Output 2 Achievement document

Output 2 is the culmination of the project’s strategic, ecosystem-level activities into a vision document and a strategic innovation roadmap. The output is described as follows:

“The innovation roadmap is a high-level document developed with the aim of proactively identifying shared territorial challenges and innovation opportunities to take global leadership in the emerging market of smart port applications. It furthermore is a living vision translating the shared strategic needs for data-based innovation in the logistics sector into thematic priorities and development principles for the development of technology to meet the shared challenges.”

The ‘living vision’ is delivered in the form of the Smart Port Manifesto (https://www.smartportsecosystem.com/manifesto/), which is made public and further disseminated through a Smart Port Manifesto webinar in March 2021. The living aspect of the document means it will be put up for further interaction with port stakeholders who will b offered a chance to undersign the Manifesto and further enrich it.

The shared territorial challenges were identified by the XXASB. The short version is the following:

FIGURE 1: KEY DRIVERS AND BARRIER DOMAINS FOR THE DEVELOPMENT OF THE SMART PORTS MARKET

1. Push towards collaboration & integration
2. Availability of data mining opportunities
3. (ubiquitous) digital transformation
4. Resource shortages
5. The energy transition
6. Infrastructure automation
7. Globalization
8. Push towards sustainability

The opportunities were identified in the form of smart port application types: broad families of user applications where data-based technologies propel ports forward in terms of efficiency and resilience. An overview of these 22 application types, which were also integrated in the smart port maturity model, is shown below:

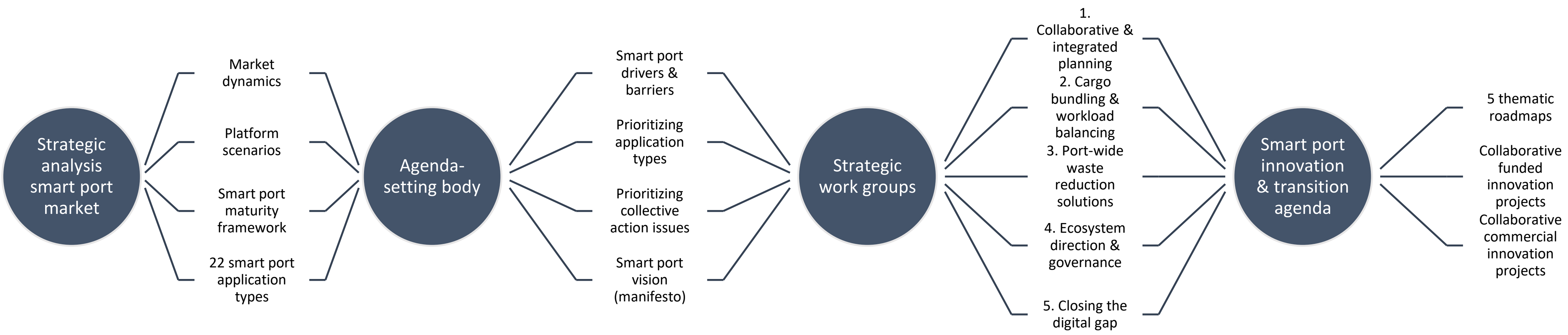
Application type	Description
Inter-port suspicious cargo notification and tracking solutions	This application type allows port stakeholders to be able to flag outgoing cargo for further inspection on arrival. Customs cooperation regarding incoming and outgoing ships may further curb malicious and misdeclared cargo. An example would be the Cargo Incident Notification System (CINS) that employs a shared database to identify deficiencies in cargo declaration and cargo packing among competing shipping lines. A relevant source for more info is: http://www.cinsnet.com/
Port-wide Intelligent anomaly monitoring solutions	The monitoring of aerial (e.g. drones), aquatic (e.g. underwater and vessel movements) and physical movements (e.g. IAM logs) in the port for anomalies
Pro-active Search and rescue solutions	Monitoring of the port premises (land and water) for accidents (slips, trips, contamination) to enhance a quicker response time and save lives. A relevant source for more info is: Port of Singapore Report Database - https://www.mpa.gov.sg/web/portal/home/about-mpa/annual-report
Port-wide Identity and Access Management (IAM) solution	Port stakeholders that access the port premises get one federated unique identifier (multi-factor authentication-enabled). Access is increasingly managed centrally. This increases simplicity and security. Auditing and reporting is then also possible.
Port-wide (Cyber) security management	A port-wide enforced security system that scans critical infrastructure and assets for vulnerabilities and allows to follow-up on them. Business continuity is ensured through fallback procedures.
Virtual fencing & Drone Surveillance	Drone detection of abnormalities, intrusions, suspicious behavior. Virtual fencing allows port stakeholders to get notified once unauthorized entry in prohibited areas is observed. A relevant source for more info is: Port of Singapore Report Database - https://www.mpa.gov.sg/web/portal/home/about-mpa/annual-report
Asset and Cargo damage inspection	Strain monitoring and fault-detection (e.g. micro-cracks, weld cracks, plastic deformation) through structural IoT health monitoring sensors will ensure timely intervention of equipment or cargo. This information can then be used for a quicker root-cause analysis. A relevant source for more info is: 2018 - Yang, Yongsheng; Zhong, Meisu; Yao, Haiqing; Yu, Fang; Fu, Xiuwen; Postolache, Octavian - Internet of Things for Smart Ports: Technologies and Challenges

