

RESILIENCE OF CRITICAL INFRASTRUCTURES: BENEFITS AND CHALLENGES FROM EMERGING PRACTICES AND PROGRAMMES AT LOCAL LEVEL

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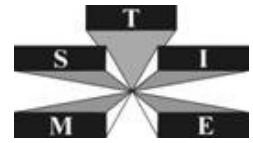
ABSTRACT:

As no single organisation is able to cope with variety of risks and complexity of interconnectedness of Critical Infrastructures (CI), their effective Protection and Resilience (P-R) depends on numerous public and private stakeholders collaborating at different institutional and operational levels. In this regard, regional initiatives have emerged worldwide as one of the key strategies to deal with CIP-R issues in the context of Emergency Management (EM) and Community Resilience policies. Since the beginning of 2010 there has been a boom of Public-Private Collaborations (PPCs) with this aim in North America and partly in Europe and Australia as well. It is the main approach for today's practitioners to deal with CIP-R issues. Recent research has set the theoretical base of PPCs and claimed their high potential for enhancing CIP-R that is vastly unexploited due to challenges in their establishment and management, so they sometimes fail to perform and bring benefits as expected. It is now necessary to move forward to addressing the practical side of these regional programmes. Through studying seven worldwide cases (considered as best practices), this work compares and analyses different PPC approaches. The study sheds light on how engagement of all stakeholders is achieved to improve CIP-R and how the main challenges are faced. Findings specifically focus on the four core elements constituting a regional programme: context factors, guiding principles, management model, and practices. They are eventually suggested as the constituents of a framework for the development of successful Regional CIP-R Programmes.

KEYWORDS: Critical Infrastructure Resilience, Public-Private Collaborations, Emergency Management, Community Resilience, case study

1. INTRODUCTION

An infrastructure is a set of basic facilities, services, and installations that are necessary for the functioning of a community (American Heritage Dictionary of the English Language, 1996) or society, such as electricity, gas and oil production, transport and distribution; communication and transportation systems; water supply; public health; financial and security services, etc. Contemporary societies are increasingly dependent on availability, reliability, correctness, safety and security of many technological infrastructures, commonly referred to as Critical Infrastructures (Ouyang, 2014; EC, 2005). A Critical Infrastructure (CI) is an array of assets and systems that, if disrupted, would threaten national security, economy, public health and safety, and way of life (McNally et al., 2007, Hilton, 2007). In the face of many CI breakdowns current CIP-R approaches have often proved inadequate and with major limitations (Kröger, 2008; Boin & McConnell, 2007). Recent years have brought major governmental initiatives and rapidly increasing number and spectrum of activities all over the world addressing the issues regarding CIP-R. There are pervasive efforts to improve protection and resilience of CIs and ensure service continuity in wake of broadened range of hazards and treats.



As for service delivery, interconnected infrastructures largely have a regional scope, thus in case of disruptions their interdependencies and service restoration need to be addressed regionally. Local level is where the CIP-R issues are first tackled. Depending on the organization of a country, its population and infrastructure density, 'local' ranges from a big city metropolitan/urban area, parish, region, or a few regions acting as one when dealing with CIP-R, all the way to a (small) country.

Effective CIP-R depends on numerous stakeholders collaborating at different institutional and operational levels and exchanging information by means of a variety of channels. In this regard, regional initiatives have emerged worldwide as one of the key strategies to deal with CIP-R issues in the context of Emergency Management (EM) and Community Resilience policies (Dunn-Cavelty & Suter, 2009; DHS, 2013). Since the beginning of 2010 there has been a boom of Public-Private Collaborations (PPCs) in North America and partly in Europe and Australia as well, as the main approach for today's practitioners around the world to deal with CIP-R issues. Even though PPCs hold great promise to provide resounding value for both government and businesses, they also face significant obstacles. Indeed, PPCs come with challenges in their establishment and management so they sometimes fail to perform and bring benefits as expected, a phenomenon that may lead to a fracture between the appearance and the reality of PPCs on CIP-R. This is why the characteristics of the PPC that runs a specific Regional CIP-R Programme have strong influence on the scope, objectives, activities, and eventually on the quality of achievements of the programme itself.

Recent research has set the theoretical base of Public-Private Collaborations (PPCs) and claimed their high potential for enhancing CIP-R that is vastly unexploited due to challenges in their establishment and management (e.g. Dunn-Cavelty & Suter, 2009; Givens & Busch, 2013). We move forward by studying partnerships' practical side. Through exploratory multiple case study analysis we try to understand the role and contribution of regional programmes in shaping the contents and results of CIP-R efforts. It is done by comparing and analysing different PPC approaches, highlighting how engagement of all stakeholders is achieved to improve CIP-R and how the main challenges are faced. Based on the discussion of findings from the cases we propose a general framework comprising the core elements for setting up a successful Regional CIP-R Programme.

