Evaluating the observation protocol of the Team Resilience Assessment Method for Simulation (TRAMS)

Amanda Jaber
Linköping University
amaja463@student.liu.se

Björn J E Johansson
Linköping University
bjorn.j.johansson@liu.se

Linnea Bergsten
Linköping University
linbe360@student.liu.se

Joeri van Laere
Skövde University
joeri.van.laere@his.se

Peter Berggren
Linköping University
peter.berggren@liu.se

ABSTRACT

This work in progress paper presents an initial evaluation of the observation protocol of the Team Resilience Assessment Method for Simulation (TRAMS) conducted in a crisis response simulation project. TRAMS is designed to assess the resilience of crisis response teams. The TRAMS observation protocol uses six core resilience functions from the Systemic Resilience Model as its theoretical foundation. Three independent observers used the protocol during a pilot study and six actual simulation games. Strategies relating to three out of six core resilience functions could be identified. The observations made were distributed similarly among the observers, indicating that the components of the TRAMS protocol are stable enough to continue developing the protocol. This study describes changes made to the protocol since the original design, and describes how the strategies relating to the six core resilience functions can be identified in the simulation games.

Keywords

Simulation games, training, Systemic Resilience Model, team resilience, assessment

INTRODUCTION

How should resilience in multi-organisational crisis response teams be assessed? The increasing complexity of society creates challenges as small disruptions in individual systems may propagate across other systems and create large disruptions. Multiple actors in the financial system provide different kinds of services that jointly create the pre-requisites for services we take for granted, such as credit card payment, online payment, billing, etc. A multi-disciplinary team must thus handle disruptions. The ability to uphold these services is often referred to as *business contingencies* or *resilience*. The payment system can be described as an "inverted pyramid". At the top of the inverted pyramid is the broad base of economic actors whose daily activity in the market economy gives rise to payment obligations. This base of economic actors consists of individuals utilizing retail payment services provided by banks, and a variety of business enterprises in the goods and service industries. The next level includes specialized firms, such as brokers and dealers, involved in the money, capital and commodities market, which also rely on bank payment services. (Blommstein & Summers, 1998, p. 27).

However, the payment system is vulnerable. A cyber-attack or even a bad software update of a common cash register system may cause a nation-wide disruption to the payment system. This issue is being addressed in a project called Creating Collaborative Resilience Awareness, Analysis and Action for Finance, Food and Fuel System in INteractive Games (CCRAAAFFFTING). Reliability in highly networked critical infrastructures has been studied before, but mostly in the form of case studies (Schulman et al., 2004; Berthod et al., 2017). The goal for this project is to develop a simulation-gaming environment (combining table top role-playing exercises with computer simulation) to present a context where the payment system is represented and where dependencies between different actors in the food, fuel, and financial domains become evident. This approach allows for controlled studies of how resilience is achieved and maintained during disruptions to critical infrastructures (Laere, et al., 2017). The long-term objective of the project is to provide tools and methods for team-training of decision-makers that are responsible for handling crisis situations in multi-organisational contexts. The project will also increase knowledge of how multi-organisational networks manage crises, which is an area in need of further study as pointed out by for example Berthod et al. (2017).

A critical issue in simulation games is the question of how to evaluate them? This paper presents progress in the development of an assessment approach to evaluating resilience in crisis response teams called the *Team Resilience Assessment Method for Simulation* (TRAMS) (Johansson, Laere, & Berggren, 2018). TRAMS was developed for assessing team resilience in simulation games, based on the Systemic Resilience model (see below). The first version of TRAMS was presented at ISCRAM 2018 in Rochester, NY. Since then, a pilot study (with student participants) has been conducted, leading to some minor alterations to the protocol. After that, data has been collected using the TRAMS, which has led to a number of additional suggested changes to the method and the protocol.

The purpose of this work in progress paper is to present the initial evaluation of the Team Resilience Assessment Method for Simulation (TRAMS) based on data from six simulation games. The results will be used to improve the design of the TRAMS observation protocol and create some guidelines in how to use it in future data collections.

The paper begins with an overview of the problem domain (the financial system) and the theoretical basis of the paper, the Systemic Resilience Model. Then, it presents the TRAMS method, the data collection, and the evaluation. Finally, changes to the TRAMS as well as implications of the initial results are discussed.

