



Long term investments in critical infrastructure under environmental turbulence; Dilemmas of infrastructure responsiveness

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ABSTRACT

Organizations operate in a turbulent environment which implies that the potential of long-term strategies is highly uncertain. Especially critical infrastructure providers face this issue as they typically invest with a time horizon of 50 years or more. Therefore, these organizations want to be *responsive*: they have the desire to take future developments into account when making strategic decisions, in order to avoid disinvestments. Literature on responsiveness is scattered and there are various related concepts including ambidexterity, organizational resilience, and stakeholder theory. This study builds on these bodies of knowledge to analyze the responsiveness strategies of six Dutch critical infrastructure providers. Confronting the responsiveness strategies as practiced with the literature results in nine dilemmas of responsiveness. Together these dilemmas show where, from the point of view of these organizations, future research may help taking long term trends into account more effectively.

1. Introduction

Many organizations find themselves navigating a turbulent environment [1,2]. On the one hand, technologies are developing, opening up new possibilities for creating value. On the other hand, societal norms are developing, changing the expectations that organizations have to meet [3,4]. Trends in technologies and expectations are especially relevant for critical infrastructure providers, as these organizations typically make investments with a time horizon of 50 or more years, for example when investing in roads, railway tracks, electricity grids, canals, and ports [5]. Because of these long-term investments, these organizations strive for *responsiveness*: they try to take future developments into account when making strategic decisions, in order to avoid disinvestments.

The literature on responsiveness is scattered, and there exists a myriad of related constructs including adaptiveness [6], agility [7], learning [8], absorptive capacity [9], and flexibility [10]. The literature often takes a prescriptive perspective, suggesting what directions strategies should take for organizations to become more responsive. Studies that observe responsiveness strategies as practiced by organizations are scarce [11,12]. This study aims to bring responsiveness as practiced and prescriptive theory closer together by taking the responsiveness strategies of critical infrastructure providers as a starting point and analyzing them from the perspective of existing theory. Studying how responsiveness as practiced relates to the literature is relevant, as the results of such a comparison serve to develop a research agenda with questions that are relevant from a practical perspective. The resulting research agenda indicates avenues for closing the gap between strategy formula-

tion based on theory and implementation in practice [13]. Because of the friction between the turbulence of the environment they operate in, and the long term of their investments, critical infrastructure providers form a good setting for studying responsiveness as practiced.

Concordantly, the aim of this study is to contribute to literature on responsiveness, by contrasting responsive strategies of six critical infrastructure providers with existing literature. The accompanying research question is: which trends do critical infrastructure providers foresee and which strategies do they propose to accommodate those trends? The remainder of this article is built up as follows. The background section reviews earlier studies on responsiveness and connects responsiveness literature to related streams of literature. The method section describes the design of this study, namely a case study of six Dutch critical infrastructure providers. The results section compares the six organizations, and the discussion connects the results with the different strands of literature as touched upon in the background in the form of responsiveness dilemmas. These dilemmas serve as a research agenda, indicating avenues for research that will help organizations advance towards more effective responsiveness.

2. Background

Strategic decision making is concerned with setting out a course for the long term and is crucial for organizational survival [14]. Traditionally, literature on strategic decision making focused on the organization itself, including its core competencies [15]. More recently, strategic decision making has shifted focus towards the environment an orga-

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Table 1
Key characteristics critical infrastructure providers (figures from 2016).

	Infrastructure	Form	Employees	Revenue
Alliander [26]	Energy	Joint-stock company	5621 FTE	€1600 million
Port of Rotterdam [27]	Port	Joint-stock company	1130 employees	€675 million
ProRail [28]	Railways	Concessionaire	3959 FTE	€1254 million
Rijkswaterstaat [29]	Highways and waterways	Agency	About 8700 employees	€4296 million
Schiphol [30]	Airport	Joint-stock company	2063 FTE	€1435 million
Vitens [31]	Drinking water	Joint-stock company	1399 employees	€384 million

nization operates in, and the capability of the organization to adapt to changes in that environment [7,10]. However, different streams of strategy literature have very different ideas on what it takes to succeed in anticipating future trends. Some focus on technological change and an organization's ability to innovate [6], while others focus on changing expectations from stakeholders and an organization's ability to maintain legitimacy [16]. Below, the relevance of three related streams of literature are discussed in the light of responsiveness: ambidexterity, stakeholder engagement, and organizational resilience. These three bodies of knowledge were selected because of their relatedness to the concept of responsiveness, and because they together provide a broad basis from which practices of responsiveness can be analyzed. Although other streams of literature can also be linked to responsiveness, this study was purposely restricted to these three because the increased comprehensiveness of including more literature would come at the cost of comprehensibility.