(Semi)-Autonomous ships	Use of (semi)-autonomous ships for aquatic inspection, tugboats, fireboat, icebreaking, inland and short-sea shipping, assisted pilotage and assisted dredging. Relevant sources are: 2018 - Li, Suying; Ma, Zhenzhou; Han, Peitao; Zhao, Siyang; Guo, Peiying; Dai, Hepeng - Bring Intelligence to Ports Based on Internet of Things, https://www.aquaticdrones.eu/
Inter-port or inter-terminal workload balancing	To proactively avoid delays and congestion due to limited capacity, terminals and ports should be able to distribute the workload to optimize their utilization A relevant source for more info is: http://www.negenborn.net/rudy/projects_itt.html
Cargo Bundling platform	A platform matching demand and supply for trucks, terminals, (inland) barges & trains. Next to the cargo itself, the containers can also be repositioned to minimize unused equipment. A relevant source for more info is: Carlan, V., Sys, C., Calatayud, A., & Vanelslander, T. (2018). Digital innovation in maritime supply chains: experiences from Northwestern Europe.
Collaborative, integrated & predictive planning	Optimizing the planning process can lead to more predictable business outcomes by capturing more data on and integrating: arrival and departure planning, berth planning, handling planning, storage and yard planning, distribution planning and (corridor-based) modality planning. Planning can be optimized by enabling and fostering interactions between the relevant stakeholders. By allowing collaboration, exception management can be optimized, by fully integrating planning information asymmetry can be avoided, and based on the available data predictions can be made more accurate. Relevant sources are: Jiang, B., Li, J., & Shen, S. (2018). Supply Chain Risk Assessment and Control of Port Enterprises: Qingdao port as case study. The Asian Journal of Shipping and Logistics, 34(3), 198-208., Kamolov, A., & Park, S. H. (2018, June). An IoT Based Smart Berthing (Parking) System for Vessels and Ports. In International Conference on Mobile and Wireless Technology (pp. 129-139). Springer, Singapore.
(Fully) automated cargo handling	Use of automated equipment for (un)loading (automated quay and stacking cranes), distribution (Automated and intelligent guided vehicles), gate automation and truck appointments. This can be part of a Terminal operating system. Relevant sources are: Zhong, M., Yang, Y., Yao, H., Fu, X., Dobre, O. A., & Postolache, O. (2019). 5G and IoT: Towards a new era of communications and measurements. IEEE Instrumentation & Measurement Magazine, 22(6), 18-26., Jiang, B., Li, J., & Shen, S. (2018). Supply chain risk assessment and control of port enterprises: Qingdao port as case study. The Asian Journal of Shipping and Logistics, 34(3), 198-208., Yang, Y., Zhong, M., Yao, H., Yu, F., Fu, X., & Postolache, O. (2018). Internet of things for smart ports: Technologies and challenges. IEEE Instrumentation & Measurement Magazine, 21(1), 34-43., Heilig, L., & Voß, S. (2017). Information systems in seaports: a categorization and overview. Information Technology and Management, 18(3), 179-201.