THEORETICAL BACKGROUND

Resilience is used to describe how a system critical to society, such as industry, infrastructure, finance or ecology, can absorb changes or disturbances and still persist (Holling, 1973; Foster, 1993). Resilience is not to be confused with *robustness*, or stability, which describes how much stress something can take before it seizes to function. It is possible for a system to be robust and lack resilience (Holling, 1973). The financial system is robust when considered over a longer time-period, but also sensitive to local or short-term disruptions that can cause severe cascading effects that have impact even on a global level. It is therefore of great importance to society to improve resilience of the financial system. Resilience has however been interpreted in many different ways (Bergström, van Winsen, & Henriqsen, 2015), making it hard to operationalize resilience into useful strategies and measurable indicators. Lundberg and Johansson (2015) have proposed the Systemic Resilience Model (SyRes) model, in which they have made an effort to merge and compile different points of view in the field of disaster and crisis response resilience. The SyRes model is a way to describe the process, functions and strategies of resilience on a conceptual level in an effort to synthesize different theoretical models and frameworks. The model can be seen as a downward spiral activating certain basic resilience functions and their associated strategies. It is common to divide crisis into three phases: pre-event, event and recovery (before-during-after) (Shaluf, Ahmadyn, & Said, 2003) and the SyRes model applies a similar logic. There are four different sections in the SyRes model: *Event-based constrains, Functional Dependencies, Adjustment of capabilities* and *Strategy* (See Figure 1).

Event-based constraints refer to how the event is handled which put different constraints on the responding system during different phases of the event. Functional dependencies point to the core functions that must be maintained. *These core functions are realized in the form of strategies*, which are depicted on the lower side opposite of the functions in the model. Strategies are in practice the different ways of coping with an event that relate to the core functions. It is common that these strategies are visible in terms of actions taken to keep a system out of harms, for example constructing barriers (immunize) or creating response systems (control). The core resilience functions are: *Anticipating, Monitoring, Responding, Recovering, Learning, and Self Monitoring.*

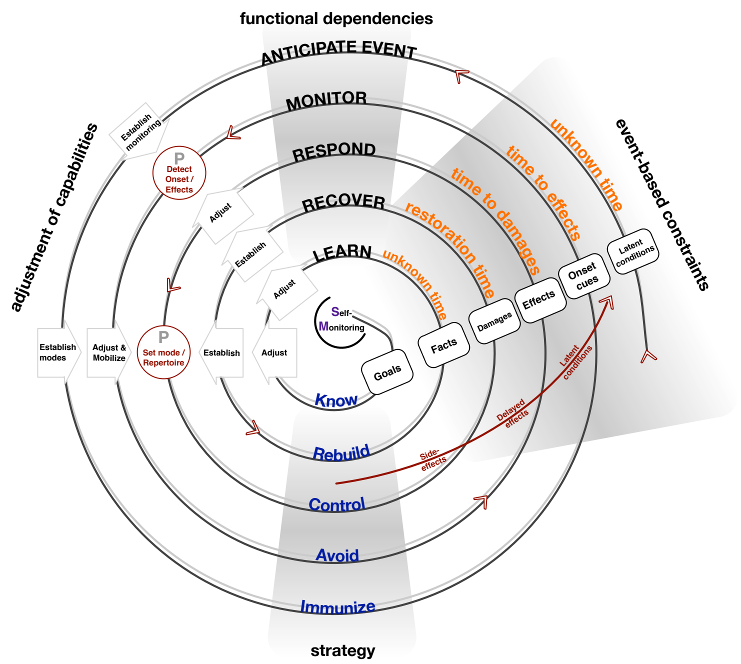

Figure 1. The systemic Resilience Model (Lundberg & Johansson, 2015. Used with permission from the authors).

Each function holds the potential to cope with an undesired development in the *before*, *during,* or *after* phases of a disturbance. For example, if a threat is *anticipated,* it can be mitigated or prevented from happening at all or if *monitoring* is directed in such a way that threats can be detected, harm can potentially be avoided. *Responding* is a consequence of anticipation or the detection of a threat, or even as a reaction to an event that is discovered first when it is already ongoing, and results in strategies for controlling the situation. *Control* is applied to minimize or avoid harm. *Recovery* comes into place when a system takes damage in some form and it needs to re-construct the system after the event. To avoid similar events and adapting ways of working in the future refers to the *learning* steps, which is an essential function to improve the resilience of the system. At last, *self-monitoring* is a continuous process to see if the current way of working is appropriate to maintain an acceptable level of safety and resilience in the system (Lundberg & Johansson, 2015). A lack of resilience manifests when there is a lack of strategies corresponding to the core resilience functions. The TRAMS instrument was created to capture the development of such strategies by teams participating in simulated, multi-domain, crisis response scenarios, hence assessing the capability of resilience of the teams.

