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Towards Digital Transformation of a City Resilience Framework

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Abstract

Improving city resilience is among the most challenging strategic goals for city administrators worldwide. To support their work, frameworks providing technical support and methodological guidance have been developed. Such frameworks define resilience improvement processes based on multidimensional resilience models to assess one city's resilience level, plus a collection of policies to increase such level in different dimensions. Although some frameworks include software tools to support the process, their scope is limited to a particular step of the process, and global management is still done manually, hindering agility in the process. In this paper, we present our work towards the digital transformation of a city resilience framework. The use of process technology to specify and enact the process is combined with the application of model-based development techniques to provide interoperability of the different framework tools. Our work is framed within a three-year project started in mid 2020. Here, we report about the results of the first year of the project. Specifically, we describe the architecture of the solution proposed, as well as the major features of our approach.

1. Introduction and motivation

According to United Nations, 55% of the world's population lives in cities, with a growth prospect of 68% by the year 2050 [1] . Urban areas are more attractive to citizens since they usually provide high-quality opportunities in terms of economic development, knowledge transfer, innovation, and social interaction, among other dimensions [2] . But the overcrowding of many cities has made their management more complex and critical [3] . Furthermore, current societies frequently face threats from a wide variety of sources, such as terrorism, climate change, economic crisis, pandemics, among other hazards [4] that make cities increasingly vulnerable, not to mention when some of them happen linked in series, as the recent Covid crisis and its consequences at the economic and social dimensions have demonstrated [5] .

In this context, city resilience emerges to study the capacity of cities, communities, or societies to resist, absorb, adapt, and recover from the effects of risks in a timely and effective manner [6] , [7] , minimizing loss of or damage to life, livelihoods, property, infrastructure, economic activity, and the environment [8] . Based on these postulates, there is a growing interest to develop cities more resilient and prepared to address shocks and stresses.

Improving cities' level of resilience to expected and unexpected disasters is of utmost importance and requires a holistic approach [9] [10] that goes beyond reliable technology, including an understanding of dependencies across city services, potential vulnerabilities and cascading effects, and cross-organizational resilience and collaborative efforts. Such a holistic approach can only be achieved with extensive Information and Communication Technologies (ICT) support [11] . In a general way, ICT allows to involve people and to enhance the urban system, which in turn results in an improvement in urban resilience [12] .

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In this paper, we introduce our work towards the digital transformation of a city resilience framework. The work presented is the result of the first year of the INCREMENTAL project, a three-year coordinated research initiative with the partnership of three universities. The project aims at creating synergies between researchers coming from different cultures like City Resilience, Prospective and Software Engineering, to approach to city resilience from a digital transformation perspective. This is, to the best of our knowledge, the first research work where a similar initiative is taken.

Starting from the original *Smart Mature Resilience* (SMR) framework for City Resilience, [13] , we analyze and describe each step of the transformation and the components of the supporting framework developed for this purpose.

Although some frameworks and conceptual models have been developed to define the attributes and priority areas of resilient cities [14] [15] [16] , they have been criticized for being far from providing resilience operationalization when going from theory to practice and making resilience tangible and practical for cities [9] . By operationalization we mean to provide automated means to show resilience managers what are the next steps at any moment, recommending specific strategies, and monitoring the overall process. Currently, such an operationalization is far from being achieved; existing ICT tools give only partial coverage to the theoretical frameworks, making it difficult to provide city administrators full-lifecycle tool support.

Only a full digital transformation of city resilience building processes can provide the level of support required by resilience managers. We present the main principles that drive SMR into a digital transformation process by operationalizing the application of its principles and policies. The transformation is based on the alignment of the SMR model with model-driven and process-based technology, leading to a city resilience Portal that guides city administrators during the full resilience building process by automatically providing a set of policies to be implemented, plus their prioritization based on their current maturity stage and the interdependencies among policies.

Model-based techniques [17] are used to facilitate interoperability between the different tools used in SMR. Specifically, we have obtained a unified data model by model transformation from individual tools' data models, in a way that a single, global state of a city is recorded and managed. Such global state is missing in most current resilience building frameworks.

The unified data model, combined with flexible process technology, is the foundation of the automation of the resilience building process itself, easing tasks like monitoring and measuring, and providing large-scale automation. Having flexibility in both process definition and execution paves the way to increase adaptivity of SMR to different contexts and situations. Moreover, the organizational dimension of processes opens the door to the participation of new stakeholders -especially, of citizens- in the process.

