Digital Twins in Action

Complexity Management Including Process Models and Workflow Standards

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Hazard Situations

- Homeland security
- Attacks in public places
- Bioterrorism
- Chemical hazards
- Cybersecurity
- Traffic accidents
- Drought
- Earthquakes
- Explosives
- Extreme heat
- Construction disasters
- Fires
- Floods
- Hazardous materials incidents
- House fires
- Chemical hazards
- Household hazards
- Hurricanes
- Mountain hazards Avalanches
- Mudslides and Debris flows
- Long-term unemployment
- Nuclear weapons / explosions
- Nuclear power plants
- Pandemics / epidemics
- Blackout
- Water safety
- Smog
- Snowstorms / extreme cold
- Space weather
- Storms
- Thunderstorms and lightning
- Hurricanes
- Tsunamis
- Volcanoes
- Pests
- Supply chains
- Critical infrastructures

Facets of Urban Resilience

We start from a holistic approach to information management for intelligent cities / smart cities, which is characterized by

- societal demands regarding massive pent-up demand
- current problems and challenges,
- more advanced requirements of urban infrastructures
- advanced technological development,
- internal security and disaster prevention,
- ecological / climatic perspective,
- social / sociological issues
- fractionalized production and supply chains

Facets of Urban Resilience

- Urban growth,
- Agglomeration,
- urban infrastructure,
- Dynamics of urban land use
- Urban health,
- waste management,
- climate change,
- well-being and quality of life
- Urban public safety, pollution,
- urban hot spots
- urban ecosystem services,
- environmental planning,
- urban management,
- artificial intelligence,
- urban hazards and societal impact,
- CRITIS critical infrastructures
- urban governance,
- intelligent solutions,
- urban space and planning,
- Internet of Things (IoT),
- intelligent transport systems (individual transport, rail-based transport, air transport, etc.)

Urban Digital Twin - The Principles

Principle 1 - Common good

Principle 2 – Value

Principle 3 – Quality

Principle 4 – Adaptability

Principle 5 – Openness

Principle 6 - Security and privacy

Principle 7 – Curation

Principle 8 – Standards

Principle 9 - Federated model

Principles for Spatially Enabled Digital Twins of the Built and Natural Environment in Australia https://www.anzlic.gov.au/sites/default/files/files/principles_for_spatially_enabled_digital_twins_of_the_built_and_natural_.pdf (übrsetzt)

Industrial ecosystems \ EU data spaces	Manufacturing	Green Deal	Mobility	Health	Financial	Energy	Agricultural	Legal	Procurement	Security	Skills	Open Science	Media	Cultural heritage	Tourism	Construction	Smart communities
Construction	✓	✓			✓	✓		✓	✓		✓	✓		✓		✓	✓
Tourism		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓		✓
Textile	✓	✓						✓	✓		✓	✓					
Proximity and social economy	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓
Mobility-Transport-Automotive	✓	✓	✓			✓		✓			✓	✓					✓
Health	✓	✓		✓				✓			✓	✓					
Energy intensive industry	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓				✓	✓
Energy renewables	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓				✓	✓
Retail	✓	✓	✓		✓		✓	✓			✓	✓			✓		
Electronics	✓	✓				✓		✓			✓	✓					
Digital industries	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓
Cultural and creative industry	✓	✓						✓			✓	✓	✓	✓	✓	✓	
Agri-food	✓	✓					✓	✓			✓	✓			✓		
Aerospace & Defence	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Mappings between industrial ecosystems and common European data spaces

Urban Digital Twins Ontologies

formal specification of a common conceptualization

- Terms
- Properties
- Relations
- Identity
- Status
- Context
- Annotation
- Role
- Causality
- Semantic networks
- Procedural networks

with the processing capabilities

Comparison, Union (merge), Generalization, Coherence Analysis

Urban Digital Twins Basic Elements of Information Management

- homogenized / coherent terminology / vocabulary
- formats (syntax)
- Metainformation (semantics)
- **Standardized workflows** (pragmatics)
  SOP- Standard Operating Procedures
- **just-in-time Analyses, Decision Support, Logistics, Automation**

