NMCAs and Digital Twins – business models, value and open questions

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PhD Research and Presentation Structure

About me and my research:

- 3rd year student at University College London
- Researching what Digital Twins mean for NMCAs:
- *Geospatial component of Digital Twins, Value, Requirements, Target State*
- **Digital Twin Cookbook for NMCAs (*in development*)**

What I'll be talking about today:

1. Context of the research
2. Results from a study on the current-state of NMCA business models
3. Unpacking value in the context of foundational geospatial data in DTs

Part 1

Context to this research.

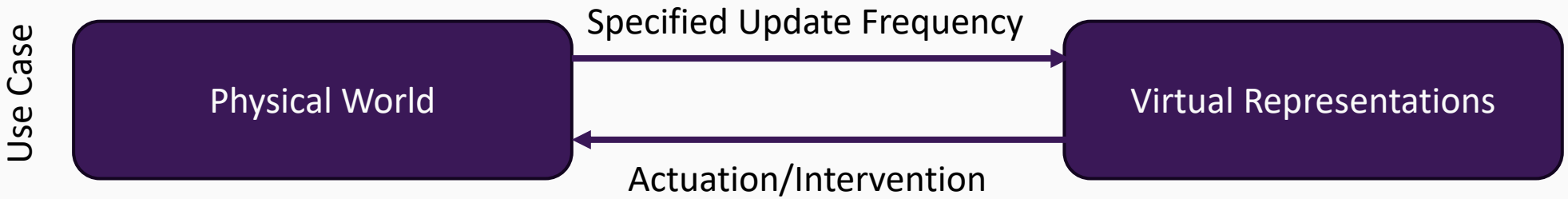
Forces affecting NMCAs

- Policy
  - EU HVD “open by default”
  - Revenue pressure
- Markets
  - Alternative providers
  - Role Questioning
- Technologies
  - Artificial Intelligence
  - Digital Twins
  - Shifting expectations
- Public Task
  - National mandate
  - Environment: Climate Change
  - Socio-economic services
  - More collaboration

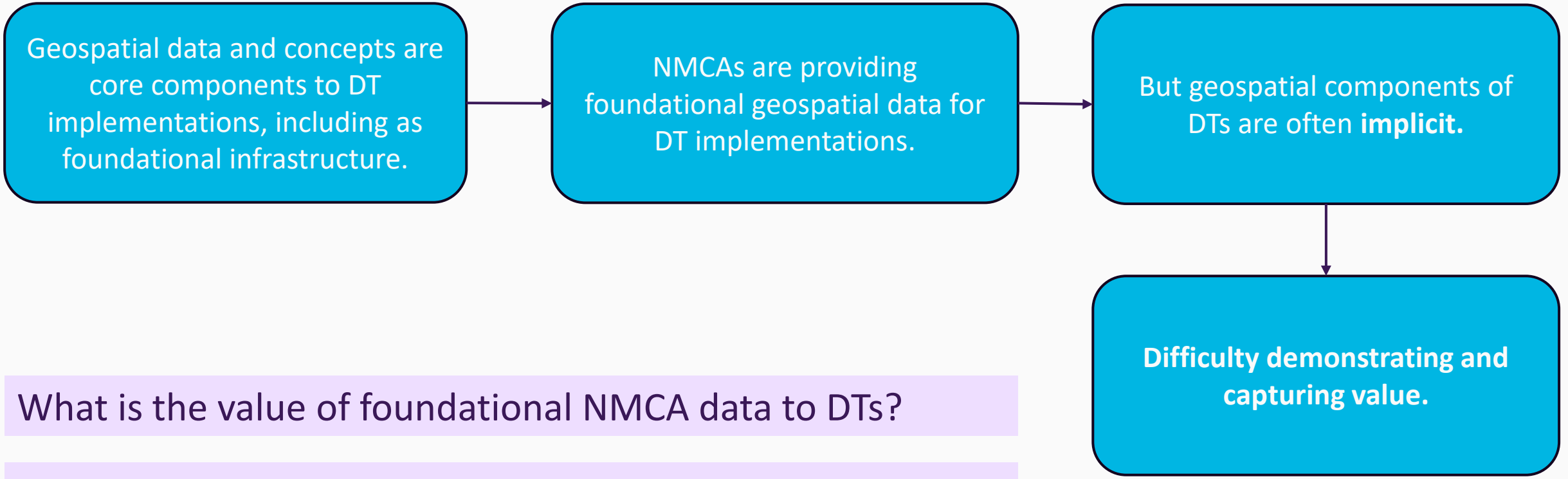
Forces affecting NMCAs: Digital Twins

Essential Digital Twin Characteristics:

- Integrated representations of real-world systems,
- Updated at specified frequencies,
- Solving a well-defined problem,
- (Ideally) automatic feedback/actuation but also includes human-in-the-loop,
- **Geospatially-enabled** (“beyond the factory floor”)



NMCAs in Digital Twins



What is the value of foundational NMCA data to DTs?

Do business models need to adapt to support this role?