This paper is structured as follows. Section 2 provides the foundations and limitations of SMR. Section 3 presents the process towards the digital transformation of SMR. In Section 4, we discuss about the benefits and challenges of the digital transformation. Finally, conclusions addressing the implications of the findings and possible directions for future research are given in Section 5.

2. Smart Mature Resilience

The *Smart Mature Resilience* (SMR, http://www.smr-project.eu/home/) European research project, funded under the Horizon 2020 framework programme of the European Union, was a multi-disciplinary research project working for more resilient cities in Europe, pursuing far-reaching and holistic approaches to enhance their capacity to resist, absorb, adapt to, and recover from the potentially critical effects of different shocks and chronic stresses.

According to the SMR framework, a resilient city is such that [18] [19] :

- is prepared to identify, resist, absorb, adapt to, and recover from any shock or chronic stress while maintaining its essential functions;
- involves all stakeholders, especially citizens, in disaster risk reduction through co-creation processes;
- reduces vulnerability and exposure to natural and man-made disasters while managing to thrive;
- increases its capacity to respond to climate change challenges, disasters, shocks, and other unforeseen chronic stresses, through enhanced emergency preparedness.

The result of the SMR project was the development of the so-called *European Resilience Management Guideline* (ERMG) [19] , which guides cities in the resilience operationalization through a five-step process. The ERMG includes five different tools, which support municipalities in implementing city resilience processes. The steps, and their corresponding tools, are as follows (see Figure 1):

1. Baseline review. Assessment of the current resilience level of a city, performed by its local government through a dedicated team. The *Resilience Maturity Model* (RMM) provides resilience managers with five sequential maturity stages (starting, moderate, advanced, robust, and vertebrate) that serve as a roadmap for effectively building city resilience. Each of the model's maturity stages contains a description of the

Figure 1. SMR's European Resilience Management Guideline

objectives and a list of policies that should be implemented to move to a more advanced stage.

2. Risk awareness. Regular risk assessment and/or analysis of the perils the city faces in different sectors and levels of governance. The *Risk Systemicity Questionnaire* (RSQ) helps cities to analyze the current risks they are exposed to.

3. Co-creation of a resilience strategy. Development of a resilience strategy, which includes a strategic action plan, across different timescales with targets, indicators, and timeframes. The plan is built with the help of the *Resilience Building Policies* tool (RBP), a portfolio of policies that provides examples of how to put the policies identified in the RMM into practice. Additionally, the *Resilience Information Portal* (RP) is a Community Engagement and Communication tool—that provides a platform for stakeholder interaction.

4. Implementation and monitoring. Implementation of the resilience strategy and the included action plans, as well as a continuous monitoring of all implemented actions and activities. This step is supported by the *City Resilience Dynamics Tool* (CRD), a System Dynamics model that enables cities to test different policies and understand the dynamics and the relationships among the policies defined in the RMM.

5. Evaluation and reporting. Evaluation of results and effective process for reporting back to politicians, stakeholders, and the public. Both the RBP and the CRD are used in this step.

Taking the SME results (i.e., the ERMG and the five resilience tools) as a starting point, our aim is to take a further step towards the operationalization of the resilience process by overcoming some limitations of the framework. Specifically:

- The connection between the different SMR tools should be improved since they currently work independently, producing information islands. Consequently, data flow among them is lacking and makes it necessary a large amount of human processing of the data produced by the different tools.

- The assessment of the current maturity level of a city needs to be carried out manually, going through the five maturity stages of the RMM and finding evidence for each policy to evaluate its implementation level. The definition of indicators for measuring the level of implementation of the RMM policies will enhance this assessment, enabling the automation of the measurement of the cities' resilience level within RMM's maturity roadmap.

- The identification and prioritization of the next policies to implement to achieve a more advanced stage is another aspect to enhance, since it also requires human processing. This prioritization process is not trivial since it requires considering relationships among policies that condition their effectiveness.

Our work aims at tackling these limitations by providing a global operational view to SMR coming from the alignment between SMR and principles, techniques and tools from Software Engineering and Business Process Management. The implementation of these enhancements to the SMR project results will facilitate the integration and digitalization of the resilience building process, providing cities with an environment that supports the definition and continuous monitoring of their resilience improvement process.

Since other city resilience frameworks suffer from similar limitations [20] , our solution could be adapted and applied to other city resilience frameworks.

