INTRODUCTION TO THE CONCEPT

The smart pier concept is based on four main themes, which are visible in all areas of the concept: smart technology, modularity, suitability and adaptability. The concept’s design draws from a storehouse-centric approach and the woodland scenery that is characteristic of Finland. The distinctive design language and the concept’s themes support the potential productisation of the concept into an export product. Internationality has been taken into account in the design from the outset.

The smart pier is largely based on mass-produced modules that enable a cost-effective and modular concept. The possible layout solutions are endless, guaranteeing a unique solution with a recognisable design language. The grid infrastructure that will be placed between the floating pier module and various layout options will enable the site and any services it requires to be customised, taking seasonal variation into account.

The concept is based on the assumption stated in the commission that the smart pier will be piloted in Turku, with the site located in the Aura River. The site provided certain dimensions and limits for the concept’s design. At the moment, the largest planned smart pier module will serve ferries up to 20 metres in length when moored by the flank. When moored by the bow or stern, the size of the ferry will depend on the location of the smart pier. The disembarking height of moored ferries may be a maximum of approximately 1.5 m. The small boat module will serve small boats at normal pier height. However, the smart pier concept is designed to allow the size (and height) of the pier module to be scaled in both directions to serve several different sites and purposes.

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The smart pier concept serves residents, tourists, private entrepreneurs, companies, possible ferries, public organisations and the city of Turku, transforming the popular Aura River area into a hub of services and events.

SUMMARY

ÄlyVESI – Smart City Ferries is a 6Aika project funded by the ERDF. ÄlyVESI is a conceptualisation, product development and innovation project between cities, companies and institutions of higher education. The purpose of the project is to develop smart solutions and services for the transport of people on urban waterways. One objective was to generate ideas and create a concept for an autonomous smart pier that will be capable of supporting ferries of the present and the future as well as provide residents with a new meeting place and event venue, increasing the range of services and events available. The smart pier concept is part of the ÄlyVESI project.

Remotec Oy, Satu Salmela
ÄlyVESI project, smart pier concept
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Figure 1 - Illustration of a smart pier (1)
Figure 2 - Illustration of a smart pier (2)
SMART TECHNOLOGY – Supports smart infrastructure

Our current advancements in technology enable almost all operations and structures to be ‘made smart’. In practice, this means cost-effectiveness, user-friendliness and proactive operations that significantly ease the life of ordinary people.

Smart technology can be used to change the visual appearance according to seasonal events (Christmas, Easter, May Day, Midsummer, etc.) or the themes of one-time events, such as Medieval Turku, DBTL, Tall Ships Races, etc.

Visual appearance can be influenced in the following ways:

- **Lighting**
  - RGB LED lights in ‘birch trees’ and on railings allow the colour tone and atmosphere to be changed
  - Opportunity for theme-based lighting (would support the concept of the Fabulous Aura River, for example)
  - Lighting the water area surrounding the pier with RGB lights
  - The lighting adapts to the surrounding brightness and also functions as an effect during the day
- **Information displays and transparent (OLED) display panels**
  - The chosen theme or atmosphere can be supported by editing the wallpapers and content of information displays and adapting their colour scheme to suit the ‘theme lighting’
  - If necessary, transparent OLED displays can be used as ‘windows’ to feature information or graphics that support the theme
- **Easily replaceable surface elements**

However, at best most smart functions are unnoticeable to the users. They operate in the background, directing and guiding users. They also warn users about various dangers and prevent them. The smartness of the systems also provides a great deal of data on various sites’ visitor numbers and the movements of the crowds within and near the pier areas. This ‘heat mapping’ data may be valuable in the future.