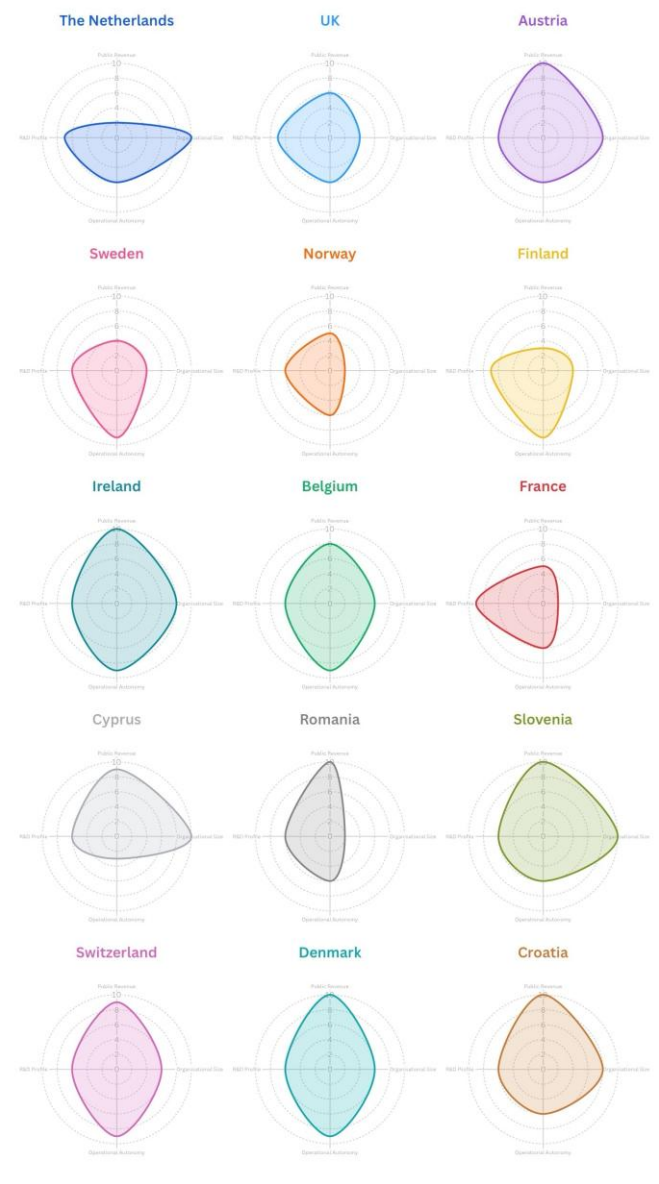
But, what are current NMCA business models? How different are they?

Part 2

Understanding the status-quo and heterogeneity in NMCA business models

Results from a recent EuroSDR questionnaire (n=15).

NMCAs are heterogenous.



Group1 – IGN (France), Ordnance Survey (GB) – *lower public funding, small organisations (normalised by country area), some autonomy, broad R&D*

Group 2 – Croatia, Austria, Slovenia, Cyprus – *higher public funding, large organisations,* low autonomy and narrow R&D

Group 3 – Finland, Sweden – *lower public funding, smaller organisations, high autonomy and narrower R&D*

Group 4 – Switzerland, Denmark , Ireland, Belgium – *high public funding, moderate organisation sizes, high autonomy, narrower R&D*

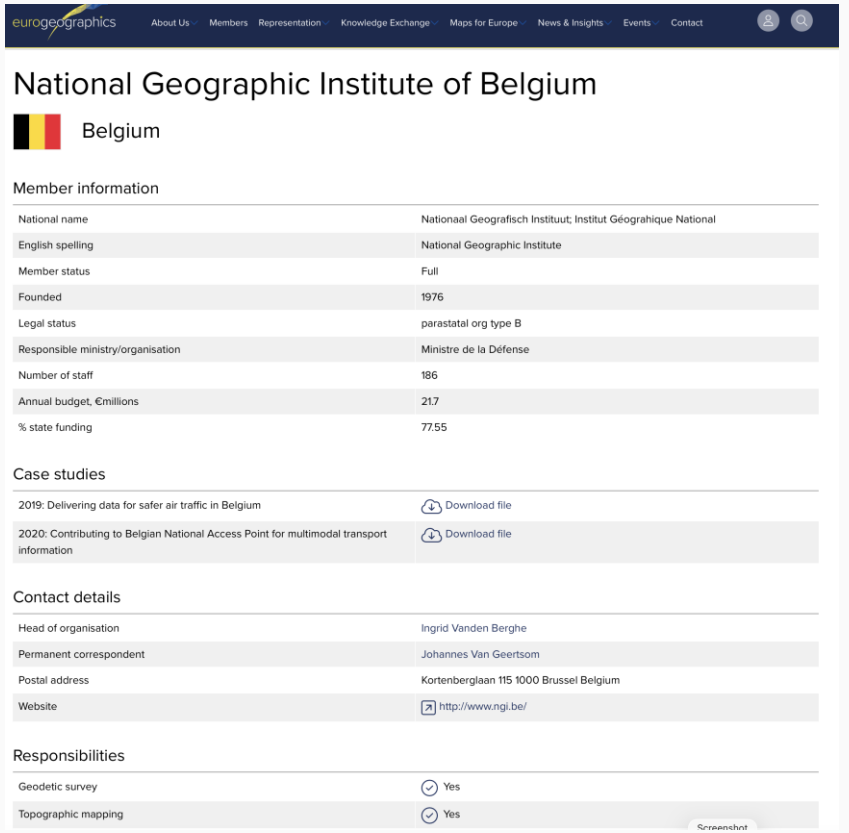
Group 5-7 (outliers) – Romania, The Netherlands, Norway

