller Foundation's 100 Resilient Cities Network (100 Resilient Cities, 2016a). In the Academy of Management Reviews journal, resilience has been defined as: "… 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).

Thus, one of the key elements of resilience is an ability to assess and manage risks effectively, which is particularly relevant in the context of larger and smaller cities which provide homes for the majority of the world's population (The Economist, 2015). However, according to Arup's report which officially informs the Rockefeller Foundation's 100 Cities Network (2016: 5), whilst 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." This explains why the overall interest in the studies of resilience has grown considerably in the recent decade (Aldunce et al, 2014; Boin and McConnell, 2007; Crichton et al, 2009; Labaka et al. 2015), even if the literature on this topic remain by large fragmented and context-specific (Bång and Rankin, 2016; Linnenluecke,

2017). The focus on cities also entails incorporating the terminology characteristic to the studies of city resilience, such as differentiating 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, 2016b), or appreciating the notion of 'bouncing forward' which roughly refers to using risk events as opportunities for learning and improvement (Malalgoda et al, 2014; Manyena, 2006; Taleb, 2013).

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, and instead it is essential to understand risks as forming complex networks, which in practice is a non-trivial endeavour.

Typically organisations are encouraged to undertake risk assessment using a risk register that lists the risks and makes a judgment about their potential impact and the probability of their occurrence. Indeed, the EU guidelines (The 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 ignores the interactions between risks and more significantly the systemic interactions between their consequences. The EU guidelines also suggest to draft possible *risk scenarios* as a way of preparing for risks, and to consider possible knock-on effects deriving from such scenarios. These demands are similar to those described in the traditional project management risk register (Chapman and Ward, 1997; Hull, 1990; Thompson and Perry, 1986), and as outlined in the documents such as the Association of Project Management's PRAM Guide (Simon et al, 1997), or the chapter covering project risk management in the PMBOK (Project Management Institute, 2013). In other words, these standards stress the need for the

categorisation of individual risks, in particular measurable technical risks. However, categorisation of risks may lead to seeing risks as independent from one another, which is seen as a too limiting view and which calls for a more holistic approach to risk assessment (Ackermann et al, 2007, Ackermann et al, 2014).

This paper aims to describe an approach to assessing and mitigating risks that addresses risk systemicity. We describe the development of a risk systemicity questionnaire (RSQ) that recognises risk scenarios as complex networks of risk consequences, and recognises the interaction between these scenarios. Whilst risk systemicity has already been discussed in business settings (Ackermann et al, 2007; Ackermann et al, 2014), this paper reports research that operationalises the theoretical perspectives on risk systemicity to a city context through working with seven European cities. This collaborative development of the RSQ co-produced a tool designed to help European cities in their consideration of risk systemicity with respect to their local contexts.

The structure of this paper is as follows. Firstly, risk systemicity is characterised, covering such concepts as vicious loops, unintended consequences, and portfolios of risks. Causal mapping is also introduced as the method used in this work to represent peoples' views regarding risk systemicity. Secondly, drawing on this initial description of risk systemicity, and building on the recognition of the need to operationalise risk systemicity in cities, we discuss how the RSQ was developed involving active participation of seven European cities. We explain how the data used to inform the construction of the RSQ was collected during a series of workshops facilitated with the use of a computer supported Group Support System –

Group Explorer[1]. Subsequently, the iterative process of designing the RSQ is explained in detail, with particular focus placed on recognising opportunities and challenges identified during this process. The discussion concludes with a section where the possible uses of the RSQ are elaborated, and it is suggested how the RSQ can be operationalised to develop cities' capability with respect to assessing and mitigating risks, and consequently contribute to building city resilience.

We conclude by suggesting that consideration of risk systemicity can enhance the existing standards associated with assessing risks in the public sector.

Risk systemicity and causal mapping

In project management, both in the public and private sectors, the typical approach to risk assessment is the use of traditional risk registers (Williams, 1993). A risk register is a repository of different types of identified risks, combined with the evaluation of their risk level. However, risk registers suffer from a number of 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

[1] Group Explorer is a Group Support System that facilitates high group productivity and the real time construction of causal maps. The software utilises Causal Mapping software (Decision Explorer from Banxia.com, and Group Explorer is freely available.

explained by the 100 Resilient Cities Network (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 the traditional risk registers.

