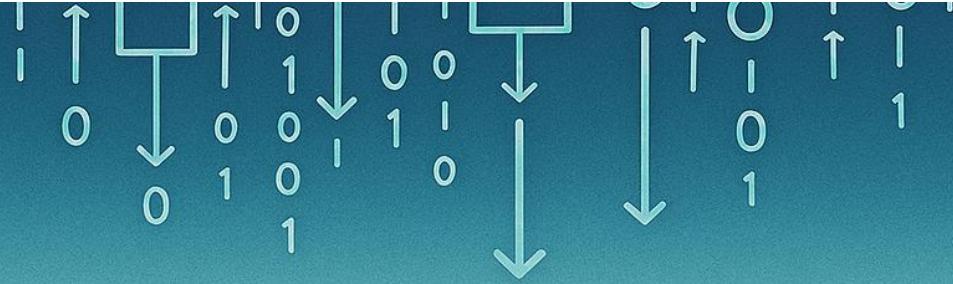


SEDDIT Thematic  
workshop:  
Situation readiness and  
resilience  
2025-11-18  
Thomas Ekström

Sensor informatics and Decision-making for the  
Digital Transformation (SEDDIT) - “From data to  
decision”



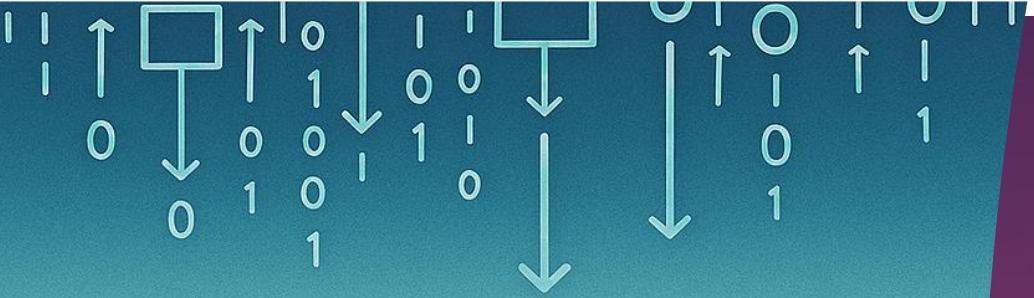
## From information to decision – A resilience perspective



# Agenda

(Mission: "To contribute to a resilient and sustainable society")

- Geopolitical and environmental context
- My perspectives on some concepts of fundamental(?) importance to SEDDIT
- Resilience in theory
- Resilience in practise
- Summary



# From information to decision – A resilience perspective



## Geopolitical and environmental context

# External requirements on societal resilience and total defence

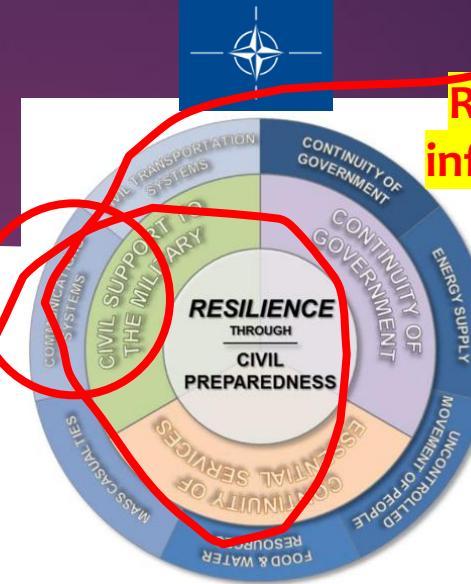
- ▶ As a consequence of **environmental changes**:
  - ▶ UN:s global goal for a sustainable development #9:
    - ▶ Build **resilient infrastructure**, promote sustainable industrialization and foster innovation
- ▶ As a consequence of **geopolitical changes**:
  - ▶ NATO:s requirements:
    - ▶ Article 3 in the NATO treaty => baseline requirements on **resilience in seven societal sectors**
  - ▶ EU:s requirements (**to become Swedish Law in 2026(?)**):
    - ▶ The CER directive (Critical Entities Resilience) => requirements on **resilience in eleven societal sectors**
    - ▶ The NIS 2 directive (Network and Information Systems) => requirements on **resilience in 18 societal sectors**
- ▶ The Swedish Total Defence:
  - ▶ **12 new preparedness sectors**

# Geopolitical and environmental context: Requirements

Requires resilience in infra-



sustainability and structure systems



Require resilience in infrastructure systems



The domain of information and decisionmaking



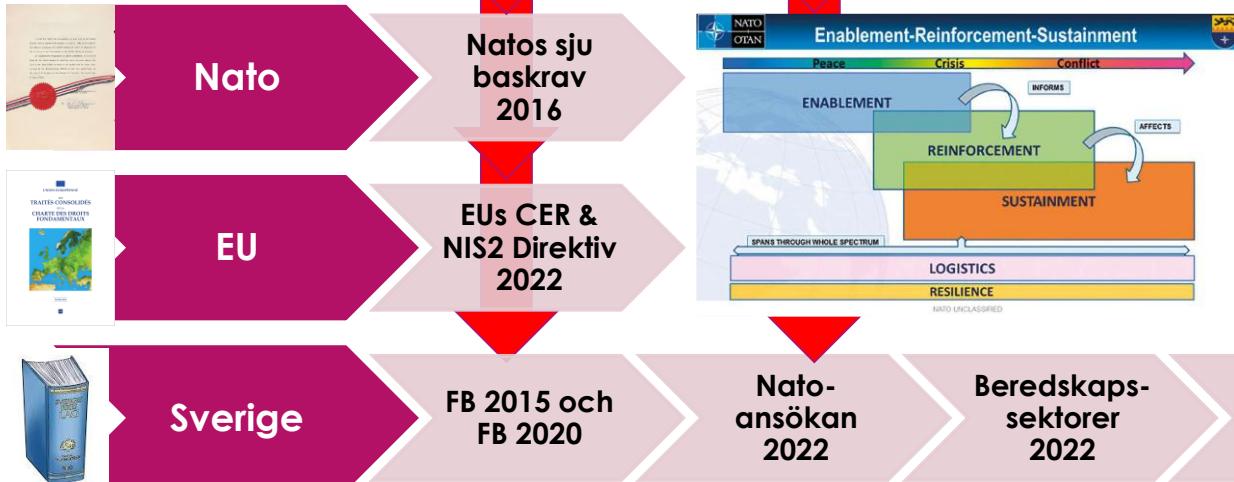
# Geopolitical context: Background



Georgien  
2008

Krim  
2014

Ukraina  
2022



Sverige (10+2 = 12 beredskapssektorer)	EU (11 sektorer med kritiska entiteter)	NATO (Artikel 3 => 7 baskrav)
Hälsa, vård och omsorg	Hälso- och sjukvård	Förmåga att hantera stora skadeutfall
Livsmedelsförsörjning och dricksvatten	Dricksvatten; Produktion, bearbetning och distribution av livsmedel	Resilient livsmedels- och dricksvattenförsörjning
Ordning och säkerhet		Förmåga att effektivt hantera okontrollerade befolkningsrörelser
Räddningstjänst och skydd av civilbefolkningen		
Transporter	Transporter	Resilient civilt transportsystem
Ekonomisk säkerhet	Bankverksamhet	
Elektroniska kommunikationer och post	Digital infrastruktur	Resilient civilt kommunikationssystem
Energiförsörjning	Energi	Resilient energiförsörjning
Finansiella tjänster	Finansmarknadsinfrastruktur	
Försörjning av grunddata		
	Avloppsvatten	
	Rymden	
	Vissa aspekter av sektorn för offentlig förvaltning	Säkerställande av politiskt beslutsfattande och centrala ledningsfunktioner