Gaming simulation

The interconnected infrastructure in the payment system is experienced through simulation in the CCRAAAFFFTING project. Simulation generally aims at designing a model of a system in a complex problem area in order to perform various experiments (Grune-Yanoff & Weirich, 2010). In this case, the simulation includes a number of grocery stores (ranging from local convenience stores to mega-stores), petrol stations, banks and the flows of goods, fuel, and payments (both cash and by other transfers) that occur between these. The gaming approach is used to gain deeper insight into the behaviour of the participants by evaluating how various resilience strategies relating to the core resilience functions of SyRes (or the absence thereof) are displayed by team members (Laere et al., 2018). It also creates a learning opportunity since the participants are active participants in the simulation and are not just passive observers.

THE TEAM RESILIENT ASSESSMENT METHOD FOR SIMULATION (TRAMS)

As pointed out in the introduction to this paper, the initial TRAMS was presented at ISCRAM 2018. Since then, pilot studies as well as actual data collections have been conducted. **Figure 2**, describes the development process of the TRAMS protocol and method as up until this publication. The TRAMS method, and the process of updating it, is described in detail below.

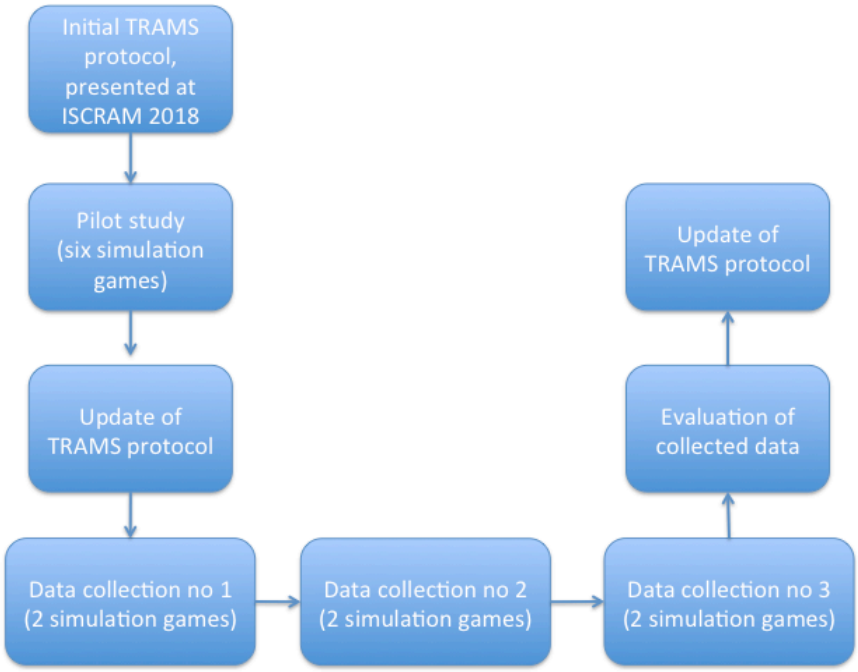

Figure 2. An outline of the TRAMS development process up until this publication.

The approach of the CCRAAAFFFTING project is founded on the premises that stake-holders in society and the financial system that normally don't work together work as a team to manage a disturbance in the payment system. TRAMS is developed evaluate if teams participating in the simulation games are resilient in the sense that they exhibit behaviors, in the form of strategies, that reflect the core resilience functions anticipating, monitoring, responding, recovering, learning, and self-monitoring. The TRAMS instrument comprises several assessments (Johansson, Laere, & Berggren, 2018), such as observations, workload (Helton, Funke, & Knott, 2014; Funke et al., 2012), team trust (cf. Willems, 2016; Seers, Petty, & Cashman, 1995), and shared understanding (Berggren, Johansson, & Baroutsi, 2017; MacMillan et al., 2005) (see **Figure 3**).