NMCAs Business Models – the starting point

EuroSDR

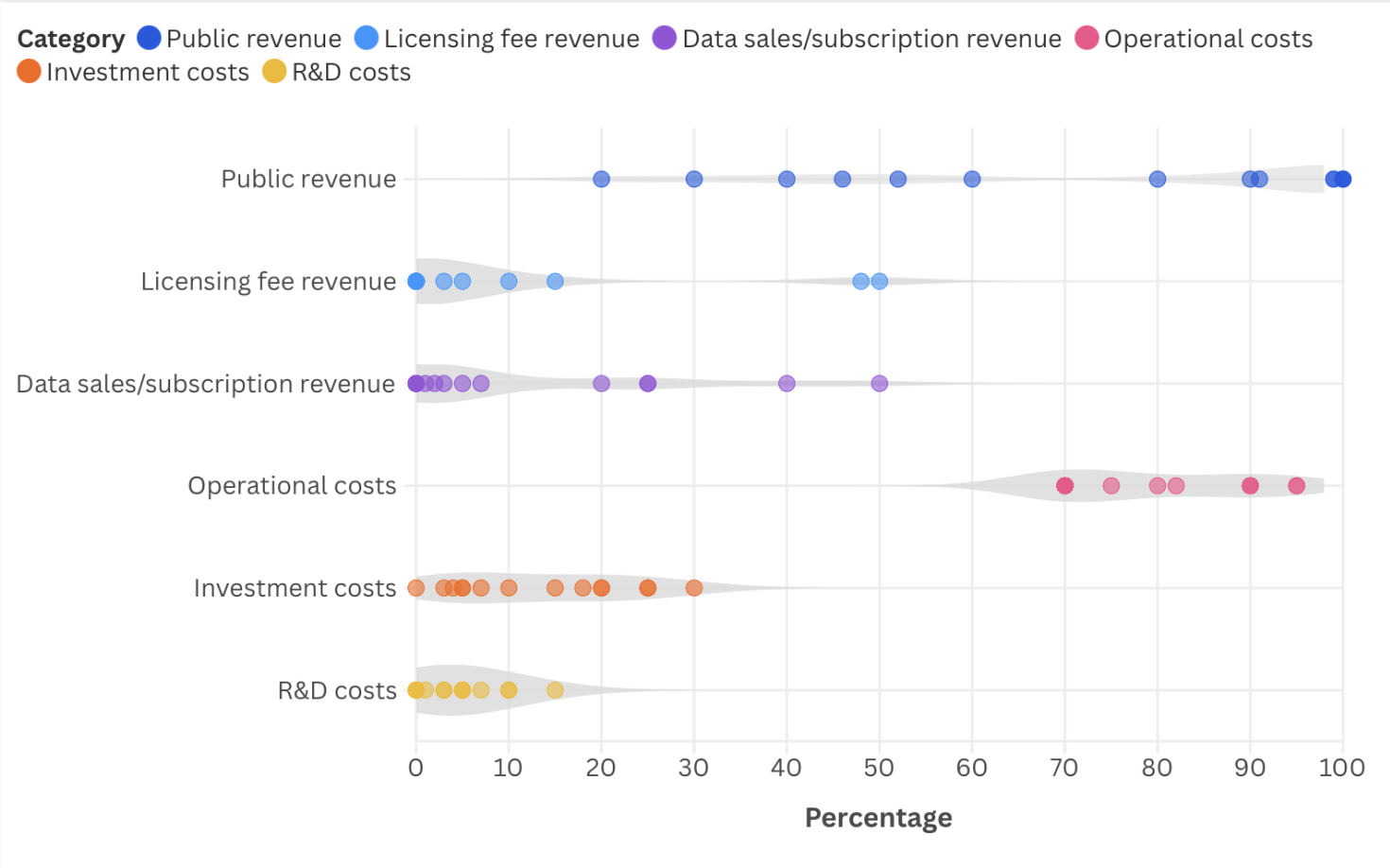
Key partners	Key activities	Value Propositions	Customer relationships	Customer segments
- Government - Cities & municipalities - Local self-governments - Academia - NGOs - Private sector companies - Citizens - International partners	- Producing geospatial information - Managing geospatial information - Distributing geospatial information - Add value to geospatial data and services - Leading geospatial information in a country	- Providing and managing authoritative geospatial data of a country	- Customer facilitation - Customer awareness - Customer acquisition - Customer retention - Customer loyalty - Customer satisfaction - On-demand support - Cooperation/Partnerships - Automated services - Self-service - Co-creation	- Data acquisition - Modelling, integration and processing - Information usage - Visualisation (cartography) - Business - Knowledge transfer
	Key resources - Human resources - Organizational resources - Technological resources - Data resources - Communication resources		**Channels** - Data value chain - Communication channels - Sales channels - Research & Development	
Cost structure - Organizational costs - Operational costs - Investment costs			**Revenue streams** - State budget - Financial loans/grants and donations - Service (SLA)/licensing fees - Intellectual property revenues (royalties, patents) - Membership fees - Crowdfunding - Others (sales, subscriptions, marketing, taxation)	