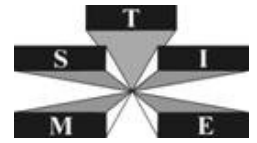
2. THEORETICAL BACKGROUND

2.1. Moving from protection to resilience

The landscape of threats and vulnerabilities affecting CIs is becoming even more uncertain, dynamic and complex. Counting both high prices of highly reliable preventive efforts and private sector reluctance to invest more in preventing very-low-probability events, despite their expected high-impact, advantages of resilience-based approaches are reduction of expenses of protection amelioration for certain risk scenarios (which may or may not occur) and improvement of response and recovery activities that cover all hazards (De Bruijne & Van Eeten, 2007; Pursiainen, 2009). Resilience generally means the ability to recover from shock, insult, or disturbance, and the quality or state of being flexible, and it is used quite differently in different fields (Bouchon, 2006). Technical resilience consists of improving the level of resilience of infrastructures (e.g. adding redundancy, geographical isolation, backups, etc.), whereas a full-spectrum approach (Boone & Hart, 2013) comprises organizational resilience (intra- and inter-organisational) and societal resilience. The need for moving from a protection-driven strategy to a resilience-driven strategy for sustaining the sustainable development of CIs is well-established in US policies and regulations, whereas this paradigm shift is still at its early stages in the European context.

2.2. Governance issues to support CIP-R, hierarchical and PPC approaches in EM

Government's interest and obligation is to ensure providing of essential services that are vital for national security and the well-being of population, even in a context of market liberalisation. On the other hand,



the focus of private organizations is on running their business and the security issue is not at the top of their priorities, so there is *'a different sense of urgency in concerning the problem'* between two partnering sides (Dunn-Cavelty & Suter, 2009). Private sector does not have funds earmarked for this purpose or is just unwilling to invest more in security and in many cases costs of improving security measures or vulnerabilities mitigation outweigh the benefit of reduced risk (Auerswald et al., 2005; Percy, 2007). Moreover, no single organization has all the necessary resources, relevant information and competence to cope with complex inbound and outbound interdependencies under different accident scenarios (DHS, 2012; Petrenj et al., 2013). Protecting and ensuring the resilience of critical infrastructure thus became a shared responsibility between government and the private sector (PCCIP, 1997). It requires engagement of all stakeholders in order to cope with CI interdependencies and improve resilience. Resilience development at both strategic and operational level is approached through the implementation of Public-Private Collaborations (PPCs). PPCs *'serve as the medium through which that infrastructure functions and protects itself'* (Barnes & Newbold, 2005).

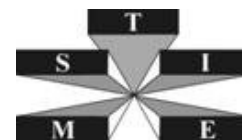
There is a wide range of PPC forms, characterized by their objectives, models, organization, relationships, leadership, contracts, size, type of actors, etc. While the original concept of Public-Private Partnership (PPP) is project-based and aims to add value and increased efficiency to the specific service, compared to other options such as concluding a more traditional contract (EC, 2005), PPCs with a purpose of collaborative efforts for CI protection and resilience (in scope of this work) are more programme-oriented (i.e., not limited by time periods). They aim not at enhancing operational efficiency, but at increasing security and vital service continuity (Dunn-Cavelty & Suter, 2009).

The scientific literature addressing CIP-R emphasises three PPC governance models (Table 1): self-governance, governance by a lead organisation and governance by a network administrative organisation (NAO) (Provan & Kenis, 2008). The successful adoption of a particular form of governance is seen to be dependent on four key structural and relational contingencies: trust, size (number of participants), goal consensus, and the nature of the task (need for network level competencies). Each of the approaches has its advantages and drawbacks. Scholars are aware of how the governance form impacts on the network functioning and effectiveness, as well as on crisis response (Moynihan, 2009), but further analysis should be conducted for a better understanding and assessment of the impact on the information sharing and collaboration forms within CIP-R PPCs.

3. STUDY METHODOLOGY

With a focus on emerging PPCs at regional level to address CIP-R issues, the study investigates what are the main elements that are needed for a successful and sustainable programme design and implementation. The analysis does not cover merely the basics of partnership but focuses on all the aspects that eventually emerge as relevant in practice. Aspects included in the scope of the study are: PPC approaches and different settings, their strengths and possible weaknesses, challenges and issues, contribution to CIP-R in general.