Therefore, suitable methods are required that can enable a city to identify, explore, understand better, and present in a clear way causal networks of different types of risks. The method used in this reported 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, Bryson et al, 2014) 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). 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 the dedicated group support software (Ackermann and Eden, 2011, 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 then 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 experienced 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 1 where the city is affected by riots, leading to a portfolio of risks: 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.

Insert Figure 1 about here

A causal map such as that depicted in Figure 1, especially if developed further with the contributions of different experts, can also help to appreciate the knock-on events and non-obvious consequences of risk events as well as identify the risks themselves. Importantly, such interactions can link assumed categories of risks. 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, Carlile 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 2: 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 negative consequences for the cities, and for this reason vicious loops need to be attended to carefully. A visual representations 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 2, 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.

Insert Figure 2 about here

In the research reported here, a specialized city resilience tool called the risk systemicity questionnaire (RSQ) was developed to support cities in collective thinking about risk systemicity – its likelihood and mitigation. In the following sections we discuss how the RSQ was constructed and designed based on the data collected during a series of workshops which were facilitated with the aid of a computer based group support system, a system equipped

with a causal mapping facility. It is believed that the work reported here is the first attempt to implement risk systemicity in the context of risk assessment in cities. In the next section we discuss how city practitioners effectively engaged in the process of co-creating the potential risk scenarios which operationalizes the idea of risk systemicity in their everyday practice.

Facilitated Group Support System workshops: informing the RSQ

The reported research was undertaken as part of a large EU-funded project called Smart Mature Resilience (SMR, 2017). The overall goal of the project was to develop a number of tools which would support cities in improving their resilience, and thus form a new European Resilience Management Guideline. The authors of this paper represent one of four academic institutions from different European countries involved in the project, and this discussion reports on one of the five tools constructed as part of the whole project – the Risk Systemicity Questionnaire (RSQ). In this section we discuss how empirical data, contained in causal maps, were collected to inform the RSQ, and in the subsequent section we discuss how, drawing on this data, the various features of the RSQ were designed. Before elaborating on the data collection, a brief introduction to the content of the RSQ is presented below.

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. 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 vicious cycle scenarios because our 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, as evidenced in the following discussion, in this research the existing ideas are developed and translated into a public sector context.

Group Explorer [2], a group decision support system, was applied to facilitate a series of interactive workshops. Five workshops took place over the course of one year in five different locations: Riga, Latvia; Bristol, UK; Rome, Italy; Vejle, Denmark; and Kristiansand, Norway. Representatives of each of these five host city councils attended each workshop as well as representatives from Donostia/San Sebastian, Spain; and Glasgow, UK. 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 can be regarded as generalists with a broad picture of the discussed risks and policies rather than specific subject experts. The data collection regarding risk events possibly facing the cities took place during the first three workshops, during which three broad themes related to city resilience were explored: critical infrastructure, climate change, and social issues. The remaining two workshops were used to test the initial prototype of the RSQ and to embellish the policy suggestions gathered in previous sessions.

The reason for selecting *Group Explorer* for conducting the workshops is that 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, 2011). Facilitator of the workshop can use *Group Explorer* to monitor users'

[2] *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 r4epresented 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.

contributions. 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 concludes with a tangible outcome – a co-created shared causal map which was subsequently analysed.

During the sessions, and based on feedback from city representatives, there was high level and 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 workshops conducted as part of the reported research 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 the shared patterns and commonalities between the maps.

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 when it would validate contributed material. 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 the following workshops.

In order to further analyse the map, all statements were allocated into different categories: chronic stresses (risk events which unwrap gradually such as rising inequalities), acute shocks (risk events which happen suddenly), tried policies (policies already implemented in the participating cities), and policy ideas (suggestions for new policies). 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).