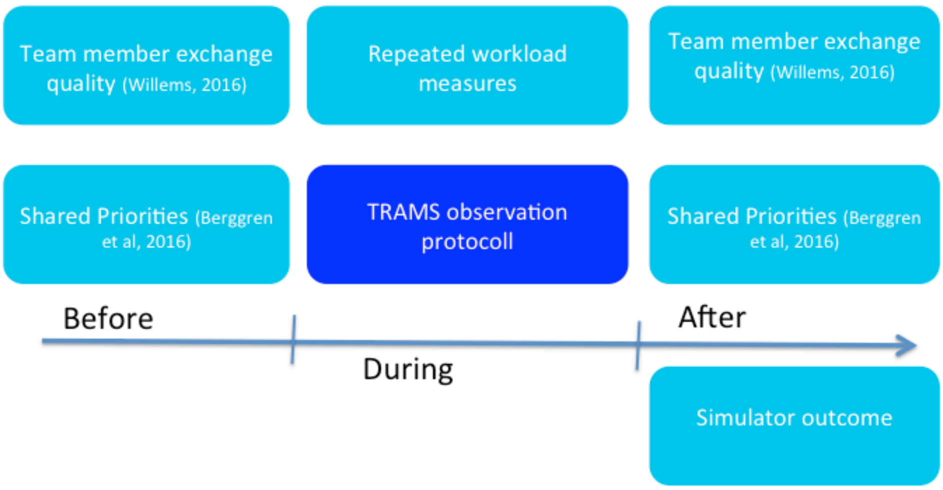

Figure 3. The various assessments of the TRAMS instrument as described in Johansson, Laere, and Berggren (2018). The focus of this paper is the TRAMS observation protocol.

While workload, team trust, and shared understanding are based on established methods, observations are supported by the TRAMS protocol, which is the focus of this paper. Henceforth, *when using TRAMS, and referring to alterations to TRAMS, it is the protocol that is meant*. The protocol, in its original design, consisted of an Excel sheet with the core resilience functions listed on the left-hand side (left column). The protocol is presented in **Figure** 4, followed by a more elaborate explanation of each column.

SyRes functions	Strategies in days 1---N	Developed by…	Core values	Involved actors	Expected effects	Implementation	Simulator outcome
Anticipating							
Monitoring							
Controlling							
Recovery							
Learning							
Self-Monitoring							

Figure 4. The TRAMS observation protocol as described by Johansson, Laere, and Berggren (2018).

SyRes functions

As pointed out, the core resilience functions of the SyRes model can be found in the first column to the left in the instrument. These functions are working as a guidance for identifying strategies that was used by the participants in the simulation during different simulated days of the simulation games. The strategy *anticipating* can take form such as brainstorming, consulting experts, discussing possible consequences of actions under consideration, etc. The strategy *monitoring* is based on earlier experience or actions in the gaming simulation. For example, checking resources or cash flow to understand the disturbance better. The strategy *controlling* is the coping of a disturbance and those actions that are implemented in the gaming simulation. *Recovery* can be based on what is anticipated, currently happening or after a disturbance has happened. For example, if a disturbance is expected in the card payment it can become less severe if all ATMs are prepared with enough cash to support such payments. Strategies relating to *learning* reflect that you learn from the disturbance. For example, creating reporting systems or assuring that experiences made during an event is incorporated in staff training. Strategies relating to *self-monitoring* takes on the form of self-criticism or reflection that alters the way the team works, for example re-organization of responsibilities within the team or changing decision mandates.

Strategies in days 1---N

The fictive days columns reflect the events in the gaming simulation. These are normally known to the researcher/training facilitator and can be described in the instrument. Strategies identified should be noted in the corresponding day. Doing so makes it possible to track what strategies that where developed in the different day. Note that several strategies may be developed in certain days while other days may include no strategies. This depends entirely on the participants and the outline of the scenario used in a particular gaming simulation.

Developed by

This column should be used to describe from whom a specific strategy originates. Was it a collective decision within the team, or did an individual participant suggest it? This information can be used to assess how well collaboration between the different participants work, who (what participant) is taking initiative, and if a certain organization is more prone to pushing strategies.

Core values

This column should reflect the core value that is affected by, or connected to, the strategy observed. This could, for example be revenue of a supermarket, or the well-being of citizens in a municipality. Core values are central to the SyRes model as they are key to the question *resilience of what*, i.e. what the strategies developed actually aims to protect.

Involved actors

The implementation of a strategy will normally involve several actors, both within the participating team and "external" (simulated) actors in the gaming simulation. If possible, these should be noted in this column.

Expected effects

Often, the participants express what kind of effects they believe the strategies they implement will have on the outcome of the gaming simulation. If this can be captured, it should be noted here. This information can be used to analyze what kind of understanding (mental model) the participants had of the scenario and their actions.

