

Improving resilience against a pandemic: A novel technology for strategy development with practitioners and decision-makers

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ABSTRACT

The project Systemic Pandemic Risk Management (SPRM), funded by the Research Council of Norway, has developed methods to assess and manage pandemic systemic risks. The project consortium includes an enterprise leading the project, public partners and research institutions in Norway, Sweden, and Italy.

Kristiansand municipality, a partner in the SPRM project, adopted the project methods to assess and manage systemic risks. Based on a scenario about the potential spread patterns of the COVID-19 Omicron variant developed by the Norwegian Institute of Public Health, staff from Kristiansand employed the SPRM project's approach to facilitate systemic risk assessment and management workshops. Practitioners and decision-makers from the main hospital in the Agder county and several municipalities proposed risks, their causal consequences and identified practical and impactful mitigation strategies. The strategies were implemented at the county level. The approach can improve handling of systemic risk scenarios beyond pandemics.

Keywords

Systemic risk, pandemic, COVID-19, Omicron variant, risk assessment, risk mitigation, resilience.

INTRODUCTION

This paper concerns the outcome in terms of gain of experience and results for mitigating pandemic risks in the adoption of a novel strategy mapping method by the head of research (first author, E.A.) and the crisis manager (second author, S.P.) of the Kristiansand municipality, Norway. The strategy mapping method was developed by the Systemic Pandemic Risk Management (SPRM) project where the Kristiansand municipality, as project partner, contributed with stakeholders to the strategy mapping workshops of the SPRM project.

In this paper we report activities beyond the SPRM project, in that the crisis manager and the head of research of the Kristiansand municipality adopted the SRPM approach, acting as *facilitators* in strategy mapping workshops with stakeholders belonging to an established unit known as "Helsefelleskapet Agder" (Agder Health Community). The unit consists of health practitioners, health experts and managers representing primary care and the Sørlandet Hospital.

In the SPRM project, the crisis manager and the head of research of the Kristiansand municipality had an important role to contribute in person and to recruit other needed stakeholders to the strategy mapping workshops of the project. The transitioning from participating as stakeholders in the SPRM project to lead and facilitate strategy mapping workshops for the emerging pandemic challenge of the Omicron wave was incited by previous experiences with the method and the strategy mapping technology developed in the SPRM project.

To achieve the United Nations Sustainable Development Goals, it is imperative that researchers create models that are more understandable and useful to policymakers (Reichstein et al., 2021). Achieving useful, useable, and used research is still rare (Boaz & Hayden., 2002; Oliver et al., 2022). The successful adoption of the method and the strategy mapping technology by practitioner end-users reported in this contribution suggests that the project Systemic Pandemic Risk Management (SPRM) project has delivered useful, useable, and used research.

Systemic risk and strategy mapping

While there are many definitions of systemic risk, at its core is that individual risks propagate through contagion (Centeno et al, 2015; Gonzalez & Eden, 2023). Hence, the concept ‘systemic risks’ implies that the issues/risks and their outcomes interact with each other, whereby the outcomes of risks are risks themselves, leading to numerous vicious cycles which – unless properly mitigated—reinforce and escalate the risks (Williams et al., 1997). Systemic risk triggers cascading impacts that spread within and across systems. The spread can lead to potentially existential consequences and system collapse (Sillmann et al., 2022). Systemic risk is a major challenge to sustainable development (United Nations Office for Disaster Risk Reduction UNDRR, 2019).

We provide a brief description of the SPRM project, since this project developed the methods that subsequently were adopted by practitioner staff at Kristiansand municipality.

SPRM is an innovation project funded by the Research Council of Norway. SPRM has developed methods based on strategy mapping to assess and manage pandemic systemic risks. Strategy mapping is a leadership and management method based on facilitated workshops with stakeholders to understand the system in need of management and articulate the interventions needed to bring about the desired changes. Strategy mapping fosters direction, alignment, and commitment. Strategy mapping helps stakeholders visualize the cause-and-effect chains in a system and the strategies to achieve desired goals – linking aspirations with capabilities (Bryson et al., 2023, p6ff).

SPRM started 1st September 2020 and will be completed 30th June 2023. In its final phase, end-users in Norway and Sweden validate the project’s methods and tools using as case preparedness and resilience towards a future major pandemic.

The company Stepchange AS leads the SPRM project. Project partners are the municipality of Kristiansand; the Sørlandet Hospital; the Centre of Integrated Emergency Management (CIEM), University of Agder; the Center for Disaster Medicine and Traumatology (KMC), Sweden; and the Center for Research and Training in Disaster Medicine, Humanitarian Aid and Global Health (Università del Piemonte Orientale), Italy. The main objective of the SPRM project is to develop methods and tools to assess and mitigate the direct and indirect risks to the health and social care system arising from a major pandemic, such as COVID-19. The crucial challenges to strategy development for preparedness and response are posed by systemic risks.

Kristiansand is the capital of Agder county, located in the southernmost part of Norway. The population in Agder county is about 311.000, and 114.000 citizens live in Kristiansand, making it the fifth largest city in Norway, a country of 5 million inhabitants. The main campus of the University of Agder is located in Kristiansand, as well as the main location of Sørlandet Hospital, serving the Agder county with hospital services.