The analysis of the data led to the recognition of 16 key themes which cut across the three original main topics of the conducted workshops, that is: critical infrastructure, climate change, and social dynamics. The themes included: health, immigration, transport, social inequalities, social cohesion, riots in the city, and air pollution. 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 underpinned numerous aspects of risk mitigation. This result was of particular interest because social cohesion is a dominant aspect of a resilient city. 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.

Designing and testing the RSQ with the participating European cities

The process of designing the RSQ was highly iterative, with numerous tests and modifications undertaken regularly over the course of 18 months. The project workshops and further meetings with the citites, which took place at least every couple of months, were used as opportunities to collect feedback from the participating cities with respect to the possible design of the RSQ. As a result, the tool constantly evolved, with various key features emerging during the life of the project rather than being planned from the beginning of the reported research. The RSQ is equipped with new features compared to previous work that developed a similar type of risk systemicity questionnaire (Ackermann et al, 2007), many of which were voiced as suggestions in the feedback received from city participants who were testing, and effectively co-creating this tool. As discussed in this section, these new features include; a focus on vicious cycles in the presentation of risk scenarios, the option of displaying scenarios in the form of pictures, and the ability to view policy suggestions. Thus, these new features help tailor the RSQ to the needs of city practitioners who deal with risk and resilience on a day-to-day basis.

The RSQ was programmed in Excel using Visual Basic for Applications programming language. It consists of 16 risk topics which can be explored as separate tabs in Excel, for example: health, air pollution, transport, flooding, or ageing. Each RSQ topic comprises between 6 to 12 risk scenarios which describe a chain of events that may occur in the user's city. All elements of risk scenarios are linked causally, for example: 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. For each scenario, a user is asked to consider the likelihood of the scenario happening in their city by selecting from one of the five available answers: 'likely' (to occur), 'possible', 'unlikely', 'we don't know but someone else (in my organisation) knows (if the risk event is likely to occur)', and 'I don't know'. Depending on the answer, a risk weight (which refers to the level of risk) and an awareness weight (which refers to the extent to which the user is aware of the risk scenario in question) are calculated differently. In principle, 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.

In most cases, risk scenarios are presented in the form of vicious loops which were identified during the analysis of findings obtained in the *Group Explorer* workshops. For example, Figure 3 presents a risk scenario which appears under the 'health' 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: aged peoples' health problems increase, leads to city faced with a significantly growing demand for social care and healthcare, which means that the overall cost of healthcare is rising considerably and healthcare services are under increasing pressure, which reinforces overall increase of the aged peoples' health problems. 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 (peoples' health problems). As the described scenario is also undesirable, it can be seen that the risk scenario 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.

Insert Figure 3 about here

However, 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. Hence, a number of additional features were included in the design of the RSQ to address this issue. Firstly, as it can be seen in Figure 4, every vicious loop in the RSQ also has the option of being displayed as a picture. City representatives found the inclusion of pictures as 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. Moreover, during testing of the RSQ with cities it was observed that some users preferred to complete the questionnaire 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 of choosing between these two modes of presentation.

Insert Figure 4 about here

In addition to this, in order to introduce the concepts of risk systemicity and vicious loops, a description of these concepts are included in an introductory overview to the RSQ which can be accessed on its front page (see Figure 5).

Insert Figure 5 about here

Whereas city representatives appreciated the ability to explore different RSQ topics with respect to the vicious loops which their cities might face, they also emphasised the necessity

to explore how the identified vicious loops could be mitigated against or broken so that their cities can prepare themselves against the imposed threats. For this reason, 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 16 topics in the RSQ and can be explored through use of an interactive menu (Figure 6). Moreover, 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.

Insert Figure 6 about here

Another feature of the RSQ which city participants found helpful is an ability to tailor the choice of scenarios to the cities' needs. This feature is important because the RSQ includes a large amount of content as each of the 16 topics comprises between 80-150 rows in Excel, and so it would take a large amount of time to go through all of the available scenarios, especially if completing the RSQ as a group rather than as an individual user. Also, the risk scenarios in the RSQ are of general rather than city-specific character so that they address 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 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.