# Geopolitical context: Current activities in EU and NATO



## Enablement-Reinforcement-Sustainment

Peace

Crisis

Conflict

### ENABLEMENT

Möjliggörande/förmågeskapande

### REINFORCEMENT

Förstärkning/deployering

### SUSTAINMENT

Upprätthållande/försörjning/understöd

SPANS THROUGH WHOLE SPECTRUM

### LOGISTICS

### RESILIENCE

Skapa förutsättningar för att flytta+försörja

Flytta (förstärka)

Försörja

Hantera störningar

- Natogräns
- Svensk ekonomisk zon
- Logistknätverk
- Försörjningsleder

### Nato + EU

- \* Basering
- \* Transitering
- \* Förstärkning
- \* Försörjning
- \* HNS (VLS)
- \* Militär rörlighet

### Logistknätverket

(RSN, JLSN, NSN, TEN-T)  
Försörjningsnätverket

### Sårbarheter

- \* Elektrifiering
- \* Digitalisering (ERTMS)
- \* Automatisering
- \* Integrering (SoS)
- \* Globalisering

### FN + EU + Nato

- \* Resilient infrastruktur
- \* Resilient försörjning



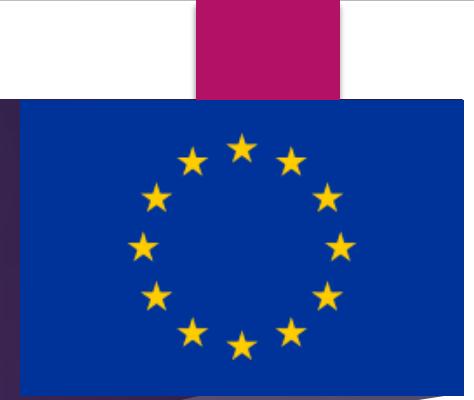
# NATO's 7 Baseline requirements applies to systems in 7 sectors



1. **Assured continuity of government and critical government services** (Ensuring decision-making, leadership succession, and crisis communication remain functional during emergencies)
2. **Resilient energy supplies** (Securing access to reliable energy sources and protecting energy infrastructure from disruption)
3. **Ability to deal effectively with uncontrolled movement of people** (Managing mass migration and displacement due to conflict or disaster)
4. **Resilient food and water resources** (Safeguarding supply chains and infrastructure for food production and drinking water)
5. **Ability to deal with mass casualties** (Ensuring healthcare systems can respond to large-scale health crises or attacks)
6. **Resilient civil communications systems** (Maintaining secure and functional communication networks, including public alert systems)
7. **Resilient civil transportation systems** (Keeping transport infrastructure operational to support civilian and military mobility)

**They all require information and decisionmaking**

# EUs CER Directive applies to entities in 11 critical sectors



1. **Energy** (Includes electricity, oil, gas, and hydrogen supply)
2. **Transport** (Covers air, rail, water, and road transport infrastructure and services)
3. **Banking** (Institutions providing core banking services)
4. **Financial Market Infrastructures** (Includes central counterparties and payment systems)
5. **Health** (Hospitals, private clinics, and entities involved in the production and distribution of medical products)
6. **Drinking Water** (Providers of potable water services)
7. **Wastewater** (Entities managing sewage and wastewater treatment)
8. **Digital Infrastructure** (Includes internet exchange points (IXPs), domain name systems (DNS), and data centers)
9. **Public Administration** (Central and regional government bodies)
10. **Space** (Operators of ground-based infrastructure supporting space-based services)
11. **Food** (Entities involved in the production, processing, and distribution of food)

**They all require information and decisionmaking**

# EUs NIS 2 Directive applies to entities in 18 critical sectors



1. **Energy** (electricity, oil, gas, district heating, hydrogen)
2. **Transport** (air, rail, water, road)
3. **Banking**
4. **Financial Market Infrastructures**
5. **Health** (hospitals, private clinics, medical and pharmaceutical manufacturers)
6. **Drinking Water**
7. **Wastewater**
8. **Digital Infrastructure** (routers, IXPs, DNS, TLDs, cloud, data centers, CDNs)
9. **ICT Service Management** (business-to-business IT services)
10. **Public Administration** (central and regional)
11. **Space** (operators of ground-based infrastructure)
12. **Postal and Courier Services**
13. **Waste Management**
14. **Manufacturing, Production, and Distribution of Goods** (food production, Processing, and Distribution)
15. **Manufacturing, Production, Processing, and Distribution**
16. **Manufacturing** (e.g., medical devices, electronics, machinery, vehicles)
17. **Digital Providers** (online marketplaces, search engines, social platforms)
18. **Research** (entities conducting critical or sensitive research)

**This is a cyber security directive!**

**They all require information and decisionmaking**

## Civilt försvar

Den 1 oktober 2022

Myndigheten för samhällsskydd och beredskap (MSB)

Centralt beredskapsråd

C  
e  
n  
t  
r  
a  
l

Sektorsansvariga myndigheter

Energiförsörjning

Elektroniska kommunikationer och post

Ordning och säkerhet

Finansiella tjänster

Ekonomisk säkerhet

Försörjning av grunddata

Beredskapssektorer

Livsmedelsförsörjning och dricksvatten

Hälsa, vård och omsorg

Räddningstjänst och skydd av civilbefolkningen

Transporter

Särskilda beredskapsområden

Psykologiskt försvar

Cybersäkerhet

Skola och förskola

Migration

R  
e  
g  
i  
o  
n  
a  
l

Civilområdeschefer med Beredskapskanslier (förslag 6)

Samverkansregioner (6)

L  
o  
k  
a  
l

Kommuner (290)

Regioner (21)

## Militärt försvar

Försvarsmaktens Högkvarter

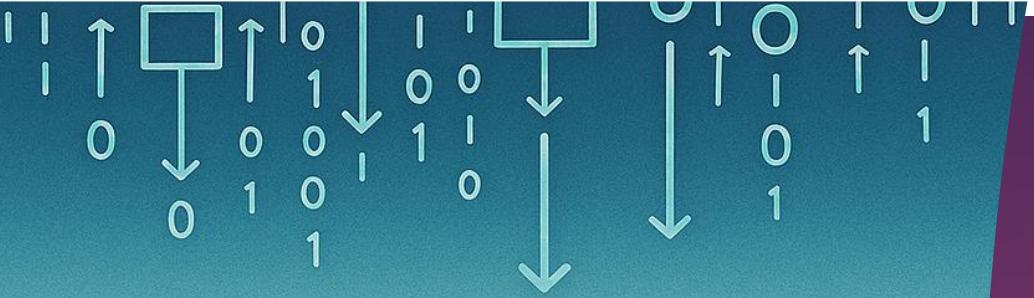


Militärregioner (förslag 6)

Garnisoner (regementen, flottiljer, etc.)

Militära förband

They all require information and decisionmaking



# From information to decision – A resilience perspective



My perspectives on  
some concepts of  
fundamental(?)  
importance to SEDDIT

# Comfort zone versus deep water

## Comfort zone

Resilience

Decisionmaking

## In between

Information

## Deep water

Situation readiness

# My (Copilot's...) perspective on situation readiness

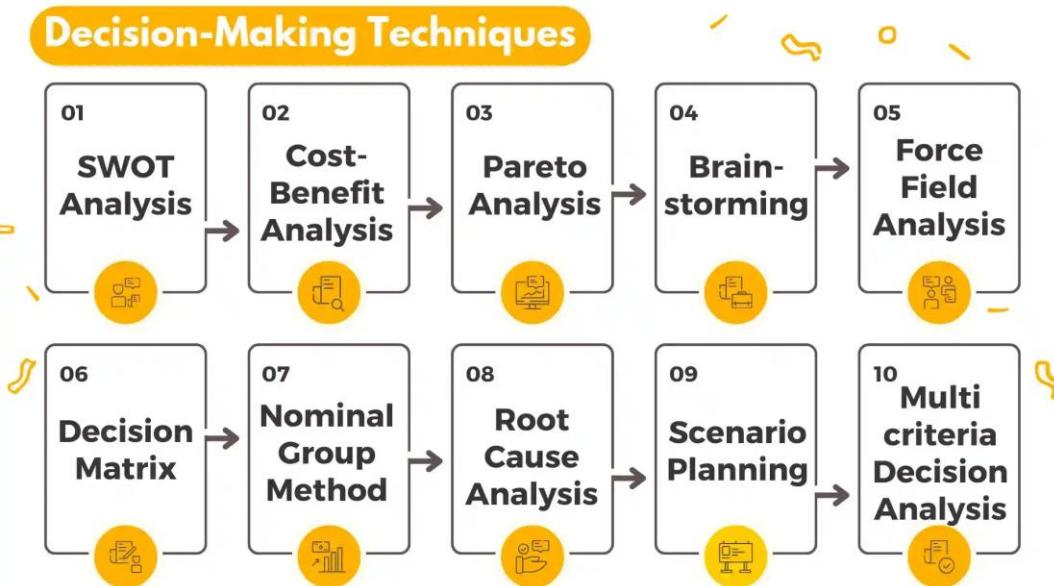
(Ergo: deep  
water)

