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Port Utilization and Capacity Development Opportunities :

Mapping Usage and Analyzing Capacity Across Europe's River Ports for United Waterways

Applied Research Project

Nicole Co
Samantha Cooke
Jiwon Shin

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Partner Organization: United Waterways
Faculty Lead: Sandeep Sengupta

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Abstract

This project investigates port utilization patterns across 83 ports of interest along the Rhine, Main, Danube, and Mosel River systems to identify locations with the strongest strategic potential for United Waterways (UW). To support UW's planned fleet expansion and improve network planning, the project addresses a critical gap in empirical, port-level utilization data across European inland waterway networks.

Using a manual vessel movement extraction methodology via the Marine Traffic historical playback platform across three observation weeks in April, July, and November 2025, the project finds that the network is deeply heterogeneous. Average utilization across all 83 ports stands at 16.6%, with only 12-18% of ports operating above the 40% utilization threshold, and approximately one third recording zero utilization across all three observation weeks. Regression analysis identifies bunker fuel availability as the strongest predictor of utilization in April and July, while shore power becomes the most influential variable in November, reflecting the operational demands of cold-season overnight stays.

Building on these findings, the study proposes a utilization-infrastructure matrix as the central diagnostic framework, classifying ports into four typologies, each requiring a distinct investment strategy and financing instrument. The project further recommends a centralized port management system integrating real-time automatic identification systems (AIS) data and internet of things (IoT)-enabled dock monitoring, designed to replace UW's experience-based Booking Difficulty Rankings (BDR) with continuously updated utilization records and support evidence-based scheduling decisions across the full network.

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Franca Kappes, teaching assistant during the first semester, deserves credit for her roles in the early stages of the project in establishing a workable timeline and clarifying the initial scope that gave the team a foundation to build from, and the structure of this report reflects decisions made with her input.

We also acknowledge the United Waterways' locks and docks team whose willingness to share the operational data underpinning this study made the empirical analysis possible in the first place.

Finally, this work would not have been possible without the sustained engagement of our partner, United Waterways and their business analyst, Tamas Csillag. His willingness to share operational knowledge, advocate for the funding of resources, and engage with the team's evolving research questions under consistently changing circumstances was instrumental to the success of this project. His engagement challenged us to think more critically about our analysis and encouraged a strong sense of ownership and enthusiasm over the development of utilization insights for United Waterways.

Abbreviations

Term	Acronym
Application Programming Interface	API
Automatic Identification Systems	AIS
Booking Difficulty Rankings	BDR
Connecting Europe Facility	CEF
European Investment Bank	EIB
EU Development Funds	ERDF
European Union	EU
Internet of Things	IoT
Inland Waterways Transportation	IWT
Multicriteria Decision-Making	MCDM
Navigation and Inland Waterway Action and Development in Europe	NAIADES
Onshore Power Supply	OPS
Ports of Interest	PoI
Trans-European Transport Network	TEN-T
Terminal Operating Systems	TOS
Utilization Rate	UTR
United Waterways	UW

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1. Introduction

1.1 Background and context

European inland waterways have long played a critical role in transportation. Since the mid-1900s, this sector has seen disproportionately limited investment and faced modernization challenges while road, rail and air networks began to gain popularity. Inland Waterways Transportation[1] (IWT) systems have historically suffered from aging infrastructure, capacity restrictions and insufficient data systems compared to these other increasingly used modes of transportation. Political support for transport modes fluctuates with changes in leadership, and investment typically follows the mode perceived to offer the greatest immediate benefit to the state, typically road or rail. In addition, lengthy multi-jurisdictional administrative procedures have deterred both public and private investment, creating a self-reinforcing cycle where deteriorating infrastructure further weakens the political and financial incentives for investment (Seitz & Oganesian, 2023; Wagner, Kotowska & Pluciński, 2022). Critical bottlenecks in river port docking infrastructure persist, citing historical neglect of amenities for passengers such as sufficient quay lengths and automated handling. This is especially seen in the 20th-century port evolutions which affect operations. Issues like yard overcrowding, labor shortages, and shallow drafts in ports along the Rhine and Danube, intensified by the rise of cruise traffic volumes (Central Commission for the Navigation of the Rhine, 2023; Danube Commission, 2020; European Barge Union, 2024). United Waterways (UW) is one of Europe's largest ship management companies, overseeing the operations of passenger vessels across both inland waterways and open seas on behalf of a diverse portfolio of vessel owners and companies. Headquartered in Basel, Switzerland, UW operates in ports along European inland waterways spanning from Amsterdam to Budapest, and covering major river systems across the Rhine, Mosel, Main, and Danube Rivers. They house a database containing general port information for around 2,000 ports across this network. Our study focuses specifically on 83 of United Waterway's 221 critical ports of interest (PoI) which spans across 44 cities in France, Luxembourg, and Germany that are designated as critical operational routes by United Waterways for expansion planning *(as seen in Figure 1 and Annex C: Master PoI Excel with Amenities Excerpt).*

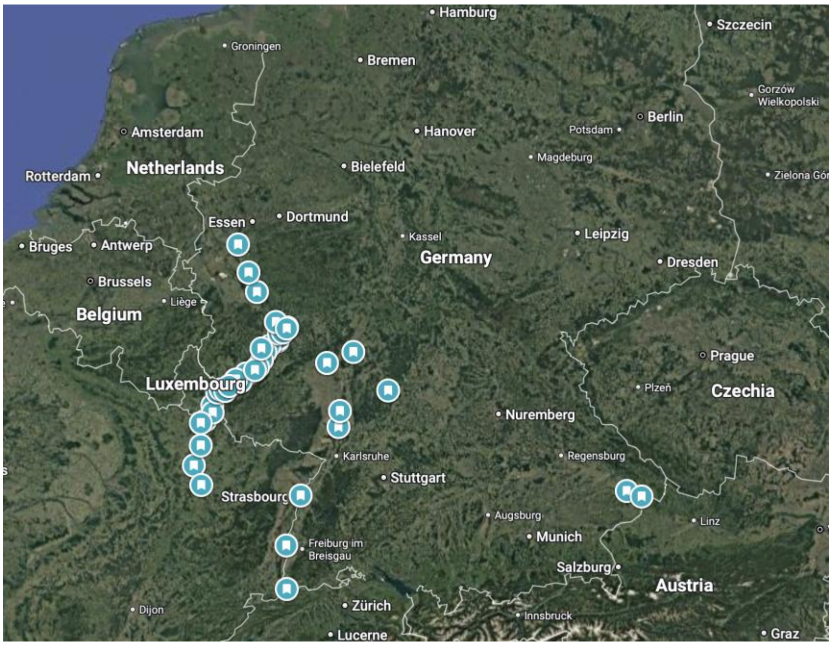

Figure 1: Map of Initial PoI Cities

[1] Inland Waterways Transportation is the movement of people or goods through rivers, canals, and lakes rather than through roads, railways, or the ocean.

United Waterways is operating at a decisive moment for the future of IWT in Europe. Upcoming EU environmental requirements place growing pressure on infrastructure quality and operational efficiency across the IWT network. The current priorities of UW concentrate on ensuring strategic infrastructure investments to accommodate the additional ships that will join the waterways in the next 10-15 years and on maximizing port utilization rates.

Throughout this report, we will refer to both *ports* and *docks* interchangeably, where both terms refer to the structure where vessels tie up to shore and may have access to any amenities offered.