As evidenced in this section, city representatives participating in the reported research were continually proactive in co-creating and testing the RSQ. Their views were regarded as essential due to the high novelty of the tool and the wish to operationalise risk systemicity in the city resilience context. However, whereas city participants' contributions proved highly valuable to the design of the RSQ, their role was perhaps even bigger in helping to understand the possible uses of the RSQ. This was an essential matter due to a key objective of the project was to develop a tool which would be implemented, and be of use, to cities, and which could enhance the European standards with respect to mapping and mitigating risks in cities.

Using the RSQ in cities

Overall, as commented by city representatives, the RSQ proved useful in allowing people to familiarise themselves with risk systemicity and think more intentionally about it. Thus, the RSQ can be considered much more as an educational tool, as well as a tool for facilitating group conversation about risk systemicity, rather than merely a diagnostic risk assessment tool. Indeed, city representatives tended to pay considerably more attention to the causal dynamics between the risk events appearing in vicious loops rather than to the generated risk score which is returned at the end of each RSQ topic.

Following experiments and testing of the RSQ within cities the practitioners identified several different potential types of use. Each of these are founded on the principle that the RSQ cannot cover all possible risk scenarios and so the presented scenarios can be used to prompt a focused and thoughtful discussion that can lead to helping the prioritizing of resources. The RSQ would be the basis for promoting and facilitating a designed and structured discussion about risk assessment and risk mitigation. 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.

The most obvious use identified is through the involvement of City Project Teams, particularly the Resilience Office Team. Here the RSQ would be used before the launch of a project in order for the team to become aware of potential risks outside of the obvious project risks – helping identify the systemic impact on other aspects of the city. City representatives also regarded the RSQ as an effective way of involving politicians in developing a better understanding of the complex ramifications that may unfold from the implementation of apparently simple policies.

Secondly, practitioners saw a significant benefit from using the RSQ as a way of consciousness raising among the population of the city. The RSQ would be the basis for focus group meetings involving 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 would be expected to promote discussion about the potential risks to social cohesion.

The third primary use was seen to be its use with politician groups, both for awareness raising and induction to newly elected politicians.

In all of these uses the discussion that ensues, as groups seek to reach agreement about the validity of the scenarios they will address in the RSQ, and the evaluation of the degree of risk (from the risk and awareness scores) is likely to be the basis for raising awareness. But, in addition, the final evaluations become the basis for prioritizing resources for risk mitigation.

Limitations of the RSQ

Most of the limitations of the RSQ are caused by the restricted timeframe and resources available during the reported research

Firstly, the risk scenarios included in the RSQ do not cover all of the possible risks and policies that fall under the 16 key themes in the RSQ. All data used for constructing the RSQ was gathered during the series of Group Explorer workshops, and so there were limitations in how much content could be gathered from cities during the available time. Moreover, the representatives of seven participating cities provided contributions from their own perspectives, and based on their idiosyncratic experiences, which meant that not all European cities' views were represented in the gathered material, let alone the views of cities at the global level. However, most of the seven participating cities came from different European countries and were located in different geopolitical parts of Europe (e.g. Spain, the UK, Latvia, or Denmark), and they were of very different sizes and character (e.g. Rome in Italy and Kristiansand in Norway), which supports an argument that, to a limited extent, the RSQ does cover a fair representation of the risk landscape which cities may face.

Secondly, representatives of cities who took part in the Group Explorer workshops possessed generalist knowledge of the landscapes of risks, but many of them were not subject experts of the three main areas explored during the research (critical infrastructure, climate change, and social issues). As a result, the risks and policies included in the RSQ were not explored in great depth, but instead they were evaluated at a general level. This however does not

constrain the main purpose of the RSQ which aims to support cities in consideration of the broader risk landscape, which is how the different types of risks interact with one another, rather than take a detailed view that could be of interest to a narrow specialist audience.