2.1. Ambidexterity

An organization is said to be ambidextrous if it is both able to make incremental changes as well as radical changes [17]. Organizations try to improve what they already do by becoming ever more efficient. However, these incremental improvements assume that the environment in which the organization operates remains relatively stable. Indeed, focusing too much on incremental improvements has been associated with being unable to timely adapt to changes in the environment, with Kodak as a classic example of an organization that was overwhelmed by environmental turbulence [18]. Ideally, being responsive would not come at the costs of incremental improvements. In the literature on ambidexterity this is referred to as being able to combine exploitation and exploration: "to compete in mature technologies and markets where efficiency, control, and incremental improvement are prized *and* to also compete in new technologies and markets where flexibility, autonomy, and experimentation are needed" [19]. This is especially challenging for critical infrastructure providers, as these organizations are traditionally focused on reliability, which is close to exploitation, with exploration being a potential threat to reliability.

2.2. Stakeholder engagement

Stakeholder theory is about simultaneously creating value for multiple stakeholders [20]. Creating value for stakeholders assumes that an organization is able to assess what stakeholders find valuable. Stakeholder engagement encompasses the activities that organizations employ to increase stakeholder involvement [21,22]. As such, it helps meeting "the need to identify and address the concerns of their stakeholders to ensure their decisions and business activities are more socially acceptable" [23]. This is closely related to Jacobs' definition of responsiveness: "an organization's ability to listen, understand and respond to demands put to it by its stakeholders" [16]. This too is especially challenging for critical infrastructure providers because of the focus on reliability, as changing stakeholder expectations can be seen as a threat to reliability.

2.3. Organizational resilience

There is a vast literature on resilience, covering domains as psychology, ecology, and strategy [12,24]. A large share of this literature is interested in the ability to cope with events rather than trends, sometimes focusing on the operational or tactical level rather than the strategic level, but the notion of *organizational* resilience also covers strategies to anticipate long term trends, including climate change, terrorism, and economic downturns [25].

3. Method

3.1. Case description

Critical infrastructure providers typically make long-term investments with a time horizon of 50 or more years. The challenge of taking future developments into account in today's investments is particularly prominent at these organizations. Therefore, this study focuses on the responsiveness of critical infrastructure providers. In the Netherlands, a number of critical infrastructure providers joint forces in a knowledge consortium called 'Next Generation Infrastructures', which funded this research project. Although the consortium funded the research, the researchers were completely autonomous in conducting their research and reporting their findings. Table 1 below shows the key characteristics of these organizations.

3.2. Case study method

The study was conducted as a case study [32], based on the six cases of the Dutch critical infrastructure providers mentioned in Table 1. As mentioned in the introduction, the research question was: which trends do critical infrastructure providers foresee and which strategies do they propose to accommodate those trends? Documents provided by the organizations were used to answer these questions [33]. The organizations provided both publicly available and confidential documents. The three streams of literature that relate to responsiveness (ambidexterity, stakeholder theory, and organizational resilience) were used as coding themes when carrying out the document analysis, to support a structured analysis of the data. Iterating between theory and data [34], the analysis specifically focused on seeming contradictions between the two. This resulted in nine dilemmas of responsiveness, discussed as a separate section below. Regular meetings were held with representatives of the organizations and researchers to safeguard both scientific and practical relevance. Two workshops were organized to discuss the results. The research project was preceded by eight bachelor theses on the same topic, which were presented at a conference with participants from the critical infrastructure providers. See for a summary of the data used in this research project Table 2 below.

4. Results

This section presents for each critical infrastructure provider the main trends they foresee as well as the strategies they propose to accommodate those trends.

Table 2
Data sources.