1.2 Problem statement and objectives

The research question, "What are the strategies for strengthening the docking infrastructure to boost utilization and accommodate the planned increase of ships?" is directly relevant to the current challenges and strategic priorities of the IWT sector. Given the historical underinvestment in docking and port infrastructure, identifying where and what kind of investment opportunities exist supports United Waterways' vision to prepare for future fleet expansion and enhance overall port utilization. Building on the existing static data of our PoIs, this study will address the knowledge gaps arising from the lack of utilization data to investigate critical bottlenecks in Europe's River docking infrastructure.

1.3 Scope and structure of the report

The goal of this project is to understand patterns of existing inland waterway port utilization along European rivers to provide recommendations on areas for future investment to maximize port utilization. The existing literature reviewed deepens background knowledge on EU policy, port capacity, investment strategies, capacity challenges, and utilization patterns primarily among European IWT for passenger vessels. The methodology of this research combines primary data extraction, desk research, surveys, and data correlation and regression analyses to provide insight into potential booking challenges, bottlenecks, and port underutilization. Throughout the analyses of our 83 ports observed over three week-long periods, our limited sample size, data extraction biases, and data regression margin of error are noted. The findings detail general utilization patterns including which port amenities had greater correlation with port utilization, commonalities between zero utilization ports, and further insights as to why. The project concludes with recommendations on infrastructure investments, and other recommendations related to maximizing port utilization, including areas for future research on the topic.

2. Literature review

2.1 Introduction

Our literature review examines work on port capacity assessment and optimization methodologies in conjunction with studies on infrastructure investment barriers and strategic planning or industry reports. It is strategically developed through converging objectives set by European infrastructure policy, environmental mandates, and economic competitiveness. Rather than viewing these segments separately, recent industry reports and policy frameworks increasingly acknowledge the systemic interdependencies shaping investment priorities and operational strategies for river ports and inland navigation networks.

2.2 Policy Drivers and Regulatory Frameworks

European policy architecture for IWT has evolved from basic transport connectivity objectives towards integrated sustainability frameworks. The Navigation and Inland Waterway Action and Development in Europe (NAIADES) programs showed a paradigm shift in strategic planning, operating beyond infrastructure maintenance and toward a holistic system optimization (PLATINA 2, 2016). The FuelEU Maritime regulation, while initially focusing on ocean-going vessels, introduced broader decarbonization pressures that inland waterways cannot avoid, particularly as river cruise vessels face scrutiny despite current regulatory exemptions (DNV & Ricardo, 2024). This regulatory landscape creates both constraints and opportunities, where ports investing in onshore power supply (OPS) infrastructure remain competitive, and those delaying are at greater risk of being phased out in the industry as emission standards tighten.

The European Barge Union's (EBU) 2024-2025 Annual Report highlights a critical tension in policy implementation: while the EU's TEN-T (Trans-European Transport Network) regulation mandates infrastructure improvements, funding mechanisms remain fragmented across member states, creating bottlenecks where national borders interrupt waterway corridors (EBU, 2025). This fragmentation undermines the theoretical advantages of IWT, namely, that 75% of operations are cross-border, yet infrastructure quality varies dramatically between jurisdictions (EBU, 2025).

2.3 Assessing the port capacity & efficiency and making infrastructure investments

Despite the widely recognized environmental benefits of IWT, investment levels in inland waterway ports remain significantly lower than those in road and rail networks. The overall goal of our research is to understand variables that impact port over/underutilization and use that to prepare recommendations on where improvements could be made. While some academic sources introduce a Multicriteria Decision-Making[2] (MCDM) approach on determining optimal river port locations, several studies assess port capacity using different methodological approaches, such as probabilistic models, Bayesian networks, digital optimization tools, and simulations.

To identify priority ports, researchers incorporated the four-stage MCDM approach combined with GIS-based spatial analysis to evaluate potential ports based on technical, economic, environmental, and legal criteria. They established a baseline of existing and planned transport infrastructure, identified potential locations through stakeholder surveys, and compared locations using proximity to land transport through a quantitative ranking strategy (Wiśnicki et al., 2021). This framework demonstrates how to locate, analyze, and quantify the priority ports along Odra River Waterway, giving insights to our project's methodology for identifying and analyzing ports of interest along other European river waterways.

To assess port capacity and efficiency, and identify "weak" areas of the port, researchers have used probabilistic approaches and theoretical models analyzing variables such as ship processing time at port, number of ships that can be moored in the port at the same time, and terminal area utilization (Paulauskas et al., 2025). A broader approach is from a probability analysis between variables such as port availability, port connectivity, port environment, port service, port facility, and port economics and

[2] Multicriteria Decision Making is a method used to make a choice or decision when you have multiple factors to consider at the same time, and those factors may conflict with each other.

inland port performance (Hossain et al., 2019). These all work to highlight the different factors that shape port performance. A broader approach can be taken from a Bayesian perspective, where both qualitative and quantitative variables, such as port availability, port connectivity, port environment, port service, port facility, and port economics are included in the analysis (Hossain et al., 2019).

Empirical studies have been done in the port of Szczecin to conduct correlation analysis to estimate how enhanced port capacity and accessibility can affect the port's competitiveness (Natalia Wagner et al,. 2022). This step is complemented by qualitative interviews with shippers to validate and contextualize numerical findings, revealing non-economic factors that influence decision-making. The study demonstrates that port investment analysis should incorporate both performance metrics and user perspectives. Overall, these methodological approaches demonstrate that port capacity and utilization depend on both internal port efficiency and infrastructural improvements.

Another inland port performance index was introduced through the Bayesian network which measures the overall utilization of IWT based on six dimensions. Hossain et al's "Metrics for Assessing Overall Performance of Inland Waterways Ports" (2019) proposed this to combine quantitative and qualitative factors compared to the status quo of ranking throughputs. This addresses performance challenges and improvement opportunities because it breaks down performance by availability, port facility, service, connectivity, economics, and environment. It also uses sensitivity analysis on the Bayesian network to identify which characteristic matters most for improving the index. This proves that there are composite performance indexes for inland ports rather than cargo ports. This network approach can handle interdependencies and uncertainty in port performance factors which can contrast this research's regression-based utilization analysis.

2.4 Digitalization and Intelligent Port Systems

Additionally, digital tools, such as IoT-enabled solutions or Terminal Operating Systems (TOS), can play a vital role in maximizing port capacity and utilization by improving energy efficiency, assisting with route planning, increasing operational visibility, and managing general port operations. Digital utilization monitoring, including tracking vessel docking times and port congestion, improves decision-making for both port authorities and private operators (Calderon-Rivera et al., 2024). In the context of United Waterways, digital systems would enable easier classification of over/underutilized ports in the future and support evidence-based investment strategies. Studies on TOS also illustrate how digital management tools such as scheduling, communication, dock allocation, and passenger check-ins can increase port operational capacity by reducing delays and improving coordination across port operations (Hervás-Peralta et al., 2019).

Gbako et al.'s systematic review treats digital technologies as a largely positive, system-wide enabler that could unlock unused capacity and improve efficiency, safety and environmental performance if deployed at scale, emphasizing untapped potential and the need to close implementation gaps. But in contrast, digitalization challenges stress governance, institutional and investment barriers portraying digitalization less as a ready-made solution and more as a contested process limited by slow standardization and uneven readiness of ports and authorities (EBU, 2025).

2.5 Decarbonization Strategies and Energy Transition

The river cruise sector is diverting towards a net-zero carbon target by 2050, covering the majority of the industry which requires ports to shift beyond vessel-focused measures and strategically develop highly utilized green infrastructure. This includes onshore power supply, alternative fuel bunkering and advanced waste management and emissions treatment (Mehammer et al., 2024; CLIA, 2024; DNV, 2024). Looking into current trends in fleets' sustainable progress, ports must accelerate investments in grid-connected OPS, compatible green bunkering systems and port-side energy storage to provide accessible and reliable low-carbon services to cruise vessels.