Guiding functions of the smart pier:

- Illuminated smart guidance system (crowds from the pier to a ferry and vice versa)
- Gates operated with a motion sensor or QR code (ticket inspection)
  - In the case of public/ferry transport subject to a fee
- Clear signage on information displays

Functions related to safety:

- **Fire safety**
  - Fire alarm system (traditional & utilisation of cameras)
  - First-aid fire extinguishing equipment at the pier
  - See Also choices of material
- **Smoke alarm**
See Fire safety
Can be deactivated

General safety
- Recording video surveillance and applying pattern recognition
- Surveillance of the periphery of the pier with a thermographic camera and an automatic alarm system that alerts about persons in the water enable an automatic alarm if someone falls overboard and a lifebuoy to be thrown based on data provided by the thermographic camera
- Emergency exit signage on information displays

Functions related to services:
- Remotely controlled power distribution points in the guest harbour module
  - Enables services without personnel
- AV capability (cable trays and connections)
  - Supports the use of the module during events and concerts
- Information boards (guidance, instructions, advertising, etc.)
  - Real-time departures
  - Safety instructions
    - Locations: Walls of storehouses and ‘trunks of birch trees’
- Refuelling
  - If electricity is available, electrically powered vessels can be charged at the smart pier
  - The concept does not technically exclude the possibility of fuel distribution and storage, but its implementation requires more detailed further review with regard to environmental laws and regulations
  - The Finnish Government has enacted a decree on the environmental protection requirements for liquid fuel distribution stations, which defines these rules in more detail
  - Among other things, the decree states that:
    ‘The location must be such that the water table or water level does not cause harm to the fuel tanks, fuel transfer equipment, soil or groundwater protection structures or the sewerage’
  - For more information on the protection of soil and groundwater (Section 6), treatment and channelling of oily wastewater (Section 7), and periodic inspections on equipment and structures (Section 12) see: [https://www.finlex.fi/fi/laki/alkup/2010/20100444](https://www.finlex.fi/fi/laki/alkup/2010/20100444) (in Finnish)
  - Permit matters also vary by municipality:
    ‘The municipal environmental protection authority decides on environmental permits for operations regulated under Paragraphs 2 to 4 of Subsection 2 of Section 28 of the Environmental Protection Act and the following operations regulated under Section 1 of the Act, unless otherwise stated in Subsection 1 of Section 31 of the Act or above in Section 5’ ([https://www.finlex.fi/fi/laki/alkup/2010/20100235](https://www.finlex.fi/fi/laki/alkup/2010/20100235)) (in Finnish)
  - A separate land module can be designed for small boats (guest harbour module) for refuelling, discharging waste generated aboard the vessel and pumping toilet tanks and/or bilge water.
• Online/remote booking system for the storehouses
  o The system also enables the monitoring of electricity consumption and control of sockets
  o Paying for storehouses via a booking system
  o Depending on the intent, there are alternative ways to implement the booking system:
    ▪ Example 1 – outsourced to a third party. In this case, the third party would be in charge of developing and operating the booking system, storing the modules and transporting them to sites
    ▪ Example 2 – partially outsourced, allowing the city to control the booking system, for example, while outsourcing the logistics (storage & transport)
• Anti-theft alarm systems at storehouses
• The water tanks at the corners of the floating pier enable stability and height control of the pier
  o The angle sensor installed to the ramp and the information displays on shore enable information to be conveyed to residents if the angle/degree of the ramp exceeds or falls below the recommended angle (6 degrees) by +/- 2 degrees
  o The information displays on shore also make it possible to warn people about the ramp being slippery (according to weather data)
• Open WIFI to customers and later a 5G base station
• ‘Heat mapping’ for monitoring crowd flows
• Utilisation of data
  o Movement of crowds (based on heat mapping data)
  o Statistics on ‘falls overboard’ (based on data from the thermographic camera)
  o Rainfall (along rain gutters)
  o Renting profiles (from the storehouse booking system)
  o Amount of sunlight (from the solar panels)

Ecological functions:
• Energy from solar panels (transparent new monocrystalline panels)
  o Solar panels can be placed on canopy modules (see figure 3)
  o The canopy module can be folded down for washing and snow removal
  o The canopy module channels water inside the floating pier via a rain gutter
• Recycling bins, possibly featuring an automatic ‘full’ notification
• A floating Seabin in the guest harbour module
• Toilet storehouse: waterless urinal (Novosan Oy)
• Heating of the storehouses with a heat pump in the winter, utilising river water
Figure 3 - Illustration of a smart pier (3)

Figure 4 - Illustration of a smart pier (4)
Image 5- Canopy modules
MODULARITY – Scalable to the site
Pier modules customised according to the spatial needs and limitations set by the location and intended purpose of use.