Source	Description	Goal
Theses	Eight bachelor theses, each investigating one critical infrastructure provider	Exploring the topic of responsiveness
Conference	One conference in which authors of the bachelor theses presented their results	Discussing the topic of responsiveness with practitioners
Documents	Alliander: 2016 Annual report [26], 2017 Annual plan [35] Port of Rotterdam: 2016 Annual report [27] ProRail: 2016 Annual report [28], 2017 Control plan [36], Long Term Railway Agenda [37] Rijkswaterstaat: 2016 Annual report [38], confidential: Kerndocument Netwerkbeheervisie Rijkswaterstaat [29] Schiphol: 2016 annual report [30] Vitens: 2016 Annual report [31]	The documents provided data to answer the questions which trends critical infrastructure providers foresee, and which strategies they present to take these trends into account
Meetings	Eight meetings between 21 February 2017 and 17 April 2018 with representatives from the six critical infrastructure providers, the Next Generation Infrastructures knowledge consortium, and the author (on average 10 participants)	Discussing progress of the research, making sure that the research continues to be both scientifically and practically relevant
Workshops	A workshop on 20 March 2018 and a workshop on 28 June 2018, both with participants (21 and 11 respectively) from critical infrastructure providers, the Next Generation Infrastructures knowledge consortium, and researchers	Discussing results of the research, identifying knowledge gaps for future research

4.1. Distribution system operator Alliander

As a distribution system operator, Alliander is responsible for distributing natural gas and electricity to over three million customers. In its 2016 annual report it mentions three main trends that will impact the energy system, all three related to the Paris climate agreement on reducing CO₂ emissions that acts as a catalyst [26]:

- More local generation. The shift from fossil to renewable electricity generation results in proliferation of solar panels and windmills on the countryside.
- Electrification. Despite increasing energy efficiency, demand for electricity will rise as fossil technologies are replaced, for example through the diffusion of electric vehicles and heat pumps. Natural gas in the built environment will be phased out, leading to a significant decline in the use of natural gas in the coming decades.
- Digitization. Advancements in information technology are a high-impact driver of change in the energy system, enabling increased efficiency in existing services as well as the development of new services.

Alliander states that its stakeholders expect it to make a substantial contribution to the reduction of CO₂ emissions, end mentions four main strategies to meet this expectation [26]:

- Helping customers to make decisions that are optimal from the perspective of the energy system as a whole, for example through variable energy pricing and facilitating automated decision-making processes.
- Creating alternative networks (e.g. heat, biogas, direct current) with equal access for energy producers and consumers.
- Digitization to quickly resolve disruptions, to make smarter investments, and to allow customers to make sensible decisions. As such, advancements in information technology can be used to avoid costly network upgrades.
- Excellent network management, through a focus on efficiency and economies of scale.

4.2. Port of Rotterdam

With a cargo throughput of 461.2 million tones, the Port of Rotterdam is Europe's largest port. In its 2016 annual report it mentions two main trends that will impact the port [27]:

- Energy transition. The Paris climate agreement greatly impacts Port of Rotterdam, as is heavily depends on fossil resources, both in the industry and in logistics. The transition means that existing activities

need to become more sustainable, and that new activities will need to be build.

- Digitization. An increasing number of logistic organizations want to use new opportunities provided by advancements in information technology, by increasing the exchange of data and information between parties in the total chain. In addition, digitization impacts the labor market.

Port of Rotterdam mentions several strategies to accommodate energy transition and digitization [27]. The energy transition impacts the goals of Port of Rotterdam to be competitive in mature markets, to be a leader in developing new markets, and to be leading in sustainability of chains and clusters. The Port of Rotterdam wants to develop and apply new technologies for reducing CO₂ emissions, including carbon capture and storage, and utilizing residual heat, e.g. for district heating. The Port invests in attracting new activities, including offshore wind industry, biobased chemistry, and circular economy. Digitization mainly impacts the goals of Port of Rotterdam to be leader in growing markets and to be the most efficient and safe in handling in all modalities. New developments in information technologies provide opportunities for increasing efficiency and reducing costs. Port of Rotterdam invests in making data and information available and developing new applications of information technology, through investing in obtaining data and cooperating in pilot projects.

4.3. Railway track operator ProRail

As concessionaire, ProRail is responsible for managing, maintaining, and developing the Dutch railway infrastructure. ProRail does not present an explicit analysis of environmental trends in its annual report. Nevertheless, three main trends can be observed throughout the report. These trends can be linked to the provider of the concession, in that time the Ministry of Infrastructure and Environment, which provided an overview of long term trends in its 'Long Term Railway Agenda' [37]. This agenda formed the foundation for the concession that ProRail is carrying out.

- Increasing demand for passenger and freight transportation [28]. This trend is amongst others the result of increasing population size and increasing demand for mobility through urbanization, increasing participation in the labor market, and increasing ease of intermodal transportation [37].
- Digitization [28]. Developments in information technology will result in an increased availability of data, and new opportunities for connecting with travelers [37].
- Increasing focus on sustainability [28,37]. Clients are putting increasing value on sustainability.