Pragmatics / Process Management

Pragmatics Models

- Processes
- Web Service Compositions
- Workflows
- Action Models
- Behavior Models
- Event Chains
- Dependencies

applied in the formal ontologies for the management concepts of dynamic situations and operational decision and action, as well as in modeling goal reaching

Fig. 1: Pragmatics Models

Kremers, Horst: Global Programs and Conventions: Coherence and Mutual Synergies from Holistic Information Management. LNIS Lecture Notes in Information Sciences. Selected Papers. Geoinformation and Sustainable Development 9 (2020) 90-100, CODATA-Germany, ISBN 978-3-00-062981-5 https://tinyurl.com/GlobalProgramsCoherence2020

Standard Operating Procedures in Emergencies

The database documents the physical resources of each participating organization. For instance:

The Feeding Support Group enters information related to its resources and capabilities such as:

- Availability of a food pantry.
- Ability to provide meals (hot or cold).
- Availability of a mobile delivery service.
- Number of meals that can be served in one day during a disaster.

The Shelter Support Group enters information related to its resources and capabilities such as:

- Number of people the space that can be accommodated.
- Availability of volunteers to assist in staffing each shelter.

The Points of Distribution (POD) and Disaster Assistance Center Support (DAC) Groups enter information related to their resources and capabilities such as:

- Availability of site.
- Number of volunteers available to staff each site.

The Warehousing Support Group enters information related to its resources and capabilities such as:

- Dimensions of the space available.

The Volunteer Support Group enters information related to its resources and capabilities such as:

- Number of community volunteers available.
- Whether these volunteers can assist in mitigation activities (shuttering, debris removal).

The Services for the Elderly and Crisis Counseling/Spiritual Care Support Groups enter information related to their resources and capabilities such as:

- Number of volunteers available.
- Area in which these volunteers will serve.

The Mass Communication Support Group enters information related to its resources and capabilities such as:

- Availability of communication networks.
- Type of media used.

By documenting resources and facilitating communications, the M-D C.O.R.E. database assists in the overall collaboration of the disaster relief effort. This will include identifying resource gaps, reducing response time, and increasing the speed of recovery within the community.

Miami-Dade Communities Organized to Respond in Emergencies (M-D C.O.R.E.), Manual – Volume II, Standard Operating Procedures (SOP) 2015 32 p https://www8.miamidade.gov/core/library/manuals/manual-volume-2.pdf

Challenges in Process Models and Techniques for Urban Digital Twin Management

In addition to current basic efforts to achieve cross-instrument information coherence, future technical implementations will need to address decisions about the choice and possible change of innovation stages, as well as appropriate management methods and techniques in the areas of

- Cloud Computing, IoT, AI
- Situations Models, Facts, Actors, Documentation, Procedural Use
- Processes, Processes Groups, Chains, Networks,
- Standards
- Clearinghouses, Observatories, Testbeds
- Quality-of-Service Measures, Quality Management of Information (syntactic, semantic, pragmatic)
- Multiple Representations, Hierarchies, Generalisation, Abstractions
- Synergy Effects (cross-domains / cross-organisational / cross-border)
- implementing „just-in-time“ demands

Complex cross-domain and cross-organizational information models supporting just-in-time critical operations typically include a large number of variables and complex dependencies on functional, analytical, and operational constraints (resources, actors, time, space, facts, decisions, actions, affected people).

Recommendations for Action and Achievement of Objectives

- Recording of status and situation (information, processes, cause-effect relationships)
- Evaluations of documentation of previous experiences
- Requirement analyses incl. data management plans
- Decision support or online control?
- Strategic foresight (foreseeable and unforeseeable developments)
- Scenarios and their boundary conditions / alternatives
- Complexity management
- Feasibility and goal achievement
- Components, areas and synergies
- Prioritizations / negotiation of operational objectives
- Action plan / implementations / milestones
- a priori open source / testbeds (data, analyses, processes)
- Audits
- Realization, impact and success monitoring
- Improve resilience, security and sustainability simultaneously
- Ensure traceability

Thank you for your attention !

For more detailed presentations, further information, communication and cooperation please contact me at:

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