MODULE DIMENSIONS:

1. Storehouse: internal 3.4 m x 4 m, 13.6 m² / external 3.6 m x 4.4 m
2. Canopy module: 2 m x 2 m, 4 m²
3. Vestibule module: 2.3 m x 1.5 m, 3.45 m²
4. Pier module, large: width 46 m and depth 8.4–9.5 m
   A large pier module can accommodate a total of 9 storehouses, 5 at the lower level and 4 at the upper level.
5. Pier module, small: width 14.8 m and depth 7.3–8.4 m
   A small pier module can accommodate a total of 2 storehouses.

Other modules: vestibule, guest harbour and railing modules.

- The layout supports modularity
  - Water, electricity and drainage points to support the storehouses
    - For example, the largest module (48 x 12 m) is equipped with water, electricity and drainage points for 0–9 storehouses
  - Different layout options for modules of different sizes and intended for different purposes
  - Each module has a designed grid infrastructure solution that supports different layout options

- Accessibility
  - The slope of the pier’s ramp is between -6% and +6%
    - The slope can be adjusted by changing the length of the ramp
  - Unobstructed passage on the pier module, possible ramp approx. 6%
  - Choices of material: The planned cladding material for the storehouses is painted standing seam sheet metal (tin roof). The ends of the storehouses will be made of glass – in enclosed storehouses (such as toilet facilities), the ends will be covered with wooden boards
  - The accessibility solutions also support cyclists, strollers, rollators and people with reduced mobility
  - Guiding visually impaired people with tactile guide strips
Figure 6 - Illustration of the view from shore to the pier

Figure 7 - Illustration of the view from shore to the pier
Figure 8 - Illustration of the view from shore to the pier

Figure 9 - Perspective view of a vessel moored alongside the pier (1)
Figure 10 - Perspective view of a vessel moored alongside the pier (2)

- **Floating pier**
  - Floating pier made of steel
  - Elevated shore vs. low shore
    - By changing the length of the ramp (due to accessibility, the ramp must stay within -6% and +6% degrees)
  - Water tanks at the corners of the pier for stability and height adjustment
    - Determines the disembarking height of ferries
  - Crisscrossed anchor chains
  - Prospective supplier: Western Shipyard Oy (WSY)

- **Ship and loading**
  - The smart pier serves ferries up to 20 metres in length when moored by the flank. When moored by the bow or stern, the size of the vessel depends on the location of the smart pier, with a maximum disembarking height of approx. 1.5 m. The possible loading of these vessels will be carried out by first loading the cargo on the pier (via the access ramp), from which the cargo will be transferred to the vessel.
  - Does not support the use of vehicles

- **Movability**
  - Towable

- **Municipal utilities are critical for power supply. The toilet can be operated without municipal utilities**
Figure 11- Modularity
SUITABILITY – Supports planned services

Layout and infrastructure (storehouses, toilet facilities, canopies, seating, etc.) according to the planned services/operations

The smart pier will provide city residents with a new and comfortable meeting place and event venue, a low threshold for travelling in the Turku region and the archipelago, an increased range of services and events as well as an opportunity to book a storehouse/carry out a business pilot, among other things.

For the city, the smart pier will bring added value in many ways, such as by supporting the building of ecological and smart urban infrastructure in line with sustainable development, developing the city’s image and brand, taking the City of Turku brand elsewhere in Finland and abroad with a distinctive visual design, building the residents’ sense of community and supporting local companies, services and residents.