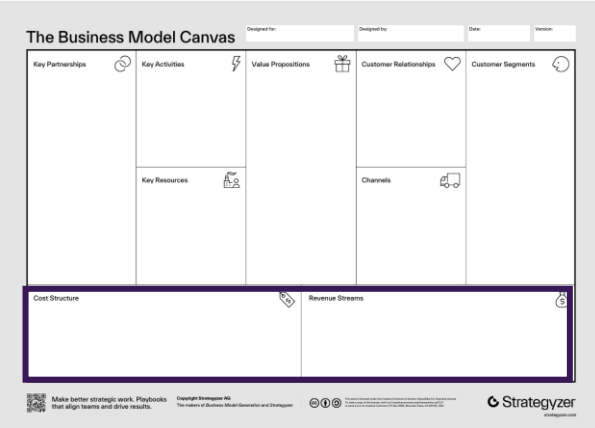
Figure 2: proposal for a generic Business Model canvas for National Mapping and Cadastral Agencies inspired by Alex Osterwalder and Yves Pigneur works (2011)



EuroGeographics

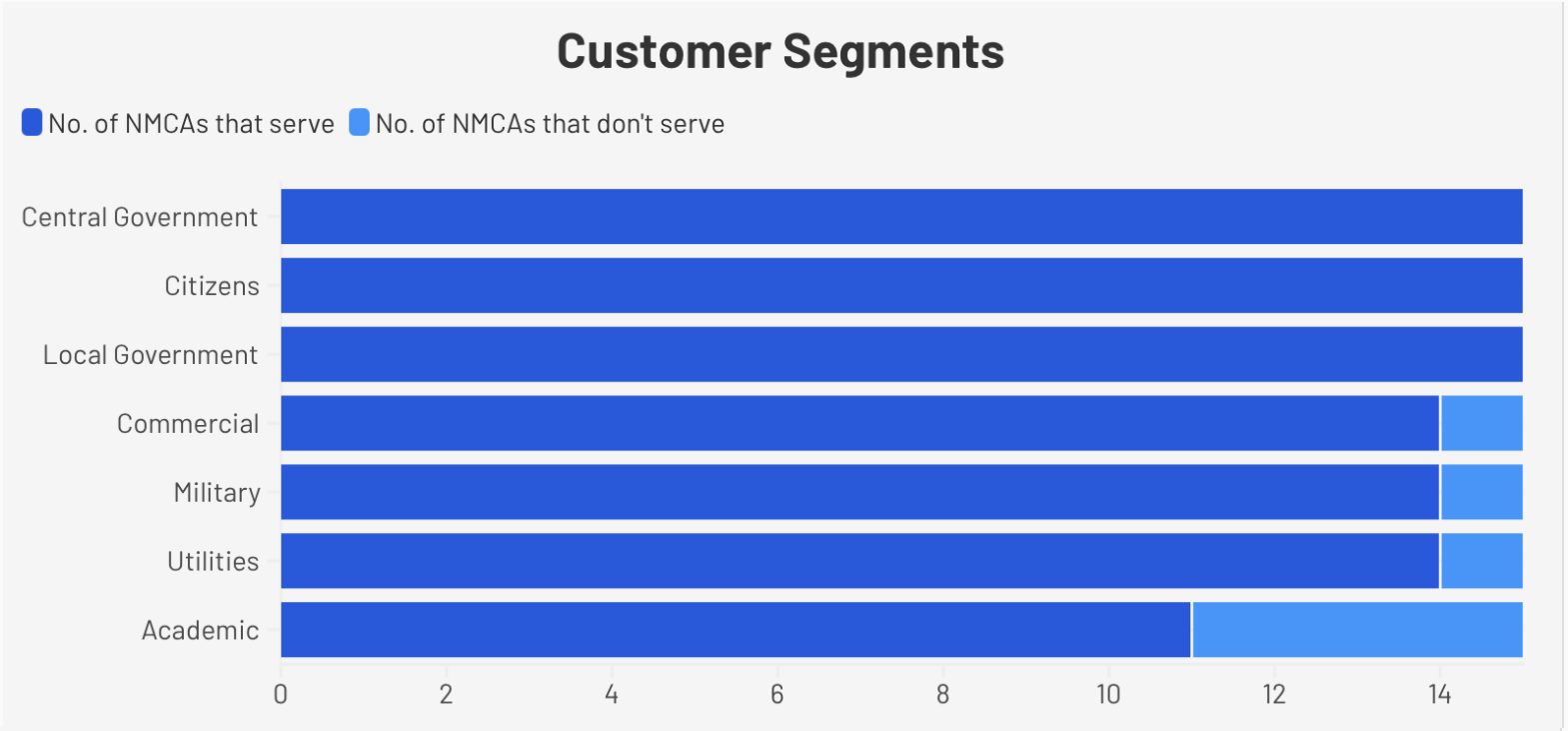
Revenue Streams and Costs.