As the prior research into practical aspects of PPCs with a goal of CIP-R is quite limited, the case method is well suited to the research questions at hand (Benbasat et al., 1987; Walsham, 1995). Case research allows a relatively full understanding of the nature and complexity of phenomena and lends itself to exploratory investigations when phenomena are still insufficiently understood (Eisenhardt, 1989; Meredith, 1998; Voss et al., 2002; Yin, 2003; Seuring, 2008). Case studies are suitable for exploring issues that are too complex for empirical survey or experimental research. We therefore decided to adopt an *explanatory-exploratory multiple-case* study research strategy (Yin, 2003) as the most suitable choice, focusing on local PPCs with a goal of CIP-R as the unit of analysis. This approach is suitable for understanding CIs as one of the biggest and the most complex socio-technical systems in combination with PPCs that are concurrently coping with issues of different nature. The cases were selected for the analysis due to the fact that they are



among the leaders in the field (regarded as best practices among practitioners) and at the same time diverse in characteristics and with different focuses. We do not use ‘extreme cases’ but major and representative ones and in this way we partly deal with the issue of generalisability. Seven PPP were studied (Table 2) while the diversity of cases, by means of location, size and main focus has been assured. Each individual case presents a complete study where facts were gathered and conclusions drawn. In the further step, using cross-case analysis and being able to look from a broader perspective, we capture some common and distinctive features and thus eliminate contingent influence of location specific factors (e.g. cultural or political characteristics).

Table 1. Key predictors of Effectiveness of Network Governance forms (Provan & Kenis, 2008)

Governance forms	Trust	Number of Participants	Goal consensus	Need for Network-Level Competencies
Shared governance	High density	Few	High	Low
Lead Organization	Low density, highly centralized	Moderate number	Moderately low	Moderate
NAO	Moderate density, NAO monitored by members	Moderate to many	Moderately high	High

Table 1. Cases general features

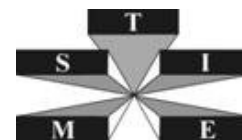
	Established	Location	Focus	Size/Level
Louisiana BEOC	2010	USA	Business continuity and community resilience	State
Scottish Gov.	2011	UK (Europe)	Critical National Infrastructure Protection and Resilience	Country with separate jurisdiction
PNWER	PNWER in 1991; Partnership for disaster resilience in 2001	USA/Canada	Disaster resilience and Cross-border Emergency Management	Multi-state Economic Region
Lombardy	2010	Italy (Europe)	Emergency Management	Administrative Region
VRK	2007	The Netherlands (Europe)	Safety and Emergency Management	Safety Region
Montreal	2000	Canada	CI Interdependencies identification, assessment and mitigation	Big city – Metropolitan Area
Copenhagen	1991 – The link opened in 2000	Denmark (Europe)	Emergency management	Administrative Region with cross-border dependencies

In order to better analyse and confirm the validity of the findings, multiple sources of data have been used (data source triangulation – Denzin, 1984; Yin, 1994). Source materials for the analysis of the cases (Table 3) included 1) a set of semi-structured interviews with people engaged in PPCs and some partnering organisations (CEOs, Managers, Private Sector Coordinators, Civil protection representatives, etc.); 2) documents, reports, action plans, websites and other publications; 3) participation in meetings, roundtables, discussions and tabletop exercises; 4) organisation of focus groups; 5) on site visits.

4. SUMMARY OF THE REGIONAL PROGRAMMES AND THE MAIN FINDINGS

Or the sake of concision, Table 4 reports a summary of the main findings for each one of the seven case studies according to the following elements:

- Type of programme: specification of the regional level, institutional and legal references, PPC type and core members;
- Main focus: resilience scope, aim and objective of the programme;
- Distinctive features: core elements the programme relies on and those that make it unique (if any).



5. DISCUSSION

Discussion is organised around four elements that emerged as the key constituents of Regional CIP-R Programmes and those that potentially determine not only its characteristics and objectives, but also its achievements and performance: context factors; principles; management model, and practices.