- ▶ Situation awareness (**used in the military**):
  - ▶ The ability to perceive, understand, and project the status of elements in a dynamic environment
- ▶ Situation readiness (Copilot):
  - ▶ The state of being prepared to act effectively in a specific situation, based on available resources, plans, and awareness
  - ▶ Refers to an individual's or organization's ability to effectively respond to a specific context, threat, or opportunity by combining preparedness, adaptability, and decision-making capacity".
- ▶ Aligns very well with my understanding of resilience.

# My (OR) perspective on decision-making and decision- making techniques

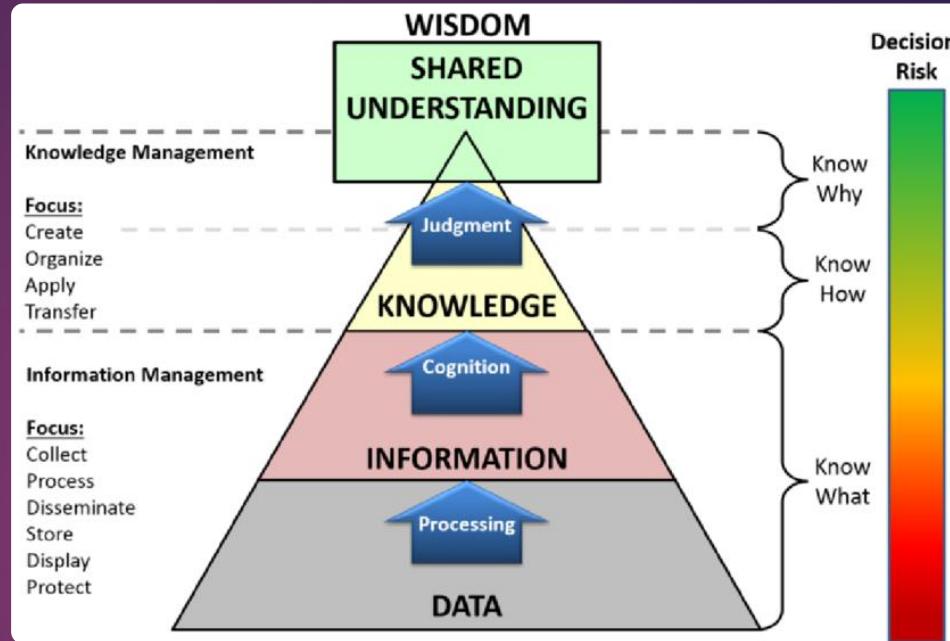
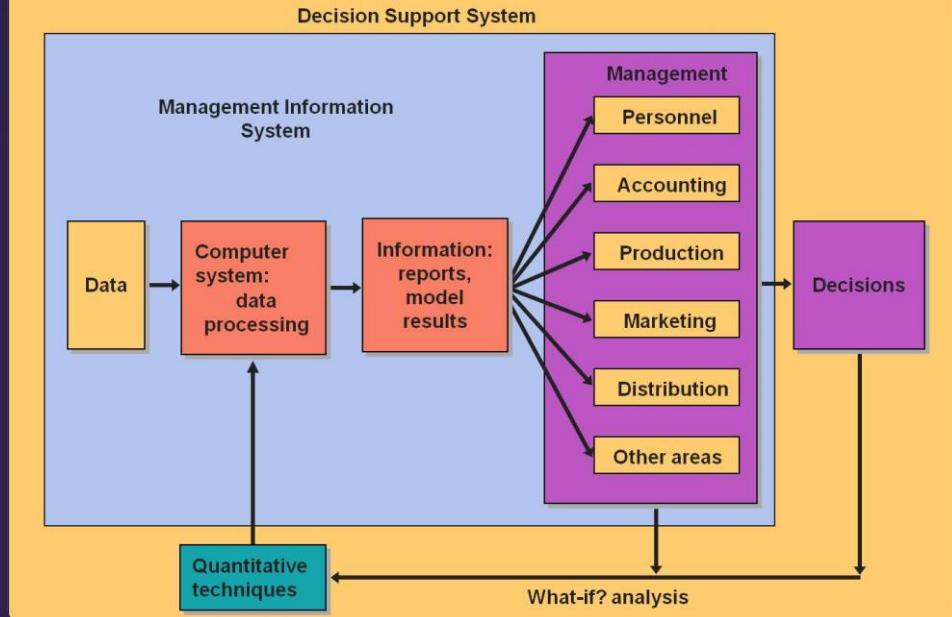


Decision Making Process Factors



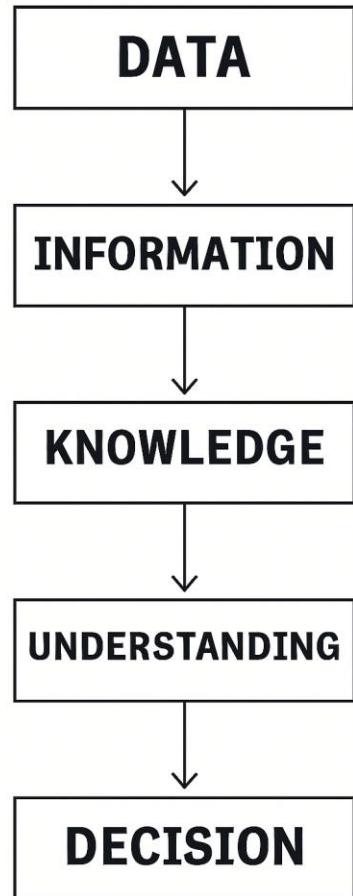
The 10 Best Decision Making Techniques in Management - Risely

## Decision Support System



DOI: [10.13140/RG.2.2.33114.00969](https://doi.org/10.13140/RG.2.2.33114.00969)

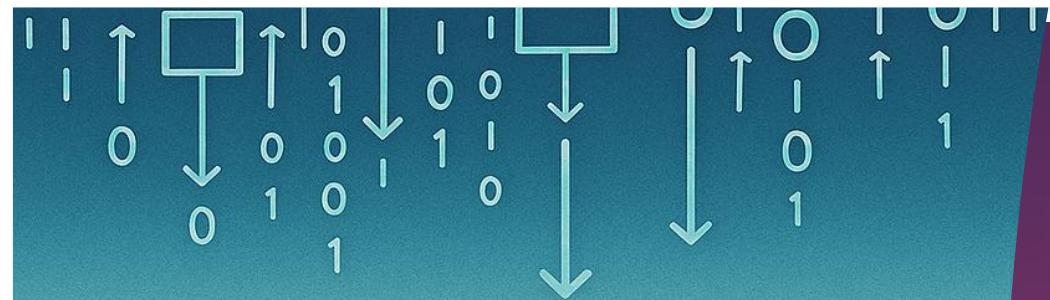
My (OR) perspective on information: It is essential for decision making



From raw data to informed decision – What can possibly go wrong and how can we prevent it from going wrong?

I assume that this is your area of expertise?

So, I will focus on mine



## From information to decision – A resilience perspective



## Resilience in theory

A picture is worth a thousand words...