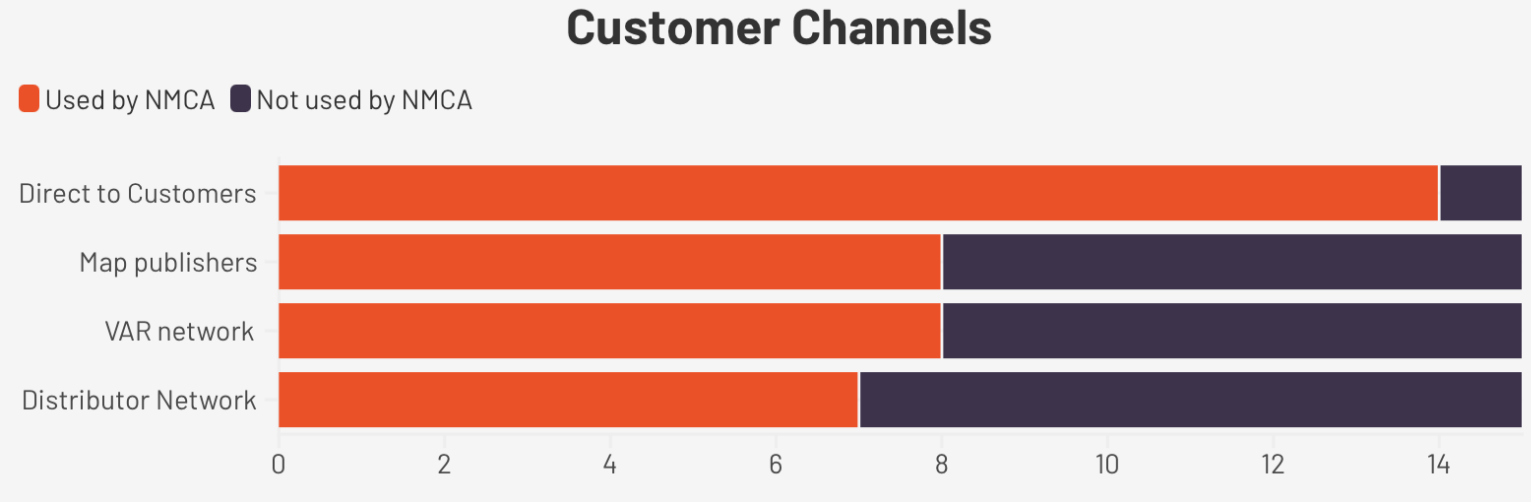


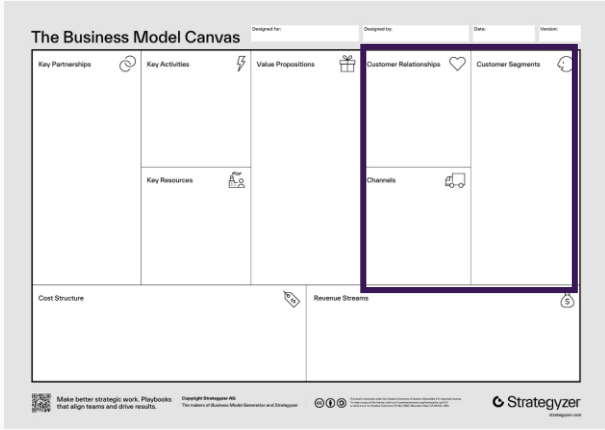


NMCAs have different revenue constraints and cost pressures.

Customers (users).