The limitations concerning the generalist and non-exhaustive nature of risk scenarios in the RSQ are not considered to be major issues as the RSQ is intended to be used largely as an interdisciplinary team engagement tool, which means that the available risks scenarios should prompt more focused discussions between different types of experts. In other words, users are invited to think about the likelihood of the risks scenarios that are covered in the 16 of the RSQ topics, but are also encouraged to explore other examples of vicious loops which may be applicable to their cities. By educating users about the concepts of risk systemicity and the nature of vicious loops in the context of city resilience, the RSQ thus allows users to develop a capability to consider the systemic character of the landscape of risks in their everyday work, which goes far beyond the sole exercise of completing the questionnaire.

The third limitation is that the risk scores generated upon completion of the RSQ cannot be regarded as objective scores, but instead they should only be taken as rough indicators to allow discussion focussing on a comparison between (i) individual user's scores and (ii) between different risk topics. The reason for this is that the weights assigned to the risk scenarios were agreed by the researchers based on their judgment as of how much impact those scenarios may inflict on cities, but those weights were not underpinned by a dedicated research that would validate the assigned weights. Thus, whilst the available risk weights offer a certain sense of priority and urgency, further work could focus on validating these scores.

However, it should be emphasised that the RSQ is not intended as a tool that fully represents the risk landscape that affects cities. Instead, it is intended as a team engagement and

facilitation tool, which can be used to promote a focussed discussion about risk systemicity to encourage different stakeholders to examine how risks affect and reinforce one another, and how those interactions of risks should be addressed appropriately by the city.

Conclusions and Summary

The foundation of the project reported in this paper is the assertion that the resilience of cities is dependent, at least in part, on an effective risk assessment. Using only a traditional risk register represents a narrow view of risk assessment because it does not recognize the interaction between risks or the ramified consequences of risks. In particular the possibility of some risks generating powerful vicious cycles is ignored, where the ramifications of the risk is accelerated and so difficult to mitigate. Thus the evaluations of risk is seen as exploring risk *scenarios* rather than simply individual risks. The research reported here is an attempt to recognize these aspects of risk assessment. In addition it has sought to recognize that risk mitigation, as a key part of building city resilience, is likely to be interdisciplinary and involve a portfolio approach to mitigation of risk scenarios.

The research has involved experts from a range of European cities in an attempt to involve practitioners in the co-creation of a risk systemicity questionnaire that can be actively used in a city setting.

The development and implementation process would have likely been significantly different without the involvement of practitioners. However, their involvement has also illustrated a number of problems with our attempt at recognizing risk systemicity, and these have been identified above. Perhaps most importantly the issue of validating the causal assertions that are the essence of the risk scenarios used in the RSQ has proven to be problematic. There is, of course, an inevitability about this problem. Validating assertions about the future is riddled with issues. As Schumacher (1973) commented: "Predictions are always unreliable

and particularly so when they are about the future". Nevertheless, city practitioner/managers are necessarily hidebound by their particular experiences and so some degree of wider validation is crucial, but very time-consuming.

Although industry has used risk systemicity with great success, in those instances extensive focused research and historical data has been available for validation and so the risk assessment itself is relatively reliable. In the project reported here it has been crucial to recognize that the RSQ must be seen more as a vehicle for focussed discussion and consciousness raising rather than as a form of precise assessment.