5.1. Context factors

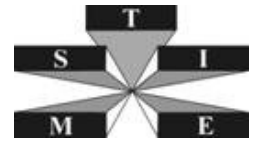
In addition to EC legislation on CIP (EC Directive 2008/114/EC) and the related European Programme for Critical Infrastructure Protection (EPCIP), national legislation in single Member States plays a crucial role in shaping regional initiatives on CIP-R. In several EU countries, opportunities for engaging stakeholders in the development of a local CIP-R programme might be found directly in extant legislation:

- Thanks to awareness and concern of CI operators induced by responsibilities and enforced requirements for action (e.g. in Scotland and Italy);
- Well established culture and standards at national level thanks to a coherent regulatory framework (e.g. The Netherlands);
- Resources – financial, technological, skills and knowledge – made available at national level (e.g. in the Netherlands and Denmark);
- Full or partial devolution of CIP-R responsibilities with clear interfaces with national and EC levels (e.g. Scotland).

Table 2. Data sources used in each case

	Interviews	Documentation, Reports, Action Plans, other pub.	Focus groups	Table-top exercise	Website	Contribution to the case description by involved personnel	On site visits
LA BEOC	X	X			X		X
Scottish Gov.		X	X		X	X	X
PNWER	X	X		X	X		X
Lombardy		X	X	X		X	X
VRK		X	X			X	X
Montreal	X	X				X	X
Copenhagen		X			X		X

Next, the characteristics of the PPC that runs a specific Regional CIP-R Programme have strong influence on the scope, objectives and core activities. There are some examples of shared governance where private CI operators are more directly engaged in defining scope and goals of the collaborative network, such as the case of Montreal Metropolitan Community (Canada). In this case, the PPC is collectively led by CI operators and technically supported by the Ecole Polytechnique de Montreal, scope and goal of the partnerships is however limited to the understanding and assessment of interdependencies among CI in the area. When the PPC is a direct result of a public policy for involving the private sector in the development and/or implementation of CIP-R programmes, such as in The Netherlands where “Security Regions” are mandated to do so, the size is generally larger, and the scope and objectives are predominantly set by public authorities. This highest potential for impact on the region is balanced by the challenges brought by a relatively lower level of trust and goal consensus. As an example, it may happen that in practice not all the involved CI operators are willing to commit themselves to implementing collaborative plans, containing additional responsibilities or the mobilisation of additional resources, put in place under the strong leadership of public authorities. PPCs are able to collaborate without any legal agreements, but documents such as Memorandums of Understanding (used in PNWER and Lombardy), charters, confidentiality agreements (at CRP) or collaboratively written Standard Operating Procedures (at LA BEOC) are able to assist partnership maturation or new partnership development efforts.



Every PPC has its own specific scope and main purpose that the collaborating organisations want to achieve. Each adjusts its set of activities according to the issues that is facing. Not every PPC cover all infrastructure sectors, interact with all stakeholders, or be engaged throughout the EM life cycle. They of course try to cover as much as possible, but it usually starts small and develops over time. Depending on the goal of the Programme, the scope can be limited to only some of the phases of the EM cycle, such as prevention and/or preparedness. This is the typical case when the PPC that manages the Regional CIP-R Programme is largely composed and led by private stakeholders (e.g. association, CI operators, etc.), which do not have any responsibility and power to directly manage emergency response and recovery. The most important scoping factor is the policy/strategy background set for the programme, that is: protection-centred vs resilience-centred programmes. PNWER, as a cross-border region, has a particular challenge of bringing together the American and Canadian stakeholders within an agreed and conformant partnership. To do so, proper communication between local and national stakeholders and also across the border is an important key. Correspondingly, PNWER accents the importance of communicating stakeholders' validated regional disaster resilience recommendations to state and provincial governments and policymakers as an objective. This can be definitely recognized as a good practice to convey regional concerns to higher-level authorities. On the other hand, the Lombardy Region has an extensive view on the importance of information sharing so that it has been considered in its goals and objectives to standardize communication among the actors, mapping information relevant and communication channels. Interoperability and security aspects of information sharing are covered as well. Such a perspective cannot be seen among other regional cases.

Although it is noted by all the regional case studies that risk and resilience evaluations must be implemented into the management mechanisms of industrial and governmental systems, the Centre Risque & Performance (CRP) of Montreal has a more stress on the integration of CIP-R tools and practices into day-to-day professional activities of network administrators. CI operators and scientific institutions collaborate, through a well-established network, to investigate and analyse CI interdependencies. In case of the Kennemerland Safety Region, a subject which is considered widely in the regional strategy is the legal issues. It is emphasized to ensure the legal conformance of the regional disaster plan with the Dutch national laws since according to laws, the responsibility for managing emergencies is delegated to the safety regions. In the Copenhagen case, since the partnership has a specific focus on the safety of the Oresund Bridge, the goals and objectives are set particularly for an infrastructure, not a region.