Industry reports increasingly frame such port investment decisions within the broader energy transition, highlighting that choices on fuel infrastructure will shape ports' long-term competitiveness as energy hubs. In this context many strategic roadmaps advocate "technology-neutral" policy frameworks at the European Union (EU) and river-basin level but also underline that persistent uncertainty over future fuel uptake and regulation is delaying the large capital commitments needed for transformative port infrastructure projects (Danube Commission, 2025; Waterborne TP, 2023)

2.6 Infrastructure Investment Priorities, Barriers and Capacity Challenges

Industry reports revealed a fundamental argument about investment prioritization: should resources focus on eliminating existing bottlenecks or on expanding capacity for future growth? The EBU associated specific infrastructure shortages, locks with insufficient capacity, bridges with inadequate clearance, and shallow-water sections limiting vessel drafts, yet acknowledges that addressing these requires well-coordinated transnational investments rather than individual national initiatives that is particularly the case in Europe (EBU, 2025).

From a capacity perspective, inland waterways face growing tensions between relieving current congestion and accommodating future traffic growth (European Court of Auditors, 2015). Low port utilization rates can sometimes be caused by ageing locks constrained by bridge clearances, recurrent low-water periods that limit loading/unloading, and reliability of vessels that can operate year-round (European Court of Auditors, 2015; Central Commission for the Navigation of the Rhine, 2014; Gobert, 2023).

Even when investment priorities are clear, structural barriers continue to hinder effective IWT infrastructure development. Implementing these capital-intensive improvements demand long-term strategies, which remain a challenge for many ports and waterway systems (Calderon-Rivera et al., 2024). Regulatory and administrative requirements further complicate implementation, with technological, safety, environmental, and planning regulations. The literature stresses the importance of adopting a holistic approach to investment decisions, recognizing socio-environmental impacts and regional development objectives rather than focusing solely on financial indicators (Seitz & Oganesian, 2023). These findings suggest that infrastructure bottlenecks persist not only because of limited funding, but also because of the regulatory and coordination challenges inherent to cross-border waterways systems.

2.7 Utilization Patterns and Modal Shift Potential

Once we understand port capacity, we can gain a better understanding of port utilization. One way this has been approached is by analyzing the impact of cargo port capacity through a "discrete event simulation" where four alternative hub scenarios were simulated against the current reality to understand which variables could have the greatest impact on improving port waiting times (Caris et al., 2011). Additionally, the Central Commission for the Navigation of the Rhine found that the factors that most impacted cargo port utilization were water levels, connectedness to land transportation (i.e. rail, and road), decline in transport demand, geopolitical conflicts, and poor overall port infrastructure (CCNR, 2025). However, these results were derived from cargo ports rather than passenger ports, which can yield very different results and variables of impact. Nevertheless, the methodological approaches, such as identifying key variables and cross-referencing infrastructure characteristics against utilization outcomes, remain instructive for this study's framework.

A recurring theme in industry research is the paradox of underutilization amid capacity scarcity. The Strategic Research Agenda for Inland Navigation Europe emphasizes that IWT operates with "free capacity" relative to congested road and rail networks, yet modal shifts remain limited (PIANC, 2019). This suggests that capacity constraints are not uniformly distributed; certain high-traffic corridors face congestion while overall network utilization remains low. Understanding these spatial disparities is essential for targeting investments effectively.

The cruise sector exemplifies utilization complexity. DNV and Ricardo's (2024) mapping study reveals highly seasonal and geographically concentrated operations: 50% of ocean cruise fuel consumption during port visits occurs at just 23 ports, with Barcelona, Southampton, and Piraeus dominating bunkering (DNV & Ricardo, 2024). River cruise operations show similar concentration, with 71% of sailings lasting 9 days or fewer, and Amsterdam and Budapest serving as primary embarkation hubs (DNV & Ricardo, 2024). These patterns demonstrate that infrastructure investments must strategically account for differences between different locations and not assume uniform demand and usage.

2.8 Research Gaps

Despite offering valuable methodological insights, the existing literature reveals several gaps and limitations specifically with passenger vessels in European inland waterways. Cruise and passenger vessels currently make up a relatively small portion of the IWT sector, although it is actively growing.

First, much of the existing research focuses on cargo vessels and ports, where vessel size, docking times, port necessities, and other valuable factors can widely vary and do not necessarily translate directly to impact on passenger vessels. The geographic focus from much of the research is primarily on seaports, land ports, or on rivers outside of Europe. This gap highlights the need for adapted methodologies capable of evaluating port capacity in the Mosel, Danube, Main, and Rhine River cruise contexts, where seasonal patterns, docking operations, and expanded coordination can play a central role.

Next, while much of the literature examines fleet infrastructures and green engines projects primarily funded and implemented by governments, few analyses address port-side infrastructure sustainability projects emphasize sustainability funded by the private sector, highlighting different operational and financial considerations.

Finally, there continues to be a lack of port utilization data, which limits the depth of the analyses and assessments that can be done to guide infrastructure investments of under and over utilized ports. The lack of granular data on port-specific utilization rates, makes it difficult to distinguish capacity constraints from operational inefficiencies. In the project, we will employ a multi-faceted approach to port utilization data collection and find most promising strategies in IWT ports along the Mosel, Rhine, Main, and Danube River so that the United Waterways can accommodate the planned increase of ships.

3. Research Questions

Drawing from the literature review, existing studies on port capacity and utilization largely focused on cargo vessels and seaports, leaving a notable gap in the context of European inland waterway cruise ports. The lack of port utilization data limits the depths of infrastructure investment assessments along key rivers including Rhine, Mosel, Main, and Danube. Combined with the growing demands on UW's network and the operational challenges UW is facing, this highlights the need for systemic assessment of port capacity across its key operational routes.

This study therefore addresses the following research question:

> "What are the strategies for strengthening the docking infrastructure to boost utilization and accommodate the planned increase of ships"

4. Methodology

4.1 Research Design

This study adopts a quantitative research design to investigate port utilization across key inland waterway ports in the European Inland Waterways. The research was initially planned as a mixed-methods approach, combining quantitative utilization data with qualitative interviews intended to clarify data gaps and contextualize the findings. However, as primary data through institutional channels proved unavailable despite extensive outreach efforts, the team pivoted toward an exclusively quantitative methodology centered on the manual extraction of vessel movement data from a commercial vessel tracking platform.

The research process evolved through several distinct phases as data collection strategies were pursued, refined, and ultimately adapted to the constraints encountered. Each phase shaped the direction of the next, ultimately leading to a structured data extraction, correlation, and regression-based analysis aimed at producing concrete investment recommendations for UW.

4.2 Data sources and collection

4.2.1 Phase 1: Data Acquisition through United Waterway's External Partner

The initial strategy for data acquisition relied on UW's engagement with Linatech, an external partner with established contacts among infrastructure managers across European inland waterways. UW had provided Linatech with a shortlist of approximately 100 high-priority locations and asked them to gather utilization data on the project's behalf. As this channel offered direct industry access, it was considered the most promising route for obtaining high-quality data, as discussions had been ongoing since before the start of the project. However, the negotiations went on for longer than expected and by the time the team needed to move forward with the project, no agreement had been made between the two organizations.[3] This prompted the team to pursue alternative collection strategies independently.