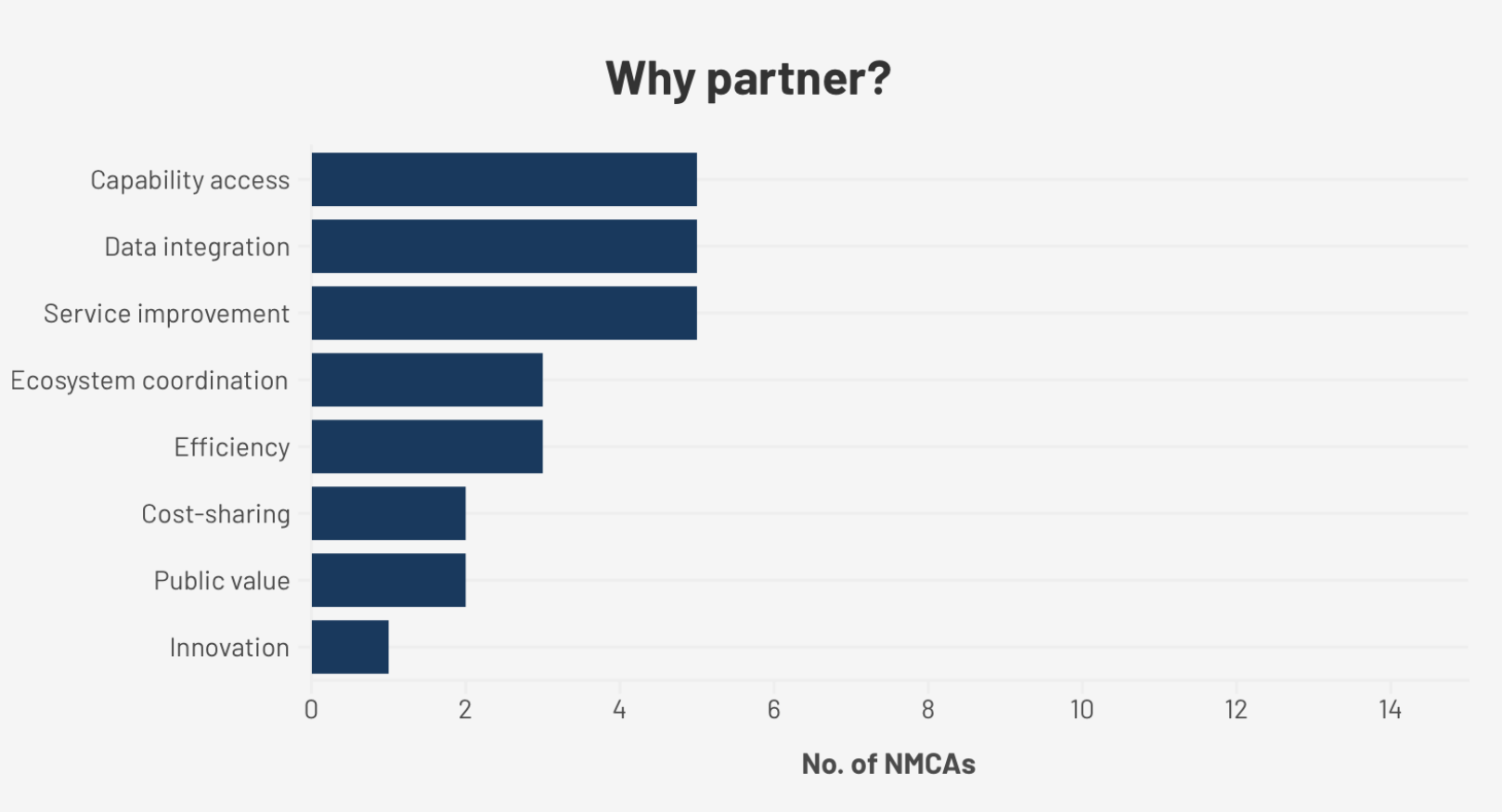


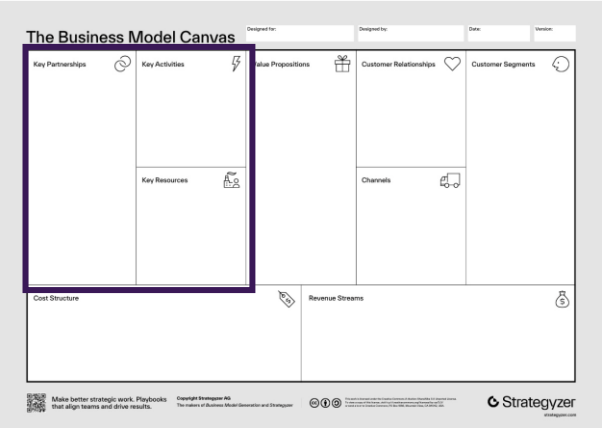


Consistency in customer segments but more variation in channels to customers.

Some NMCAs are closer to their customers than others.

Partnerships, activities and resources.