The SPRM project used throughout the *Strategyfinder*TM tool. *Strategyfinder* is a software platform for causal mapping using participatory modelling. This said, the high number of systemic risks caused by the COVID-19 pandemic posed extreme challenges to the analysis tools of *Strategyfinder*. To meet these challenges, the company owning *Strategyfinder* enhanced the analysis tools as needed by the SPRM project.

The SPRM’s methods have been described extensively in conference proceedings (Eden & Gonzalez, 2023; Gonzalez et al., 2021; Gonzalez & Eden, 2022;). In addition, the IBM Center for the Business of Government has showcased the SPRM project’s methods and results in an easily available free report (Bryson et al., 2023, p24-30). The IBM Center for the Business of Government facilitates discussion of new approaches to improve the effectiveness of government at the federal, state, local, and international levels. A brief description of the strategy mapping with *Strategyfinder* is provided on p5ff of this paper.

The remainder of this paper is organised as follows: We first explain how the response to the COVID-19 pandemic was organised in Norway. Then, we describe the Omicron wave scenario that provided the background for the systemic risk assessment and management workshops led by staff of the municipality of Kristiansand. Next, we

briefly describe the strategy mapping method and technology used in the systemic risk workshops and the workshops results. In the last section, we comment on the insights achieved in the light of the overarching request that the outcome of the systemic risk projects ought to lead to understandable and useful results to policy-makers and, thus, contribute to resilience building toward disaster risk reduction of major threats.

ORGANIZATION OF PANDEMIC CRISIS MANAGEMENT IN NORWAY

During the pandemic, the county governor represented the Agder county in communication with the national government and arranged regular meetings with representatives from all 25 municipalities in the county and the hospital trust. The county administration has the responsibility for public transport and high schools in the county and participated in meetings with the county governor.

In Norway, the municipalities have the responsibility for local crisis management and cooperation with most public and private enterprises located within the municipality. Municipal public services include kindergartens, primary education, and junior high schools as well as primary health care services. Along with the police force organized by the state, the municipality of Kristiansand was responsible for border control at the harbour and the airport, and test facilities at the border.

In the health care sector, the Norwegian Institute of Public Health (NIPH) is responsible for analysis and national and regional forecasting of how the pandemic could develop. NIPH is also available for advice to municipal public health officers in charge of local prevention of contagious disease; it provides recommendations to national health authorities, and communication with WHO, the European Centre for Disease Prevention and Control, and other international partners. The municipalities are responsible for services provided by family physicians, child and school health services, home care and nursing homes. During the pandemic, the municipalities organized information about local pandemic measures to citizens representing native as well as immigrant groups from multiple nationalities – with and without trust in how the response to the pandemic was organized by local and national authorities. The municipalities organized test-track-isolate-quarantine measures and repeated vaccination of the population.

THE OMICRON WAVE SCENARIO

The Omicron variant of the SARS-CoV-2 virus was first reported to WHO from South Africa on 24th November 2021 and was classified as a variant of concern by WHO on 26th November 2021. This classification implied that WHO recommended countries to intensify measures to reduce their risk of COVID-19 (WHO, 2021). WHO anticipated increased COVID-19 caseloads and associated pressure on the overburdened health system and recommended national health authorities to ensure mitigation plans to maintain essential health services and health care resources to respond to potential surges (WHO, 2022). This would include capacity plans for health workers as well as plans for providing additional practical support to health workers.

As response, the Norwegian Institute of Public Health published reports describing a situation with an expected surge in need for hospitalization, ventilator beds and efforts from health care professionals in primary care and hospitals (Norwegian Institute of Public Health, 2021a). Based on available information, the reports described the uncertainty of vaccine effect on the new Omicron virus variant and the possibility of a simultaneous wave of influenza. It was also uncertainty about how dangerous the Omicron variant would be.

At that time, most available resources in primary care and hospitals had been in different stages of alert for more than 20 months and had arranged regular meetings to discuss the present situation and possible scenarios that could happen. The possibility of a surge in the pandemic due to a more contagious variant of the virus had been discussed.

The reports from NIPH were based on modelling scenarios (Figure 1) of possible future development under specific assumptions on the intrinsic transmissibility and changes in the vaccine effectiveness against the new variant (Norwegian Institute of Public Health, 2021b). Various scenarios clarified how different levels of control measures, vaccine efficacies and uptake, would interact with the new Omicron variant. The weekly report from NIPH, issued 22nd December 2021, registered a sharp increase in the number of new patients (Norwegian Institute of Public Health, 2021c). The number of new patients admitted to the intensive care unit was higher than in previous weeks. The incidence of hospitalizations and deaths overall in recent weeks before the report was significantly higher for the unvaccinated than for the fully vaccinated, and there was a concern about low vaccination rate among immigrant groups. Unvaccinated immigrants made up 40 per cent of those admitted to hospital nationally.