Real Time Traceability-enabled cargo monitoring	Tagging of containers, pallets and other cargo types to provide traceability (location, temperature) for stakeholders involved through the entire supply-chain. Relevant sources include: Carlan, V., Sys, C., Calatayud, A., & Vanelslander, T. (2018). Digital innovation in maritime supply chains: experiences from Northwestern Europe., https://www.ocean-insights.com/, Heilig, L., & Voß, S. (2017). Information systems in seaports: a categorization and overview. Information Technology and Management, 18(3), 179-201.
(Emergency) Drone Deliveries	Use of Drones to do emergency deliveries of small high-priority parcels such as medical supplies or to quickly supply hard-to-reach areas (e.g. due to a fire).
Dynamic Digital Twin	A Digital Twin has multiple potential uses. It can convert multiple monitoring screens for vessel traffic management, to an easily comprehendible interactive, and thus dynamic, digital twin of the port. This can similarly be used for traffic management in the port. Another use would be to use it as a tool for simulations or to get an overview during emergencies. Relevant sources are: 2019 - Tedeschi, Pietro; Sciancalepore, Savio - Edge and Fog Computing in Critical Infrastructures: Analysis, Security Threats, and Research Challenges, Fernández, P., Suárez, J. P., Trujillo, A., Domínguez, C., & Santana, J. M. (2018). 3D-Monitoring Big Geo Data on a seaport infrastructure based on FIWARE. Journal of Geographical Systems, 20(2), 139-157.,
Digitized document flow	Digitization of all paper-based information flows. These procedures are related to logistics (customs handling, import and export declarations, transport orders, dangerous goods declarations, etc.) and other port related activities. Digitization of paper-based information flows also implies the use of document and case management systems. This entails information flows concerning G2G, B2G (Maritime Single Window) and B2B communication. A relevant source for more info is: Carlan, V., Sys, C., Calatayud, A., & Vanelslander, T. (2018). Digital innovation in maritime supply chains: experiences from Northwestern Europe.
Port-wide waste reduction platform and solutions	A platform measuring and matching port-wide generated wastes as inputs for port stakeholders and beyond. Many port stakeholders (e.g. BASF) are optimized at the company-level, but waste that they generate might be useful for other, yet unknown, stakeholders. A relevant source for more info is: Serrano, B. M., González-Cancelas, N., Soler-Flores, F., & Camarero-Orive, A. (2018). Classification and prediction of port variables using Bayesian Networks. Transport Policy, 67, 57-66.