Implementation

This column is used to describe if a strategy actually was implemented and if so in what way? In this study it was very clear if the strategies were implemented since the participants needed to write down strategies they wanted to implement and hand these over to the game leader. This also makes is possible to fill in the column afterwards.

Simulator Outcome

The actual simulator outcome of the implemented strategies is noted in this column. This outcome can be used for analysis and the de-briefing session. According to Johansson, Laere, and Berggren (2018) three major performance areas are important, these are: 1) payment options, 2) goods flows, and 3) security.

METHOD

To evaluate, test, and further develop the TRAMS protocol, it was applied in a pilot study, using students as participants, and then on six actual simulation games (out of a planned set of 30 simulation games) with representatives from different stakeholders from society and businesses. In the latter case, three groups played two simulation games each. Three independent researchers applied the protocol when observing the games.

Pilot study

The pilot study was conducted in order to rehearse the procedure of the simulation games, verify that the computer simulation was working, and try the various data collection methods, such as the TRAMS protocol. The data collected was mainly used for verifying that everything worked as imagined. However, the experiences led to some alterations of the protocol. The design, instrumentation, and procedure of the simulation games were identical in both the pilot study and the actual data collection.

Participants

In the *pilot* study, three teams of students and colleagues played the roles of the crisis response teams. Each team consisted of 3-5 participants. The team members had no prior experience of the roles they were assigned to in the simulation games.

In the actual data collection, which is part of the planned 30 simulation games to be conducted, three teams of participants participate. Each team was composed of 6-8 participants from representative businesses, authorities and public organizations. The *first team* consisted of seven members: one from the fuel distribution sector, two from food distribution (mega-store managers), one from the county administration board, one bank manager, one from the money distribution sector, and one journalist from a local radio station. The *second team* also consisted of seven persons: One from the municipality crisis management team, one from a local convenience store, one from a supermarket, one from the police, one from the money distribution sector, one bank manager, and one from the county administration board. The *third team* consisted of two members from the county administration board, one from the municipality crisis management unit, one grocery store owner, one police, one petrol station manager, one from the money distribution sector, and one bank manager.

As can be seen, the groups were not identical in their composition of competences, but sufficiently representative of the type of individuals that are likely to be involved in a crisis response during a failure of the credit card system.

Instrumentation

The simulation games were audio recorded with Zoom R8 with an Aston Spirit microphone to support note-taking with the TRAMS instrument.

The simulation is implemented and runs on the AnyLogic™ platform. The model uses a Geographic Information System (GIS) space to visualize the locations of food stores, gas stations and ATMs in a region that covers four municipalities (Lund, Malmö, Lomma, and Staffanstorp) in Skåne county, southern Sweden. The total population for the modeled region is 440,000 citizens. Typical shopping behavior is modelled based on available statistics from SCB Statistics Sweden and estimates made by the modeling team (Laere et al., 2018).

Scenario

The scenario describes a crisis in the payment system where card payments go down for ten days. In Sweden, almost all payments are made with cards and many shops even refuse to accept cash. Most people have no preparedness for a breakdown in the card payment system, and the amount of money available in ATMs is not sufficient to support a situation where all citizens needs to pay all their expenses with cash. As pointed out above, the simulation is based on a model of southern Sweden including both a large city and rural areas, is modeled in terms of stores (ranging from small convenience stores to mega-stores) and petrol stations (both manned and unmanned). All transactions, flow of goods, petrol etc. as well as customers and the amount of cash available in ATMs.

Procedure

All participants filled in a consent form and replied to a set of questions about their professional experience as well as experience from actual crisis response events. Then, the background to the CRRAAAFFTTING project was described, as well as the scenario outline for the simulation. After this, the simulation was started. During the simulation game, two researchers were available at all times, ready to answer any questions the participants had about the progress of the simulation or other concerns. The participants in the simulation game takes on the role as a crisis response council that need to suggest actions to handle the situation on days 1, 3, 6 & 9 in the simulation game. They are free to implement a number of things such as introducing new means for payment, providing information to the public, changing the number of security guards or police officers in stores and society, change opening hours of stores or petrol stations, or even close them, etc.

Three observers (denoted A, B, and C respectively) equipped with the TRAMS instrument sat adjacent to the participant team where they could see the participants and the simulation game output. There were no strict guidelines for the observers on how to use the instrument. During the simulation the observers tried utilize as many of the components of the TRAMS instrument as possible. After the simulation games, the observers compared their notes with each other and analyzed similarities and differences.