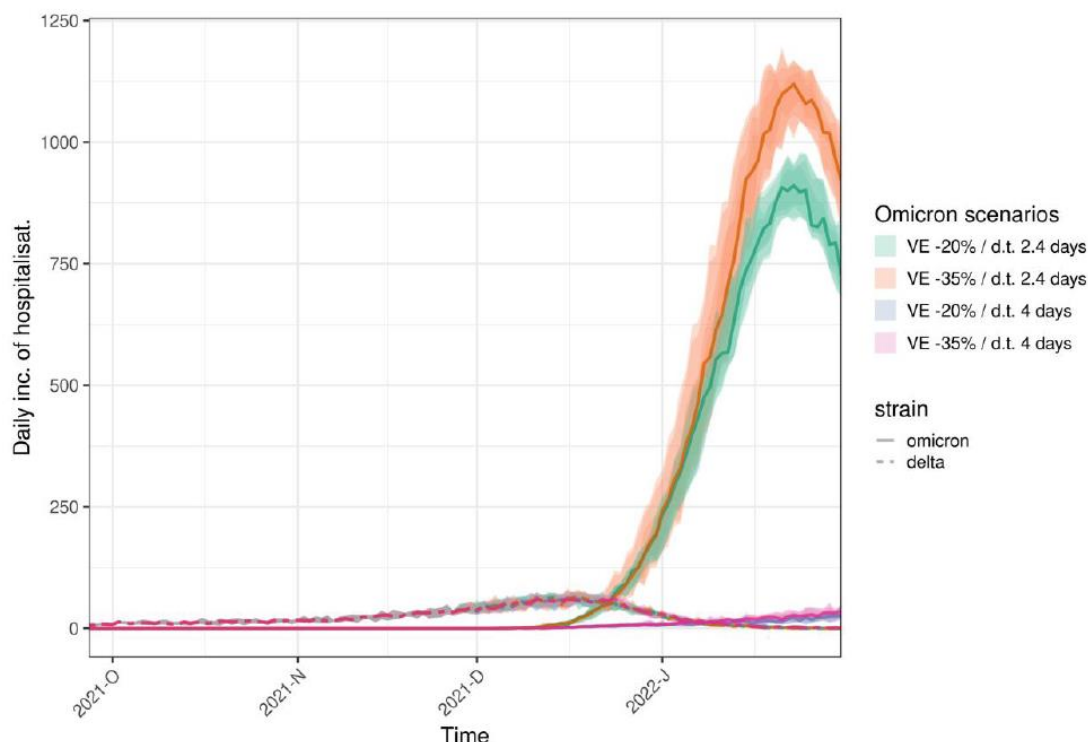


Figure 1 Scenario for daily incidence of hospitalisations in the baseline scenarios until end of January 2022 for the Omicron variant (straight line) and Delta variant (dashed line). VE: vaccine effect; d.t.: doubling time of the Omicron wave. Source: Norwegian Institute of Public Health, 2021b.

Applied to a local setting, the worst-case scenario published by NIPH would imply that the capacity of the local hospital (estimated at 125 patients simultaneously hospitalized with contagious diseases) would be exceeded (shown with red colour on Table 1). The immigrant groups in Kristiansand represented nationalities with low vaccination rates, and they already represented a large share of patients admitted to hospital in Kristiansand.

Table 1 Expected peak at Sørlandet Hospital – Worst case scenario.

	31.12.21	07.01.22	14.01.22	21.01.22	28.01.22
Daily new referrals	13	25	38	56	38
Simultaneously hospitalized	53	105	158	236	158

THE SYSTEMIC RISK WORKSHOPS

The strategy mapping software

The workshops used the causal mapping browser-based software *Strategyfinder*. With *Strategyfinder*, a group of stakeholders, in person or online (same time, different location), collaboratively work on messy problems, elicit, and visualise a map of issues and how the issues influence each other causally, identify core objectives, for the purpose of developing impactful and practical strategies to reach the objectives. For procedural justice (Ackermann & Eden, 2011, Ch. 2; Kim & Mauborgne, 1991, 1995, 1996), the participants/stakeholders in the workshops enter risks, causal links between the risks, rate issues and strategic priorities anonymously. The objectives can be positive (desired, such as when an enterprise seeks strategies to achieve competitive advantage) or negative (to be avoided, such as risks).

With *Strategyfinder*, groups explore what causes what—means and ends—so that agreements can be negotiated with a full understanding of the expected outcomes and unexpected ramifications. Participatory modelling increases ownership of results (Ackermann & Eden, 2011; Cronbach et al., 1980). In order that the strategies may get implemented, it is crucial that the stakeholders group includes power-brokers, i.e., persons who can take decisions or can influence decision-makers (Eden & Gonzalez, 2023).

Strategyfinder is particularly helpful in situations where the complexity is, in part, due to differing perspectives. It allows each participant to simultaneously add their own views to the growing system of strategic issues or risks, via their own computer, thus increasing productivity. It also allows participants to see their views set in the context of others' perspectives. Participants add causal links representing causal influences. In the resultant system of issues/ risks, participants often discover feedback loops, including vicious and virtuous cycles. *Strategyfinder* has powerful analysis tools to detect feedback loops and find the parts of the system that are most central.