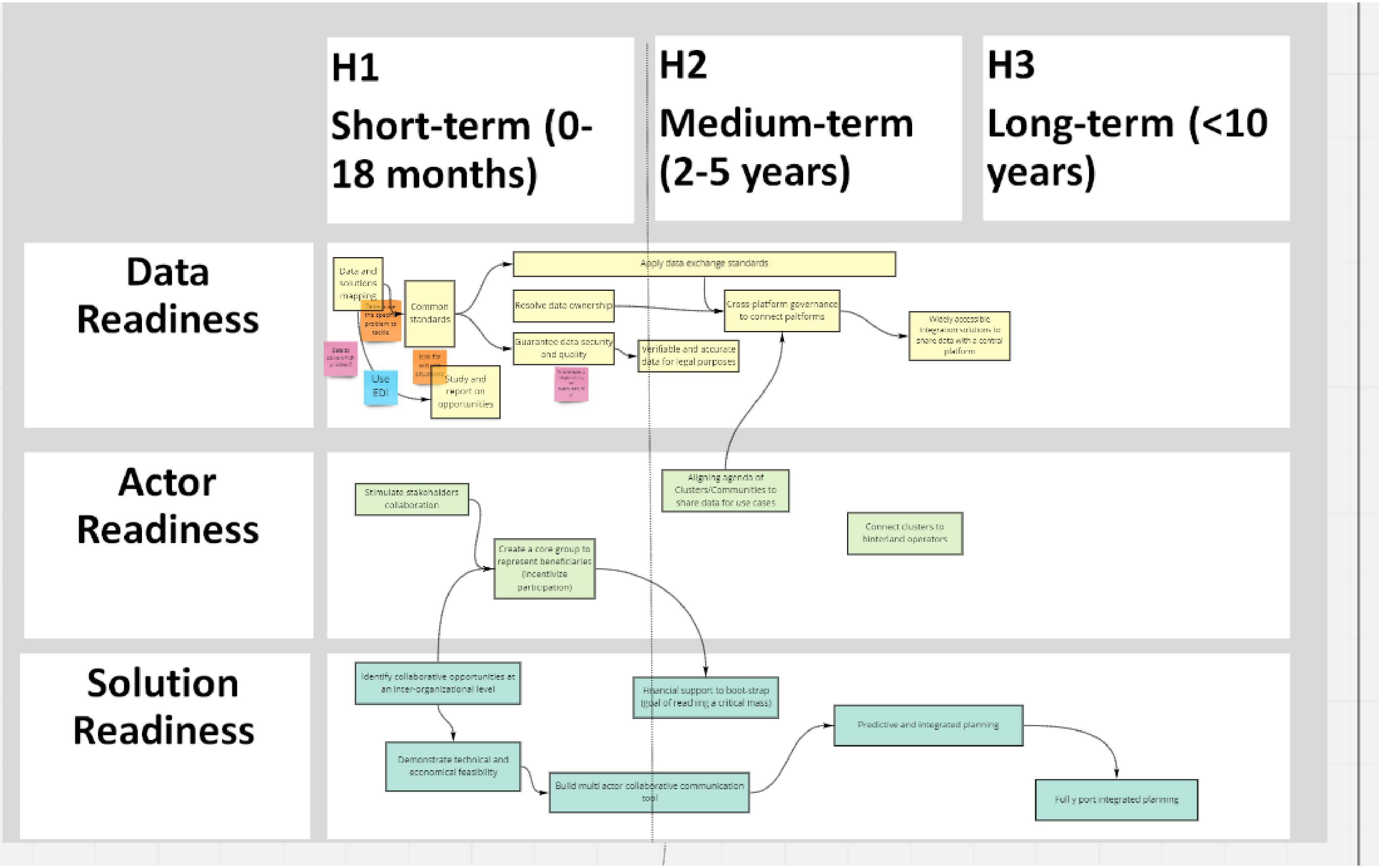
Integrated Emergency Response solutions	Once anomalies merge that cause casualties, economic and environmental damage. A system must be in place to broadly communicate and coordinate (and simulate) exercises to react with multiple agencies in unison against vessel incidents, biological infections, chemical and oil spills. Relevant sources are: Port of Singapore Report Database - https://www.mpa.gov.sg/web/portal/home/about-mpa/annual-report , Carlan, V., Heaver, T., Sys, C., & Vanelslander, T. (2016). Oil spill response in/and around the North-west European ports.
Real-time Noise, Air (PM, NOx, SOx, COx), Sediment & Water quality measurement	Dashboards and notification tools to measure and track the source of pollution. This enables quicker resolution of complaints regarding the source of discharge of undesired compounds. A relevant source for more info is: Serrano, B. M., González-Cancelas, N., Soler-Flores, F., & Camarero-Orive, A. (2018). Classification and prediction of port variables using Bayesian Networks. Transport Policy, 67, 57-66.
Energy consumption reporting & compliancy solutions	This entails applications that can be used for energy use management. This may include monitoring and control requirements of environmental management systems (EMAS & ISO 14001). A relevant source for more info is: Serrano, B. M., González-Cancelas, N., Soler-Flores, F., & Camarero-Orive, A. (2018). Classification and prediction of port variables using Bayesian Networks. Transport Policy, 67, 57-66.
Energy Use optimization solutions	Energy use optimization tools turn knowledge of required energy use into actionable energy use optimization. This can entail smart energy port infrastructure (e.g. movement sensor-enable road/yard lighting, smart grid infrastructure to optimally distribute excess energy, shore-side power supply etc.), port activities (e.g. pro-active data-based dredging) and smart ships (e.g. greenhouse gas optimal routing). Relevant sources are: Jun, W. K., Lee, M. K., & Choi, J. Y. (2018). Impact of the smart port industry on the Korean national economy using input-output analysis. Transportation Research Part A: Policy and Practice, 118, 480-493., Tan, K. W., Kan, M., Tan, P. J., & Schablinski, S. (2018, October). A Framework for Evaluating Energy Sustainability Efforts for Maritime Smart Port Operations. In 2018 International Conference on ICT for Smart Society (ICISS) (pp. 1-5). IEEE., Molavi, A., Shi, J., Wu, Y., & Lim, G. J. (2020). Enabling smart ports through the integration of microgrids: A two-stage stochastic programming approach. Applied Energy, 258, 114022., Jović, M., Kavran, N., Aksentijević, S., & Tijan, E. (2019, May). The Transition of Croatian Seaports into Smart Ports. In 2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO) (pp. 1386-1390). IEEE.

