Functional Requirements

ID	Requirements	Comment	Priority
1	***Environmental Information***		
1.1.0	**Water information**		
1.1.1	System displays real-time water level, depth and flow	Ijssel River, Twente Canal, around locks and bridges	4
1.1.2	System alerts users when water level is lower/higher than certain level	Such as When the IJssel River water level is lower than possible water pumping water level, it alerts users	4
1.1.3	System calculates and displays predicted water level/depth for next several weeks	Based on past data, weather forecast, etc.	4
1.1.4	System alerts users when predicted water level/depth is lower/higher than certain level	Such as When the predicted IJssel River water level is lower than possible water pumping water level, it alerts users	4
1.1.5	System allows users to set specific conditions to activate alarm	Such as: Give an alert when water level lower than 8 meter	3
1.1.6	System displays water temperature		2
1.2.0	**Weather information**		
1.2.1	System displays weather forecast	Including temperature, wind, etc.	2
1.2.2	System alerts users when adverse weather are forecasted/observed		2
2	***Operational management***		
2.1.0	**Operational plan management**		
2.1.1	System alerts users about possible need to adjust loading layer, capacity and transport routes	Such as When the water level rises, the loading layer height needs to be adjusted because it may be caught by the bridge's maximum passing height limit when passing through the bridge. Based on water levels, vessel type, cargo loads, bridge height restrictions, malfunction on the route, etc.	4

2.1.2	System displays information on narrow and difficult waterways, obstructions on waterways, obstructions on transportation routes		4
2.1.3	System allows users to create and save operational plan	Transportation method (ship, truck, rail and its type), route, scheduling, cargo handling operation plan, etc.	3
2.1.4	System allows users to modify/adjust the operational plan		3
2.1.5	System allows users to view the operational plan		3
2.1.6	System provides real-time estimated time of arrival, cargo status, and estimated time of plan completion	Based on transportation status	3
2.1.7	System calculates and suggests optimal transportation plan to transport destination	Based on distance, water conditions, road conditions, CO2 emission and other various information on the transportation route	3
2.1.8	System calculates and suggests optimal scheduling and provides information such as optimal sailing speed	Based on vessels, canals, lock passage times, and variety of other operational factors	3
2.1.9	System calculates possible load capacity per route	Such as With this type of vessel and considering water level, a total of X kg worth of cargo can be loaded to the vessel. Based on route conditions(water conditions) and transportation method information (vessel, truck, train type)	3
2.1.10	System alerts users when a transport plan is planned with less than 80% of the vessel's load capacity	Regulations could require companies to pay 80% of transportation costs if less than 80% of the cargo is loaded	3
2.1.11	System provides port operation simulation tool		3
2.1.12	System provides information on traffic volume and congestion on roads		3
2.1.13	System indicates which cargo		2

	requires specific inspection before loading and unloading		
2.1.14	System provides comparisons based on water level predictions, by ship vs. truck or other transportation methods	For example: on 9-1-2025 transport with a vessel from Almelo to Beverwijk is equivalent to 61 trucks.	***S***
2.2.0	**Ship information**		
2.2.1	System displays an overview of available ships and its information	Possible load capacity, engine specifications/emissions information, etc	3
2.2.2	System displays real-time vessel navigation status	Ship number, location, speed, cargo information, load capacity, crew size, availability, etc.	3
2.2.3	System displays recreational activities information on the canal		2
2.3.0	**Facilities management**		
2.3.1	System displays the condition status of port facilities along the canal	Depth and structural strength of the facilities, etc. Data recorded in a system called GBI	3
2.3.2	System displays real-time status and information of port facilities along the canal	Information on availability, operation status, number, size, location of facilities etc. Facilities such as berths, docking facilities, loading/unloading platforms, etc.	3
2.3.3	System suggests regular maintenance and upgrade schedules based on predictive maintenance algorithms		3
2.4.0	**Bridge and lock management**		
2.4.1	System displays bridges/locks information along the canal	Bridge height restrictions, malfunctions, maintenance schedules, open time, difficulties in opening bridges, rules(e.g. passing speed, maximum loading capacity) etc.	4
2.4.2	System displays real-time waiting		4

	time at the locks and bridges		
2.4.3	System displays real-time operational status of lock/bridge		4
2.4.4	System updates lock status at least every 30 minutes		3
2.4.5	System alerts users when there is a malfunction with bridge or lock		3
2.5.0	**Cost management**		
2.5.1	System calculates expected transportation cost based on operational plan		3
2.6.0	**Fuel/CO2 emission management**		
2.6.1	System notifies users when weather and environmental factors that significantly affect fuel consumption are observed along the transportation route	Such as wind strength and direction, temperature and wave height	3
2.6.2	Systems calculate and displays the amount of fuel required per route	based on information about the vessel, water level, navigational resistance, fuel type and other information	3
2.6.3	System displays estimated CO2 emission information for transportation plan available on the route		3
2.6.4	System calculates and displays CO2 emission after completion of transportation	Based on fuel consumption, ship type, mileage, etc	3
3	***Storage management***		
3.1	System allows users to manage inventory information for their warehouses		***N***
4	***Data sharing & Collaboration***		
4.1.0	**Communication channel**		
4.1.1	System provides communication channels between vessels and lock,		3

	bridge operator		
4.1.2	System provides communication channel for emergency communication with government and carriers		3
4.1.3	System provides communication channels to share information about return trip	Help to reduce the number of empty return trips	3
4.1.4	System provides communication channels between vessels in operation		3
4.1.5	System provides communication channel between shipowner and factory to coordinate loading/unloading time		3
4.1.6	System provides communication channels for sharing information regarding recreational activities on the waterways		2
4.1.7	System provides communication channel for inter-organizational communication	Between companies, company-government, etc.	2
4.1.8	System provides communication channels for each of the various locations	Such as at berths, docking facilities, locks, bridges, etc.	2
4.1.9	System provides communication channel to communicate with Dutch rail transport management department		2
4.2.0	**Information hub**		
4.2.1	System provides contact information for ports, locks, and related companies		4
4.2.2	System alerts users when a vessel is no longer able to pass through a particular area		4
4.2.3	Systems provides information on potential disruptions through predictive analysis based on historical		3

	data and current conditions		
4.2.4	System provides information hub to share information from government		3
4.2.5	System displays weather, river news, etc.	NOS Teletekst provides these	3
4.2.6	System provides information on emergency contact, response guideline information, evacuation route and plan		3
4.2.7	System alerts users immediately when navigation along the river is restricted to one-way traffic		3
4.2.8	System displays port fees and other costs incurred at ports by port		3
4.2.9	System provides information related to social service facilities available in the docking area		2
5	***Additional Requirements***		
5.1.0	***Account***		
5.1.1	System limits the account types that create, modify, view operational plan		3
5.1.2	System provides role-based access control	Accounts with different permissions and access levels	2
5.1.3	System limits the account types that can send/read messages per communication channel		2
5.2.0	***Payment***		
5.2.1	System provides functionality for payment of canal passage fees and port fees		2
5.3.0	***3D Visualization***		
5.3.1	System provides 3D visualization simulation tool		***S***

Non-Functional Requirements

ID	Requirements	Priority
1	***Reliability***	
1.1	System provides long-term, accurate water level forecasts with over 70% accuracy	4
1.2	System provides only reliable and accurate data	3
2	***Security***	
2.1	Information such as vessel location, cargo information, etc. are protected by a sophisticated security system	4
3	***Usability***	
3.1	UI is understandable and actionable, even for users without a technical background	4
4	***Compatibility***	
4.1	The UI displays on Smartphone, Tablet and Desktop displays	4