The software serves two main purposes: first, collecting and organizing knowledge as a causal network and, second, analysing the causal network to help produce negotiated strategies that recognize the systemic nature of complex problems. In our case, *Strategyfinder* enabled an issue/risk system to be jointly constructed by the members of the group. The resulting causal map shows the range of issues/risks and their causes and outcomes that contribute to the problem situation the group faces.

There is evidence that strategy mapping has ample benefits for content and process when developing strategies. Particularly important is the synergy between content and process (Figure 2).

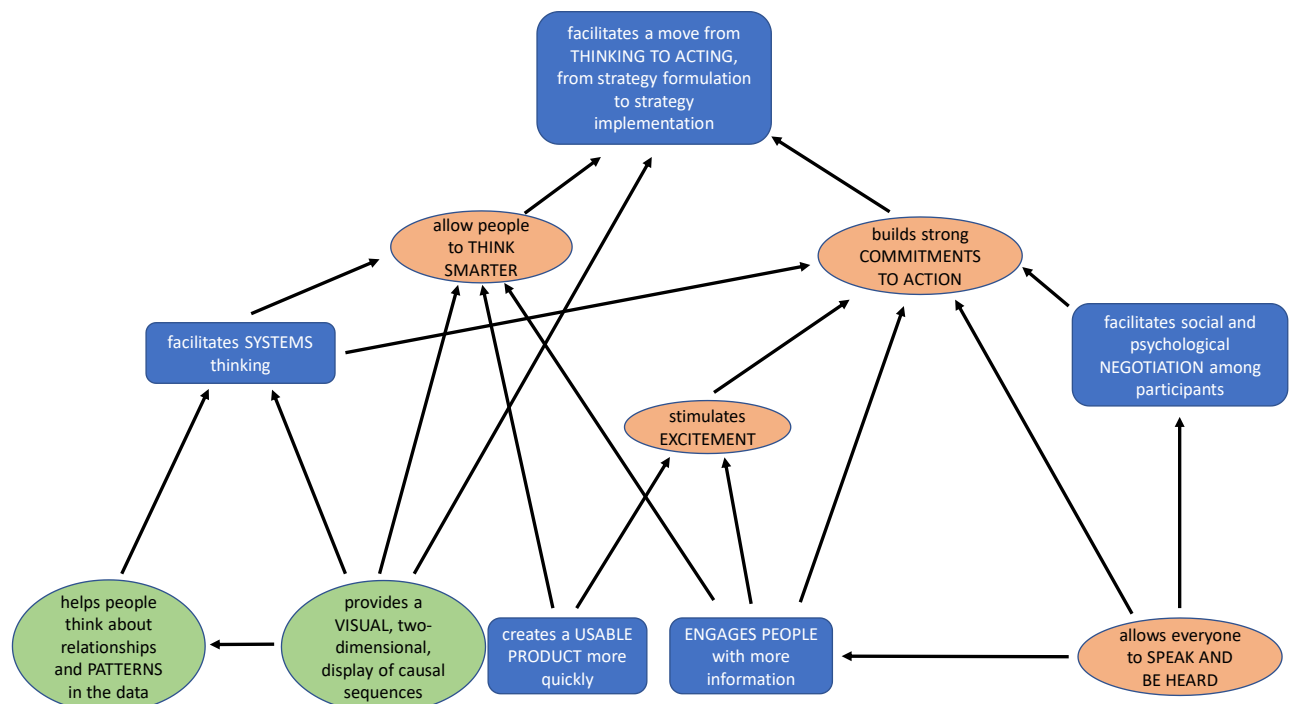


Figure 2 A map of the most important benefits of strategy mapping (green background: content benefits; amber background: process benefits; blue background: content and process benefits). Adapted from (Bryson et al., 2014)

WORKSHOP DETAILS

When the scenario of a surge in the pandemic due to the more contagious Omicron variant was presented, staff from the Kristiansand municipality led two consecutive workshops with relevant stakeholders from the Agder Health Community (cf. p1), representing health services and crisis management from municipalities and the Sørlandet Hospital in Agder county. The workshops were facilitated by professionals familiar with the *Strategyfinder* tool, viz., the head of research (first author, E.A.) and the crisis manager (second author, S.P.) of Kristiansand municipality. The SPRM project manager (third author, J.J.G.) attended the workshops as fly-on-the-wall and occasionally provided counsel as needed (which happened rarely). The workshops aimed at achieving a common understanding of the scenario, identifying risks and understand the complexity in the scenario and consequences of possible actions.

Strategy mapping workshops with *Strategyfinder* addressing systemic risks typically consist of the following

stages (Eden, 2022; Gonzalez et al., 2021):

- Selection of participants to ensure that the relevant expertise and ability to implement the strategies is present
- Develop a TEAM understanding of the situation faced
 - Develop the STRUCTURE of the problem in an action-oriented manner
 - Identify the SUB-SYSTEMS and GOALS of the problematic situation being addressed
- Promote listening through a process of understanding, editing, refining and adding to the risk model: validating the model
- Strategy/Action Development and Agreements
- Identification of responsibilities for implementation

The number of workshops needed for strategy mapping of systemic risks depends on the complexity of the challenge. The Omicron wave concerned an emergent episode in the long COVID-19 pandemic. It presented urgent issues that had not been addressed before, requiring additional strategies to the existing portfolio of strategies.