4.2.2 Phase 2: Direct Port Calls and Surveys

Primary data collection began in November 2025 with a survey-based outreach targeting 70 PoIs identified by UW. The goal was to collect individual port-level utilization data for three representative weeks: one week in April, one in July, and one in November. These three months were selected to capture seasonal variation in port activity. Our team called each port directly to briefly introduce the study and obtain the best contact email address before sending the survey. Where phone contact was not possible, UW's existing contact list was used. Surveys were then distributed by email to all ports in English, French, or German, depending on the location of each port, to maximize comprehension and response rates.[4]

The survey instrument was designed in accordance with data protection requirements under the General Data Protection Regulation. No personally identifiable information was collected, and all respondents were informed of the study objectives, the team's affiliation with the Graduate Institute, and the connection to UW. Access to collected data was restricted to research team members and supervisors, and a non-disclosure agreement was signed with UW to ensure the confidentiality of all information provided by stakeholders.

Despite these efforts, no ports responded to the survey, and our team turned to alternative data collection strategies. The lack of responses from the ports can be hypothesized in a few different ways. The first reason the team received no responses could be because the contact information being used to reach out to them was out of date or not often checked by the port operator. A second reason could be that there was minimal incentive for them to respond, and with heavy workloads, it was not a priority. A final potential reason that the team did not receive any responses could be that they were not permitted to share the information with team due to privacy or confidentiality reasons.

4.2.3 Phase 3: United Waterways Booking Difficulty Rankings (BDRs) Data

UW provided a list of PoI with Booking Difficulty Rankings[5] (BDRs), ranging on a scale from 1 to 4, reflecting the frequency with which vessels are unable to secure a booking at a given port. A ranking of 1 indicates that booking fails 80% of the time or more; a ranking of 2 corresponds to a 60-80% failure rate; a ranking of 3 reflects a 40-60% failure rate; and a ranking of 4 is a minimal booking difficulty, with a failure rate lower than 40%. Across the full BDR dataset, 97 ports are rated 1, 80 are rated 2, 44 are rated 3, and several hundred ports are rated 4, serving as a comparison baseline with least booking difficulty. The BDR dataset also includes additional port-level attributes such as availability of certain

[3] After the team had pursued other data collection paths, discussions between LinaTech and UW concluded, and no data was obtained.
[4] Emails were sent using the IHEID-created ARP group email account to add legitimacy to our request
[5] Booking Difficulty Rankings that United Waterways provided are essentially an internal, experience-based scoring system. UW staff assigned ports a ranking of 1 to 4 based on how frequently vessels fail to secure a booking at a given port, but this was drawn from operational experience and institutional memory rather than from systematic, empirically collected data.

amenities including water supply, shore power, waste and sewage facilities, fuel access, port pricing, and port capacity.

The BDR data serves as a key contextual variable in the analysis, enabling cross-referencing with empirical utilization rates to understand whether booking difficulty is driven by physical capacity constraints, infrastructure deficiencies, or other factors. While it would have been possible for this study to draw analyses and highlight patterns based strictly on this dataset, the rankings were not based purely on factual data and relied more on inferences the locks and docks team had made on the PoIs. The research team decided that it would be more beneficial to search for alternative ways to collect utilization data to be able to draw more accurate conclusions.

4.2.4 Phase 4: Contacting Vessel Tracking Platforms

The team engaged with different commercial vessel tracking companies to see whether port-level utilization information could be obtained from their dataset. VesselTracker and Marine Traffic were contacted via email and online inquiry forms to assess data availability and historical coverage.

VesselTracker provided only Automatic Identification System (AIS) positional data at the vessel level, which did not directly support port utilization analysis. However, Marine Traffic offered port-level data with historical coverage, and after numerous meetings between Marine Traffic and UW, UW purchased the year-long enterprise subscription to allow the research team full access to the platform.

Upon creating the account under UW and accessing the Marine Traffic website, however, the team encountered a significant limitation. The platform's port arrival and departure data logs showed vessel arrival and departure times at the city level rather than the individual dock level. This means that arrival and departure records for a given entry (arrival or departure time for each vessel), such as in the port of Passau,[6] reflect all vessels across an entire cluster of geographical proximate ports, rather than the specific PoIs at the individual level. As a result, the specific docking data could not be extracted, and the logs could not be used to differentiate which vessels had arrived at and departed from our specific PoIs.

The team explored alternative features within the platform, including a custom area-drawing tool that would monitor the activity within a defined area or specific port boundary. However, this tool did not support queries for historical playback periods and could not be applied to the targeted weeks in 2025. Following 10 separate meetings with Marine Traffic between December 2025 and March 2026, including a dedicated platform training workshop, it was determined that efficient, automated historical data extraction would require an additional advanced application programming interface (API) subscription, which was not a feasible option for the team.

[6] 'Port' in this context refers to the network of docks within the larger city-wide port system where the Port of Passau, for example, includes every dock in the vicinity.

4.2.5 Phase 5: Manual Playback Extraction

One week-long playback observation of a given area being watched at full speed lasted about 15 minutes.[8] However, it should be noted that to record each vessel arrival and departure time, the speed would need to be reduced, paused or the playback would be rewound altogether in order to capture the most accurate time, drastically increasing the total amount of time it would take to finish an entire playback observation.

Given the limitations of API data access, the team adopted a manual extraction methodology using Marine Traffic's historical playback feature. This tool enables users to replay vessel's movements within a defined geographic area for a specified historical time frame. For each assigned PoI, the team navigated to the relevant map area, set the playback to the target week, and recorded each vessel's arrival and departure times at each specific PoI.[7] This process was repeated for three-time frames: 6-12 April 2025, 6-12 July 2025, and 16-22 November 2025.

The extracted data was recorded in a shared spreadsheet *(as seen in Annex D: Data Extraction Excel Excerpt)*. Within the spreadsheet, the team inputted each vessel name that arrived and departed from the PoIs, the arrival and departure time of the PoI, and the maximum capacity of vessels permitted at a port. From this information, the total duration of time the vessel spent at port and total port utilization rate was calculated automatically. Utilization rate (UTR) was calculated as the total number of hours a dock was occupied by vessels divided by 168 hours, the maximum possible occupied hours in the observation window, times the total vessel capacity of the port, expressed as a percentage.

Utilization Rate Formula

UTR (%) = [Total hours dock was occupied ÷ (168 hours × Maximum vessel capacity)] × 100

Where:

- 168 hours = 24 hours × 7 days (total observation window per period)
- Total hours occupied = sum of all individual vessel docking durations recorded at that dock
- Maximum vessel capacity = the maximum number of vessels the dock can accommodate simultaneously
- Result expressed as a percentage, where 100% indicates full occupation for the entire 168-hour window

Example: A dock with a maximum capacity of 1 vessel, occupied for a total of 42 hours across a 7-day observation period, records a utilization rate of 42 ÷ (168 × 1) × 100 = 25%.

4.3 Scope and Sample

The original scope of the study encompassed 221 PoIs across 44 cities in three countries. Given the time and labor-intensive nature of manual playback extraction, this was narrowed to 83 PoIs across nine cities in Germany, selected to ensure representation across BDR scales from 1 through 3 and to allow for meaningful comparison within a region. The team focused exclusively on Germany as the geographic scope, **strategically selecting PoIs across:** Köln (11 PoIs rated 1, 5 rated 2), Passau (14 rated 1, 1 rated 3), Schweich (2 rated 1, 2 rated 3), Düsseldorf (8 rated 1, 8 rated 2), Koblenz (5 rated 1, 2 rated 2, 2 rated 3), Traben (2 rated 1, 2 rated 3), Frankfurt (9 rated 1, 6 rated 2, 1 rated 3), Bernkastel (6 rated 1, 2 rated 3), and Cochem (2 rated 1, 2 rated 2, 2 rated 3) *(as seen in Figure 2)*.