## Suboptimisation!

Their staff were not able to get to work, and...

NYSE was closed anyway...

Goldman Sachs had their own electricity supply, but...

**Everything is connected =>  
Robustness and resilience  
require a holistic  
perspective!**

**“On August 14, 2003, a cascading failure of the power grid plunged more than 50 million people into darkness in the northeast US and Canada. It was the most significant power outage ever in North America, with an economic impact north of ten billion dollars”.**

# Questions we could/should ask

- ▶ What does resilience mean in theory and practise?
- ▶ How do we operationalise, quantify and measure it?
- ▶ How does it relate to
  - ▶ robustness?
  - ▶ resistance and recovery?
  - ▶ redundancy, flexibility and agility?



# Requirements on resilience: Against what?

- ▶ Disruptions ≠ risks/uncertainties – We do not know probabilities or impacts
- ▶ Disruptions = Black Swans = "Unknown Unknowns"
- ▶ (Very) High Impact - (Very) Low "Probability" ("Very large ignorance") = HILP
- ▶ Categories:
  - ▶ Natural disasters
  - ▶ Cyber attacks
  - ▶ Pandemics
  - ▶ Terrorism
  - ▶ War



There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know.

(Donald Rumsfeld)

izquotes.com

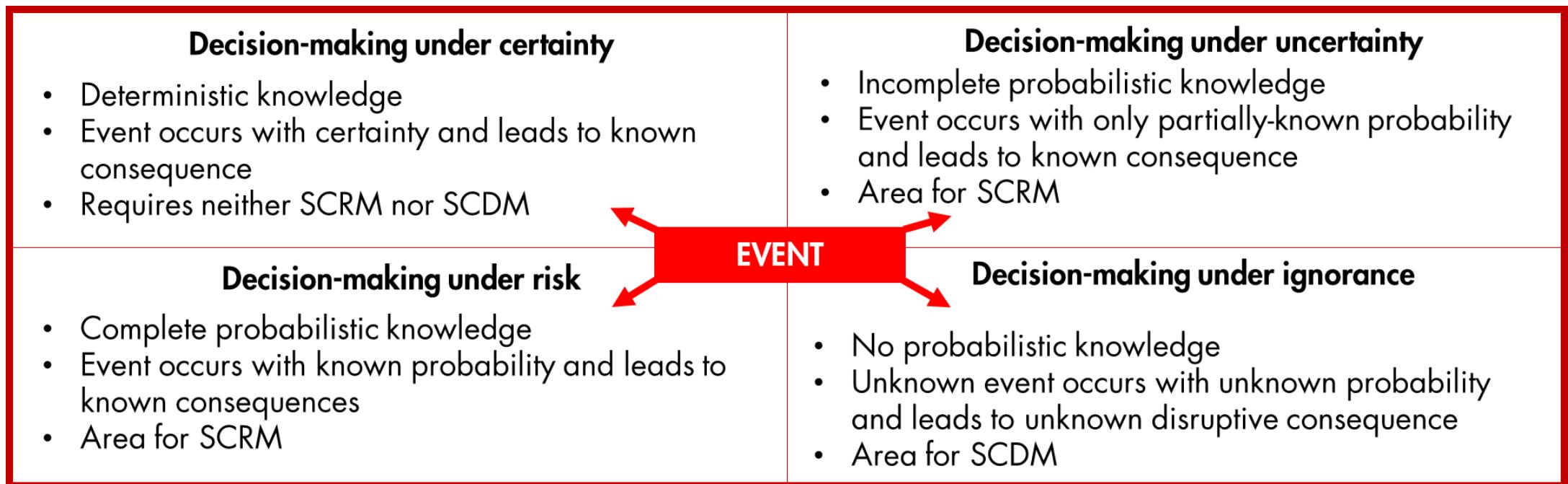
**BRASKLAPP I**  
Resilience against one disruption, does not necessarily mean resilience against another disruption!

**BRASKLAPP II**  
Some define disruptions as risks/uncertainties, to be dealt with by traditional risk management methods...

		Known to self	Not known to self
Known to others	Known to self	Arena	Blind Spot
	Not Known to Others	Façade	Unknown

# Requirements on resilience: Against what?

- ▶ A combination of Classical/Modern Decision Theory and the Johari Window



## Resiliens

Översättning?



Krav på  
"resilience"  
Betydelse?