RESULTS

The pilot study provided valuable input, which led to alterations of both how the TRAMS protocol was used and the design of the protocol in itself. An important observation was that the observers should note only one strategy for each line used in the protocol to avoid mismatches in the number of strategies observed. Observers should also avoid chunking information, meaning that only one strategy should be noted at each occasion. For example, if the participants discussed monitoring sales figures for a specific store and the amount of cash available in the ATM outside the store, this should be noted as two separate observations, not one. Further, the days 1-n was replaced by individual columns in the TRAMS protocol sheet, where each column corresponds to a decision event, i.e. days 1, 2, 3, 6, & 9.

Data from the actual data collection found strategies relating to three of the six core resilience functions; *anticipation, controlling,* and *self-monitoring*. The strategies *recovery* and *learning* were not observed during the game simulation.

The average distribution of observations over categories of strategies noted by the three observers A, B and C (percentage of the total amount of observations by each observer) from all six simulation games is found in **Table 1**. A criterion was used in order for a category of strategy to be included in the analysis: at least two observers would have to have noted the same strategy. Hence, learning is not included in the analysis as only observer B identified that. This is discussed further below.

Table 1. Average distribution of observed strategies in each category by each observer and the average total (in percent of the total amount of observations by each observer).

	Observer A	Observer B	Observer C	Total average
Anticipation	73.9%	64,2%	73,9%	70,7%
Monitoring	0,9%	7,4%	0,2%	2,8%
Controlling	25,3%	24,4%	25,2%	24,9%
Recovery	0%	0%	0%	0%
Learning	0%	0,3%	0%	0,1%
Self-Monitoring	0%	3,9%	0,6%	1,5%

On average, the observers made 109 observations per simulation game (Observer A=114, Observer B=111, Observer C=103). As can be seen in **Table 1**, and from the average number of observations conducted by the observers, the inter-observer consensus regarding what strategies were used in the simulation games is good. These numbers should be interpreted with some caution given the fact that they are based on only six simulation games.

Strategies relating *anticipation* were the most common of the observed strategies during the six simulation games. Strategy was identified during the game when the participants were talking about a potential development in the simulation, a consequence of the development, or the potential consequence of an action but did not go through with it. This type of reasoning was by far the most common during the simulation games. In essence, the participants were collectively discussing various hypotheses about what would happen during the simulation game and how their own action potentially could affect this development. It could for example be if they wanted to implement alternative means of payment early in the first day, but they never implemented it in the simulation. Other common topics were if customers would start hoarding products, whether there would be enough money in the ATM’s, and the effects of information to the public – would it lead to increased attempts to buy things, or decrease them? Another example is when participants are worried about the stores’ stock but did not check this against the simulation or did anything about it. In summary, the strategy anticipation is applied when the participants discuss and brainstorm potential actions and developments and think about important aspects to solve the disruption problems, but they don’t implement them in the simulation game or check it in the game, at least not at the same game-day as the discussion takes place.

Strategies relating to *monitoring* were only classified a few times by the observers. On rare occasions, the participants in the simulation game asked the researchers running the simulation model about the state of specific parameters in the simulation game. In all such cases, they were given feedback. At some occasions, the participants also asked about the underlying logic in the model on which the simulation is based. Examples of monitoring are questions about the amount of money in ATMs, the number of citizens that are hoarding, or what kind of behavioral model that was used for customer behavior.

Strategies relating to *controlling* were the second most common in the observed simulation games (see **Table 1**). This is not surprising as the participants were asked to describe what actions they would like to have implemented on days 1, 3, 6, & 9 in the simulation game. Typically, they performed actions such as adjusting opening hours of stores, fill up the ATMs with cash, introduce alternative payment methods, and provide information to the public about the state of affairs and suggested actions to citizens. Controlling actions generally focused on minimizing the consequences of the payment disruptions, both in terms of lost incomes of business owners and from a community perspective.

Strategies relating to *recovering* were not observed during the simulation games. The main reason for this is probably that the participants interpreted the task of the scenario as dealing with the foreseeable and immediate consequences of the disruption. Recovery as such was thus not yet necessary.

Strategies relating to *learning* were observed by only one of the observers (Observer B) and are therefore not counted in this assessment. The lack of strategies relating to learning can partly be explained by the fact that the simulation game was seen as an exercise, and learning may have been interpreted as something that will take place after rather than during the simulation game.

Strategies relating to *self-monitoring* were observed at a few occasions. Examples of this are when participants begin to discuss whether the way they are organizing their work or begin to question if the approaches they adapt are viable or not.