For companies, the smart pier will offer a central location to advertise and conduct business operations, a venue for pop-ups, low-threshold facility rental, facilities that support seasonal business operations as well as new business opportunities.

- Examples of services are listed below:
  - Sale & purchase of tickets
  - City information
  - Real-time departures (buses and ferries)
  - Storehouses
    - Pop-ups
    - Private consumer/companies/public sector services
    - Display booths
    - Kiosks
    - Café/restaurant services
    - Activity companies (SUP/canoeing/ice skating, etc.)
    - Storage facilities
    - Toilet facilities

*Figure 12 - Storehouse images*
ADAPTABILITY – Adapts to new needs
The layout and infrastructure can be adapted to suit changed operations, seasonal variation or a need to renew or improve operations.

- The frame structure of the storehouses is self-supporting
  - An opportunity to expand the same recognisable design language to the banks of the Aura River, marketplaces and streets, for example
    - For example: Expanding the Christmas market to the Aura River
  - In this way, the concept acts as a unifying force in supporting the improvement of the cityscape and increasing its visibility

- Recognisability facilitates:
  - the findability of event information
    - joint website/application
  - sales and facility rental
    - companies and other service providers will quickly become familiar with the visual appearance and operating model

- The storehouses can be equipped with exits/entrances at every side with door and vestibule elements
  - Various door, window and vestibule elements can be installed on the covered sides of the storehouses
  - Enables the concept’s flexible layout
  - Facilitates the customisation of the storehouses for different purposes
  - Enables passage
  - Optimises the placement of emergency exits in combinations of several storehouses (see the next section)

- Combining more than one storehouse is possible
  - Storehouses can be combined with vestibule modules, by removing the side walls on the inner side or by keeping the side walls of the storehouses
  - This allows the indoor space to be expanded easily when necessary

- Replaceable elements according to different needs

- Suitable for different environments
  - Different pier locations and offshore use

- Movable
  - Need for change
  - Offshore use

- The smart pier supports changed operations
  - The concept takes new and/or changing business operations into account
- The threshold for renting a storehouse is low (opportunity to rent for a short period of time), and the storehouses can be changed by combining two storehouses, for example
- A SUP board rental business operating in the summer can be easily replaced by a Nordic ice skate rental business for the freezing months of winter thanks to the low threshold for renting as well as indoor spaces that support both types of services

  o Possible new location
    - The physical layout can be changed to meet the needs and purpose of use of a new location

  o Seasonal variation
    - Example 1 – increasing the utilisation rate in the winter, when there are no summer activities or ferry traffic, by increasing other activities (such as increasing the amount of indoor space)
    - Example 2 – changing the layout for events, such as fairs, bazaars, concerts, performances, etc.
    - Example 3 – the smart pier and its modules can be utilised as a different type of event venue and Christmas market platform during Christmas, for example

  o Improvement of functions
    - For example, ‘heat mapping’ technology can provide data on the flow of people and possible bottlenecks. This information can be used as a basis for improving the functions:
      - Example 1 – guiding people
      - Example 2 – removing bottlenecks
      - Example 3 – possible changes to paths and entrances/exits of storehouses

  o Changed need for space
    - Example 1 – expansion/reduction of a patio area
    - Example 2 – combining storehouses into one space
Figure 13 - Two storehouse modules joined in a row

Figure 14 - Storehouses combined with a vestibule module (side by side)
Figure 15 - Storehouses combined with a rain gutter module, with or without side walls (side by side)

Figure 16 - Storehouse parts
DESIGN

‘Scandinavian, minimalist, modern, recognisable.’
Refers to waterside storehouses and fishing villages.

Although the product, the smart pier, is expected to also become an exported product, the design was easier to build based on the idea that its visual appearance would fit naturally in the Aura River in Turku. It is already conceivable at this stage that the smart pier concept can be easily adapted to another location by adapting its design.

