Green Inland Ports

Good Practices

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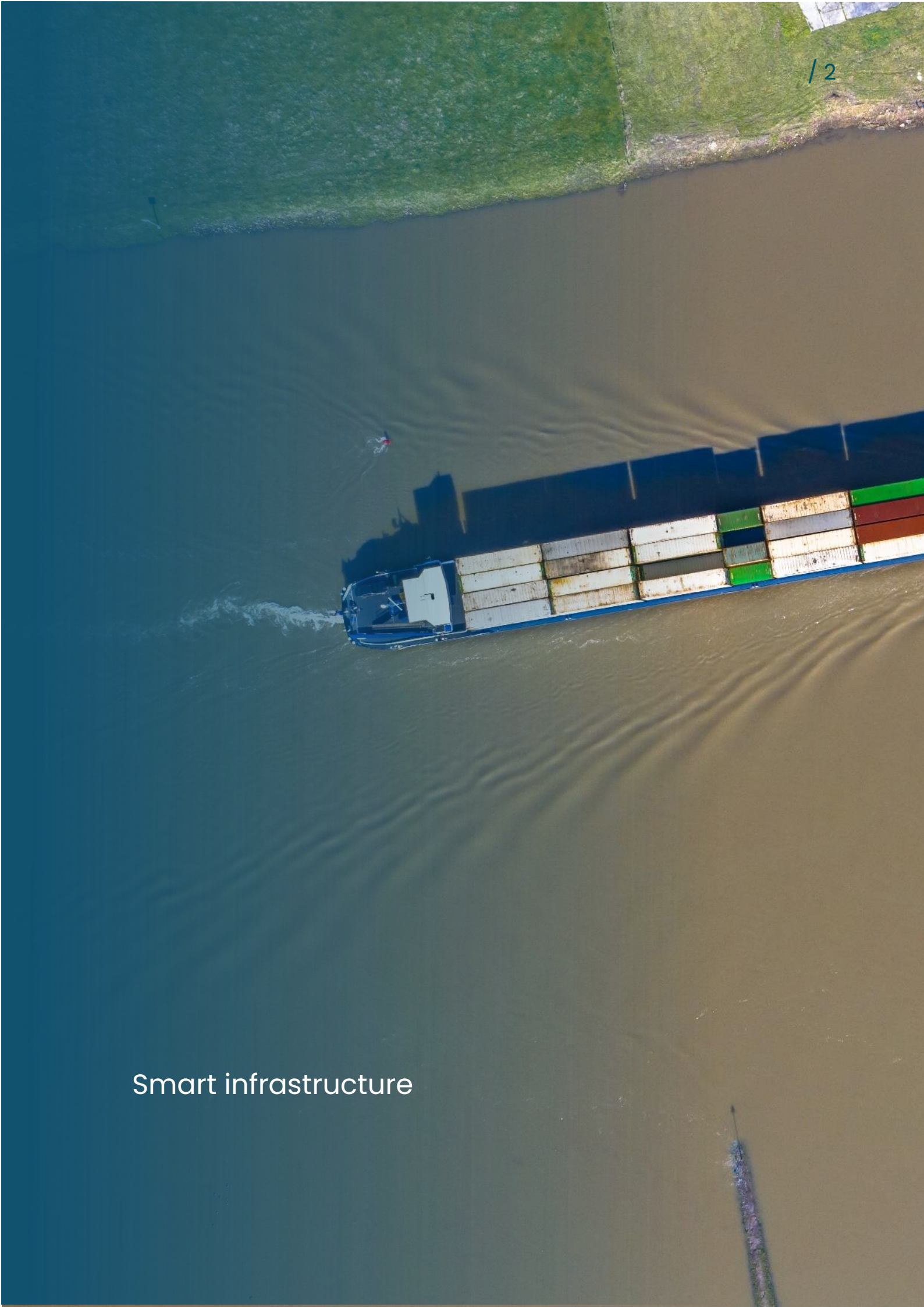

Smart infrastructure

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1.1 Description

According to Japan P&I Club (2018), nearly 90% of the total marine accidents are caused by human errors. Specifically, incidents such as collisions, groundings, and damage to harbour and fishery facilities are almost entirely caused by human mistakes. Among these, approximately 61% are due to incorrect manoeuvring decisions. Smart infrastructure can play a vital role in supporting skippers during manoeuvring to reduce such errors.

An example of such a system is **SmartKai**: a ship-independent port-side assistance system which supports mooring, passage and lock manoeuvres where sight is crucial but limited. The system makes use of different technologies, including lidar sensors, to determine distances and vessel speeds quickly and precisely. It is used to develop a comprehensive picture of the environment/conditions on site. This minimises the risks of potential ship and port infrastructure damage, which may result in property damage, personal injury, environmental pollution or prolonged port blockages (DLR, 2022; Niedersachsen Ports, n.d.).

