RESILIENCE AND CRITICAL INFRASTRUCTURE

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Abstract

Critical infrastructure resilience is about sustainment continuity of delivering essential sorts the services, energy, goods etc. regardless of disruptive events that may occur. In this context infrastructure resilience it is possible to see as the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event. Protection and resilience critical infrastructure are not opposing concepts; they represent complementary and necessary elements of a risk management. The foundation developed for critical infrastructure protection continues to be an essential part of risk management in all critical infrastructure sectors.

Key words
Resilience, critical infrastructure, infrastructure protection, efficiency.

1 RESILIENCE – SCOPE AND DEFINITION

Modern societies are widely considered to harbour an increased propensity for breakdowns of their critical infrastructure systems. While such breakdowns have proven rather rare, Hurricane Katrina has demonstrated the catastrophic consequences of such breakdowns. Present-day society relies on the effective functioning of CI networks to provide public services, enhance quality of life, sustain private profits and spur economic growth. This growing dependence is accompanied by an increased sense of vulnerability to new and future threats.

Resilience has become an important dimension of the critical infrastructure protection. Infrastructure resilience is about "delivering the goods" regardless of disruptive events that may occur. Although each critical infrastructure sector operates differently, a common definition of infrastructure resilience is needed namely for public policies and governance to be effective.

The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event.

The protection and resilience are not opposing concepts; they represent complementary and necessary elements of a comprehensive risk management strategy.

Definition

Infrastructure protection is the ability to prevent or reduce the effect of an adverse event. Infrastructure resilience is the ability to reduce the magnitude, impact, or duration of a disruption.

Resilience is the ability to absorb, adapt to, and/or rapidly recover from a potentially disruptive event. [4]

Another view of resilience

- The term "resilience" means the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents. [7]

- Resilience is the ability of a system to withstand threats and continue to function, and is related to durability and performance to expected standards over time.
- Resilience is also the capability of the system and/or material to continue to function – i.e. perform to expected standards – in the face of such threats and is best explained in terms of the notion of durability. So, resilience is 'durability plus', or the ability to cope with environmental, economic and political changes; or, to weather all kinds of storms.
- Resilient Infrastructure is those systems of physical assets that will be able to survive and perform well in an increasingly uncertain future. This necessitates existing physical assets and new assets becoming more adaptable; and, being created, designed, built, operated, and / or, disposed of in the light of current as well as 'new and emergent futures'. [6]

Critical infrastructure resilience is characterized by three key features:

- Robustness: the ability to maintain critical operations and functions in the face of crisis. This can be reflected in physical building and infrastructure design (office buildings, power generation and distribution structures, bridges, dams, levees), or in system redundancy and substitution (transportation, power grid, communications networks).
- Resourcefulness: the ability to skillfully prepare for, respond to and manage a crisis or disruption as it unfolds. This includes identifying courses of action, business continuity planning, training, supply chain management, prioritizing actions to control and mitigate damage, and effectively communicating decisions.
- Rapid recovery: the ability to return to and/or reconstitute normal operations as quickly and efficiently as possible after a disruption. Components include carefully drafted contingency plans, competent emergency operations, and the means to get the right people and resources to the right place. [5]

What do we really mean when we talk about resilience? What actions can the homeland security enterprise take to promote greater resilience?

The strategic goals of resilience:

1. Enhanced preparedness,
2. Effective emergency response,
3. Rapid recovery,
4. Hazard mitigation.

These four goals encompass the actions that will be necessary to manage the consequences of any incident and to quickly restore operations. [2]

2 THE FRAMEWORK OF RESILIENCE

With the publication of the Department of Homeland Security (DHS) Quadrennial Homeland Security Review Report: A Strategic Framework for a Secure Homeland (QHSR) in February 2010, the Administration established a new strategic framework for DHS. This framework established **resilience as one of three core concepts in a comprehensive approach to homeland security:**

1. Security: Protect the United States and its people, vital interests, and way of life
2. Resilience: Foster individual, community, and system robustness, adaptability, and capacity for rapid recovery
3. Customs and Exchange: Expedite and enforce lawful trade, travel, and immigration

The concept of resilience encompasses mitigating risk to communities, enhancing recovery capabilities, and ensuring continuity of essential services and functions. [4]

There were established two core resilience objectives:

- An objective of ensuring broad-based resilience: Improve capabilities of families, communities, private sector organizations, and all levels of government to sustain essential services and functions.
- An objective of ensuring infrastructure resilience: Enhance the ability of critical infrastructure systems, networks, and functions to withstand and rapidly recover from damage and disruption and adapt to changing conditions.