[7] This process would often have to be repeated numerous times for the larger cities since the PoIs in the given area could not all be accurately observed in the same zoomed frame.

[8] It is also important to note that when more than one individual was using the platform at a time doing playbacks, the playback would become glitchy, increasing the time it took for a full speed week-long playback from 15 minutes without stopping to 40 minutes.

Figure 2: Map of Rhine-Main-Danube-Mosel River system with PoI Cities

4.4 Limitations

There are several limitations to be noted. First, there is no standardized, and publicly available port utilization reporting system across European inland waterways. Therefore, the data collection was both essential and labor-intensive, and left the team dependent on commercial vessel tracking platforms with imperfect port-level resolution and no reliable way to cross-check information. While Marine Traffic, in theory, had all of the historical data of the ports, it was all presented in a vessel-focused manner, meaning that getting the same information from the specific PoI was not as straightforward.

Second, since the team had to reduce the sample size from 221 to 83 PoIs, we recognize that the conclusions based on the German port cluster that was focused on cannot necessarily be generalized to the other PoIs. The manual extraction method, while rigorous, introduced practical constraints on the volume of data that could be feasibly manually processed within the project timeline. These limitations are acknowledged in the interpretation of results and in the scope of recommendations offered.

4.5 Measurement Reliability

Throughout our manual data extraction process and during the playback sessions, the team noted numerous inconsistencies within the platform that created some variability to our data and led to data collection with an estimated 2.6% margin of error at 95% confidence level. This is based on a total 1,398 data extraction points including arrival and departure times for every vessel utilizing each of the 83 PoIs over the three time periods. There were numerous platform challenges during playback viewing that led to inconsistencies in our data collection. The first was that the playback feature did not always have accurate vessel positioning on the map, causing some vessels to appear to be on land rather than docked at port *(as seen in Figure 3),* making it challenging to decipher which port the vessel was actually docked at. Similarly, there were instances where vessels appeared to stop between two ports, again making it challenging to decipher which port the vessel was actually docked at. The second was knowing exactly when to record each vessel's arrival and departure solely based on when the vessels appeared to stop moving at the PoI or began moving away from it.[9] The third challenge was a cross between the platform's playback feature and the port information not being up to date. We had numerous cases where there appeared to be more than one vessel at a specific port that had indicated that the maximum capacity was one, meaning that either the playback view was inaccurate and the ships were actually at different ports, or the port information was out of date, and they had higher capacity than initially stated.

2.6% Margin of Error : ***MOE* = $z \times \sqrt{p(1-p) \div n}$**

- $z = 1.96$ (corresponding to a 95% confidence level)
- $p = 0.5$ (maximum variance assumption, used as a conservative estimate)
- $n = 1{,}398$ (total data extraction points: arrival and departure records across 83 ports over 3 observation periods)
- $MOE = 1.96 \times \sqrt{0.25 \div 1{,}398} = 1.96 \times 0.01337 \approx 0.026 = 2.6\%$

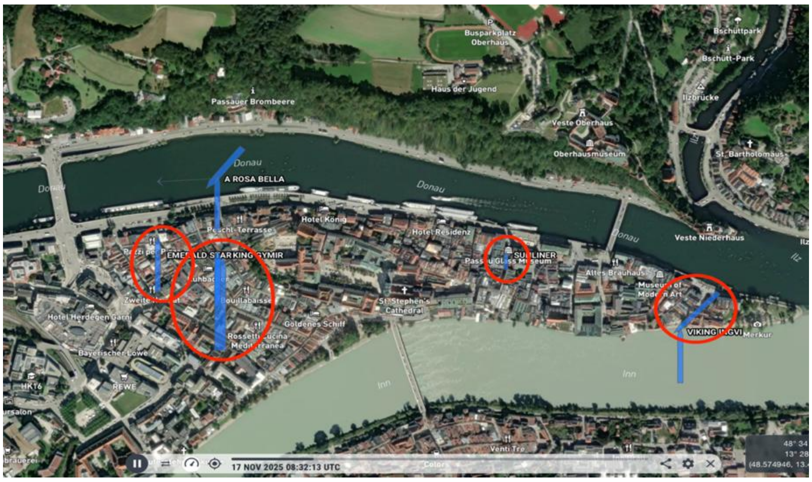

Figure 3: Playback Screenshot Sample of Vessels

5. Findings and Discussion

5.1 Technological and economic characteristics of the port system

Access to technological equipment is remarkably uneven. We found that out of our 83 ports observed, only 13 of them offer the full bundle of all five services including loading/unloading capacities, bunker fuel, shore power, waste management services, and water supply while others may only have four or

[9] During playback, the vessel would have an arrow coming off of it which indicated that it was in motion, which would disappear when the vessel stopped. However, this did not always appear to be accurate, as there would be instances where a vessel would be sitting at port for a prolonged period of time and still have the arrow indicating that it was moving, and vice versa.

less of these facilities. In our selected sample, nine of the fully equipped docks are concentrated in Passau, whereas other cities tend to have simpler docks.

Price per dock also varies more based on the attractive locations or strong commercial demand rather than on the number of services they provide. It has been observed that even when the dock is well-equipped, they are not automatically the most expensive in the sample. With that, the cruise port system is heterogeneous in nature. Additionally, pricing does not tend to have a strong negative correlation with utilization rates, given that Köln, Düsseldorf, and Passau have the highest docking prices but maintain some of the highest utilization rates.

5.2 Infrastructure capacity, utilization patterns and priority segments

Across 83 docks, the utilization wheel distinguishes three priority bands based on the observed weekly utilization rates with bands representing docks that had zero-utilization, 1- 40%, and exceeding 40% utilization. As seen in the monthly utilization diagram of each of the three observation periods, a group of docks remains visibly unused; another group falls below the 40% threshold and only a smaller subset reaches or exceeds it *(Figure 4. Monthly Utilization Rates)*. That this three-tier split: idle, low-use, and active docks holds across all three seasons points to something structural in how vessel traffic is distributed across the network, not a pattern explained by any particular month or observation window.

Monthly Utilization Rates (out of 83 docks)

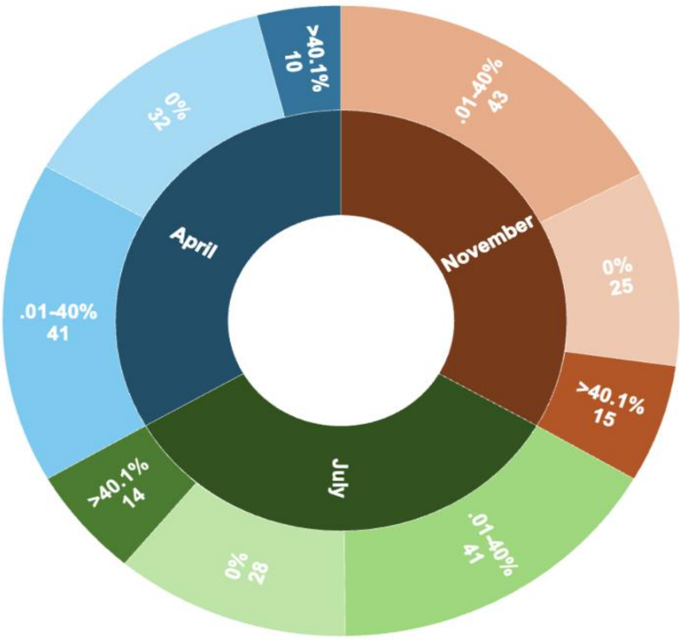

Figure 4: Monthly Utilization Rates

On average, docks in the sample operated at 13.8 percent utilization in April, 17.9 percent in July, and 18.1 percent in November, corresponding to an overall mean utilization of 16.6 percent across the three observation weeks *(Table 1. Monthly Average Utilization of 83 PoI)*. At the same time, the percentage breakdowns in Table 1 show that in each observation week roughly one third of the 83 sampled docks recorded zero utilization, about half operated at low utilization between 0.1 and 40 percent, and only a small minority between 12% to 18% of docks exceeded the 40 percent utilization threshold.