5.2. Fundamental principles

From the cases, five fundamental principles at the roots of a successful CIP-R programme development clearly emerged: subsidiarity; continuous improvement and evolution; balanced benefits; all hazard approach; risk-informed approach.

Subsidiarity and complementarity principles are at the roots of the European EPCIP Programme. Regional strategies and programmes for CIP-R represent the best existing examples of a bottom-up approach to the subject and, as such, the most promising opportunity for a deeper and more effective deployment of the subsidiarity principle in the CIP-R domain. The quality of relationships, collaboration and coordination among stakeholders shown by ongoing Regional CIP-R Programmes is apparently of higher quality and effectiveness than those reached by national or continental actions. This situation is clearly observable both in USA and in Europe. As National Critical Infrastructure are concerned, involving stakeholders at regional level does not mean involving 'regional' CI operators only, but more precisely establish collaborative processes with relevant/national CI operators at a level that is closer to the implementation arena. Secondly and most important, a bottom up approach can leverage on existing local experiences to design and implement an effective CIP-R strategy. This subsidiarity 'in action' is made of recognition, support, involvement, harmonisation and sometimes devolution to single stakeholders or group of stakeholders that brings distinctive capabilities for building an effective strategy.

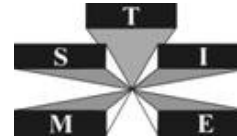
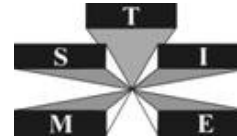


Table 4. Summary of the seven cases on Regional CIP-R Programmes

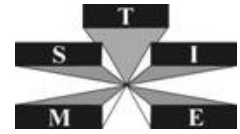
Case	Type of Programme	Main focus	Distinctive features
Kennemerland Safety Region (Netherlands)	The Netherlands multi-level partnership for alignment of security management and process. Involves 13 public and 6 private organisations of several kinds	A safety region is a mandated cooperation of the local and regional public authorities to address and manage critical events and disasters within that region. Aim is to deliver CIP-R through assurance of conformance with legal instruments, maintenance of the PPC for planning and crisis management, assessment and updating of plans, and conduct of exercises to prove the practical viability and value of such plans.	<ul style="list-style-type: none"> Partnership not convened as a single entity – operates through a series of working groups Crisis response structure covering Strategic, Tactical, Operational levels and On-site Command Safety Regions organised under a common legal framework, with subsidiarity at strategic and tactical level Nationally developed EM information system (LCMS) – a net-centric, web-based data system Multi-level partnership arrangements in every region, between regions (cross-region support), and scale-up from regional to national Development driven by shared concerns of front line organisations who wish to collaborate Sharing of resources – reduces costs, provides access to scarce requirements
Scottish Government (UK)	A sector and cross-sector multi-level partnership between UK Government, Scottish Government and local authorities with private sector in complete accordance with the UK National Security Strategy.	Critical Infrastructure Resilience in general and all the involved aspects.	<ul style="list-style-type: none"> <i>Preparing Scotland</i>, set out as a ‘hub and spokes’ model – the hub, including philosophy, principles, governance structures, regulatory and good practice guidance Support by the Government, providing Leadership, Enabling Partnerships and reviewing Outcomes Principles of Integrated EM – All hazard approach Government Protective Marking Scheme for exchange of information Operation Estrela – infrastructure resilience exercise programme to threat from insider attack
Lombardy Region (Italy)	Partnership between Lombardy Region Administration and 16 (initially 11) operators of energy and transport infrastructures.	Integrated Regional Programme dealing with CI modelling and risk analysis, resilience management and collaborative planning.	<ul style="list-style-type: none"> Systematic identification of information needs and missing information flows in EM Focus on interdependencies information with regard to service delivery at node level, not proprietary and sensitive business or asset data Collaborative web platform for cross-sector information sharing and collaborative EM Thematic Task Forces for collaborative discussions and bringing actors together
Montreal Metropolitan Community (Canada)	Initiated by owners and operators of seven Critical Infrastructure Systems in Montréal and public safety representatives of the city.	The Centre Risque & Performance (CRP) is dedicated to the study of interdependencies between CIs, integrating risk and resilience evaluation into the management mechanisms of industrial and governmental systems.	<ul style="list-style-type: none"> Establishment of ‘give-and-take’ relationship. Each stakeholder senses benefits right away Flexible cartography approach to preserve the confidentiality of information Ways for only temporary pooling of information and limiting number of recipients Keeping only the necessary actors at the table