Community resilience is connected with the capability to return citizens to work, reopen businesses, and restore the basic services and economic stability of a community or a linked group of affected communities. [4]

Definition of resilience mentioned above, that resilience is the ability to absorb, adapt to, and/or rapidly recover from a potentially disruptive event figure 1 summarizes the distinguishing characteristics of the capacities.

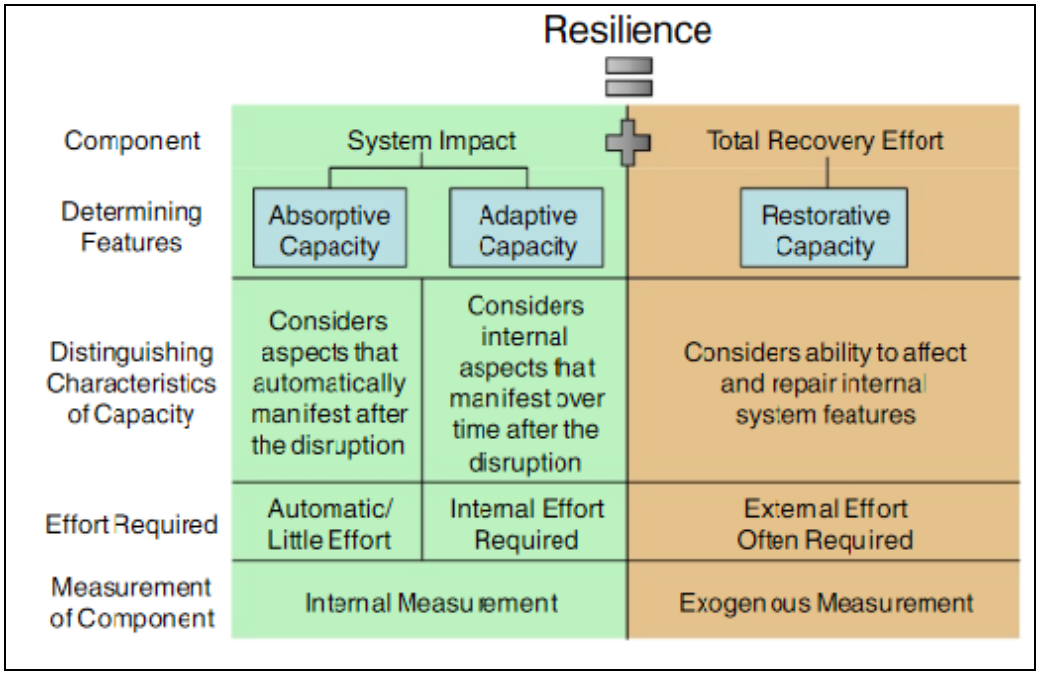


Fig. 1
Resilience capacities of a system [1]

Absorptive Capacity

Absorptive capacity is the degree to which a system can automatically absorb the impacts of system perturbations and minimize consequences with little effort. The absorptive capacity is an endogenous feature of the system.

For example, storage can enhance the absorptive capacity; if a chemical plant is disabled but a large amount of collocated storage of its product is undamaged, customers can continue to be supplied by the stored quantities, with little cost to the producer or customer,

while the plant is repaired. Examples of resilience enhancement features that can increase absorptive capacity include:

- System robustness, which decreases systemic impact through the strength of individual connections in the system.
- System redundancy, which decreases systemic impact through providing alternate pathways for the system mechanics to operate.

Adaptive Capacity

Adaptive capacity is the degree to which the system is capable of self-organization for recovery of system performance levels.

It is a set of properties that reflect actions that result from ingenuity or extra effort over time, often in response to a crisis situation. It reflects a dynamic ability of the system to change endogenously throughout the recovery period.