In order to serve the city of Turku and its companies and residents, the smart pier must merge naturally into the scenery of the Aura River and inspire interest in people. For this purpose, the smart pier needed a theme to help in the creation of the design. By studying certain cityscapes in Finland, it is apparent that storehouses are recognisable features in cities like Oulu, Uusikaupunki and Porvoo, and they can even be recognised in postcards. Storehouses have become landmarks in these cities.

The design process can identify something new in something old and progress towards a new pattern of thinking from there. In the case of the smart pier, old storehouses transformed into a mental image of modern storehouses, providing a theme and design language for the smart pier.

The modern storehouse modules are located on top of pier modules, forming the sort of repetitive structure that is typical for storehouses and one of their most important characteristics. Unlike old storehouses, the modern storehouses are modern design objects with regard to all their details, structures and shapes. Placed on top of pier modules, the modern storehouses are also smaller. The main purpose of the modern storehouses is to house pop-ups, kiosks, small cafés, display windows, information points, etc.

From the outset, the modern storehouse modules were designed to also be easily placed on land with regard to their design language, technology and structures, allowing the operating model learned at the Aura River to be spread to other sites (pedestrian streets, Market Square, other marketplaces and plazas, the area around Turku Cathedral, parks, event venues, etc.). Placing these storehouses in different locations will thereby reduce the need for storage and optimise their utilisation rate.

The planned cladding material for the storehouses is painted standing seam sheet metal (tin roof). The ends of the storehouses will be made of glass – in enclosed storehouses (such as toilet facilities), the ends will be covered with wooden boards.

With the smart pier also functioning as a marina and ferry landing site, it forms a terminal for these functions together with the storehouses. As the operations grow, the space requirements of the smart pier will also increase. In order for the smart pier to fit the river environment together with the storehouses, it is natural for space to be claimed along the river. This will form a floating street between the bank of the river and the storehouses, with services located along the street.

The paths for people must serve cyclists as well as pedestrians and wheelchair users. The first thought is that some sort of ramp must lead from the shore to the smart pier’s floating pier modules. With the smart pier located lengthwise along the shoreline, there should be access points at both ends of the pier. This idea is also supported by the fact that the operation of a ferry will create congestion in front of
the ferry and the ramp in front of it. With ramps located at both ends of the smart pier, congestion will be distributed along the smart pier, and the need for space can be determined according to the amount of traffic. For pedestrians and cyclists, the ramp’s angle of inclination is easier to implement, but it will pose a problem for wheelchairs. With consideration to wheelchairs, the angle of inclination cannot be all that great, which will mean that the wheelchair ramp will require a large amount of space. With access points to the smart pier located at the sides, the ramp can be made longer, thus decreasing the angle of inclination.

Revitalising the Aura River can be added to the criteria for the smart pier concept. Modern storehouses on a smart pier on the bank of the Aura River and next to pedestrian streets would provide the Aura River with places for people to explore the offerings of the storehouses while passing by. The new storehouse-centric approach to the smart pier concept will increase interest and provide grounds for distinctive design. The seasons must also be taken into account in order to revitalise the Aura River. In the summer, attracting people to the pier will be easy, but the concept must also function during the other seasons. In the winter, the smart pier must be clear of snow, and when it rains, the pier must provide some shelter.

With the smart pier concept based on modularity, the canopies also had to meet the terms of modularity. Furthermore, the canopies had to support the design language and pattern of thinking of the storehouse-centric approach. This led to an idea about a canopy model that was based on a Finnish birch tree forest. The individual ‘tree’ elements allow the canopy to be made into various shapes, also enabling the canopy modules to support each other. Together with the storehouses, the ‘birch tree forest’ canopy also provides a conceptual connection, making it easy for the different modular elements to engage in dialogue with each other. This led to the birth of a small birch tree village – âBy.

Figure 17 – Perspective view (1)
Figure 18 – Perspective view (2)

Figure 19 – Perspective view (3)
Figure 20 – Perspective view (4)

Figure 21 – Perspective view (5)