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Case	Type of Programme	Main focus	Distinctive features
Louisiana (USA)	Joint partnership between Louisiana Economic Development (LED), the Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP), the National Incident Management Systems & Advanced Technologies (NIMSAT) Institute at the University of Louisiana at Lafayette and the Stephenson Disaster Management Institute (SDMI) at Louisiana State University.	The LA BEOC supports the coordination of activities and resources of businesses and volunteer organizations in Louisiana and across the nation as well as with the public sector to improve response, improve self-sufficiency, reduce reliance on FEMA and other federal assistance in order to maximize business, industry and economic stabilization, returning the business environment to normal operations as quickly as possible. The LA BEOC has been recognized by FEMA as a best practice.	<ul style="list-style-type: none"> • BEOC as a single contact point between the government and businesses • BEOC serves as filter for information between businesses and the state government • Establishing B2B communication without government's involvement • Reliable situational awareness information provided to businesses by the government
Pacific North-West Economic Region (USA, Canada)	Public/private non-profit created by statute by the states of Alaska, Idaho, Oregon, Montana and Washington, the Canadian provinces and territories of British Columbia, Alberta, Saskatchewan, Northwest Territories and the Yukon.	Improving the Pacific Northwest's ability to withstand and recover and to protect its critical infrastructures from all-hazards disasters. PNWER was listed as a best practice in the NGA's Governors Guide to Homeland Security (in March 2007) and also referenced in the National Infrastructure Protection Plan (NIPP) as the model for bringing the public and private sectors together to address CI protection issues (in July 2009).	<ul style="list-style-type: none"> • Blue Cascades Exercise Series as well as numerous table-top exercises and roundtables • Northwest Warning, Alert and Response Net (NWWARN) for cross-sector information sharing • Gatekeepers are the trusted sources of information within an infrastructure • Focus on interdependencies information, not proprietary and sensitive business data • Working with organisations' emergency managers only • Washington State Fusion Center (WSFC) – a unified counterterrorism, "all crimes," fusion center, incorporating agencies with intelligence, CI, public safety and preparedness, resiliency, response and recovery missions • CRDR working with states, provinces, territories, and communities to develop regional PPCs, develop action plans, and undertake pilot projects and activities to further this mission • Coordinates several regional 'sector councils' including cyber security, banking and finance, livestock health, energy, fusion center info sharing, etc. • Provides training, education and developing tools, technologies, and approaches that build on existing capabilities
Copenhagen Capital Region (Denmark)	A partnership between the Oresundsbro Konsortiet company and 9 Danish and 6 Swedish agencies, including police, fire, rescue, medical, alarm units and the traffic and rail control agencies.	Operation, safety and maintenance of the railway and the entire motorway of the Oresund Link between Denmark and Sweden.	<ul style="list-style-type: none"> • Comprehensive preparedness planning by DEMA, EM by Regional medical Service • Joint Danish-Swedish contingency plan for the Øresund fixed link, • COMputer Based Alarm System Øresundsbron (COMBAS Ø) • Education – eLearning courses for incident handling (some common for DK and SE) • Full Scale Exercises (every 4th year), table top exercises, small scale exercises, alerting exercises (weekly)



In support of the challenge of ensuring a “regional” imperative on CIP-R, especially when the CI in question has a significant National interest (e.g. major international airport, petro-chemical facility, hydro-electric, etc.), there is a realistic necessity to balance shared interests. The analysis carried out on existing good practices identified the use of careful regulatory approaches at National level designed to ensure initial focus and scope of a PPC, so as to fulfil the National responsibility while ensuring maximum freedom at regional level (e.g. Dutch ‘Security Regions Act’ from 2010). Such approaches require that regional PPCs also recognise and acknowledge National imperatives (collaboration with National stakeholders when appropriate). All of the 25 Safety Regions are organised under a common legal framework, with subsidiarity at strategic and tactical level. Thus, subsidiarity “in action” can ensure that regional knowledge and expertise can fully address CIP-R through PPC where the bottom-up approach is regionally focused yet responsive to, and connected with, relevant national concerns. A clear example is offered by existing local CIP-R programmes, since they are not meant to replicate (or replace) national CIP or Emergency Management plans at local level. Conversely, their goal is to better integrate CIP-R issues and engage CI operators in the Emergency Management set up, by ensuring those value added activities that demonstrate to be achievable and more effective when established at local level.

Existing successful experiences demonstrate that many local CIP-R Programmes rapidly evolved over the time, thanks to the virtuous cycle of:

- Gaining commitment of some key stakeholders on relevant disruption scenarios;
- Fixing achievable and win-win objectives in the short term;
- Communicating tangible results to all stakeholders to involve new members in the PPC;
- Revising and enhancing scope, goals and objectives of the CIP-R programme thanks to the new entries.