3. Towards the digital transformation of SMR

Most city resilience frameworks still do not provide a roadmap with a detailed sequence of policies that cities can implement to define the resilience-building process [20] . Their policies are provided as a number of recommendations, but there is no ICT support for neither their application nor the assessment of their actual impact. Moreover, cities may exhibit a great variation in their level of resilience, but existing frameworks do not help to identify which policies should be implemented considering the current city situation [10] .

To deal with these weaknesses, government agents and practitioners, who have the responsibility for building city resilience, need support and guidance to operationalize the resilience-building process [15] .The digital transformation of SMR's ERMG can bring it to its full potential on the way to make cities more resilient against climate change and other threats. The transformation consists of the use of process technology to provide automation to SMR and make its activities more systematic. We have developed a process-based implementation of SMR's ERMG. It is a flexible process specification that defines the sequential and iterative application of the ERMG.

As part of our research, we developed the *Core City Resilience Model* (CCRM), a structured data model integrating all the properties relevant for modelling and managing the SMR city resilience building process. These properties come mostly from the data managed by the different SMR tools. Finally, as a way of supporting the detailing and customization of the processes to different cities´ profiles, we developed a library of policies, specified as subprocesses, to allow the selection of variants according to each city´s profile.

The global outcome of the digital transformation is the so-called *City Resilience Portal* (CRP), a multi-tenant, web-based software environment allowing cities to develop an iterative resilience building process involving all relevant stakeholders. The architecture of the CRP, shown in Figure 2 has three main functional blocks. The *Digital Library* (DL) is a Web information space including information about city resilience in general, and the SMR framework in particular, as well as city-specific spaces where a particular city can show information related to itself and its resilience building process in its corresponding public Web space, and manage its profile and other parameters of its resilience process in its private space.

The *Resilience Manager* provides the core functionality required for the operationalization of the resilience building processes. It includes two components, namely the *ERMG Operationalization Module* and the *Reporting Module*. The goal of the former is to define, execute and monitor the ERMG for each city in the portal. A *Process Engine* can read the specification in a process definition language of the ERMG (see Section 3.2) and creates a process instance for each city registered in the CRP. The *Process Variability Manager* selects the policies to be added to the project at each iteration of the process (see Section 3.3). On the other hand, the *Report Module* processes the data generated during the process and produces reports, either as online dashboards or printed documents.

Finally, the *Resource Manager* includes several repositories containing relevant data. The *DL repository* stores all the multimedia digital objects of the DL; the *CCRM Repository* is a database whose schema is derived from the CCRM; the *Resilience Policies Library* contains process fragments representing implementations of the resilience building policies; and last, the *Process Execution Log* records all the events produced during the execution of the different instances of the ERMG process.

Logging into CRP, a city representative can 1) create the city profile in terms of the CCRM, and 2) launch a resilience improvement process that will continuously be monitored and supported by the CRP