Restorative Capacity

Restorative capacity is the ability of a system to be repaired easily. Typically, these repairs are dynamic and performed by entities exogenous to the system. In the context of infrastructure policies, the government is often considered to be the exogenous, repairing entity. These repairs usually restore the system to near its original, pre-event state, but can also restore the system to a completely new state or regime that anticipates future system requirements. Restorative capacity primarily affects the total recovery effort, although repairs to the system enabled by the system's restorative capacity may also increase the system performance, reducing systemic impact. Whereas adaptive capacity reflects the ability of a system to be changed endogenously, restorative capacity reflects the ability to be repaired exogenously. [1]

3 RESILIENCE AND EFFICIENCY

If we deal with of resilience it is necessary to mention about problem of efficiency for example in the context of dependence on suppliers resp. supply chain.

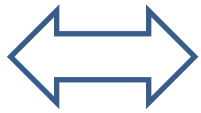
E.g. security of oil supply shall be measured by assessing the additional value of the new capacity offered by a project for the short and long-term resilience of the system and the remaining flexibility of the system to cope with supply disruptions under various scenarios. [3]

There is also a trade-off between supply chains that are simple and compact and those that are complex, redundant and dispersed. A handful of suppliers can provide deep discounts, excellent service and develop such a strong knowledge of processes that they become almost an extension of the company they sell to. However, the fewer and more concentrated the suppliers, the more likely the supply chain is to be shut down by an unforeseen event. Expanding the number of suppliers may strengthen the supply chain, but it also makes it harder to manage logistics and pricing.

The traditional tradeoff – simple and compact vs. complex and dispersed is summarizes by figure 2.

This balance between efficiency and resilience is the key tradeoff faced by supply chain managers. But it's not always a tradeoff; it may be possible to increase both. For instance, Whirlpool was able to boost both efficiency and resilience by consolidating its brands and increasing the use of standardized components.

Simple/compact
More vulnerable to disruption
Less overhead
Fewer transaction costs
More economies-of-scale potential
Harder to customize



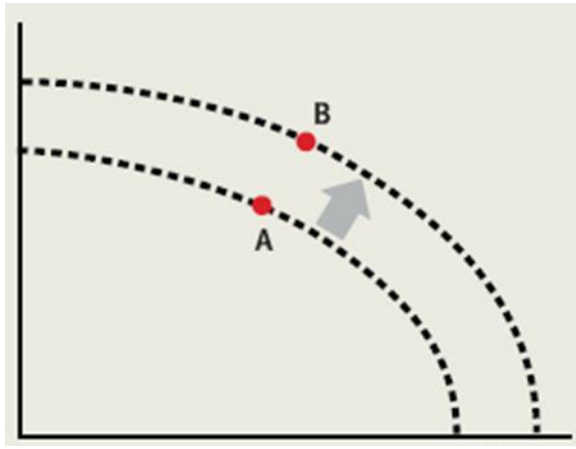
Complex/dispersed
Less vulnerable to disruption
More overhead
More transaction costs
Less economies-of-scale potential
Easier to customize

Fig. 2
Simple and compact vs. complex and dispersed [6]

Whirlpool is also simplifying supply chains by using standardized components in more products. That could mean using the same electronic component or the same screw in a washer and clothes dryer. In the previous time, 20 washers could have 20 different controls. Now Whirlpool have only four different controls for 20 models.

Increasing efficiency and resilience

Efficiency



Resilience

Graph 1
Increasing efficiency and resilience [6]

Commentary on the graph:

- The single-minded pursuit of efficiency leads to brittle supply chains.
- On the other hand, the high levels of redundancy of the most resilient supply chains make them less efficient.
- The ideal strategy moves the curve outwards, boosting both efficiency and resilience at each point on the curve (for instance, from Point A to Point B).

Reassess supply chain processes to ensure that progress towards efficiency does not boost the potential for failure in the face of economic, operational or environmental disruptions. And taking this dictum a step further, companies should attempt to control risks better and plan for various scenarios, given the unpredictable nature of the recovery.

Résumé

Resilience has become an important dimension of the critical infrastructure protection. The paper discussed the topic framework of resilience. There were established two core resilience objectives: an objective of ensuring broad-based resilience and an objective of ensuring infrastructure resilience. Resilience is the ability to absorb, adapt to, and/or rapidly recover from a potentially disruptive event. If we deal with of resilience it is necessary to go into the matter of efficiency critical infrastructure resilience.

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