- ProRail mentions several investments in IT and sustainability that can be related to these key trends.
- Through amongst others proactive maintenance, ProRail uses advancements in information technology to increase capacity of existing infrastructure [28,36]. Over a couple of years, a total of 70–80 million euros is invested in about 100 IT projects. Of these projects, about 60% aims at improving existing systems, 40% at developing new systems. ProRail increasingly shares data with other organizations.
- Strategies to reduce CO₂ emissions include exploring the potential of changing the current on overhead lines from 1.5 to 3 kV and cooperating with partners to reduce the CO₂ footprint of concrete [36]. The relatively low CO₂ emissions of train transportation allow ProRail to compete with other modalities.

4.4. Highway and waterway operator Rijkswaterstaat

Rijkswaterstaat is an 'agency': an autonomous part of the Dutch Ministry of Infrastructure and Water Management. It is responsible for the design, construction, management, and maintenance of the Dutch main road network, the main waterway network, and watersystems. Rijkswaterstaat analyses major trends and the implications for the organization in a confidential vision document written for its employees, which they granted access to for the sake of this research project [29]. In that document, three categories of key trends are discussed:

- Changes in tasks and budget. The scope of the responsibilities is broadening and increasingly focusing on health and sustainability. Budgets are getting smaller and are shifted from central to local governmental bodies, a trend which is called decentralization.
- Technological developments. There are many advancements expected in information technology including smart mobility, Internet of Things, robotizing, sensor technology, and big data.
- New forms of collaboration. The traditional mode of the government as a bidder is shifting towards more horizontal modes of collaborating.

Rijkswaterstaat mentions several strategies to accommodate these key trends [29].

- Flexibility. To accommodate changes in societal norms, infrastructure continuously needs to be adapted.
- Focus on quality of the environment. Problems should not be shifted on to later or elsewhere.
- Information provision. The exchange of information with the environment will intensify, through amongst others big data and social media.
- Area-oriented working in alliances. The developments require Rijkswaterstaat to develop integral solutions for areas, in co-creation with partners.
- Adaptivity. The pace and uncertainty of developments ask for infrastructure that can change over time, instead of trying to make a blueprint of the future with today's knowledge.

4.5. Airport operator Schiphol

Schiphol group owns and runs airports, of which Amsterdam Airport Schiphol is the largest. Its 2016 annual report discusses major trends in its environment [30], which can be summarized as follows:

- Increasing demand. The number of passengers will continue to increase, due to several trends including globalization, increasing tourism, and cheaper tickets.
- Restrictions on growth. Many European airports are approaching the limits of their physical capacity.
- Focus on sustainability. International agreements to reduce CO₂ emissions will mainly impact airlines, but airports will also have to contribute.

- Brexit. The UK represents almost 15% of Amsterdam Airport Schiphol passengers.
- Digitization. Advancements in infrastructure technology allow for new services, and impact shopping. Car sharing and self-driving cars impact choices on travel modes and demand for parking.

Schiphol mentions several strategies to cope with these trends [30]:

- Expanding capacity. A new pier and a new terminal are developed at Amsterdam Airport Schiphol. Developing its smaller airports (Lelystad and Eindhoven) to free up capacity at Amsterdam Airport Schiphol. Schiphol aims to negotiate new capacity agreements with stakeholders.
- Building on digitization by developing new services through collaborating with business partners, including mobility, retail, media, catering. Automatization, for example by using biometrics, allows for faster terminal processes.

4.6. Drinking water operator Vitens

Vitens provides tap water to about 5.7 million customers. In its 2016 annual report it mentions several trends that can be summarized as follows [31]:

- Customer expectations are rising in terms of customer centricity, integrity, transparency, and sustainability, amongst others because of developments in digitization and circular business management. High-quality drinking water and reliability are regarded as self-evident by customers.
- The quality of drinking water resources is affected by external factors. The soil is increasingly used for different purposes, including energy supply, potentially impacting drinking water resources.

Several strategies are mentioned to accommodate these trends [31]:

- Proactively engaging customers, ensuring high visibility in the media and the political debate, increasing appeal through campaigns. Minimizing negative impact of extraction through recycling.
- Protecting resources through assessments, investing in maintenance, replacement, and security, and using the right water treatment and research methods.