These challenges and opportunities were prioritized into 5 priority themes, around which work groups were formed, through the process depicted below:

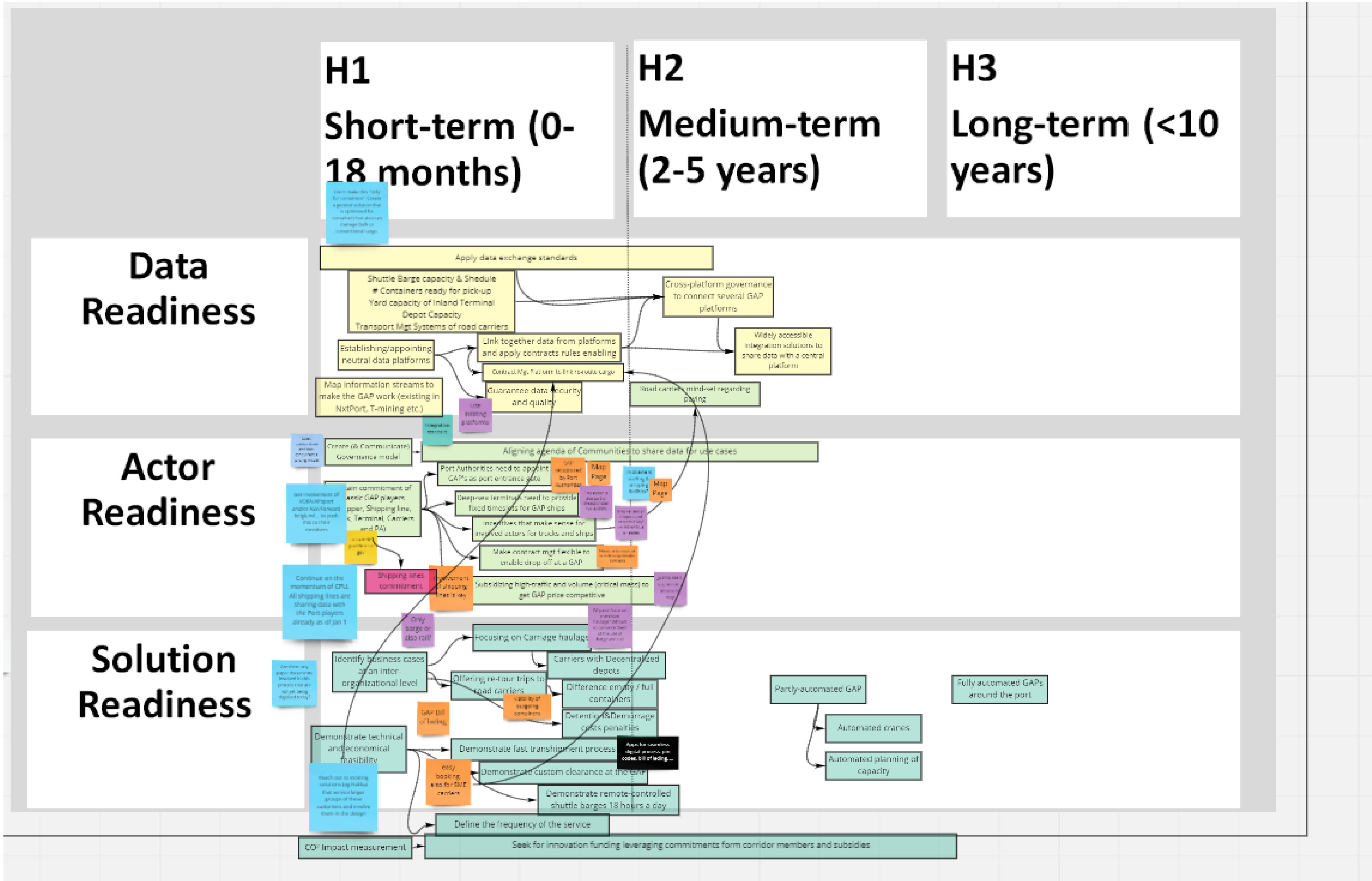


Aside from the Manifesto, the prioritized challenges and application type opportunities, these work