MODIFICATIONS TO THE TRAMS PROTOCOL AND METHOD

The data collection conducted resulted in some alterations to the initial TRAMS protocol and method. The TRAMS protocol was updated (see Figure 5) after the first simulation game. The new version of the protocol has some changes from the first version (Johansson, Laere, & Berggren, 2018) since it was noticed that it was not possible to use all components included in the original version. The most important change is that, *core values* no longer are used because it was hard to assess them during the observations. It is recommended to have at least two observers using the TRAMS protocol and have them compare the outcomes with each other. A single annotator will need to have experience in identifying the strategies and note taking. Furthermore, in some situations it is difficult to correctly assess what is happening, especially if the team enters parallel discussions. In such cases, it may be necessary to go back and listen to the audio recordings to capture what actually was discussed

DISCUSSION

Subjectivity of the involved observers obviously plays an important role as observations may be connected to the strategies differently. However, the results indicate a good coherence among the observers in this limited data collection, although the collected material was too small to calculate inter-rater reliability.

Only three of the six core resilience functions could be related to observed strategies, *anticipation, monitoring* and *controlling*. This may be due to the limitations of the game simulation, the participants or other factors. It is likely that it depends on that the participants have not had time to train enough. Alternatively, *learning* may not be visible during the games themselves. Hopefully, further studies can clarify this, because it does not mean that *controlling* and *learning* cannot be found just because it was not seen in this data collection. Also, the core values could not be assessed. The original version of the protocol had core values as an own column, but this study did not find these during the games and could not find any practical utility with it in the observation protocol.

As pointed out in the results section, it is at times hard to keep up the note taking during the gaming simulation and at least two observers are probably needed. An advantage of using two observers is also that it is possible to compare observations with each other after the game. Audio recording is also important, both as a support for verifying observations and as an important data set for retrospective analysis. Some cons are that we could not fill in the core values since our knowledge about the participants' core values was too low and it was difficult to use it during the game simulation.

The fact that only three categories of strategies relating to the six core resilience functions were found in the simulation games is interesting. Of these three categories, anticipation was clearly the most common, followed by controlling. Monitoring was only observed at a few occasions. Table 2. shows the distribution of the observations. It is not clear from the observations or experiences from the simulation games why the distribution looks in this way, but we have two main hypotheses: 1) that the teams get so engaged in their discussions about possible developments (anticipation) that they simply forget to ask the simulation managers about the actual state of affairs in the simulation (monitoring), and, 2) that the current game design, where the participants are asked to make decisions at certain points in time (simulation game days 1, 2, 3, 6, & 9) creates a situation where the participants believe that it isn't necessary to ask for additional information between these decision-points.

SyRes functions	Strategies days 1	Strategies days 2	Strategies days 3	Strategies days 6	Developed by…	Involved actors	Expected effects	Implementation	Simulator outcome
Anticipating	Put in security early?								
		Prepare billing opportunities and swish?			All	Banks, stores, transport		Yes	
			Lower the price of products that are going to go bad?		Store	Store			
Monitoring		Check how much money there are left in the stores			All	Store		Yes	Not that bad yet
				Check how it works with swish, invoice and money in the stores	All	Payments and disappointed costumers	Get an overview	Yes	Relatively good
Controlling	Inform the costumers that disruption is happening?				All	Costumers		Yes	Good effect
	Close the stores				All	Stores		Yes	Good effect
		Refill the ATMs with money			All	Banks		Yes	Small effect, but still not that bad yet
Recovery									
Learning									

Figure 5. Example of how the TRAMS protocol can be populated during a simulation game.

CONCLUSION

In conclusion, the TRAMS protocol has been modified to better support observations of resilience strategies used by the teams to cope with the disruption in the gaming simulation. The instrument is yet not fully developed and there are still columns that need to be added or deleted before it can be validated, but it is a first try to structure a data collection based on the SyRes model. The TRAMS method has so far been successfully applied to six out of a planned series of 30 simulation games. The result led to a guide and examples on the strategies *anticipation, monitoring* and *controlling*. Strategies relating to the core functions *recovery, learning* and *self-monitoring* were not found in this study. The discussion above suggests two hypothetical causes for this: 1. The style of the participants in the particular simulation games studied, and, 2.) that the design of the simulation game not encourage the formulation of strategies relating to these core resilience functions. The instrument will be continuously developed along with the simulation game approach during the following 24 simulation games. Experiences from these simulation games will help mature TRAMS until it is a validated and mature research instrument.