In defining the utilization thresholds, this research focused on the share of the 24-hour day during which ports on the Rhine-Main-Danube-Mosel River system are effectively operating. Many facilities and crews work well below continuous, round-the-clock schedules. Intermodal inland waterway transport studies show three broad regimes: operations on a daily basis round up to 14 hours, semi-continuous operations of up to 18 hours and fully continuous 24-hour operations which implies that typical terminals function at roughly 60% to 75% of the full daily time budget rather than at full capacity (Wiegmans & Konings, 2015). At the same time, EU rules for inland waterway staff set standard working time expectations around an 8-hour day and allowed a maximum of 14 working hours in any 24-hour period and 84 hours in a 7-day period which indicated normal operations fall significantly short of 24-hour full use (European Commission, 2024). Against this background, this research uses an above 40% utilization mark as conservative lower ceiling for the average operating hours of inland ports on the Rhine-Main-Danube-Mosel River system since this level is equivalent to 9 hours 36 minutes per day, still lies below the typical 60% to 75% range. This threshold therefore provides a pragmatic, evidence-informed cut-off for sorting and interpreting port utilization in our analysis while remaining consistent with the prevailing labor and operational regimes in European inland navigation.

Period	Utilization Category	Number of Docks	% of 83 Sampled Docks
April	0%	32	38%
	0.1–40%	41	49%
	>40%	10	12%
July	0%	28	33%
	0.1–40%	41	49%
	>40%	14	17%
November	0%	25	30%
	0.1–40%	43	52%
	>40%	15	18%
Statistic			**Value**
Mean weekly dock utilization (April)			13.8%
Mean weekly dock utilization (July)			17.9%
Mean weekly dock utilization (November)			18.1%
Overall mean across the three weeks			16.6%

Table 1: Monthly Average Utilization of 83 PoI

This coincides with our data collection which found that the hours where most ports had the highest utilization rates were between 06:00-12:00 and the lowest was between 01:00-03:00. An illustrative sample of the underlying data is presented in Annex D (Data Extraction Excel Excerpt). Disaggregating utilization by time of day across all three observation periods reveals a consistent intra-day pattern. The window between 05:00 and 12:00 is peak occupancy period across all docks during which the highest number of vessels are simultaneously docked. This concentration is driven by a near-universal pattern of pre-drawn arrivals: the majority of river cruise vessels arrive between 04:00 and 06:00, dock overnight or into the morning to early afternoon window of 11:00 to 17:00. As a result, simultaneous occupancy reaches its highest point in the early morning hours and gradually declines through the afternoon. These intra-day patterns have practical implications for infrastructure investment and scheduling. Congestion risk is highest in the 05:00–12:00 window, particularly at high-BDR ports in Passau, Köln, and Düsseldorf, where multiple vessels compete for the same limited dock slots during the morning peak.

5.2.1 Characteristics of persistently zero-utilization docks

A notable subset of the sample, a total of 13 ports, recorded zero utilization across all three observation periods in April, July, and November - representing docks that attracted no recorded vessel traffic regardless of season. Examining the infrastructure profiles of these docks reveals a pattern that is both striking and analytically instructive. With a single exception, every dock recording zero utilization across all 3 periods also lacks shore power connectivity *(as shown in Annex E: Cleaned Data Ranked* *by average utilization from 0%)*. The exception is Passau Altstadt Nr. 3/4, which is equipped with shore power and bunker fuel access yet nonetheless recorded zero utilization in all three observation weeks.[10]

The consistently absent amenity across zero-utilization docks spans multiple cities and rivers: Bernkastel's KD Landebrücke and KD Kues 2 on the Mosel, five Frankfurt docks on the Main including Nizza Werft Nr. 5 and Nr. 6, Hoechst Primus Linie, and Leonhardswerft, as well as Passau Altstadt Nr. 01, Traben's Freier Liegeplatz, and Schweich's Stadtsteiger. In each case, shore power is absent. This pattern does not establish a causal relationship, the regression results in Section 5.3 speak to that more precisely but it does suggest that shore power absence may function as a necessary, if not sufficient, condition for sustained inactivity at the dock level.

5.2.2 Characteristics of docks with utilization above 40%

In our sample, all docks with an average utilization above 40% combine two characteristics: they are located in structurally high demand cities such as Passau, Köln, Düsseldorf, and they provide a nearly complete bundle of services including shore power, bunker fuel, water supply and waste reception. This stands in sharp contrast to the 13 docks that recorded zero utilization in all three observation weeks, almost all of which lack shore power and several of which also lack fuel and waste services. Regression results confirm that bunker fuel is the strongest predictor of utilization in April and July, while shore power becomes the most influential variable in November, suggesting that bunker fuel availability dominates during the peak cruise season whereas shore power becomes more valuable during colder months and longer overnight stays. Together, these findings imply that investments in shore power and fuel infrastructure at commercially attractive locations are more likely to push docks into the high utilization band than generic upgrades at peripheral or poorly connected ports.

5.3 Determinants of dock utilization and caveats

This study is subject to data constraints that likely result in omitted variables, measurement noise, and a relatively small sample for some docks, so the estimates should be understood as indicative patterns rather than precise causal effects. With these caveats in mind, a simple linear model is used to explore which dock-level features are most strongly associated with utilization rates across the sample. Three linear regressions were estimated, one for each observation week, with dock utilization as the dependent variable, and price, maximum number of ships, bunker fuel, water supply, loading facilities, offshore power, and waste management services (garbage and sewage) as independent variables.[11]

Before turning to the regression coefficients, the analysis first examines whether dock amenities tend to cluster in ways that could distort coefficient estimates. To assess whether infrastructure variables tend to occur in bundles at the same docks, the analysis examines the pairwise correlations between bunker fuel, shore power, water supply, waste management services, and loading facilities. The resulting correlation coefficients are moderate, mostly in the range of approximately 0.1 to 0.4, which indicates that some amenities do co-occur more frequently at better equipped docks, but that they do

[10] Further observation into Passau Altstadt Nr. ¾ via google earth imaging revealed a possible reason for zero utilization despite it having access to shore power is its seemingly older, and low unloading area, leaving it vulnerable to flooding and high waters, making unloading without newer mechanisms seemingly impossible at certain times of day.

[11] Although it is important to note that external dependent variables also potentially play a role in determining utilization rates, such as location of port, age of port, city connectivity, and regional events, among other possible variables.

```
. corr Bunker_Fuel Shore_Power Water_Supply Garbage_Sewage Loading
(obs=83)

             | Bunker~l Shore_~r Water_~y Garbag~e  Loading
-------------+---------------------------------------------
 Bunker_Fuel |   1.0000
 Shore_Power |   0.3181   1.0000
Water_Supply |   0.1564   0.3013   1.0000
Garbage_Se~e |   0.0723   0.4076   0.1340   1.0000
     Loading |   0.1781   0.1919  -0.1337   0.2432   1.0000
```

Figure 5. Correlation matrix of amenities

not simply collapse into a single underlying 'infrastructure' dimension. In addition, correlations with price remain limited, suggesting that price captures a related but distinct aspect of dock characteristics. Overall, these diagnostics point to some degree of clustering of services, as one would expect in practice, but do not indicate such high co-movement that multicollinearity would dominate the regression results.