groups also delivered input for a thematic roadmap defining actions to tackle the opportunity or collactive action challenge, along three time horizons. These roadmaps are shown below:

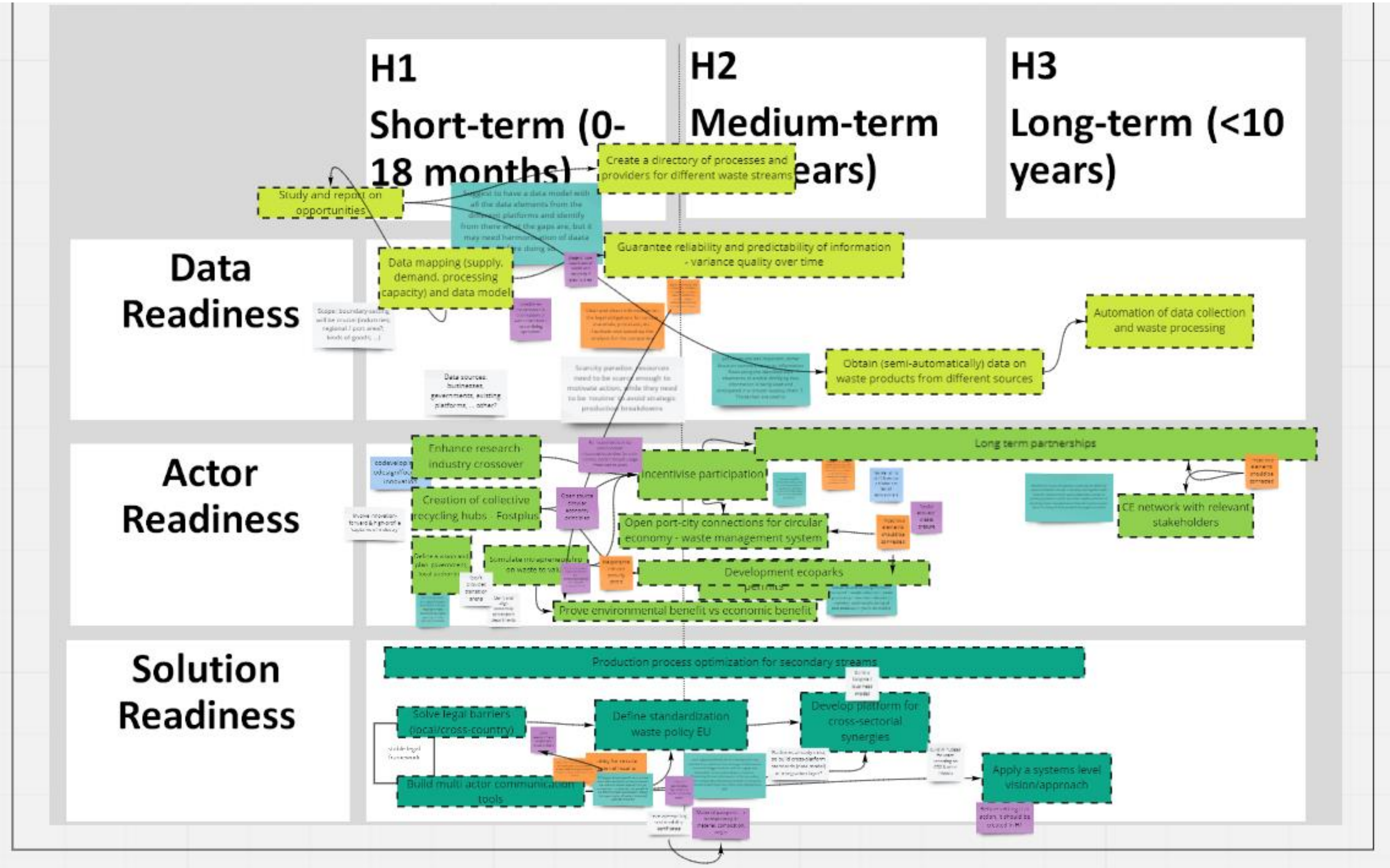
- Work group 1 – Collaborative, integrated and predictive planning