About one year before the Omicron wave, in the Fall of 2020, the SPRM project conducted as many as six strategy mapping workshops with *Strategyfinder* owing to the ambitious project's objective: to consider the full scope of the systemic risks affecting the healthcare sector and the sectors affected by and affecting the healthcare sector during the duration of the COVID-19 pandemic (Gonzalez et al., 2021). In the case of the Omicron wave, the NIPH scenario restricted the scope both in terms of its width and time duration, and the objective of the strategy mapping workshops was to identify mitigation strategies which not have been identified by the SPRM project one year before. Hence, two workshops with *Strategyfinder*, each of 2 hours duration were sufficient to address the emergent challenges posed by the Omicron wave. The facilitators spent in addition 4 hours of workshop preparation and analysis.

The twelve participants to the Omicron systemic risk workshops contributing to the risk model under the guidance of the facilitators were stakeholders, available through the Agder Health Community, from several municipalities in the Agder region and the Sørlandet Hospital. They included crisis managers, medical officers, experts in infection control, intensive care nurse, and members of the administration of municipalities and hospital (i.e., they were practitioners, experts and power-brokers – those with power to act or to influence decision-makers).

The relevance of feedback

Systems as shown on Figure 3 can have many feedback loops. Feedback occurs when a directed chain of cause and effects form a loop, such as e.g., the example shown on Figure 4.

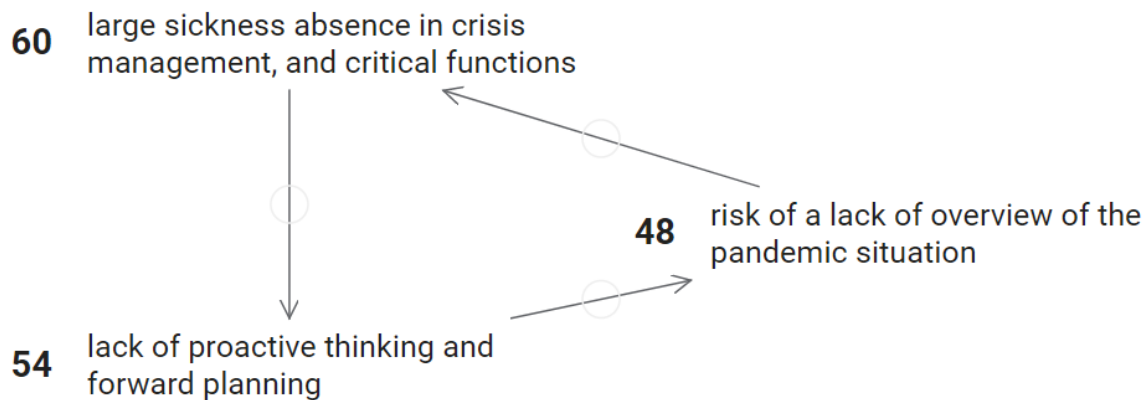


Figure 4 An example from the risk model showing a feedback loop. The loop is reinforcing: an increase in any of the risks in the loop will tend to propagate and amplify the risks in the loop over time. Inversely, if any of the risks decreases (e.g., owing to the impact of a mitigating measure) the causal propagation will tend to further decrease the risks in the loop over time.

Feedback loops can be either balancing or reinforcing. Balancing feedback (a.k.a. negative feedback) occurs when a change in a member of the loop is fed back in a manner that tends to reduce the change. Reinforcing feedback (a.k.a. positive feedback) occurs when a change in a member of the loop is fed back in a manner that tends to amplify the change. Balancing loops can be characterized as goal-seeking or stabilizing processes. They can generate oscillations triggered by time delays in the propagation of effects. Reinforcing loops are sources of growth or accelerating collapse, depending on whether the disturbances amplify growth or decay. Reinforcing loops can be destabilizing if they reinforce undesired consequences, such as risks (in that case the reinforcing feedback loops are often called ‘vicious cycles’). (Sterman, 2000, p12-13, 138-141)

Causal reasoning about a system having feedback loops is difficult owing to the reigning circular causality. This makes reasoning based upon cause and effect tricky, and it is necessary to analyse the system as a whole (Åström & Murray, 2008). For all kinds of major disasters, one faces the enormous challenge of identifying numerous risks. A major pandemic like Covid-19 triggers directly or indirectly hundreds of causally interdependent risks. With increasing number of risks and their interconnections, the resulting number of feedback loops increases exponentially. For major pandemics, such as Covid-19, millions of feedback loops shape the evolution of the pandemic of the time. Most of those millions of feedback loops are risk reinforcing feedback loops: vicious cycles (Gonzalez et al., 2021; Gonzalez & Eden, 2022). **Obviously, impactful and practical measures to mitigate major pandemics must be designed to attack the most potent risks** (see next paragraph).