5.3.1 Regression analysis

In April, the coefficient on bunker fuel is at 0.178 and statistically significant at 5% level, meaning that docks offering bunkering services on average, have 17.8 percentage points higher utilization than similar docks without this service. The coefficients on price, maximum ships, loading, shore power, waste management services and water supply are close to zero and relatively insignificant, suggesting no association with utilization in this period.

```
. regress UTR_april Price max_ships Loading Bunker_Fuel Shore_Power Garbage_Sewage Wa
> ter_Supply

      Source |       SS           df       MS      Number of obs   =        57
-------------+----------------------------------   F(7, 49)        =      1.96
       Model |  .63611412         7  .090873446   Prob > F        =    0.0805
    Residual | 2.27587342        49  .046446396   R-squared       =    0.2184
-------------+----------------------------------   Adj R-squared   =    0.1068
       Total | 2.91198754        56  .051999777   Root MSE        =    .21551

--------------------------------------------------------------------------------
     UTR_april | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
---------------+----------------------------------------------------------------
         Price |  -.0000275    .000155    -0.18   0.860    -.0003391     .000284
     max_ships |  -.0552064   .0384692    -1.44   0.158    -.1325132    .0221003
       Loading |   .1137512   .1222931     0.93   0.357     -.132006    .3595084
   Bunker_Fuel |   .1784314   .0719396     2.48   0.017     .0338633    .3229994
   Shore_Power |   .0316376   .0759538     0.42   0.679    -.1209973    .1842725
Garbage_Sewage |  -.0443057   .0699311    -0.63   0.529    -.1848374    .0962261
  Water_Supply |   .0702038    .067978     1.03   0.307    -.0664032    .2068107
         _cons |   .0197819   .1339945     0.15   0.883    -.2494903     .289054
--------------------------------------------------------------------------------
```

Figure 6. Regression of April Utilization Rate

Below is the estimate of a linear regression model with weekly dock utilization in percentage points as dependent variables and dock characteristics as independent variables. The predicted utilization in April for dock *i* is given by:

$$\widehat{UTR}_{i,April} = 0.0198 - 0.0000275 \cdot Price_i - 0.0552 \cdot max\_ships_i + 0.1138 \cdot Loading_i + 0.1784 \cdot Bunker\_Fuel_i + 0.0316 \cdot Shore\_Power_i - 0.0443 \cdot Garbage\_Sewage_i + 0.0702 \cdot Water\_Supply_i$$

where all service variables are coded as 1 if the service is available at the dock and 0 otherwise.

In July, bunker fuel coefficient increases to 0.232 and again indicating a sizable positive association between fuel availability and utilization whereas other services and on capacity remain imprecise and insignificant. Although price turned positive but not significant at any conventional levels, same goes with the other services. Together with April results, the pattern in July continues for higher utilization during its peak season.

```
. regress UTR_july Price max_ships Loading Bunker_Fuel Shore_Power Garbage_Sewage Wat
> er_Supply

      Source |       SS           df       MS      Number of obs   =        57
-------------+----------------------------------   F(7, 49)        =      2.91
       Model |  1.28295914         7  .183279877   Prob > F        =    0.0125
    Residual |  3.08206512        49  .062899288   R-squared       =    0.2939
-------------+----------------------------------   Adj R-squared   =    0.1930
       Total |  4.36502425        56  .077946862   Root MSE        =     .2508

--------------------------------------------------------------------------------
      UTR_july | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
---------------+----------------------------------------------------------------
         Price |   .0001319   .0001804     0.73   0.468    -.0002307    .0004944
     max_ships |   -.05509    .0447672    -1.23   0.224     -.145053     .034873
       Loading |   .0992326   .1423144     0.70   0.489    -.1867589     .385224
   Bunker_Fuel |   .2324275   .0837173     2.78   0.008     .0641914    .4006636
   Shore_Power |   .0112608   .0883886     0.13   0.899    -.1663629    .1888844
Garbage_Sewage |  -.0368308   .0813799    -0.45   0.653    -.2003698    .1267082
  Water_Supply |   .0881834   .0791071     1.11   0.270    -.0707882     .247155
         _cons |  -.0408799   .1559315    -0.26   0.794     -.354236    .2724763
--------------------------------------------------------------------------------

. regress UTR_nov Price max_ships Loading Bunker_Fuel Shore_Power Garbage_Sewage Wate
> r_Supply
```

Figure 7. Regression of July Utilization Rate

The linear model with weekly dock utilization in percentage points as dependent variable yields:

$$\widehat{UTR}_{i,July} = -0.0409 + 0.0001319 \cdot Price_i - 0.0551 \cdot max\_ships_i + 0.0992 \cdot Loading_i + 0.2324 \cdot Bunker\_Fuel_i + 0.0113 \cdot Shore\_Power_i - 0.0368 \cdot Garbage\_Sewage_i + 0.0882 \cdot Water\_Supply_i$$

where all service variables are coded 1 when available and 0 otherwise.

By November, shore power carries a relatively large positive coefficient of 0.165 and is close to conventional significance levels, indicating that when all else is constant, docks equipped with shore power tend to record higher utilization the late-season week than docks without this service. This is likely due to environmental and comfort benefits of connecting to onshore power rather than running on auxiliary engines in port. These benefits become more salient during winter operations, and overnight stays are densely populated in city centers when heating needs and local concerns about air quality and noise are more noticeable than in other seasons/months. A more detailed discussion of these environmental and regulatory drivers is provided in *Section 5.5 "Cross-cutting insights for sustainable and resilient inland waterways"*.

```
. regress UTR_nov Price max_ships Loading Bunker_Fuel Shore_Power Garbage_Sewage Wate
> r_Supply

      Source |       SS           df       MS      Number of obs   =        57
-------------+----------------------------------   F(7, 49)        =      2.16
       Model |  1.09332124         7  .156188749   Prob > F        =    0.0549
    Residual |  3.55100989        49   .07246959   R-squared       =    0.2354
-------------+----------------------------------   Adj R-squared   =    0.1262
       Total |  4.64433113        56  .082934485   Root MSE        =     .2692

--------------------------------------------------------------------------------
       UTR_nov | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
---------------+----------------------------------------------------------------
         Price |   .0004121   .0001937     2.13   0.038     .0000229    .0008013
     max_ships |   .0324616   .0480524     0.68   0.503    -.0641033    .1290264
       Loading |   .0438426    .152758     0.29   0.775     -.263136    .3508212
   Bunker_Fuel |   -.142611   .0898607    -1.59   0.119    -.3231929     .037971
   Shore_Power |   .1646883   .0948749     1.74   0.089     -.02597     .3553466
Garbage_Sewage |  -.1837322   .0873518    -2.10   0.041    -.3592723   -.0081921
  Water_Supply |  -.0293154   .0849122    -0.35   0.731    -.1999529    .1413221
         _cons |   -.031564   .1673744    -0.19   0.851    -.3679154    .3047874
--------------------------------------------------------------------------------
```

Figure 8. Regression of November Utilization Rate

In November, the estimated linear model with weekly dock utilization in percentage points as dependent variable. The predicted utilization for dock *i* is,

$$\widehat{UTR}_{i,Nov} = -0.0316 + 0.0004121 \cdot Price_i + 0.0325 \cdot max\_ships_i + 0.0438 \cdot Loading_i - 0.1426 \cdot Bunker\_Fuel_i + 0.1647 \cdot Shore\_Power_i - 0.1837 \cdot Garbage\_Sewage_i - 0.0293 \cdot Water\_Supply_i$$

where service variables are coded 1 if the service is available, and 0 otherwise.