**There is no  
consensus –  
Neither in  
theory nor in  
practise**

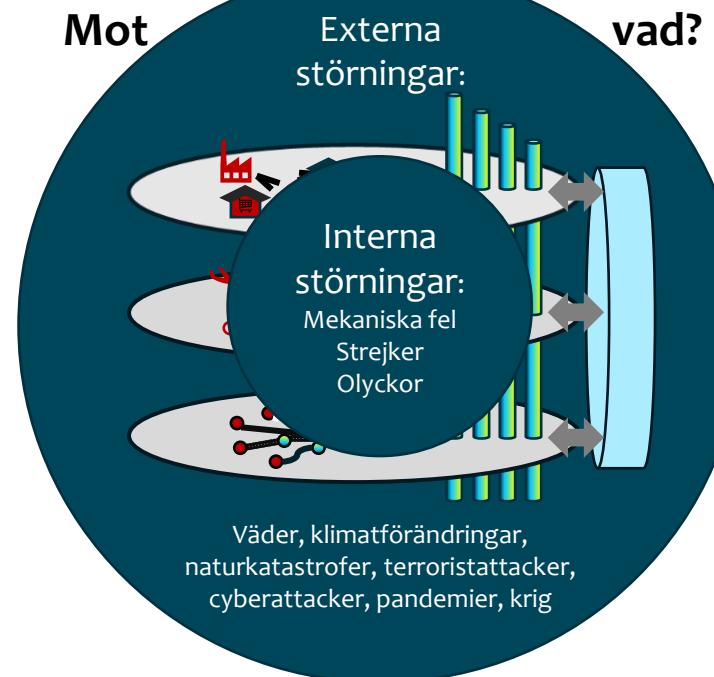


## Teoretiska perspektiv

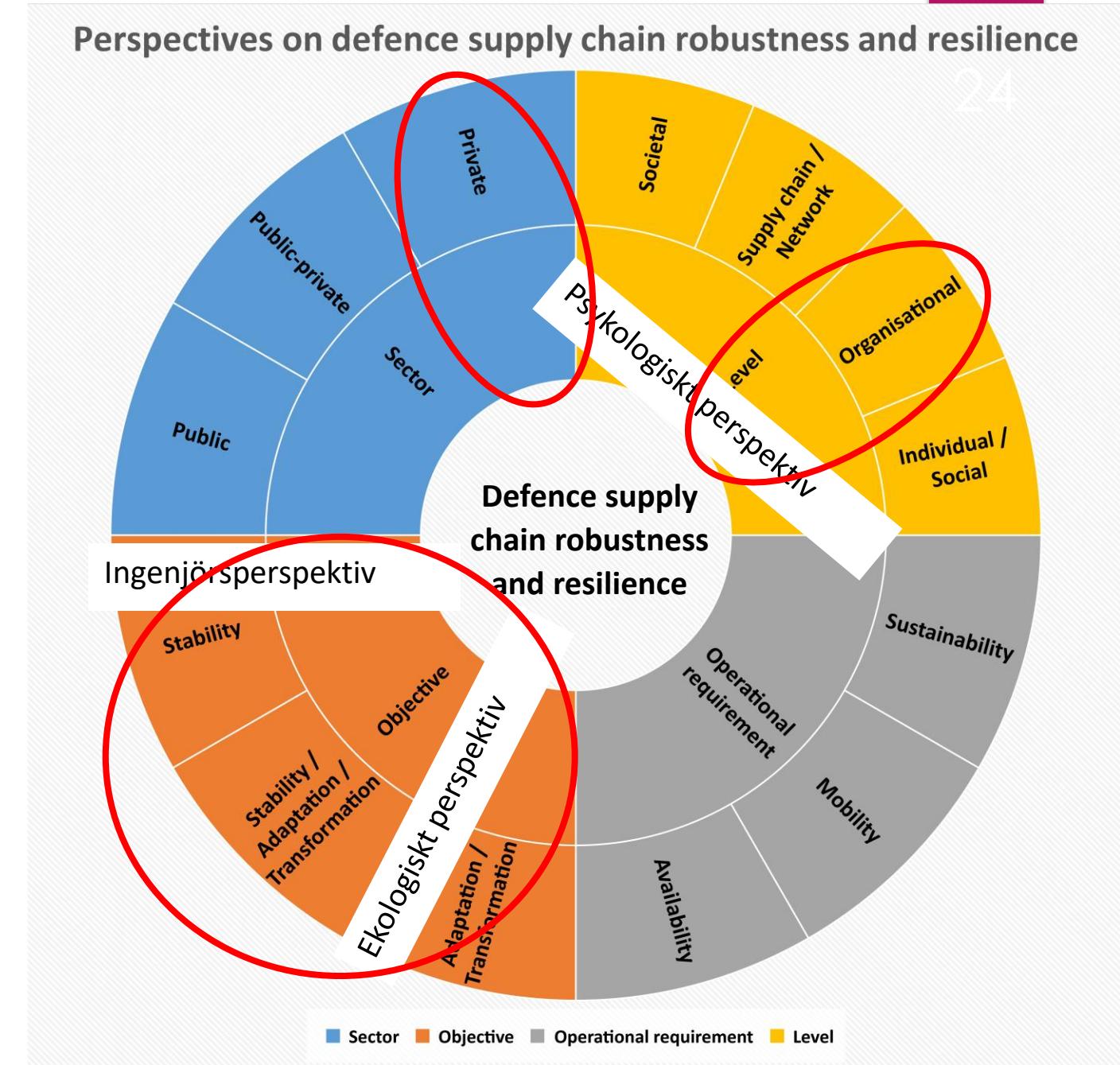
Ingenjörsvetenskap

Ekologi

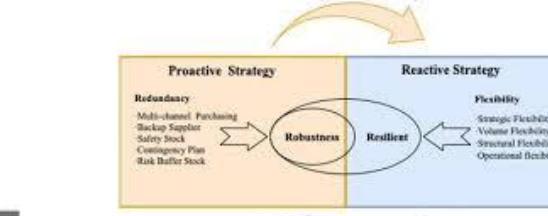
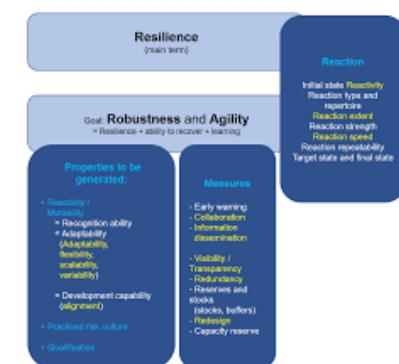
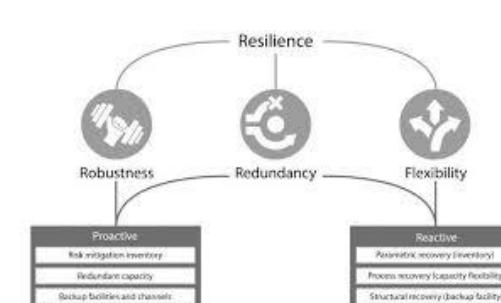
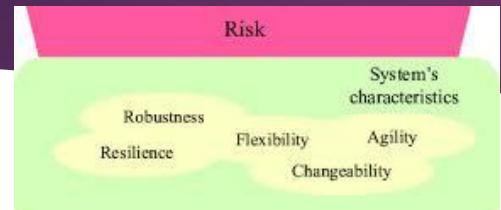
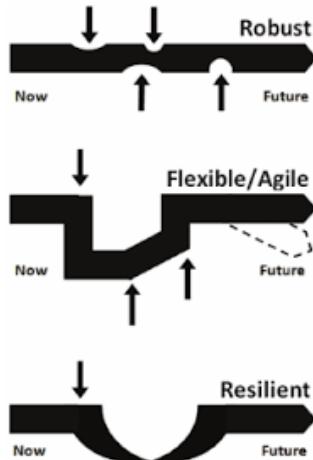
Psykologi



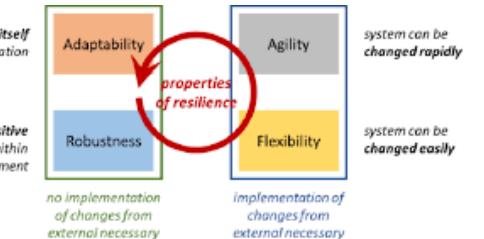
# Different theoretical perspectives on resilience



# Robustness and resilience in theory: Disagreement



## Building Resilience Through Redundancy

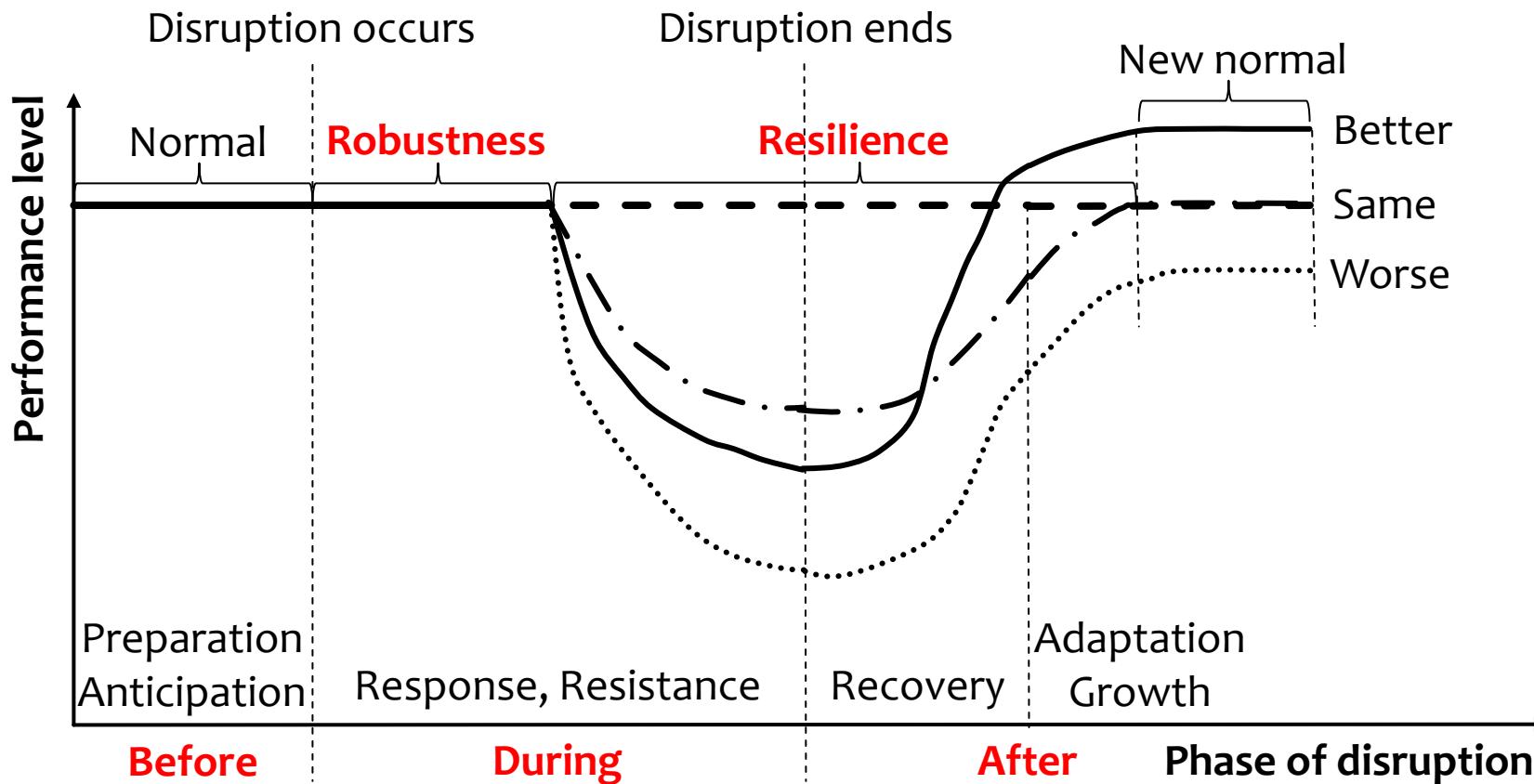


All definitions, models and theories cannot be true simultaneously...