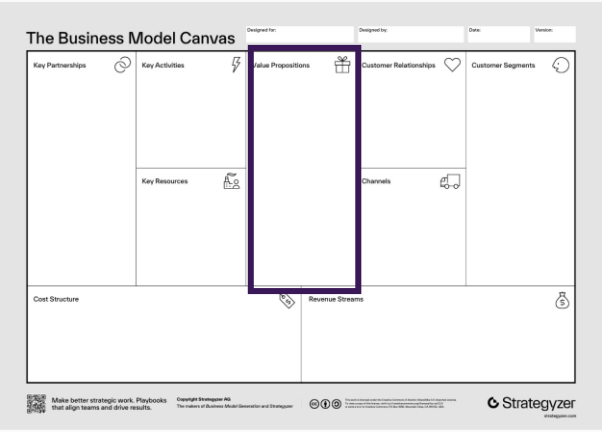


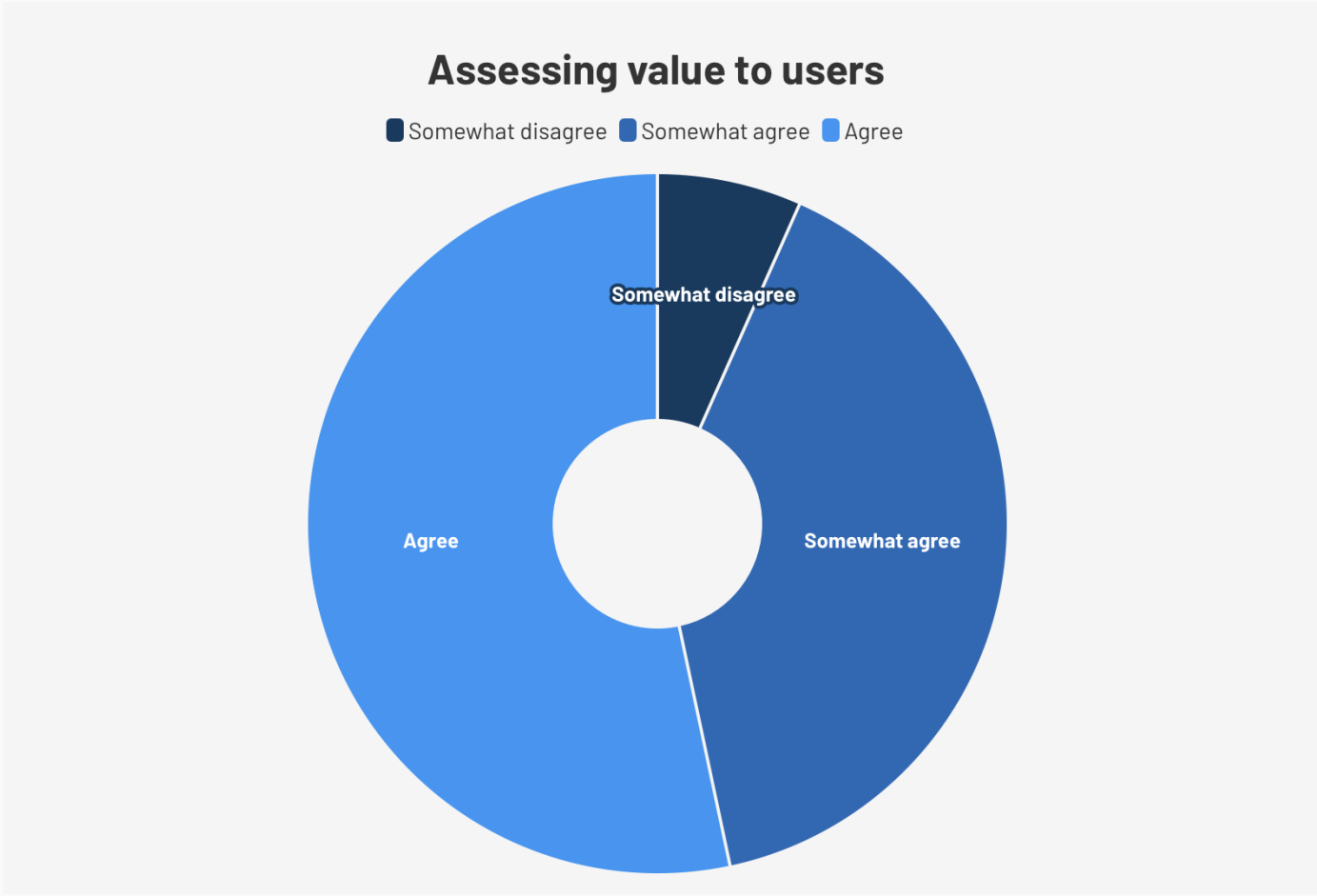


Partnerships are important for NMCAs and have many different purposes. **Constraints within NMCAs -> more reliance on partnerships**