ACKNOWLEDGMENTS

This research was supported by Grant 2016-3046 of the Swedish Civil Contingencies Agency.

REFERENCES

Berggren, P., Johansson, B. J. E., & Baroutsi, N. (2017). Assessing the quality of Shared Priorities in teams using content analysis in a microworld experiment. *Theoretical Issues in Ergonomics Science* , 18 (2), 128-146.

Bergström, J., van Winsen, R., & Henriqson, E. (2015). On the rationale of resilience in the domain of safety: A literature review. *Reliability Engineering and System Safety*, *141*, 131–141.

Blommstein, H.J. and Summers, B.J. (1998). Banking and the payment system. In: Summers, B.J. (Ed.), *The Payment System – Design, Managmenet and Supervision*. International Monetary Fund, Washington D.C., 15-29.

Berthod, O, Grothe-Hammer, M., Muller-Seitz, G., Raab, J., & Sydow, J. (2017). From High-Reliability Organizations to High-Reliability Networks: The Dynamics of Network Governance in the Face of Emergency. *Journal of Public Administration Research And Theory,* 352-371.

Foster, H. D. (1993) Resilience Theory and System Evaluation. In (Eds.) J. A. Wise, V. D. Hopkin & P. Stager, *Verification and Validation of Complex Systems: Human Factors Issues*. *(pp. 35-60)* Springer Verlag: Berlin.

Funke, G. J., Knott, B. A., Salas, E., Pavlas, D., & Strang, A. J. (2012). Conceptualization and Measurement of Team Workload: A Critical Need. *Human Factors* , 54 (1), 36–51.

Grüne-Yanoff, T. & Weirich, P. (2010) The Philosophy and Epistemology of Simulation: A Review *Simulation & Gaming*, 41, 20–50.

Helton, W. S., Funke, G. J., & Knott, B. A. (2014). Measuring Workload in Collaborative Contexts: Trait Versus State Perspectives. *Human Factors*, 56 (2), 322–332.

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics. 4,* 1-23.

Johansson, B. J. E., Laere, J. van, Berggren, P. (2018). Evaluating Team Resilience in Simulator-Based Crisis Management Training. *ISCRAM 2018,* Rochester, NY, 20–23 May.

Johansson, B.J.E., Laere, J., & Berggren, P. (2018). Evaluating Team Resilience in Simulator-Based Crisis Management Training. *ISCRAM 2018*, Rochester, NY, 20-23 May.

Laere, J. van, Berggren, P., Gustavsson, P., Ibrahim, O., Johansson, B. J. E., Larsson, A., … Wiberg, C. (2017). Challenges for critical infrastructure resilience: cascading effects of payment system disruptions. In *ISCRAM 2017* (Vol. 2017–May). Albi, France.

Laere, J. van, Berggren, P., Ibrahim, O., Larsson, A., & Kallin, S. (2018) A simulation-game to explore collective critical infrastructure resilience In: *Safety and Reliability – Safe Societies in a Changing World: Proceedings of ESREL 2018*, S. Haugen, A. Barros, C. van Gulijk, T. Kongsvik, & J. Vinnem (eds.) pp. 1305–1312. CRC Press, Trondheim, Norway.

Lundberg, J., & Johansson, B. J. E. (2015). Systemic resilience model. *Reliability Engineering and System Safety*, *141*, 22–32.

MacMillan, J., Paley, M. J., Entin, E. B., & Entin, E. E. (2005). Questionnaires for Distributed Assessment of Team Mutual Awareness. In N. Stanton, K. Hedge, E. Brookhuis, E. Salas, & H. Hendricks (Eds.), *Handbook of Human Factors Methods* (pp. 51–1–51–9). London: Taylor and Francis.

Schulman, P., Roe, E., Eeten, van M., & Buijne de M. (2004). High Reliability and the Management of Critical Infrastructures. *Journal of Contingencies and Crisis Management*, 12 (1), 14-28.

Seers, A., Petty, M. M., & Cashman, J. F. (1995). Team-member exchange under team and traditional management. *Group & Organization Management*, 20 (1), 18–38.

Shaluf, I. M., Ahmadun, F., & Mat Said, A. (2003). A review of disaster and crisis. *Disaster Prevention and Management: An International Journal*, *12*(1), 24–32.

Willems, J. (2016). Building Shared Mental Models of Organizational Effectiveness in Leadership Teams

Through Team Member Exchange Quality. *Nonprofit and Voluntary Sector Quarterly*, 45 (3), 468–492.