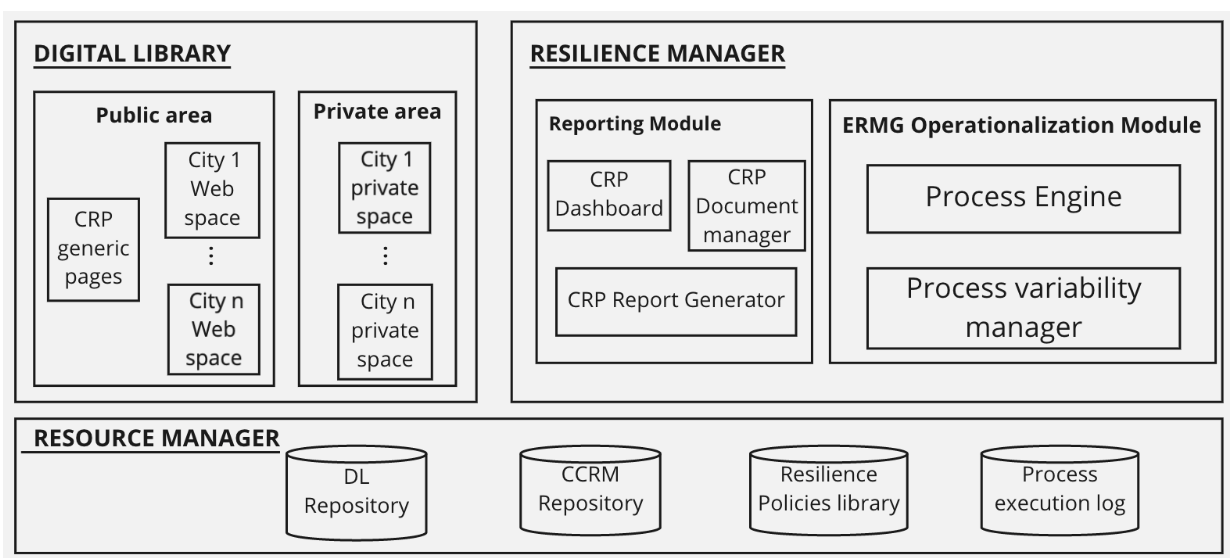

Figure 2 Architecture of the City Resilience Portal

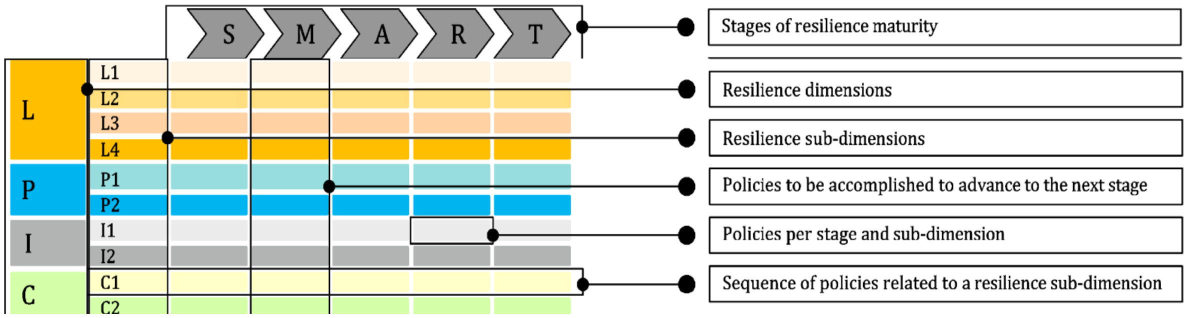

Figure 3. Structure of SMR's Resilience Maturity Model (RMM) (taken from [19])

tools. As in the original SMR model, CRP offers to the city administrators a snapshot of their resilience maturity level and may suggest a customized set of policies to be followed to scale up in the resilience maturity level roadmap; however, unlike the classical SMR framework, the set of policies are *calculated* using some metric based on a set of indicators. At each stage of the roadmap, other stakeholders (e.g., emergency services, critical infrastructures managers, NGOs, etc.) can also log into the CRP and perform their tasks within the process.

3.1. A unified resilience model

The CCRM is the result of the integration of the data models underlying the SMR tools mentioned in Section 2. It covers all the elements needed to implement the ERMG process described in section 3.2. The main components of the model are:

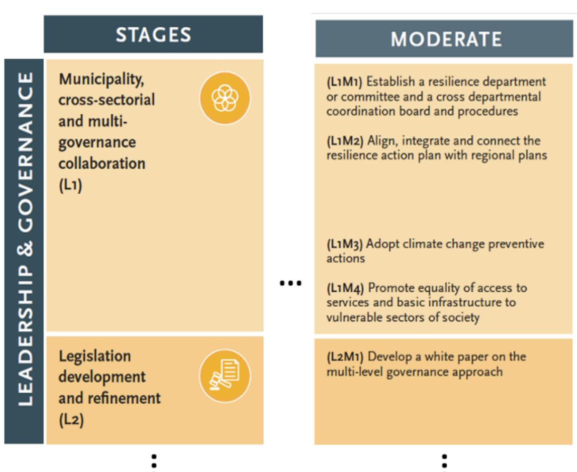

Figure 4 Excerpt from the RMM matrix

The city profile. It is crucial to support the multi-tenant nature of CRP. Each city in the portal has associated an information space including basic city data such as name, population, geo-location, climate characteristics, etc. It has also associated an organizational model that includes the roles involved in the resilience building process, as well as the users assigned to these roles. Finally, each city will have associated a web space in the Digital Library.

The maturity model. A set of classes implement SMR's RMM, against which cities will be evaluated. As shown in Figure 3, and described in [19] , the RMM is arranged as a matrix whose rows are the model dimensions that are refined into a set of sub-dimensions, allowing a hierarchical decomposition of the analysis.