# Robustness and resilience in theory: Agreement

- ▶ Four most common strategies:
  - ▶ Redundancy (reserve capacity, security stock)
  - ▶ Flexibility (ability to change, alternative suppliers)
  - ▶ Agility (ability to change rapidly)
  - ▶ Cooperation (postponement, risk sharing)
- ▶ Numerous tactics in each strategy
- ▶ Many tactics can be used in several phases:
  - ▶ Proactively
  - ▶ Reactively

# Robustness and resilience in theory (my interpretation)



## CAVEAT III

Not necessarily  
consensus regarding  
concepts, definitions  
and relationships...

### Before disruption:

Proactive strategies =  
Redundancy (e.g. security  
stocks)

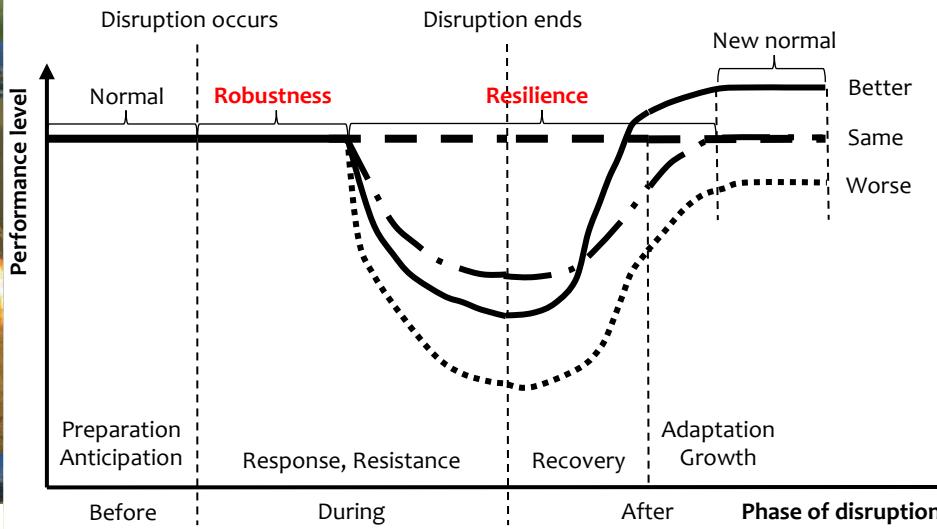
### During and after disruption:

Reactive strategies = Flexibility  
(e.g. multiple suppliers)