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List of figures

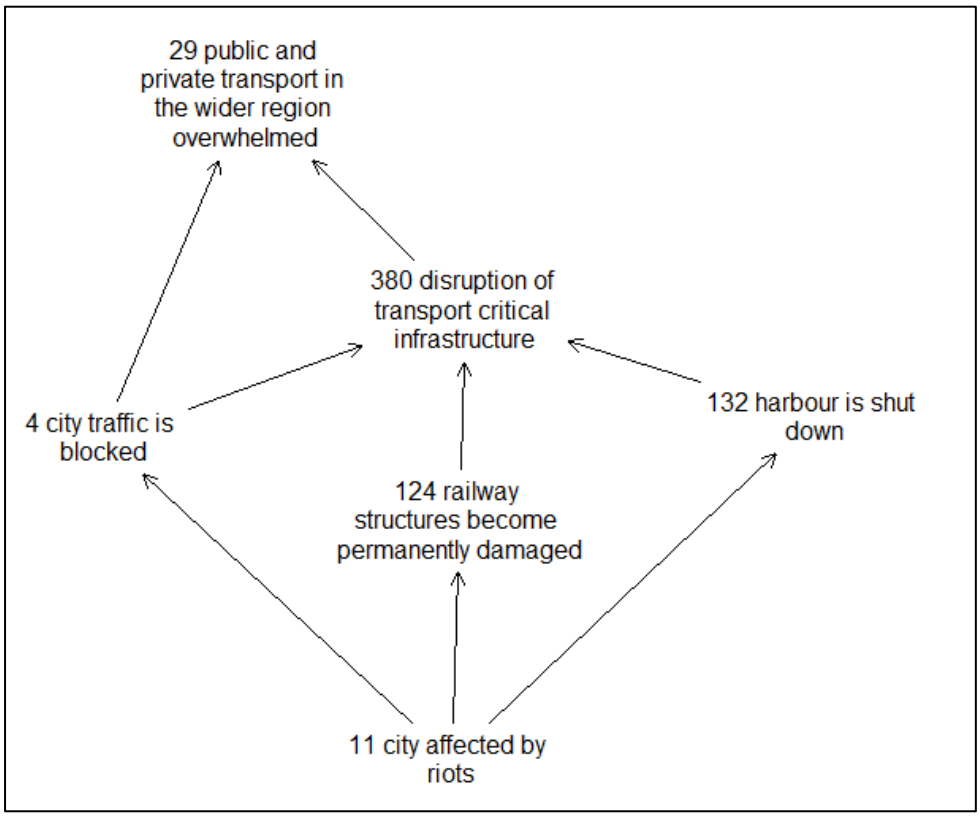

Figure 1: Example of a small part of a risk scenario

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

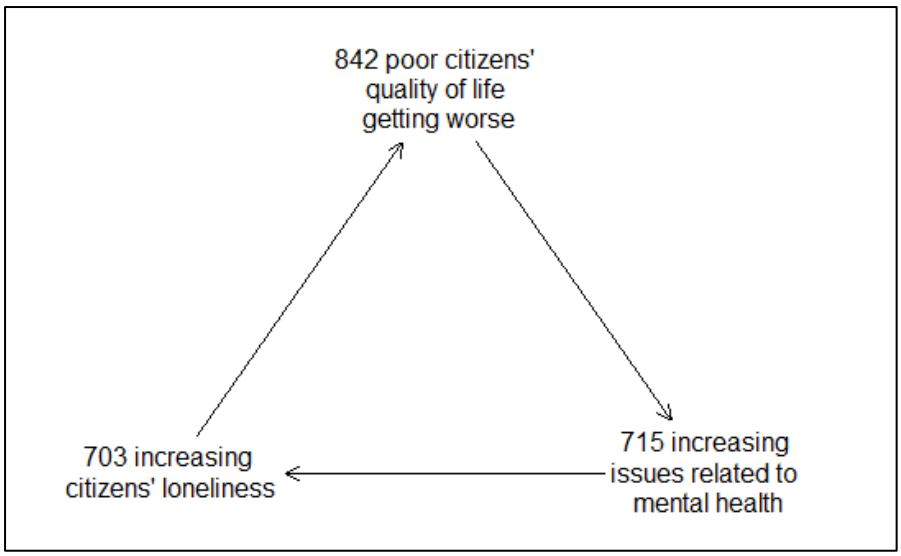

Figure 2: Example of a simple vicious loop

90	"VICIOUS CYCLE OF HEALTHCARE UNDER PRESSURE" - causal loop				
91	Overall increase of the aged peoples' health problems				View as picture
92	LEADS TO city is faced with a significantly growing demand for social care and healthcare				
93	WHICH MEANS THAT the overall cost of healthcare is rising considerably AND healthcare services are under increasing pressure				
94	AND SO the quality of healthcare is reduced				
95	WHICH REINFORCES overall increase of the aged peoples' health problems				
96	*HOW LIKELY DO YOU THINK THIS SCENARIO (in blue) WILL DEVELOP IN YOUR CITY/REGION?*				
97	High likely	Possibly	Unlikely	We don't know	I don't know - someone else does
99					