5. Nine dilemmas of responsiveness

Organizations strive for *responsiveness*: they try to take future developments into account when making strategic decisions, in order to avoid disinvestments. However, in developing responsive strategies, organizations see themselves faced with discrete choices on which direction to take, in the form of dilemmas [39]. These dilemmas point out where more research would help to advance knowledge. A dilemma is a signal that we currently lack the understanding that is necessary to effectively take control. Therefore, below, I present the dilemmas that can be observed in the six organization's strategies as a way of formulating a research agenda. The dilemmas are organized by the three streams of literature that each relate to the notion of responsiveness in its own way: ambidexterity, stakeholder theory, and organizational resilience.

5.1. Responsiveness from the perspective of ambidexterity

Dilemma 1: Developing new business models cannibalizes on existing business models.

Critical infrastructure providers aim to accommodate future trends through investing in new business models. A central dilemma of ambidexterity is that new business can come at the cost of existing business. Alliander mentions that one of its subsidiaries works on products and services that have a disruptive potential for its current products and

services [26,35]. For example, district heating is an alternative to heating through natural gas, which is a main source of revenue for Alliander. District heating has the potential of making natural gas infrastructure obsolete. Schiphol describes a similar situation: it wants to facilitate driverless cars, although this potentially disrupts its current business models which relies heavily on revenues from parking tickets [30]. Driverless cars would be able to drive themselves to a parking space at a different location after dropping off the passengers travelling through Schiphol airport. Vitens stress the potential conflicts between new subsurface activities as geothermal energy production and drinking water production [31].

The organizations also mention cannibalization between new business models. Alliander invests in both biogas and district heating, two technologies that could be used for the same purpose [26]. Port of Rotterdam invests in CO₂ capture and sequestration [27]. These investments however have the potential of increasing the competition between fossil products and services and the emerging markets in which the Port also invests.

This dilemma brings up questions as “how to deal with the cannibalization of old business models?” and “how to deal with competition between new business models?”

Dilemma 2: Developing new business models builds on collaborations with incumbents.

New business models require new business ecosystems: collaborations between various organizations that each plays its own role in maturing new business. Therefore, developing new business models alludes to investing in inter-organizational collaborations. The critical infrastructure providers engage in such collaborations, for example through the cityZen smart city project by Alliander and through co-financing new business by Port of Rotterdam [27]. However, a typical characteristic of new business models is that there is an important role for new organizations that have yet to become visible. This leads to a bias in collaborations towards incumbent organizations. This dilemma brings up questions as “how can organizations collaborate with those organizations that are going to drive new business models?”

Dilemma 3: Innovation requires different competences compared to existing business.

Developing new business models asks for different competences compared to current operations [27]. This brings up questions as “how can organizations organize innovation?” Alliander chooses to develop new business models in-house, through subsidiaries. Port of Rotterdam however has a very different strategy, of collaborating intensively with start-ups, through its start-up accelerator PortXL [27].

5.2. Responsiveness from the perspective of stakeholder theory

Dilemma 4: Engaging in an open dialogue with stakeholders requires letting go of control

A recurring theme in the documents of the organizations is that responsiveness requires an open dialogue with the organization's stakeholders. The critical infrastructure providers realize that such a dialogue could lead to insights that the organizations could not have arrived at on its own, and that setting out a strategic direction *without* engaging in a dialogue with stakeholders would result in resistance during the implementation of that direction. A pitfall is that such a dialogue does more harm than good, if stakeholders get the impression that the dialogue has a mere symbolic function, that there is no potential for stakeholders to actually influence the organization's strategic direction. Such an impression could for example arise from the statement in Schiphol's annual report, where it mentions having the intention to engage in an open dialogue with stakeholders, while also mentioning that the outcome of that discussion is already fixed (“[Our priority is to] create support for the envisaged growth among public authorities and at the political level” [30]). This dilemma brings up questions as “how can organizations prevent stakeholder engagement from being experienced by stakeholders as a symbolic process?”

Dilemma 5: Responsiveness requires being driven by the market and driving the market

Engaging stakeholders in a dialogue is seen by the critical infrastructure providers as a means of increasing responsiveness (e.g. [31]). The reasoning is that such a dialogue allows stakeholders to inform organizations about developments in the value they attach to different aspects of the organization's products and services. As an example: ProRail engages in a dialogue on the ‘railway station of the future’ to elicit such developments in demands [36]. However, stakeholders are not able to forecast their own requirements, as they have less knowledge on the potential possibilities of future products and services. This brings up questions as “is it better to drive the market or to be driven by the market?”