The huge number of feedback loops implies that strategy mapping of systemic risks requires powerful algorithms for the analysis of the risk map. *Strategyfinder* has such tools to detect feedback loops and their potency, and to find the parts of the system that are most central (Gonzalez et al., 2021; Gonzalez & Eden, 2022). Potency analysis will seek to find those risks, that if mitigated, will have an impact on the maximum number of risks and in a way that is robust (that is there are many paths to impacting goals). Typically, the central parts are extracted as sub-systems and visualised in tabs of *Strategyfinder*.

In addition, *Strategyfinder* has facilities for rating the relevance of sub-systems for then deciding which sub-systems that should be given most attention or be analysed first. When considering the proposed mitigations strategies, the preferencing facility of *Strategyfinder* allows to allocate a limited number of coloured blobs (say, blue for impact and green for practicality) to each participating stakeholder, thus emulating that resources always are limited. Mitigating strategies high on impact and practicality will pass to the final workshop session of deciding responsibility for implementation. Strategies high on impact but low on practicality can be considered in terms of finding ways of increasing practicality, And vice versa, for strategies high on practicality and low impact (ibid).

Results

The identified risks with the highest impact on municipal health services included reduced capacity of family physicians and out-of-hours services. Family physicians (GPs) usually act as gatekeepers for admission to hospital. The risk of overload of personnel responsible for providing access to home care and nursing home facilities as well as a high level of sickness absence was also acknowledged as a risk with high impact on the function of municipal health services.

In the hospital sector the impact of overload at the emergency department and accumulation of patients in hospital due to either need for intensive care or reduced capacity in nursing homes and home care was recognized. It was also a concern that patients suffering from other diseases than COVID-19 would not receive competent care. In the case of overload of capacity in hospital it would also be a risk that patients were discharged too early.

The following mitigation strategies were elicited and considered for implementation:

- Ensure sufficient competent and available guidance resources from the hospital to the municipalities.
- The municipalities must be able to receive patients (approximately) 24/7.
- Establish a buffer to be able to receive patients ready for discharge from hospitals to the municipalities (beds and personnel) – COVID-19 and others.
- Secure capacity in the ambulance services.
- Ensure inter-municipal cooperation on the reception of patients ready for discharge.
- Ensure fast communication flow when entering and exiting hospital.
- Reminder about guidelines for treatment of COVID-19 - send reminder.
- Consensus on accepting “good enough” solutions.
- Use solutions for home hospitals and remote follow-up for COVID-19.
- Establish a “fast track” for administrative office proceedings.

All the suggested strategies found their way to the participating organisations in the workshops. This said, some of these strategies were already implemented by some of the organizations before the workshops. Still, the visualisation of the risks and the impact of the strategies in the systemic risk map added value in terms of insight and preparedness for a possible surge of infections.

CONCLUDING REMARKS

Systemic risk is central in the last two editions of the Global Assessment Report on Disaster Risk Reduction by the United Nations Office for Disaster Risk Reduction (United Nations Office for Disaster Risk Reduction UNDRR, 2019, 2022). Systemic risk as keyword appears several hundred times in each of these two reports.

Quotes from the 2019 edition:

- “The systemic risks ... are embedded in the complex networks of an increasingly interconnected world. The behaviour of these networks defines quality of life and will shape the dynamic interactions among the Sendai Framework, the 2030 Agenda, the Paris Agreement, New Urban Agenda and the Agenda for Humanity. Ultimately, the behaviour of these networks determines exposure and vulnerability at all scales.” (United Nations Office for Disaster Risk Reduction UNDRR, 2019, p32)
- “Assessment and management methodologies for systemic risks that have been conceived are still in early gestation, and are not yet part of the current operations of twenty-first century risk management institutions. Nonetheless, there is a growing sense of urgency for a paradigm shift...” (ibid, p44)
- “Understanding the systemic nature of risks, and the opportunities afforded by new approaches and new concepts of risk, will be the central challenge of the first half of the twenty-first century.” (ibid, p65-66)

Three years later, the 2022 edition:

- “The science of systemic risk and systemic risk management is still in a primordial state.” (United Nations Office for Disaster Risk Reduction UNDRR., 2022, p146)

Thus, this contribution should be considered in the light of the urgency to build up resilience against disaster risk by promoting the paradigm shift toward systemic risk assessment and management. As practitioners, we have experienced taking a step forward in crisis management by adopting the SPRM method for strategy mapping.