Value Propositions

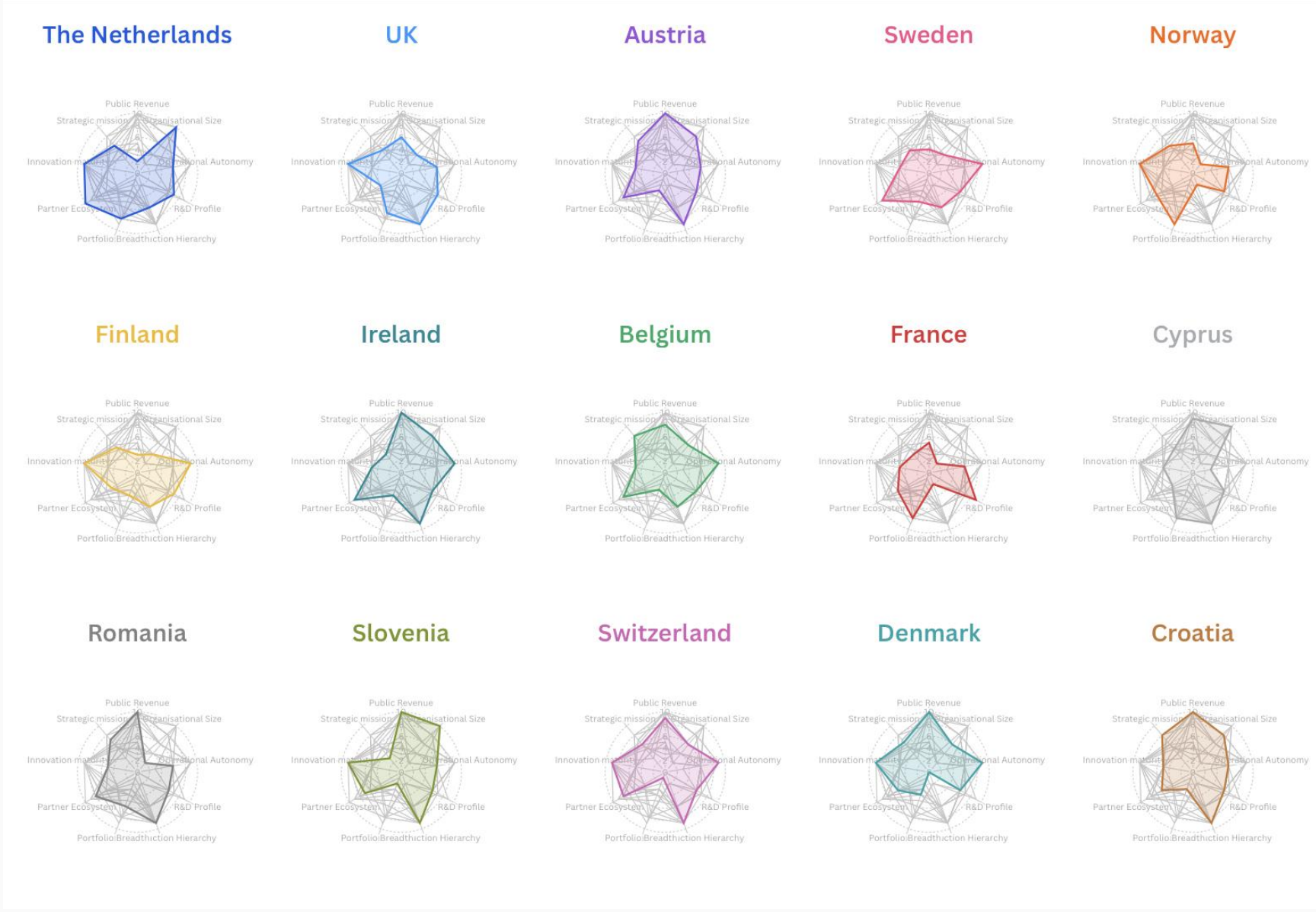
Breadth of products/services vary: 6-15





The majority of NMCAs do a form of value assessment with users though it is mostly via surveys or feedback forms and does not extend beyond direct users.

NMCAs are highly heterogenous.



Takes into account other aspects of the questionnaire: operational autonomy, missions and innovation maturities.

No "one-size-fits-all" approach to DTs.

Part 3

How NMCA data creates value in DTs and why it’s hard to capture.

Results from a conceptual analysis.

Value as a concept.

- Material/monetary worth; usefulness; importance; quality - *Oxford English Dictionary*
- Data: intangible, no inherent value until it is used and non-rivalrous (can be re-used without being used up) (Coyle and Manley, 2022).

But what about value in the context of Public Sector Geographic Information (PSGI) produced by NMCAs for DTs?

Five value types relevant to NMCA data in DTs.

Value Type	Description
Economic	Costs-avoided; productivity gains across sectors **(e.g. reduced duplicate data collection in DTs)**
Functional	Fitness-for-purpose for job-to-be-done **(e.g. reference layers enabling consistent asset/location joins)**
Societal	Public value outcomes with diverse beneficiaries **(e.g. authoritative addresses and road network for effective emergency response)**
Environmental	Improved forecasting, monitoring, mitigation **(e.g. using land cover, LiDAR and boundaries to estimate carbon stock)**
Knowledge-based	Learning, innovation **(e.g. re-use of historical LiDAR/imagery for unforeseen DT needs)**

Value is created beyond just the NMCA and the DT.

Existing methods to assess value (e.g. Osterwalder and Pigneur, 2010)

NMCA Value Attributes	Newness	Performance	Customisation	Getting the job done	Design	Brand/Status	Accessibility	Convenience
Provider of authoritative, unbiased GI		●		●		●		
National Hub of GI		●		●	●	●	●	●
Enabler of innovation / added-value	●	●	●	●	●	●	●	●
Socio-economic, societal focus		●		●		●	●	●
Expertise/Leading		●	●	●		●	●	
Ecosystem coordinator				●	●	●	●	●

Useful attributes to assess value but misses the infrastructure-like value of NMCA data in DTs, need additional attributes to capture this.

Osterwalder and Pigneur (2010) – Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers

Seven additional value enablers relevant to NMCA data in digital twin systems.

Value Mechanisms	Description
Foundational Infrastructure	Reference layers that others build on
Public Good Characteristics and Network Effects	Non-rival benefits and hard to exclude. Network effects created from shared IDs/references.
Interoperability, Standards and SDI Integration	Common schemas/identifiers and SDI reduce integration frictions (cost, risk, time)
Quality	Trust, lineage and assurance enable high stakes decisions
Historical context and option value	Archives enable trend analysis and future re-use
Cross Domain Integration	Multi-sector integration based on one spatial frame.
Spillover effects	Benefits accrue beyond the user so value is hard to attribute in a single business case.

Complex value attribution. We need a method that encompasses these mechanisms.

Challenge of communicating value (in business cases)

"8 NMCAs (n=15) record insufficient funding as a barrier to DT engagement, but only 3 state that NMCA's value to DTs is unclear" – *EuroSDR Questionnaire 2025*

Why?

Interpretation A: We understand the value we create but this is not legible to funders.

Interpretation B: Value is legible to funders, but other rules or constraints prevent capture.

To Conclude

- NMCA business models are highly heterogenous so DT guidance cannot be one-size-fits-all.
- DTs amplify the infrastructure character of NMCA outputs: existing value methodologies under specify NMCA value in DT systems.
- The issue is perhaps not recognising value but communicating and representing it.

For discussion:

- Can you elaborate on issues discussed in this presentation?
- What are your experiences with business cases for DT-related funding: What worked? What didn't?
- How do you think your business models need to adapt to support the foundations of DTs?

Questions?

Let’s continue the discussion:
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