Figure 3: 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).*

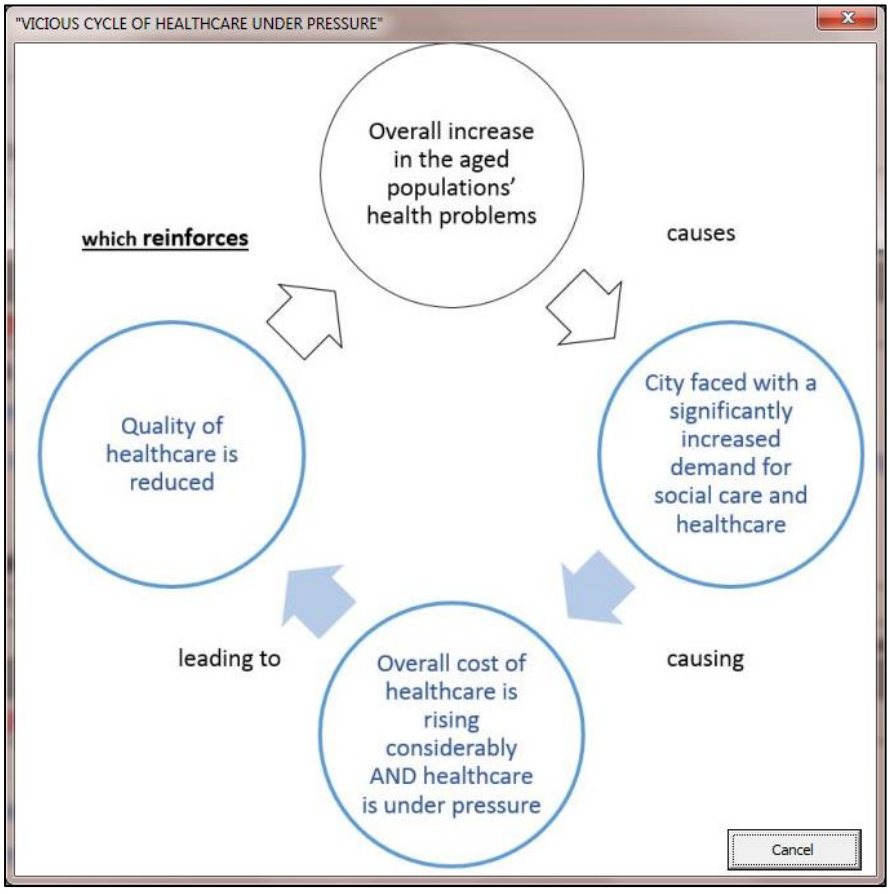

Figure 4: A picture of a vicious loop from the RSQ