Dilemma 6: Creating value for stakeholders is not always experienced as such

Critical infrastructure providers create value by meeting the needs of stakeholders. However, there is no clear one on one relation between the activities of critical infrastructure providers and the extent to which stakeholders perceive their needs as being met. For example, ProRail has to deal with a non-linear relation between objective and subjective punctuality [37]. If the punctuality is low in absolute terms, a slight increase in punctuality results in a considerable increase in passenger satisfaction. However, if punctuality is already high in absolute terms, the same slight increase in punctuality will hardly change passenger satisfaction. For Schiphol, this leads to questions as: is it better to invest in reducing waiting time at the airport, or in making the waiting time more comfortable [30]? This dilemma brings up questions as “how can organizations make sure that creating value is perceived as such?”, and “how can organizations make sure that long-term investments are in line with changing demands of stakeholders?”

5.3. Responsiveness from the perspective of organizational resilience

Dilemma 7: Increasing flexibility comes at the cost of robustness

One of the ways in which an organization can avoid having to adapt in the future is by increasing flexibility: the capability of adjusting to future developments as they occur. However, increasing flexibility comes at the cost of robustness. An example is the and-and strategy by Port of Rotterdam, consisting of both investing in the fossil industry as well as emerging markets (recycling, hydrogen, additive manufacturing) and new infrastructures (waste heat, LNG, CCS) for products and services that might reach maturity in the future [27]. By investing in different coexisting infrastructures, the Port of Rotterdam increases flexibility. However, given a limited budget for investments, this will lead to infrastructures that are less robust compared to the situation where the organization would have made a more explicit decision to invest in some emerging markets and not others.

Another example where flexibility and robustness are at odds is the following. ProRail has the desire of improving the future readiness of its railway tracks, and therefore invests in reducing the number of railroad switches. The number of switches around the busiest station has been reduced from 186 to 60 [28]. By diminishing the number of switches the robustness of the railroad system increases, because switches are a notorious weak element. At the same time however, it also decreases the ways in which trains can get from one track to the other, thereby impeding flexibility. Yet another example is the ‘room for the river’ project by Rijkswaterstaat. By relocating dykes further from the river shore the robustness of the waterway system increases, the system is less susceptible for dykes breaking through. However, this reduces flexibility in terms of the functions for which the area around rivers can be used [38].

This dilemma brings up questions as “how can organizations increase flexibility without reducing robustness?”, and “how can organizations increase robustness without reducing flexibility?”

Dilemma 8: Digitization allows increasing resilience but also increases vulnerability

One of the key trends identified by critical infrastructure providers is digitization (e.g. [38]). Digitization brings opportunities to increase

the infrastructure's resilience. For example, Alliander states that digital 'smart grids' allows being resilient in the face of different scenarios of energy demand and supply [35]. At the same time, such a development increases the extent to which the infrastructure relies on information technology, thereby increasing its vulnerability. Recently this vulnerability became visible at the 2017 cyber-attack at Port of Rotterdam which leads to millions of euros in damages. In the meanwhile, Port of Rotterdam has assigned a Cyber Resilience Officer [27]. Another example is the rollout of smart meters by Alliander. The smart meter is seen as an important means to increase resilience, but the rollout was substantially delayed because safety could otherwise not be guaranteed [26]. This dilemma brings up questions as "how can digitization increase resilience without increasing vulnerability?"

Dilemma 9: increasing resilience in the long run decreases resilience in the short run

Critical infrastructure providers aim to increase resilience through various investments. A downside is that these investments often results in a temporary reduction of resilience. For example, Schiphol mentions that investments in a new terminal might lead to trouble in the short run [30]. ProRail also mentions that investments to improve the infrastructure will have short term negative consequences [36]. This raises questions as "how can resilience in the long run be increased without decreasing resilience in the short run?"

6. Conclusion

In this study we defined responsiveness as the capability to accommodate future trends in today's investments. Building on existing bodies of knowledge, this study proposed that responsiveness profits from being able to combine exploration and exploitation, from being able of maintaining good stakeholder relationships, and from being able to prioritize organizational resilience. By contrasting existing theories with responsiveness strategies as practiced by six organizations, potential avenues for future research were identified. Through nine dilemmas, this study showed what knowledge is necessary for organizations to improve their responsiveness. Future research is necessary to help organizations navigate these dilemmas.

Declaration of Competing Interest

None.

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