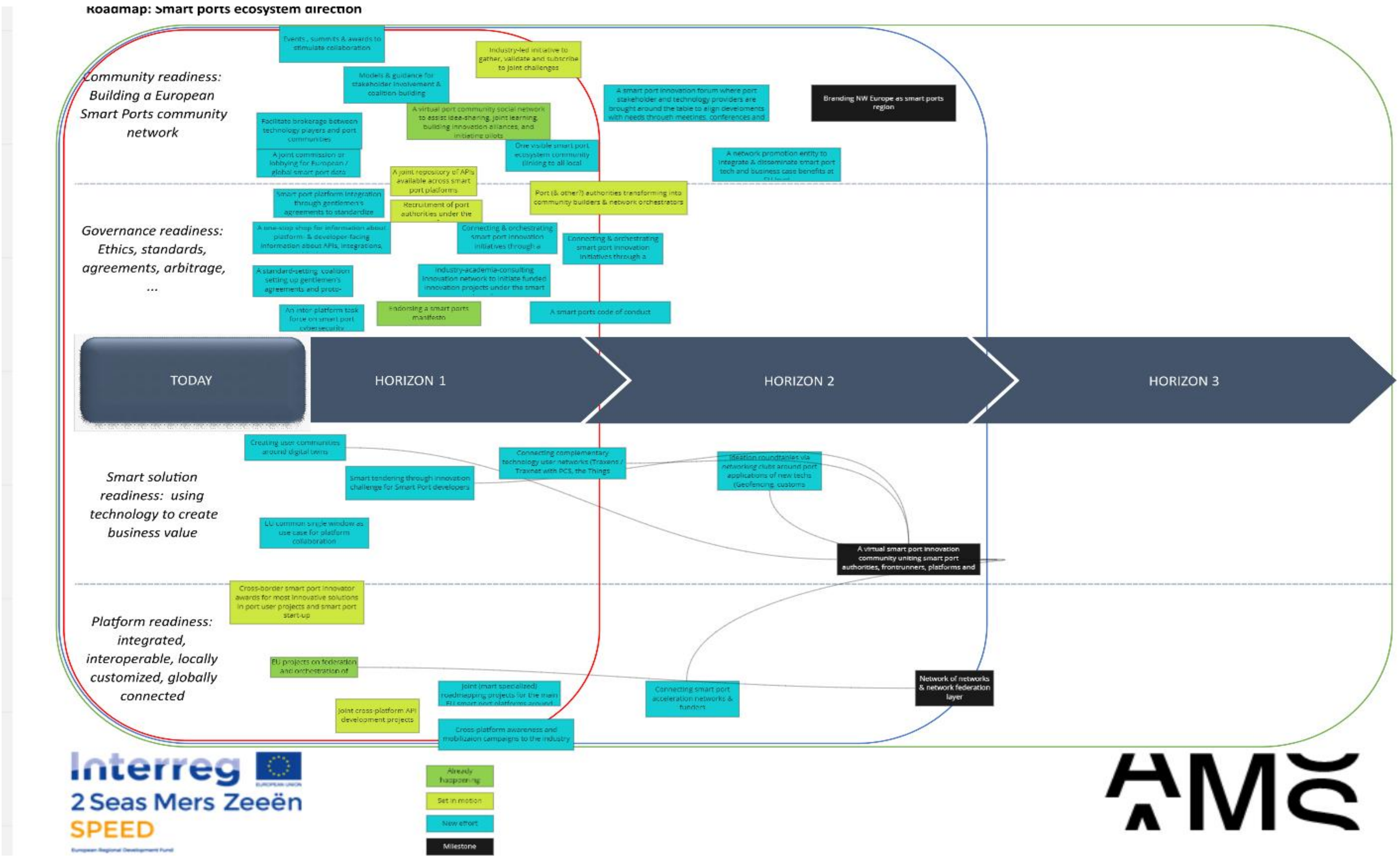
- Work group 2 – Cargo Bundling: https://miro.com/app/board/o9J_lezQc-A=/