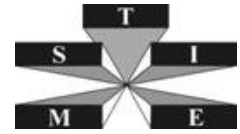
It takes time for partners to get to know each other and find a good way to work together. Over the lifetime of PPP stronger relationships and trust are built; knowledge about each other’s needs, capabilities and constraints grows; vulnerabilities get mitigated (structural/physical changes); more activities are put in place (such as training sessions, exercises and workshops); available resources expand; performance measurement systems are developed – PPC matures in general. The planning cycle – design and implementation process – does not exceed three-four years of duration in all the cases we investigated, and is conceived as a **continuous improvement process** (sometimes a formal PDCA cycle, as adopted in Kennemerland region).

A Regional CIP-Programme led by a local PPC is generally driven by a mix of different interests and needs: public authorities, responders, organisations, CI operators and owners, businesses etc. Normally, it also covers a mid-long term planning horizon. Hence, the prioritisation of different types of achievable results is a key issue. From ongoing experiences and the case studies it emerges that the strategy of pursuing **balanced benefits** – government vs business needs; short vs long term – is the most effective to assure long term sustainability of the programme and the achievement of tangible results. It is smart to give preference to win-win solutions, addressing both government and business interests, even when they seem less efficient; they pay out in the long term since they strongly contribute to strengthen the coalition, where all the stakeholders have the perception of a well balanced mix of giving and taking.

The term ‘**All-hazard approach**’ (FEMA, 1996) denotes a way of CIP-R development able to comprise all conditions, environmental or manmade, either accidental or intentional, that have the potential to cause injury, illness, death, or loss of assets, service delivery, or other intangibles; or alternatively causing functional social, economic, or environmental harm. Three closely related factors necessitate the development of a holistic, all-hazards approach to regional CIP-R: infrastructure vulnerabilities and interdependencies; information sharing processes and solutions; public-private collaboration.

Risk-informed decision-making (RIDM) is a structured process that uses a set of performance measures, together with other considerations, to “inform” decision-making. In tackling complex decision-making problems involving multiple, competing objectives, the cumulative knowledge provided by experienced personnel is essential for integrating technical and nontechnical elements to produce dependable decisions. In CIP-R, the adoption of a risk-informed approach helps to develop a more effective programme, since:

- A proactive mitigation of threats requires prioritisation of scenarios, and risk metrics are the most “fit for purpose”;



- The development of a CIP-R Programme requires consensus on priorities, and agreement among PPC member on the most appropriate mitigation strategies; evidence from the cases shows that the support of well-defined and grounded risk models and metrics – either qualitative or quantitative – is of help, particularly when multi-objectives and trade-offs are at stake.

5.3. CIP-R Programme Management model

A long lasting CIP-R Programme passes through different phases in its life cycle. Its evolution is strongly influenced by the origin and goal set at the beginning of the Regional CIP-R Programme life. Sometimes the goal may change due to changes in political priorities (e.g. security and protection issues vs safety and resilience issues) or dramatic evolutions in the most relevant threats a certain region is exposed to (e.g. due to Climate Change). Another evolutionary dimension is the increase in size of the PPC, thanks to new members, or of the geographical extension of the programme. Accordingly, the temporal evolution of the CIP-R programme, managed through its design-implementation cycles, can be driven, time by time, by different priorities or by a different mix of perspectives. Here we highlight two main development strategies, identified as the basic ones:

- **Emergency Management-driven development strategy** emphasises the operational integration of the CIP-R Programme with the management of real events. It is preferable when the PPC is led by public authorities, with security roles, or by responders; in these cases the goal of the CIP-Programme is generally more focused on EM improvement (e.g. Kennemerland Safety Region, LABEOC, PNWER);
- **Resilience-driven development strategy** emphasises the supportive role of the PPP and its Regional CIP-R Programme. The programme is developed to build protection and resilience capabilities into the regional system, that are exploited by different organisations (e.g. EM, Civil Protection agencies, or Police forces) through decision making and operational processes that are largely out of the scope of the programme (e.g. Lombardy Region, Scotland). This is typical when the PPC is led by private stakeholders (Montreal Metropolitan Community).

5.4. Good Practices for CIP-R Programme implementation

Good practices (GPs) are generally any collection of specific methods that when applied solve an existing problem, produce expected results and bring benefits. Within the context of CIP-R, the concept applies to available knowledge to addressing: i) the establishment and management of regional PPCs for Critical Infrastructure Protection and Resilience; ii) the implementation of a CIP-R programme in an efficient and effective way, thus assuring the achievement of its main goals and objectives. Every CIP-R Programme comprises the adoption of a set of practices that can be classified into:

- **Tools and Technologies** include sets of means, instruments (equipment), methods and techniques with a specific purpose of supporting achievement of goals;
- **Processes and Activities** are collections of related and structured actions, tasks, arrangements and procedures that produce a specific result and serve to a particular goal.