### Purpose:

Ensure survival  
Minimise deterioration and  
downtime

# Resilience vs. robustness



Some systems are  
both, some are  
either or

# Properties at different system levels (system vs. SoS) – Risk vs. vulnerability

**Ingen funktionalitet**

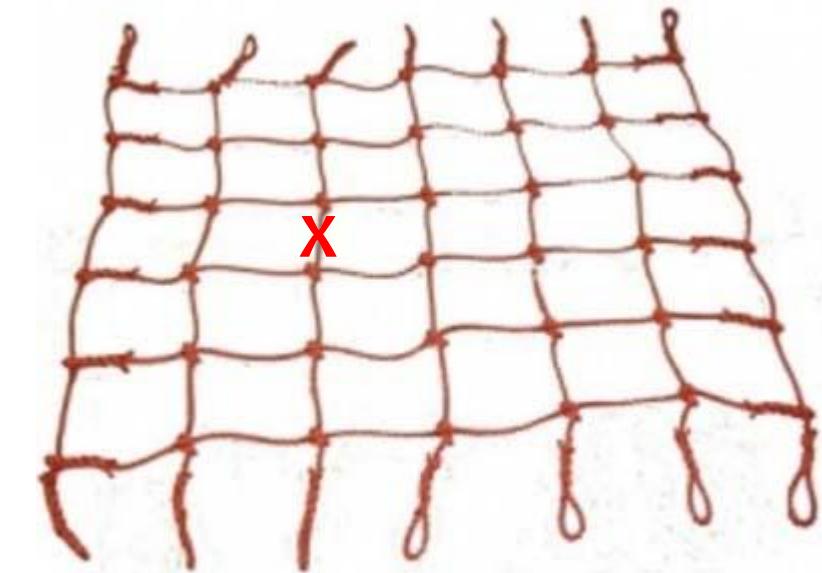


**Risk vs.  
sårbarhet**

**Försämrad funktionalitet**

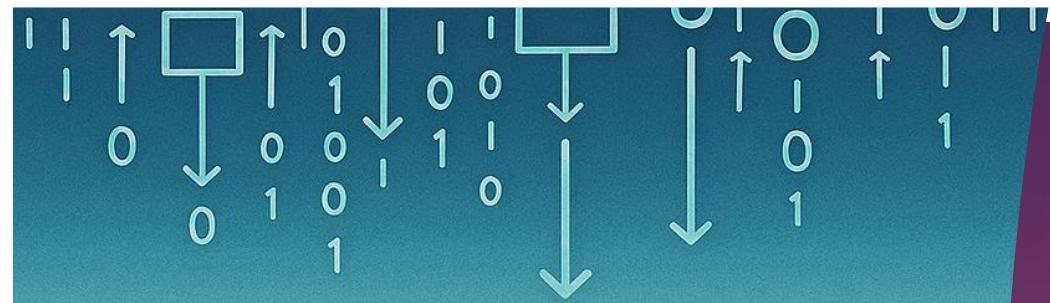


**Nästan fullständig funktionalitet**



# Properties at different system levels (system vs. SoS) – Risk vs. vulnerability



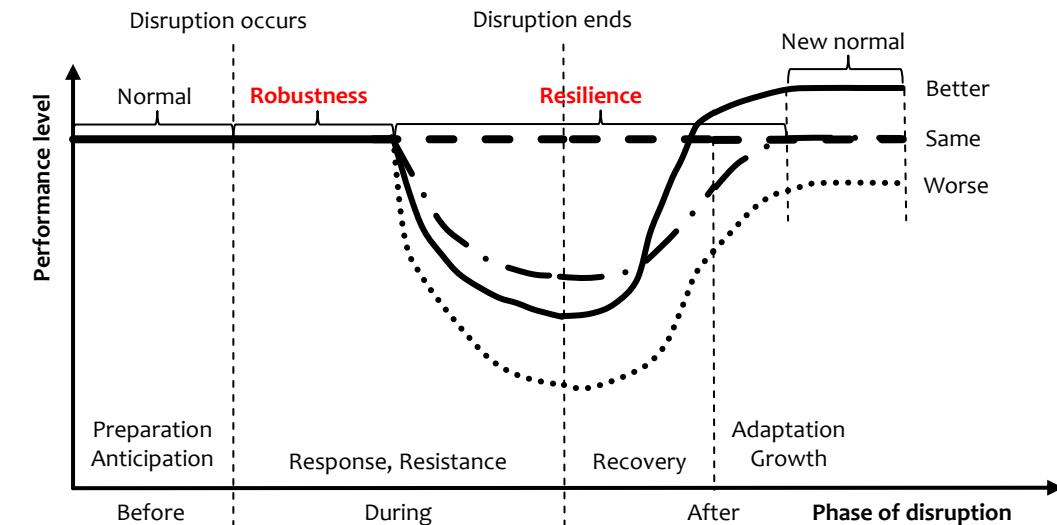


## From information to decision – A resilience perspective

Resilience in practise

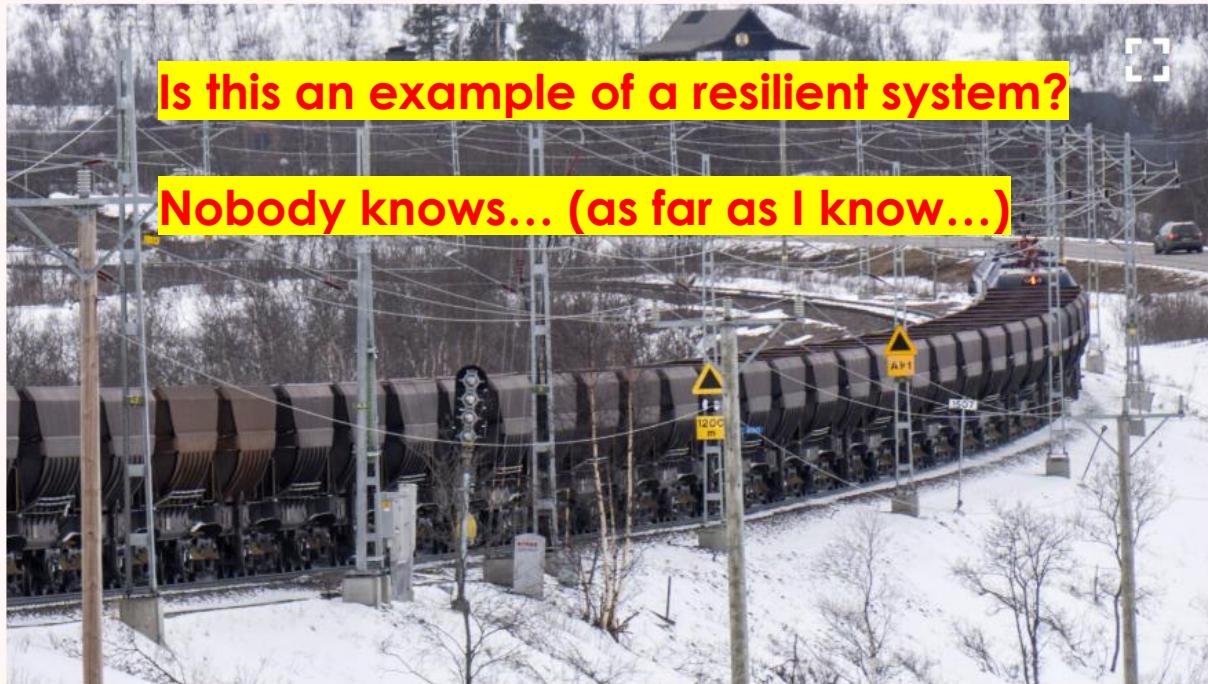
# More questions we could/should ask

- ▶ Vilka störningar skall vi dimensionera oss för?
- ▶ Hur skall vi förbereda oss (strategi)
- ▶ Vilka system/förmågor måste vara robusta? Hur länge?
- ▶ För vilka system/förmågor kan vi acceptera en nedgång i prestation?
  - ▶ Hur stora nedgångar är acceptabla?
  - ▶ Hur lång tid är en nedgång acceptabel?
  - ▶ Vilket nytt normalläge är acceptabelt?
- ▶ Så vitt jag vet ger varken NATO eller EU oss svaren på de här frågorna...

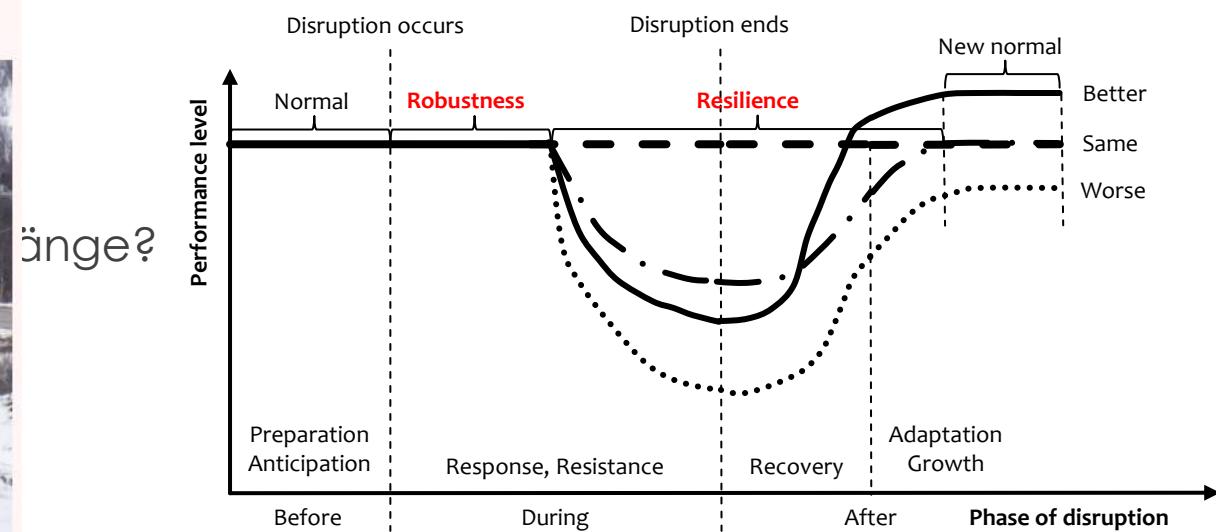


# More questions we could/should ask

## Stopp på Malmbanan - igen



Trafiken stod still på Malmbanan i 76 dygn på grund av två urspårningar i december och februari. Nu är det stopp igen. Bild: Fredrik Sandberg/TT



# The war in Ukraine

- ▶ Lessons to be learned:
  - ▶ Logistics is targeted
  - ▶ Logistics infrastructure is targeted
  - ▶ Railways, roads and bridges are targeted
  - ▶ Telecommunications and energy infrastructure is targeted
  - ▶ Hospitals, civilian housing, etc. is targeted
  - ▶ All the infrastructure that must be resilient according to EU and NATO is targeted
    - ▶ By kinetic warfare
    - ▶ By cyber warfare



# Ukrainian resilience explained

- ▶ Well developed cyber security => well prepared for cyber warfare (resilient against)
  - ▶ Experience 8 years of cyber warfare since 2014
  - ▶ Proactive help from NATO
  - ▶ Reactive help from BigTech
- ▶ Not as well prepared for kinetic warfare, however:
  - ▶ Partly unmodernised infrastructure (designed by USSR to function in WW3, still under modernisation => over capacity, old tech (half railway system electrified), etc.
  - ▶ Relatively resilient because of a large number of reactive measures (and a lot of external help)

# Lessons: Reactivity (ad hoc) that could have been proactivity

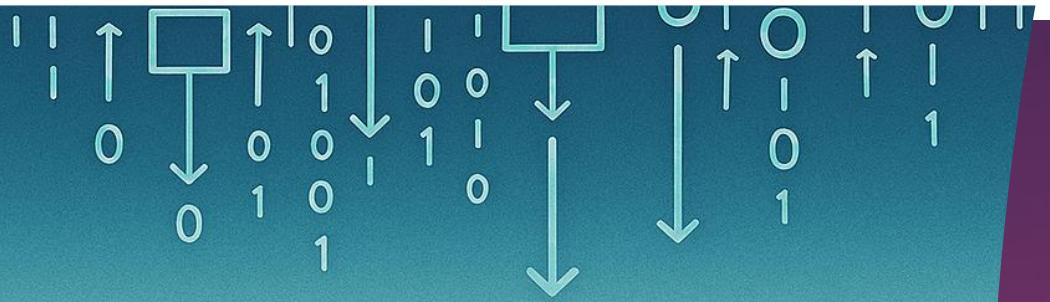
- ▶ Lagstiftning, tullar och regelverk
  - ▶ Ukraina har varit tvunget att snabbt göra ändringar, exempelvis genom att:
    - ▶ Ta bort tullar på generatorer, tillåta större lagring av drivmedel hos företag och enskilda, etc., etc.
- ▶ Redundans och flexibilitet
  - ▶ Fanns delvis pga. omoderniserade system, men Ukraina har också varit tvunget att skapa detta
- ▶ Systematiskt lärande
  - ▶ Ukraina har varit tvunget att systematisera de lärdomar de successivt dragit under kriget
- ▶ Offentlig-privat samverkan
  - ▶ Fanns delvis, men har utökats på både offentligt och civilt initiativ