The following dimensions and sub dimensions have been identified: **L**eadership and Governance (being L1 Municipality, cross-sectorial and multi-governance collaboration, L2 Legislation development and refinement, L3 Learning culture and L4 Resilience action plan development), **P**reparedness (P1 Diagnosis and assessment, and P2 Education and training), **I**nfrastructures & Resources (I1 Reliability of CIs and their interdependencies, and I2 Resources to build up resilience and response) and **C**ooperation (C1 Development of partnerships with city stakeholders and C2 Involvement in resilience networks of cities). In the remainder of the paper, we will use "dimension" to refer also to subdimensions.

The columns of the matrix correspond to the five maturity stages (***S**tarting-**M**oderate-**A**dvanced-**R**obust-ver**T**ebrated*) defined in the RMM. Each cell in the matrix contains a list of policies that should be implemented in order to move to a more advanced stage within the same dimension. Figure 4 shows a fragment of the RMM where some policies are listed in their corresponding cells.

Additionally, the RMM provides information about the relevant stakeholders that need to be involved proactively in each maturity stage. In the early stages of the RMM, few stakeholders are proactively involved in the city resilience-building process. As cities move forward through the RMM stages the number of involved stakeholders grows.

Policies. At each cell of the RMM matrix, one or more policies can be defined to help cities to move forward in the maturity level roadmap. Following the encoding schema of subdimensions, a policy's code is formed by the subdimension it belongs to, plus the stage in the maturity level roadmap; for instance, the code L1M3 corresponds to third policy at the crossing between subdimension L1 and the Moderate stage (see Figure 4). These policies are mostly defined at a generic level (e.g., "*Adopt climate change preventive actions*"), and therefore we will refer to them as *abstract policies*. Abstract policies can be implemented in different ways by *policy instances* chosen by different cities according to their specific context, as explained in [20] . A possible instance for L1M3 could be: *"Implement urban drainage systems, Fix waste containers, Implement early warning systems and Increase sewer capacity"* (example taken from [21]). More examples about how cities have implemented a policy in different ways can be found at the SMR project's website (https://bit.ly/3ypbhOt).

Dependencies. The order in which policies should be implemented to guarantee their effectiveness is not trivial. A city could invest time and resources in one policy without achieving the expected results due to that other policy has not been partially or totally implemented. Therefore, linear and transversal relationships among policies have been also identified in order to establish a prioritization order. The former refer to temporal relationships that exist among the different maturity stages. This means that policies in the lower maturity stages should be developed to implement the policies in the higher maturity stages. On the other hand, transversal relationships refer to relationships among the policies in different sub-dimensions.

Indicators. The so-called *Key City Resilience Indicators* (KCRI) measure the level of urban resilience. Unlike approaches based on Geographic Information Systems (GIS), where indicators vary according to geographic areas (especially depending on the availability of secondary data), we follow a process-driven approach aimed at guiding to relevant actors in the city resilience building process. The KCRI are aimed at measuring the performance of different resilience policies. Therefore, the set of indicators is common to all cities. They have a hierarchical nature since they determine the level of maturity of each city through the degree of implementation of the specific actions to be carried out in each policy. Since they are synthetic, they can be used to make comparisons between different cities.

3.2. The ERMG Process Specification

The ERMG operationalization consists of the transformation of the iterative process depicted in Figure 1 into a BPMN process specification (see Figure 5). Each operational step of ERMG is represented by a subprocess in a sequential control flow (respectively, *"Review City Baseline", "Analyse Risk", "Define Resilience Strategy", "Implement & Monitor", and finally, "Evaluate & Report*"). When the last subprocess is completed, there is a decision (to be made by the city's resilience planner and represented by the XOR gateway) that can lead either to a new iteration (aiming at further improving the level of city resilience) or to the end of the resilience building process. There is also a data flow between subprocesses; in Figure 5, however, only the main products generated in each subprocess are shown.

At any iteration in the ERMG process, the "*Specify Resilience Action Plan"* subprocess generates an action plan by composing one or more process fragments representing RMM's *abstract policies*. Such fragments are stored in the *Resilience Policies Library* and are retrieved on demand according to the progress of the overall process (see section 3.3). The generated plan is executed as the last activity of this ERMG stage. More details about this process can be found in [20] .