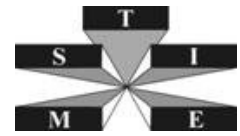
As summarised in Table 4, several practices were reported from cases, some of them are similar across the cases, and some other are real unique.

5.5. Towards a framework for the development of Regional CIP-R Programmes

The main findings from the seven international case studies, as discussed in the previous sections, can be systematically grouped to form a reference framework (Figure 1) for the development of Regional CIP-R Programme. The programme management model and development strategy are at the core of the proposed framework, supported by an appropriate set of practices. The guiding principles and context factors all together influence the objectives and contents of the programme, and shape its structure.

6. CONCLUSIONS

Regional initiatives have emerged worldwide as one of the key strategies to deal with CIP-R issues in the context of Emergency Management (EM) and Community Resilience policies. Recent research has set the theoretical base of PPCs and claimed their high potential for enhancing CIP-R that is vastly unexploited due to challenges in their establishment and management, so they sometimes fail to perform and bring benefits as expected. This study tried to move forward to addressing the practical side of these regional programmes.



Through studying seven worldwide cases (considered as best practices), this work compares and analyses different PPC approaches. The study sheds light on how engagement of all stakeholders is achieved to improve CIP-R and how the main challenges are faced. Findings specifically focus on the four core elements constituting a regional programme: context factors, guiding principles, management model, and practices. They are eventually suggested as the constituents of a framework for the development of successful Regional CIP-R Programmes. Beside the local and internal challenges that current regional CIP-R programmes have to cope with, their growing success and recognised contribution to the overall national and continental strategies for CIP-R is paradoxically bringing in a new more systemic challenge: how to establish and achieve the alignment between multiple policies, strategies and initiatives at different geographical and institutional levels? This question may also represent a call for future research.

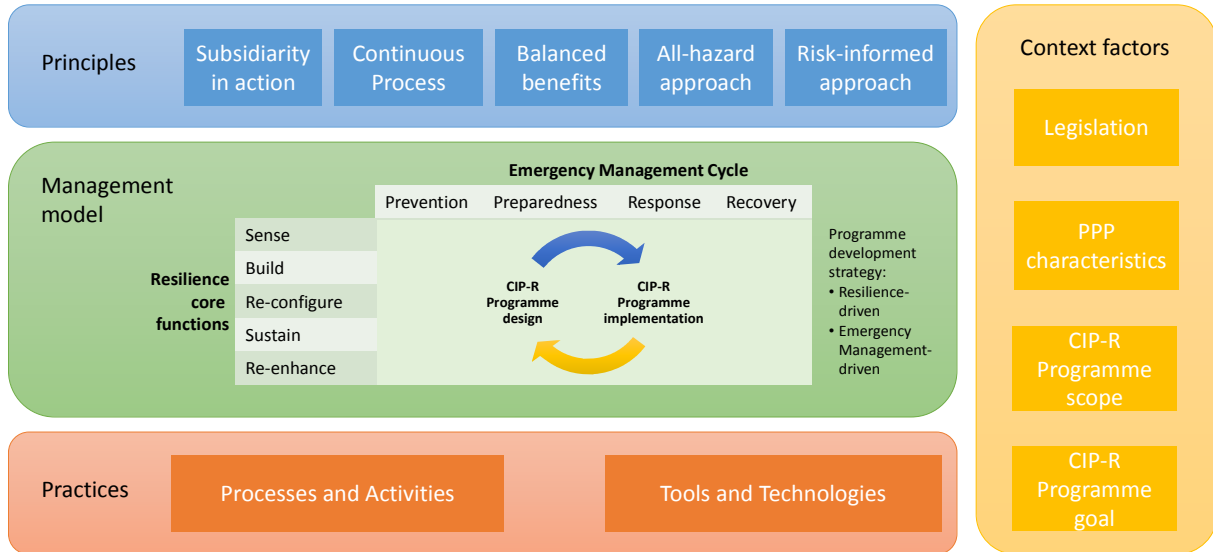
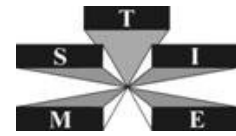


Figure 1: A Framework for the development of Regional CIP-R Programmes

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