SmartKai monitors each manoeuvre in real-time as it uses virtual reference points which provide information on the position of the ship's bow, stern and shoulder relative to the quay, and provides an overview of what is happening in the harbour. In the event of an accident, the accident investigation can be supported by a certified, detailed digital report of the entire manoeuvre (MARIVATION, n.d.). SmartKai is being tested by Niedersachsen ports.

Even though SmartKai has originally been set-up for seagoing vessels, it could also be implemented for inland waterway traffic and ports according to Feuerstack (2024). The following inland cases are currently being addressed with SmartKai:

- Lock passage and assistance, of which the system is already running 24/7;
- Under-bridge Clearance, which is still in the pilot phase;
- Precise ship positioning for automated bulk material loading facilities, e.g. grain loading including automated tilt/trimming problems detection - especially for loading facilities with high throughput. This application has been requested, but has not been implemented yet;
- There have been recent accidents with port infrastructure and the system can be also used to observe moored vessels within inland ports.

1.2 Aim

The direct aim of this measure is to prevent situations in which ships damage port infrastructure or property. Environmental pollution can be a secondary consequence of a collision which should be minimised as much as possible. In addition, identifying the causes of damage directly is a significant step forward and help to counteract and eliminate these causes (eMIR, n.d.). The added value of the SmartKai system is greatest when it is active and networked throughout the port and can be used by all arriving vessels and all data is available to the port. However, the system can also be operated

from a single terminal as an assistance system, with the data available to vessels arriving at that terminal and to the aligned terminal operator (Bathmann, 2024).

1.3 Ports with smart infrastructure

- Niedersachsen Ports

1.4 Stakeholders

- The port authority: the implementing party of this technology who partly experience part the benefits in the form of less damage to port infrastructure. The impact of the SmartKai system is optimal when the port authority implements the system, so that all arriving vessels can utilise it.
- Terminals: It is possible that a terminal implements the SmartKai system, so that only vessels arriving at that terminal can utilsze it.
- Ships that want to navigate within the port area that can use this technology.
- Hardware and software developers.

1.5 Voluntary or mandatory

The technology is currently voluntary and remains in its pilot phase. Test runs are being conducted with the system using a research vessel and a port operation ship, applying different speeds, attack angles, distances to quay and manoeuvres. This means that it is not possible yet to apply on a larger scale. When the technology is ready, it would make sense to make its use mandatory. Particularly in high-pressure situations—such as those involving heavy traffic or other challenging conditions—that increase the risk of damage.

1.6 Realised/potential impact

The SmartKai system has ran a three-day test campaign in Wilhelmshaven in 2020. During the first successful field test, 20 scenarios have been developed. The test system and data recording ran reliably during the three-day campaign. Project participants agreed that the conditions are now in place to make the Hannover quay system winter-proof and storm-proof for the next six months.

SmartKai has been active in Cuxhaven since 2021. The system has reported over 1,000 manoeuvres and has been proven to function under harsh weather conditions. The sensors can be retrofitted to existing infrastructure or positioned flexibly due to the high-resolution sensors used. Distance and approach speed to the lock gate can be measured without placing sensors on the gate itself (MARIVATION, n.d.). Long-term studies to determine the reduced accident rate through the SmartKai system have not yet been executed, but feedback has been received from captains and pilots during on-board tests that the display of the position of the entire ship's contour improves situational awareness, especially in poor visibility (Bathmann, 2024).

1.7 Possible obstacles

- The reliability of the system was the main challenge during the development, as this is a safety-relevant application and measurement errors must therefore be avoided at all costs. The accuracy in terms of sensor alignment, data fusion and calibration to achieve centimetre accuracy of the specified distances to the quay can be regarded as challenging (Bathmann, 2024).
- The system must be available during every manoeuvre. Data filtering to correctly identify the ship's silhouette has been challenging even under rain, fog and wave measurements. Hybrid ports may experience large tidal ranges. Cuxhaven, where SmartKai has been tested, is subject to large tidal changes (Bathmann, 2024).
- Independence of the ship detection from the size and type of ship is important, as the SmartKai system needs to be able to assist every arriving vessel (Bathmann, 2024).
- The costs of the system can be regarded as substantial depending on the size of the port. Estimates are that the SmartKai system costs approximately 1% of the total infrastructure value that the system protects against damage caused by collisions (Bathmann, 2024).

1.8 Key learnings

- Nearly all (marine) collision accidents have been caused by human error. This can be prevented by a ship-independent port-side assistance system, which uses sensors to prevent collisions between ships and port infrastructure and is able to investigate the cause of an accident in the harbour.
- Even though long-term effects have not been quantified yet, feedback from skippers has been very positive, as situational awareness increases a lot due to SmartKai and this is especially effective in poor visibility.

1.9 Sources

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