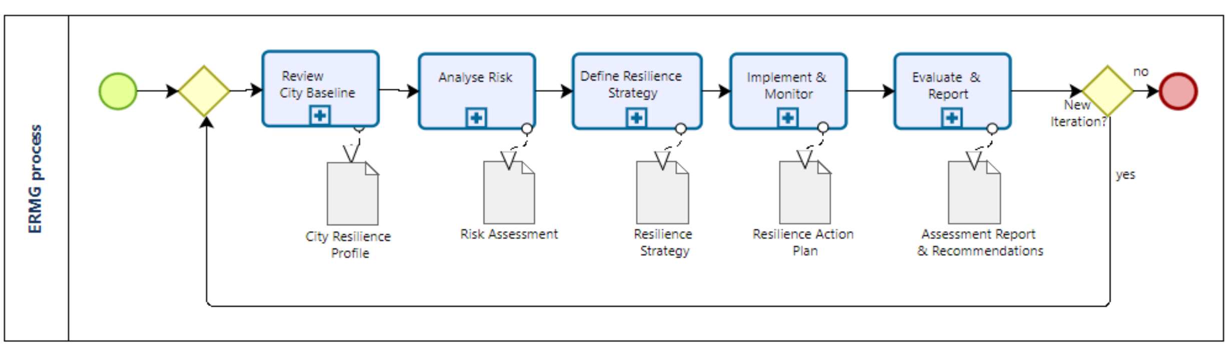

Figure 5. BPMN specification of the ERMG process

3.3. The Resilience Policies Library

The *abstract policies* that compose the RMM need to be transformed into concrete actions to be executed in a particular city resilience building process. How this transformation is made depends strongly on the context of each city. In case of the "*Adopt climate change preventive actions*" abstract policy, a city near a high mountain area would have snow melting and its subsequent floods as the main concern, defining actions leading to a better protection against them. However, the concerns of a city in a warm, coastal area would be quite different, leading to different actions to implement the same policy. To manage such diversity, the *Resilience Policies Library* aims at providing storage and retrieval facilities for policies and their instances.

The *Resilience Policies Library* is a repository where both *abstract policies* and their instances (*policy instances*) are organized and stored for reuse. Policies are described by means of metadata (name, description, keywords, etc.) to provide users with retrieval criteria, and stored as BPMN-like process fragments that can be composed to be part of the Action Plan process at each iteration of the ERMG.

The selection of specific sets of policies is performed in a two-step process (see Figures 6 and 7). In the first step, the *Specify Resilience Action Plan* subprocess generates the so-called *global process*