The path to resilience is long. Kristiansand municipality has had a strong commitment to achieving resilience towards disaster risks since the beginning of the 2010 decade. The municipality has participated as end-user in major R&D projects targeting resilience. One of these major projects, the Smart Mature Resilience (SMR) project, was a European Union-funded multi-disciplinary research project, which concluded in 2018 following three years

of co-creation, sharing, learning, and resilience-building. The SMR consortium consisted of four universities (including the University of Agder, represented by the Centre for Integrated Emergency Management – CIEM); ICLEI - Local Governments for Sustainability; DIN – the German Institute for Standardization; and seven cities from six different European countries. Systemic risk assessment targeting societal resilience was one of the key objectives of the SMR project. (SMR, 2018)

In the SMR project as well as in the SPRM project, Kristiansand participated with stakeholders who contributed in participatory strategy mapping modelling workshops. The strategy mapping software was a predecessor of *Strategyfinder*, viz., *Group Explorer* (Pyrko et al., 2019)

We emphasize again that the experiences of staff from the Kristiansand municipality as stakeholders and domain experts in the SPRM project led to the adoption of strategy mapping of the Omicron wave risks with *Strategyfinder* whereby the crisis manager and the head of research of Kristiansand acted as facilitators and analysts.

The Agder Health Community, with representatives from several other municipalities from the Agder county and Sørlandet Hospital, increased its competence and activities concerning systemic risks. The strategy mapping technology allowed input from all stakeholders, group discussions and visualisation of the risk scenario and elicited strategies that otherwise could have been overlooked. The strategies were implemented at the county level.

Our experiences with using *Strategyfinder* in workshops allowed all participants to share their competence and perceptions of the current situation and discuss how the different risks were connected. Based on the *Strategyfinder* analysis tools we were able to grasp the situation better and discuss possible measures to avoid escalating vicious circles in the identified risk scenarios and suggest and discuss measures that could reduce risks. We believe that the use of strategy mapping tools like *Strategyfinder* have the potential to include several stakeholders and improve handling of complex risk scenarios beyond pandemic risks.

After the Omicron wave workshops, strategy mapping with *Strategyfinder* has been conducted by staff from Kristiansand municipality in other areas belonging to crisis management and disaster risk reduction, such as cyber incidents leading to breakdown of networks; problems with energy supply; surge of asylum seekers from Ukraine as consequence of the Russian invasion; and cooperation between the police, the municipality and the Sørlandet hospital concerning potential risks to civil defence. Several of these strategy mapping workshops involved exchange between practitioners from Kristiansand and academics from the University of Agder.

Based on our experiences, we suggest that the strategy mapping technology has the potential to assess and manage systemic risks beyond pandemic risks.

ACKNOWLEDGMENTS

We thank the participants in the *Strategyfinder* workshops for their valuable contributions. We also thank Professor Colin Eden for support with the *Strategyfinder* tool.

REFERENCES

- Ackermann, F., & Eden, C. (2011). *Making Strategy : Mapping Out Strategic Success*, Sage, London.
- Åström, K. J., & Murray, R. M. (2008). *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton University Press, Princeton, NJ.
- Boaz, A., & Hayden., C. (2002). Pro-active evaluators -- Enabling research to be useful, usable and used. *Evaluation*, 8(4), 440-453.
- Bryson, J. M., Ackermann, F., & Eden, C. (2014). *Visual strategy : strategy mapping for public and nonprofit organizations*, Wiley, Hoboken, NJ.
- Bryson, J. M., Barberg, B., Carroll, A., C., E., George, B., Gonzalez, J. J., Rochester, J., Vandersmissen, L., and Zaki, B. (2023). *Addressing Complex and Cross-Boundary Challenges in Government: The Value of Strategy Mapping*. The IBM Center for the Business of Government, Washington, DC, USA. Retrieved January 5, 2023 from <https://www.businessofgovernment.org/report/addressing-complex-and-cross-boundary-challenges-government-value-strategy-mapping>
- Centeno, M. A., Nag, M., Patterson, T. S., Shaver, A., & Windawi, A. J. (2015). The Emergence of Global Systemic Risk. *Annual review of sociology*, 41(1), 65-85. doi:10.1146/annurev-soc-073014-112317
- Cronbach, L. J., Ambron, S. R., Dornbusch, S. M., Hess, R. D., Hornik, R. C., Phillips, D. C., Walker, D. F., and Weiner, S. S. (1980). *Towards Reform of Programme Evaluation*, Jossey-Bass, San Francisco, CA.
- Eden, C. (2022). *Strategyfinder -- Facilitator Guide*. Formfinder Software GmbH, Vienna, Austria.
- Eden, C., & Gonzalez, J. J. (2023). The strategic management of disaster risk mitigation. In J. Radianti, T. Gjøsæter, & Y. Murayama (Eds.), *Information Technology in Disaster Risk Reduction ITDRR 2022*. Cham, Switzerland: Springer Nature.