# Lessons: Reactivity (ad hoc) that could have been proactivity

- ▶ Personal- och kompetensförsörjning
  - ▶ Ukraina har varit tvunget att successivt skapa ett system för detta för att omhänderta frivilliga, krigsplacera andra, omhänderta pensionärer, omskola personal, etc.
- ▶ Reparationsplanering, Reservdelsförsörjning, Fornödenhetsförsörjning, Lagerhållning
  - ▶ Eftersom Ukraina inte var förberett på den omfattande kinetiska krigföringen fanns ingen beredskap för dessa områden
- ▶ Energilagringssystem
  - ▶ Eftersom Ukraina inte var förberett på den omfattande kinetiska krigföringen fanns ingen beredskap för detta

# Lessons: Reactivity (ad hoc) that could have been proactivity

- ▶ Lokal produktion och lagerhållning, Diversifiering av energiproduktion, Alternativ energiförsörjning,
  - ▶ Fanns delvis på plats, men Ukraina har varit tvunget att utveckla detta under krigets gång
- ▶ Backuper och reservförfaranden
  - ▶ Eftersom Ukraina inte var förberett på den omfattande kinetiska krigföringen fanns ingen beredskap för detta
- ▶ Prioritering, omdirigering och ransonering
  - ▶ Ukraina var inte förberett på stora folkförflyttningar, omfattande elavbrott, etc...



From information  
to decision –  
A resilience perspective



Summary

# Paradigm shift 1 – Requirements on resilience

40



- ▶ EU and NATO require societal resilience
- ▶ We must move from focusing on cost-efficiency to focusing on resilience
  - ▶ In the global supply chains
  - ▶ In the critical infrastructure
- ▶ Including measures for increasing redundancy and flexibility
- ▶ This will drive costs – Who should pay for what?

# Paradigm shift 2 – New area of operations

- ▶ NATO will have a new area of operations in the North
- ▶ Today, supply chains and critical infrastructure systems have a north-south focus
- ▶ This must be complemented with a west-east focus
- ▶ Including measures for increasing redundancy and flexibility
- ▶ It is also likely to include investments in new infrastructure systems
- ▶ This will drive costs – Who should pay for what?



# The need for resilient, cross-border, critical infrastructure – Paradigm shift from efficiency to resiliency and north-south to west-east

42

- ▶ Past: Bottom-up, unilateral, north-south focus, within national and organisational areas of responsibilities – Focus on efficiency in subsystems
- ▶ Present and future: Top-down, multilateral, west-east, holistical view of critical infrastructure, etc. – Focus on resiliency in cross-border systems-of-systems
- ▶ Present and future: Cooperation between nations, authorities and companies



THOMAS EKSTRÖM

#### ABSTRACT

In the post-Cold War period, many Western countries reduced their military spending, shifting their focus from territorial defence to expeditionary operations. The transformation brought with it an increasing dependence on commercial supply chains, vulnerable to disruption. Today, the geopolitical landscape is changing; the established rules-based international order is no longer secure, and nations are uniformly increasing their military expenditure to refocus on defence. But this return to an earlier posture does not mean that Cold War-era approaches are adequate for addressing contemporary issues in defence supply chains (SCRES). Previous research has primarily studied SCRES in commercial settings. This paper empirically explores barriers and enablers regarding the enhancement of SCRES in military settings. The paper identifies three sets of barriers; these are related to the defence marketplace, to the defence supply chain, and to the defence marketplaces' dependence on civilian supply chains.

**Kunskapsöversikt**  
Lärdomar från Ukraina mot svensk infrastruktur

Thomas Ekström

GrundBULT  
Utgångspunkter för forskning och beredskapshänsyn i transportsystem

Pär Eriksson (red.), Thomas Ekström, Camilla Eriksson, Linnea Eriksson, Karolina Isaksson, Erik Ingrid Johansson, Linea Kjellsdotter Iversen, Francisco J. Márquez-Fernández, Jean Ryd, Martin Svanberg, Jacob Witzell

FOL P-5672-SF



REBECCA LUCAS, THOMAS EKSTRÖM, PAOLA FUSARO, ELIZABETH HASTINGS ROE, LUCIA RETTER

## Toward Defense Supply Chain Disruption Management

A Research Agenda for Defense Supply Chain Resilience



#### Towards Defence Supply Chain Resilience – A Prestudy of the Swedish Defence Sector

Dr. Thomas Ekström  
Swedish Defence University  
SWEDEN  
thomas.ekstrom@fhs.se

#### ABSTRACT

Layered resilience has received increased attention in recent years. This paper addresses an important subset of layered resilience, which is resilience in defence supply chains. The paper reports on findings from two studies, conducted in the Swedish defence sector. The purpose of the two studies is to identify feasible solutions for how the Swedish defence sector can redesign its supply network to meet the new challenges of a re-established Swedish Total Defence. The first study used a modified Delphi technique and concluded that two Delphi panels constitute a useful modification to the Delphi technique. Two panels increase the validity of the results and can potentially lead to interesting outcomes that a traditional design is less likely to produce, particularly if combined with presenting the panels with statements from different perspectives and using workshops to discuss the findings. The second study used a survey to investigate which tactics for resilience in defence supply chains defence authorities and defence industry prefer in peace, crises, and war. Though inconclusive, the findings indicate that authorities and companies agree that multiple sourcing and pre-stocking of supplies are important tactics to achieve resilience in defence supply chains. This is in line with previous research in commercial supply chains, which identifies increased safety stock and multi-sourcing as two of the most commonly used tactics to address disruptions.

#### 1.0 INTRODUCTION

Beginning with the 2008 Russo-Georgian War and intensifying with the Russian annexation of Crimea in the 2014 Russo-Ukrainian War, the Swedish position on defence and security policies gradually shifted [1]. The Swedish Defence Bill of 2015 marked a definitive turning point, stating that "The most important priority in the defence bill covering the period from 2016 to 2020 is to increase the operational warfighting capability of the Armed Forces and to ensure the collective force of the Swedish Total Defence" [2]. Sweden defines its Total Defence as "the preparations and planning required to prepare Sweden for war" and in highest alert, "all societal functions are defined as Total Defence, which consists of military defence and civil defence" [3]. The current Swedish Defence Bill establishes that "The security situation in Sweden's neighbourhood and in Europe has deteriorated over time," continues to observe, "An armed attack against Sweden cannot be ruled out," and emphasizes that "It is particularly important that work to strengthen resilience in the most important societal functions is further developed and deepened" [4]. As of 24 February 2022, the security situation in Sweden's neighbourhood has deteriorated even further. As a result on 16 May 2022 the Swedish Government, with broad support in the Swedish Parliament, decided to apply for NATO membership [5].

NATO membership entails adherence to the North Atlantic Treaty in its entirety, including Article 3, which states that "In order more effectively to achieve the objectives of this Treaty, the Parties, separately and jointly, by means of continuous and effective self-help and mutual aid, will maintain and develop their individual and collective capacity to resist armed attack" [6]. NATO demands that "Each NATO member country needs to be resilient to resist and recover from a major shock such as a natural disaster, failure of critical infrastructure, or a hybrid or armed attack. Resilience is a society's ability to resist and recover from such shocks. Resilience combines both civil preparedness and military capacity" [7]. The Warsaw Summit in 2016 established seven baseline requirements for national resilience [7].

# Thank you! Questions?