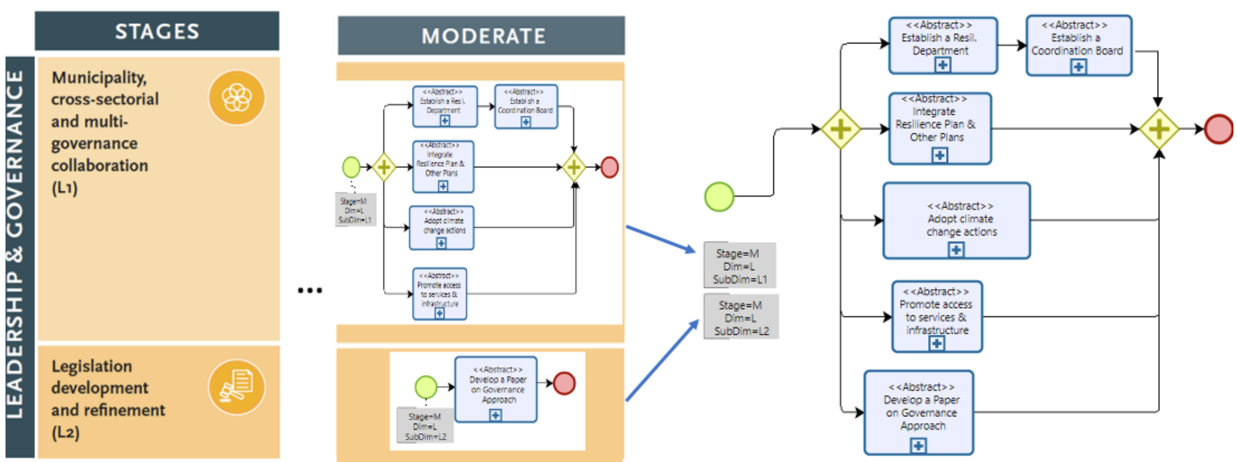

Figure 6. Composition of abstract policies into a global process

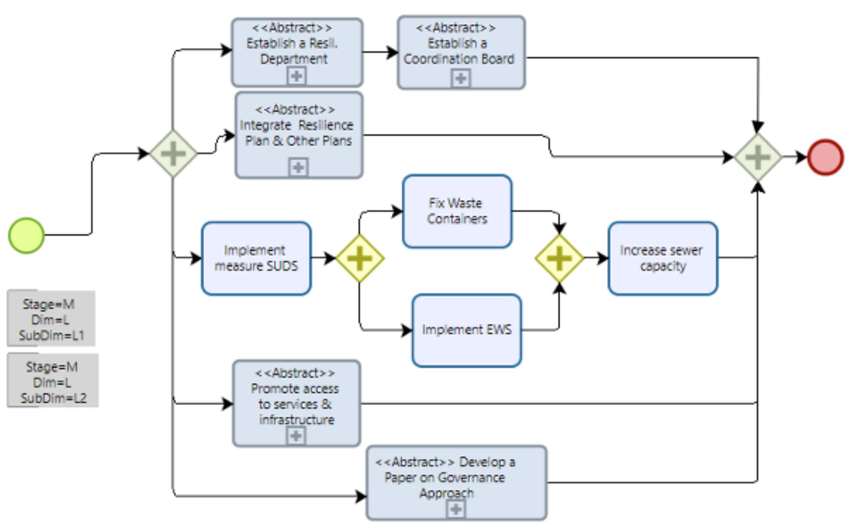

Figure 7. Replacement of an abstract policy with a policy instance

corresponding to the next iteration. Such process is the result of the composition of all the abstract policies to be applied according to the RMM and the state of the city. In the case of Figure 6, the city has completed the Starting stage and the next iteration aims at completing the Moderate stage in the L1 and L2 dimensions. Notice that the lists of abstract policies corresponding to each cell have been replaced by process fragments representing the composition of every policy in the cell. Then, the selected fragment processes corresponding to the abstract policies at the crossing between dimension L1 and L2 and the Moderate stage of the RMM matrix are composed to create the process on the right side.

In the second step, *abstract policies* must be replaced by *policy instances*. Given an *abstract policy*, a suitable instance can be searched and reused from the library. For instance, in the Figure 7, the *abstract policy* "*Adopt Climate Change Actions*" is replaced by a policy instance that include actions to reduce the flood impact in a context of climate change; in this case the actions are related to improve the urban drainage system, fix waste containers, implement Early Warning Systems and increase the sewer system capacity. If the retrieved instance fits the city requirements only partially, a new instance can be derived from it, adapted, and then added to the *Resilience Policies Library* for further reuse. If no fitting instances are found at this *Library*, a new instance can be created, added to the process, and stored in the *Resilience Policies Library* as a new *policy instance*. The process is described in detail in [20] .

4. Discussion

We have addressed the three weaknesses of city resilience frameworks mentioned in Section 3. First, SMR included by design a roadmap for resilience managers, that has been formalized as a process model; second, we have transformed informal guidelines into process specifications; and third, these specifications can be dynamically selected according to the specific context of each city. The proposal presented in this paper comes up to move city resilience building processes a step further in their definition, execution, and monitoring. Our process-based approach represents a step further in the digital transformation of the SMR city resilience framework.

Our approach preserves the foundations, principles and practices defined by SMR, yet adds a significant number of features. It allows 1) to describe an expandable data model that incorporates all data required in the processes, as they have been detailed, 2) a general process and the variants of the subprocesses that covers the differences among cities and among different types of disasters, and 3) a library of process fragments that allow dynamic process composition.

4.1 Benefits of the approach

A holistic management of the resilience building processes brings many benefits, both for city administrators and other stakeholders. It also improves the interoperability among the different SMR tools and enables knowledge sharing and reuse. Last, but not least, process technology allows strict control of the development of the process.

Creation of city resilience spaces. The CRP aims at being a virtual space for the development of urban resilience strategies. Around this space, numerous activities can take place, including creating community, increasing preparedness, and engaging citizens in the process.

Connection of the SMR tools. At CRP's backend, a software infrastructure supports all the resilience building process and tools. The use of advanced modelling techniques yields to a holistic approach where the different city resilience building tools are no longer information islands yet become part of a larger structure that will provide cities with a global view of city resilience management.

Comparison with other cities. Having a unified model plus a multi-tenant structure can lead to multi-city comparative analyses that provide more context to cities' administrators.