- Gonzalez, J. J., & Eden, C. (2022). Insights from the COVID-19 Pandemic for Systemic Risk Assessment and Management. In J. Sasaki, Y. Murayama, D. Velev, & P. Zlateva (Eds.), *Information Tecnology in Disaster Risk Reduction ITDRR 2021*. Cham, Switzerland: Springer Nature.
- Gonzalez, J. J., & Eden, C. (2023). Devising Mitigation Strategies With Stakeholders Against Systemic Risks in a Pandemic. Proceedings of the 20th International Conference on Information Systems for Crisis Response and Management, Omaha, NE.
- Gonzalez, J. J., Eden, C., Abildsnes, E., Hauge, M., Trentin., M., Ragazzoni, L., Berggren, P., Jonson, C.-O., and Abdelgawad, A. A. (2021). Elicitation, analysis and mitigation of systemic pandemic risks. Proceedings of the 18th International Conference on Information Systems for Crisis Response and Management, Blacksburg, VA.
- Kim, W. C., & Mauborgne, R. A. (1991). Implementing global strategies: The role of procedural justice. *Strat. Mgmt. J.*, 12(S1), 125-143. doi:10.1002/smj.4250120910
- Kim, W. C., & Mauborgne, R. A. (1995). A Procedural Justice Model of Strategic Decision Making: Strategy Content Implications in the Multinational. *Organization Science*, 6(1), 44-61.
- Kim, W. C., & Mauborgne, R. A. (1996). Procedural Justice and Managers' In-Role and Extra-Role Behavior: The Case of the Multinational. *Management science*, 42(4), 499-515. doi:10.1287/mnsc.42.4.499
- Norwegian Institute of Public Health. (2021a). Risiko ved Covid-19 epidemien og ved omikronvarianten i Norge. Retrieved January 5, 2023 from <https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/risikovurdering-2021-12-22.pdf>
- Norwegian Institute of Public Health. (2021b). Modelling scenarios for the SARS-CoV-2 Omicron VOC (B.1.1.529) in Norway during the winter 2021—2022. Retrieved January 5, 2023 from https://www.fhi.no/contentassets/e6b5660fc35740c8bb2a32bfe0cc45d1/vedlegg/nasjonale-og-regionale-rapporter/omicron_modelling_report_2021_12_22.pdf
- Norwegian Institute of Public Health. (2021c). Ukerapport - uke 50. Retrieved January 5, 2023 from <https://www.fhi.no/contentassets/8a971e7b0a3c4a06bdf381ab52e6157/ukerapport-uke-50-13.12--19.12.21.pdf>
- Oliver, K., Hopkins, A., Boaz, A., Guillot-Wright, S., & Cairney, P. (2022). What works to promote research-policy engagement? *Evidence & Policy*, 18(4), 691-713. doi:10.1332/174426421X16420918447616
- Pyrko, I., Eden, C., & Howick, S. (2019). Knowledge Acquisition Using Group Support Systems. *Group decision and negotiation*, 28(2), 233-253. doi:10.1007/s10726-019-09614-9
- Reichstein, M., Riede, F., & Frank, D. (2021). More floods, fires and cyclones - plan for domino effects on sustainability goals. *Nature*, 592(7854), 347-349. doi:10.1038/d41586-021-00927-x
- Sillmann, J., Christensen, I., Hochrainer-Stigler, S., Huang-Lachmann, J., Juhola, S., Kornhuber, K., Mahecha, M. D., Mechler, R., Reichstein, M., Ruane, A. C., Schweizer, P.-J., and Williams, S. (2022). ISC-UNDRR-RISK KAN Briefing note on systemic risk. Retrieved January 5, 2023 from doi:10.24948/2022.01
- SMR. (2018). Smart Mature Resilience -- for more resilient cities in Europe. Retrieved January 5, 2023 from <https://smr-project.eu/home/>
- Sterman, J. D. (2000). Business dynamics : systems thinking and modeling for a complex world, Irwin McGraw-Hill, Boston.
- UNDRR & UNU-EHS. (2022). Understanding and managing cascading and systemic risks: lessons from COVID-19. Retrieved January 5, 2023 from <https://www.undrr.org/publication/understanding-and-managing-cascading-and-systemic-risks-lessons-covid-19>
- United Nations Office for Disaster Risk Reduction UNDRR. (2019). Global Assessment Report on Disaster Risk Reduction 2019 (GAR2019). Retrieved January 5, 2023 from <https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2019>
- United Nations Office for Disaster Risk Reduction UNDRR. (2022). Global Assessment Report on Disaster Risk Reduction 2022 (GAR2022). Retrieved January 5, 2023 from <https://www.undrr.org/gar2022-our-world-risk>
- WHO. (2021). Classification of Omicron (B.1.1.529): SARS-CoV-2 Variant of Concern. Retrieved January 5, 2023 from [https://www.who.int/news/item/26-11-2021-classification-of-omicron-\(b.1.1.529\)-sars-cov-2-variant-of-concern](https://www.who.int/news/item/26-11-2021-classification-of-omicron-(b.1.1.529)-sars-cov-2-variant-of-concern)
- WHO. (2022). Enhancing response to Omicron SARS-CoV-2 variant. Retrieved January 5, 2023 from [https://www.who.int/publications/m/item/enhancing-readiness-for-omicron-\(b.1.1.529\)-technical-brief-and-priority-actions-for-member-states](https://www.who.int/publications/m/item/enhancing-readiness-for-omicron-(b.1.1.529)-technical-brief-and-priority-actions-for-member-states)
- Williams, T. M., Ackermann, F., & Eden, C. (1997). Project Risk: systemicity, cause mapping and scenario approach. In K. Kahkonen & K. A. Artto (Eds.), *Managing Risks in Projects* (pp. 343-352). London: E&FN Spon.