H1
Short-term (0-18 months)
H2
Medium-term (2-5 years)
H3
Long-term (<10 years)
Data Readiness
Actor Readiness
Solution Readiness
Apply data exchange standards
Shuttle Barge capacity & Shedule
Containers ready for pick-up
Yard capacity of Inland Terminal
Depot Capacity
Transport Mgt Systems of road carriers
Cross-platform governance to connect several GAP platforms
Establishing/appointing neutral data platforms
Link together data from platforms and apply contracts rules enabling
Widely accessible integration solutions to share data with a central platform
Map information streams to make the GAP work (existing in NxtPort, T-mining etc.)
Guarantee data security and quality
Road carriers mind-set regarding paying
Use existing platforms
Create (& Communicate) Governance model
Aligning agenda of Communities to share data for use cases
Port Authorities need to appoint GAPs as port entrance gate
Map Page
Deep-sea terminals need to provide fixed timeslots for GAP ships
Incentives that make sense for involved actors for trucks and ships
Make contract mgt flexible to enable drop-off at a GAP
Shipping lines commitment
Subsidizing high-traffic and volume (critical mass) to get GAP price competitive
Continue on the momentum of CPU. All shipping lines are sharing data with the Port players already as of jan 1
Only barge or also rail?
Focusing on Carriage haulage
Identify business cases at an inter organizational level
Carriers with Decentralized depots
Offering re-tour trips to road carriers
Difference empty / full containers
GAP bill of lading
Detention&Demurrage costs penalties
Demonstrate technical and economical feasibility
Demonstrate fast transhipment process
Demonstrate custom clearance at the GAP
easy booking, also for SME carriers
Demonstrate remote-controlled shuttle barges 18 hours a day
Define the frequency of the service
CO² Impact measurement
Seek for innovation funding leveraging commitments form corridor members and subsidies
Partly-automated GAP
Automated cranes
Automated planning of capacity
Fully automated GAPs around the port

- Work group 3 – Port circularity: https://miro.com/app/board/o9J_lYzlY2Y=/



- Work Group 4 – Ecosystem direction: https://miro.com/app/board/o9J_klqnEmc=/



- Work group 5 – Closing the digital gap: For this work group the final roadmap was not yet validated by the group, nor is the action plan developed, but the basic roadmap structure of priorities along Horizon 1, 2 and 3 has been delivered (see below): https://miro.com/app/board/o9J_kjhZWC8=/