Policy reuse and knowledge sharing. The advantages of having a library of resilience policies go beyond the compositional approach taken in the definition and iterative refinement of the process. In fact, policies can be defined once, but reused in as many processes as needed, reducing effort and time spent in the definition of the process.

Process control and measurement. Using process technology to model and enact the resilience building process brings to the scene the well-known advantages of process-support systems. On the one hand, high levels of control in the execution of the different activities of the process, and, on the other hand, the ability to monitor the execution and take corrective actions if needed.

4.2 Challenges ahead

The digital transformation of SMR gives a chance to add several features to it; some of them can be considered functional requirements of the new CRP, other relate to the digitalization of both the RMM and the ERMG, and some other represent technological challenges.

Extensibility. City resilience is an evolving field of study. New threats, risks, and hazards appear continuously that require a continuous review of the strategies developed by cities to improve safety.

Therefore, resilience models must be aware of this evolution, and adapt to the new situations. The new RMM must be open and extensible, allowing new dimensions and/or policies be added as necessary. We use metamodeling techniques to develop the CCRM with support to dynamic model updating.

Diversity/customization. The new model must be applicable to as many different city profiles as possible. This requires customization facilities in the CRP that show to each city a view of the process customized according to its specific characteristics. Moreover, mappings between the sets of policies and the different city profile types must be established to drive the assistance to city administrators in the configuration of their resilience process iterations.

Process variability. The operationalization of the ERMG using process technology must be based on flexible approaches to allow cities to configure their processes. Specifically, at each process iteration, a city should, first, be able to choose which policies to apply according to its context (funding, staff availability, citizen's degree of engagement, etc.); and second, a city should be able to choose the implementation of a given abstract policy that best fits its profile and context.

Adherence to standards. The CRP supporting infrastructure must be developed in compliance with the highest standards in usability, security, and interoperability. The aim is threefold. First, to ensure privacy of cities and users' data to a level that all the stakeholders, especially the citizens, trust the system and are willing to engage themselves in the process. Second, to generate optimal user experiences by means of customized interfaces, complete information dashboards and guidance during their participation in the process. And third, make the different SMR tools exchange data in a safe and automatic way.

5. Conclusions and further work

City resilience has been among the most relevant fields of study in the last decade. Increasing the capacity of cities to absorb and recover from different types of disruptions has been (and continues to be) a serious concern of city administrators, as well as of citizens. The knowledge generated by researchers and practitioners in different areas has been structured around city resilience frameworks that provide guidance in the city resilience building processes.

The early 2020s are starting the era of Digital Transformation, in which ICT adoption is radically changing current practices in numerous domains, especially in the Digital Government area. This was not the case, however, of the city resilience frameworks, many of which remain at a conceptual and strategic level, making use of tools only in some parts of their resilience building processes and hindering agility in their management.

In this paper, we have presented the foundations of the digital transformation of the SMR city resilience framework. The transformation is developed along three areas of action: first, the development of a unified data model to avoid the information islands derived from the lack of connections between the tools used in the different stages of the process; second, the use of flexible process technology to provide an operational (i.e., *executable*) version of the resilience building process that allows its dynamic, context-dependent reconfiguration and further monitoring and analysis; and third, the building of a *Resilience Policies Library* that feeds the resilience building process according to a number of resilience indicators.

At the time of paper submission, the CCRM is developed at 95%, expecting minor changes during the remaining years. The high-level process specification of the ERMG is almost completed, and the *Resilience Policies Library* is under development. We expect to have a functional prototype of the portal by the end of the second year of the project, and to develop evaluation pilots along the third one.

To support the work described in this paper, researchers of the project team are working on related issues. One particularly relevant is the definition of the *Key City Resilience Indicators* set. Having quantifiable indicators opens the door to the development of a policy recommender subsystem able to propose the best subset of policies to be applied at each iteration of the process.

Also, an online self-assessment tool is being developed as part of *CRP's Resilience Manager* module. The self-assessment tool is composed of a set of questions that different city stakeholders should answer to obtain the overall city maturity level as well as the maturity level for each resilience dimension. These questions are based on the *Key City Resilience Indicators* that measure the implementation level of each policy. Through this evaluation, the city has a more detailed overview of the actions that should be addressed in the future to move forward to the next maturity stage. A dashboard is being developed as part of *CRP's Reporting* module to monitor and summarize the values of indicators in a user-friendly interface. This dashboard enables the city stakeholders to have an overall picture of the resilience building process to facilitate the strategical decision-making process.

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