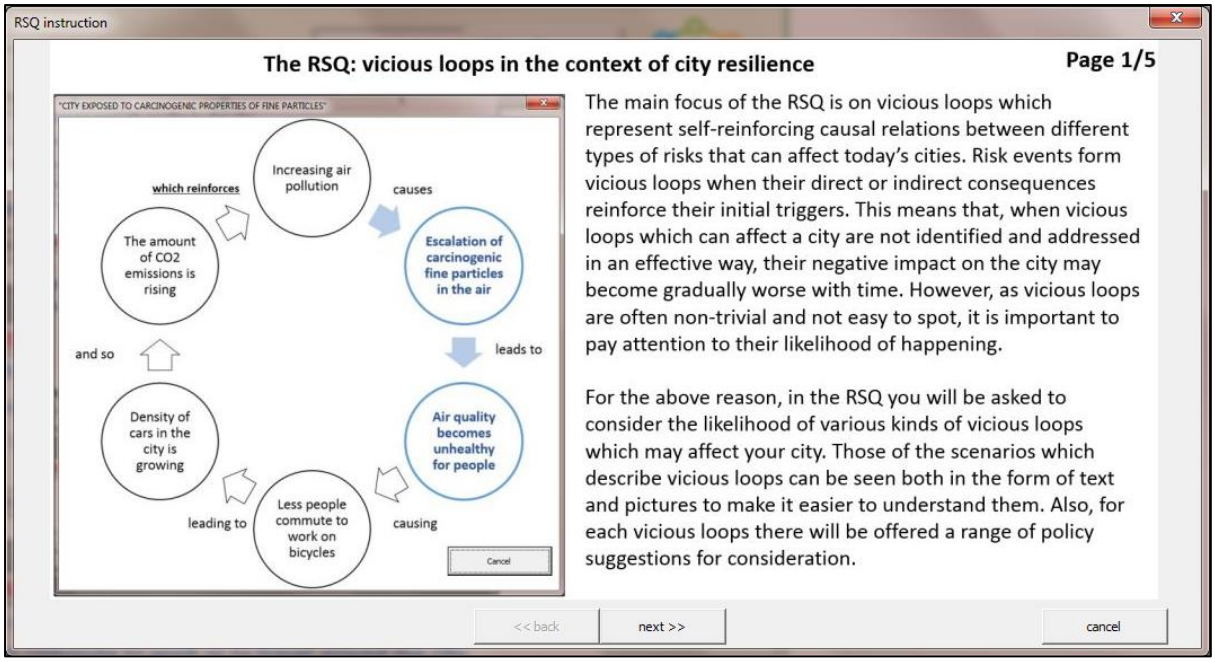

Figure 5: The first page of the RSQ instruction

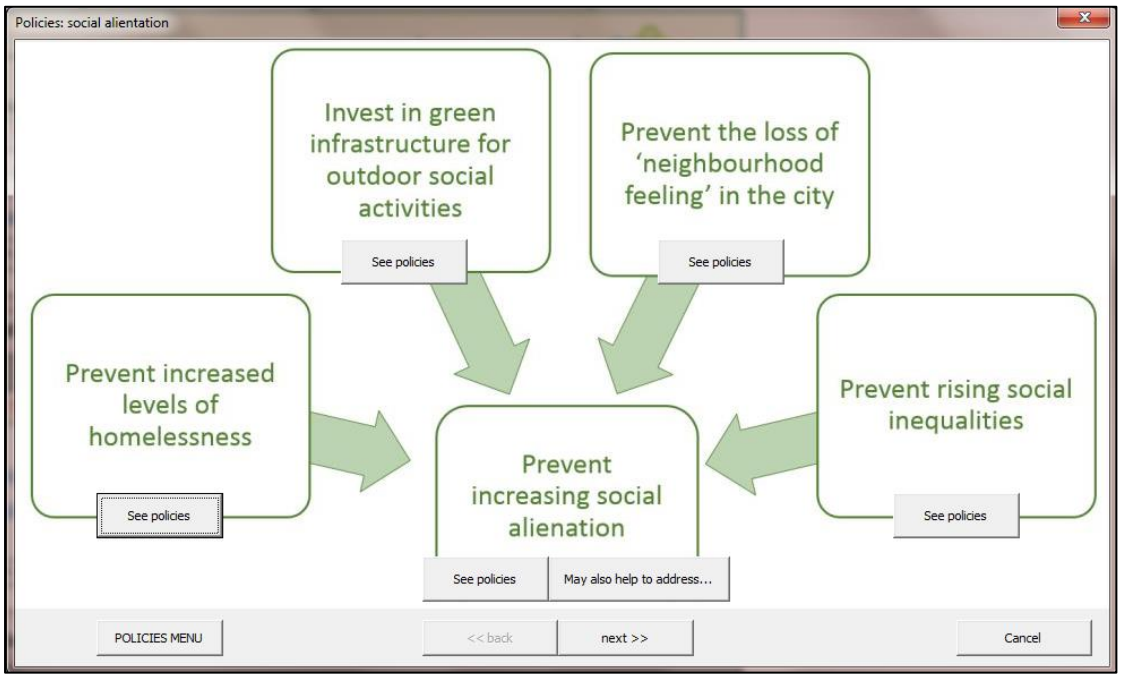

Figure 6: Exploring policy suggestions in the RSQ