5.3.2 Cross-period synthesis of regression findings

The three regression models, read alongside each other, point to a seasonally shifting pattern in which infrastructure variables drive utilization. Bunker fuel availability is the dominant predictor in April and July, with its coefficient rising from 0.178 to 0.232, a trajectory that reflects the intensifying commercial pressure of the peak cruise season. Shore power, by contrast, barely registers in April (0.032) and July

(0.011) before becoming the most substantively important variable in November, with a coefficient of 0.165 approaching conventional significance thresholds. No other variable: price, maximum ship capacity, loading access, waste management, or water supply reaches statistical significance in any of the three observation periods.

This seasonal substitution between fuel and shore power has a clear operational logic. During spring and summer, vessels make frequent, shorter port calls and fueling is the operational priority. By November, call frequency drops but docking durations lengthen. The higher mean utilization rate in November despite fewer vessels at port confirms this pattern. Vessels are staying longer, which changes what infrastructure they need.[12]

5.4 Investment Needs, Opportunities and Bottlenecks Across Corridors and Port Types

The headline figure from the data is stark: only 12-18% of the sampled docks operate above the 40% utilization threshold in any given observation week, while 30-38% record zero utilization. At the network level, total physical capacity far exceeds current demand. This is not a system running short of infrastructure, it is a system where infrastructure is very unevenly activated.

The concentration becomes clearer at the city level. In Köln, Düsseldorf, and Passau, vessels compete for a small number of slots during the morning peak window between 05:00 and 12:00. These are genuine bottlenecks. The docks in these cities would justify expansion or access improvements because the demand is documented, and the pressure is structural, not seasonal.

The contrast with zero-utilization docks is striking. Many of those docks sit in the same cities, sometimes within meters of congested neighbors, with comparable or identical service profiles. The problem is not infrastructure, it is routing. Operators are concentrated on familiar, well-known docks while adjacent capacity goes unused. That points to a coordination and information failure rather than a physical capacity deficit.

5.5 Cross-cutting insights for sustainable and resilient inland waterways

These utilization patterns show a system with considerable slack in each observation week that operates above 40% utilization only constitutes to 12-18% share of the docks while 30-38% are not used at all. With this, resilience can be improved by redistributing calls across existing capacity rather than expanding infrastructure everywhere. It is also worth noting that only a small fraction has fully equipped port services (13 out of 83 ports observed) meaning cleaner infrastructure is uneven along the Rhine-Main-Danube-Mosel route. In some of the larger ports such as Passau, Frankfurt, Köln, and Düsseldorf, there were ports with very low utilization situated directly next to ports with much higher utilization and similar or identical port features.

In the November regression, docks with shore power display a positive and statistically significant association with utilization with a coefficient of 0.165, meaning docks with shore power have a higher

[12] Vessels staying overnight in city-center ports, particularly Christmas market cruise products, face growing incentives to connect to shore power rather than run auxiliary engines, both for heating and to comply with urban noise and emissions expectations. Shore power access therefore becomes a differentiating factor in late-season scheduling decisions precisely when it was irrelevant during peak summer operations.

demand when commercial attractiveness and local environmental objectives are met. EU and industry studies on onshore power supply report that ports which frequent cruise calls near city centers justify OPS partly on the basis of reducing local emissions and noise during long stays, especially overnight or cold-season calls (Trellevik, 2018; Comer, Mao, Osipova, Rutherford, & Schopp, 2023). Winter river cruise products, particularly Christmas market itineraries with short multi-city stops, put vessels in city-center locations for overnight stays where noise and emissions concerns from residents and local authorities are most acute. Shore power connectivity in those settings is increasingly less of a nice-to-have and more of a license-to-operate consideration.

The proximity phenomenon is the most operationally significant observation in the dataset. In Passau, Frankfurt, Köln, and Düsseldorf, high-utilization and zero-utilization docks sit next to one another with nearly identical infrastructure profiles. That is not an infrastructure problem. It is a scheduling, information, and behavioral problem: one that the right booking and allocation system could address without any capital expenditure at all.

6. Conclusions and Recommendations

6.1 Summary of main findings in relation to the research questions

Docks in the inland waterways along the Rhine-Main-Danube-Mosel River system showed strong heterogeneity in infrastructure and price. Only 13 of them offer the full bundle of services including bunker fuel, shore power, water supply, garbage and sewage handling while the rest of the docks provide zero to four of them.

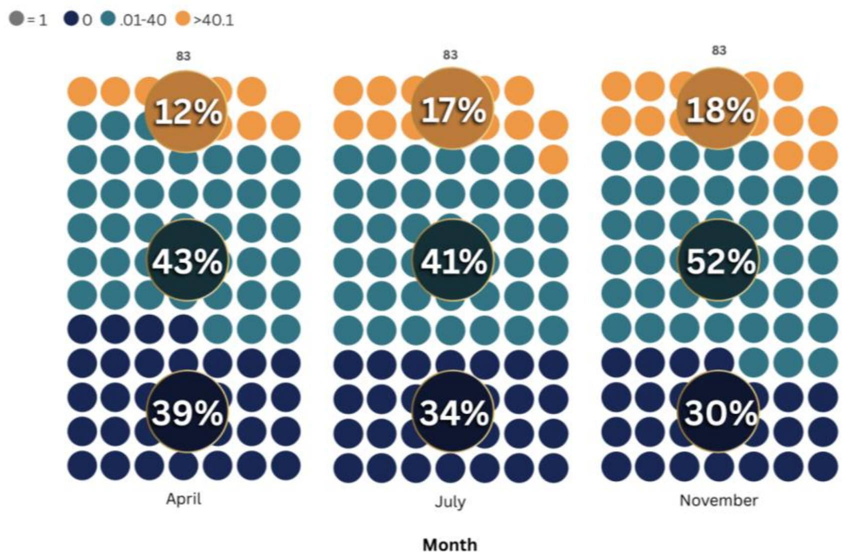

Figure 9: Distribution of Port Utilization

Observed utilization is highly condensed with only 12-18% of the total docks discovered to be operating above 40% utilization. Roughly a third of the docks are not used at all between the three observed weeks and that's within those cities that have the full services unless there are services we are not able to capture that may be potentially important. This analysis is restricted to the set of dock characteristics and external factors such as dedicated passenger access to terminals and city connectivity, available onshore services, local regulatory and environmental constraints are not considered. These characteristics may help explain why some docks remain idle despite appearing technically suitable.

The regression analysis clearly shows that for April and July, the bunker fuel has a positive association with the utilization, and in November, docks with shore power record significantly higher utilization.

Out of the three weeks we monitored, the week in November had the highest average utilization rate, despite it having the lowest number of vessels at port. This indicates that even though there were less vessels in November, they were docked longer at port, presumably spending more time connecting to shore power, which is especially needed in the colder months (November in this case) to keep the vessel heated during winter passenger cruise operations.

The findings show basic facilities and standard services do not have stable effects across the three time periods which indicates commercial and locational factors are at least as important as infrastructure shaping the dock choice.

6.2 Actionable Strategies and Instruments for Investment

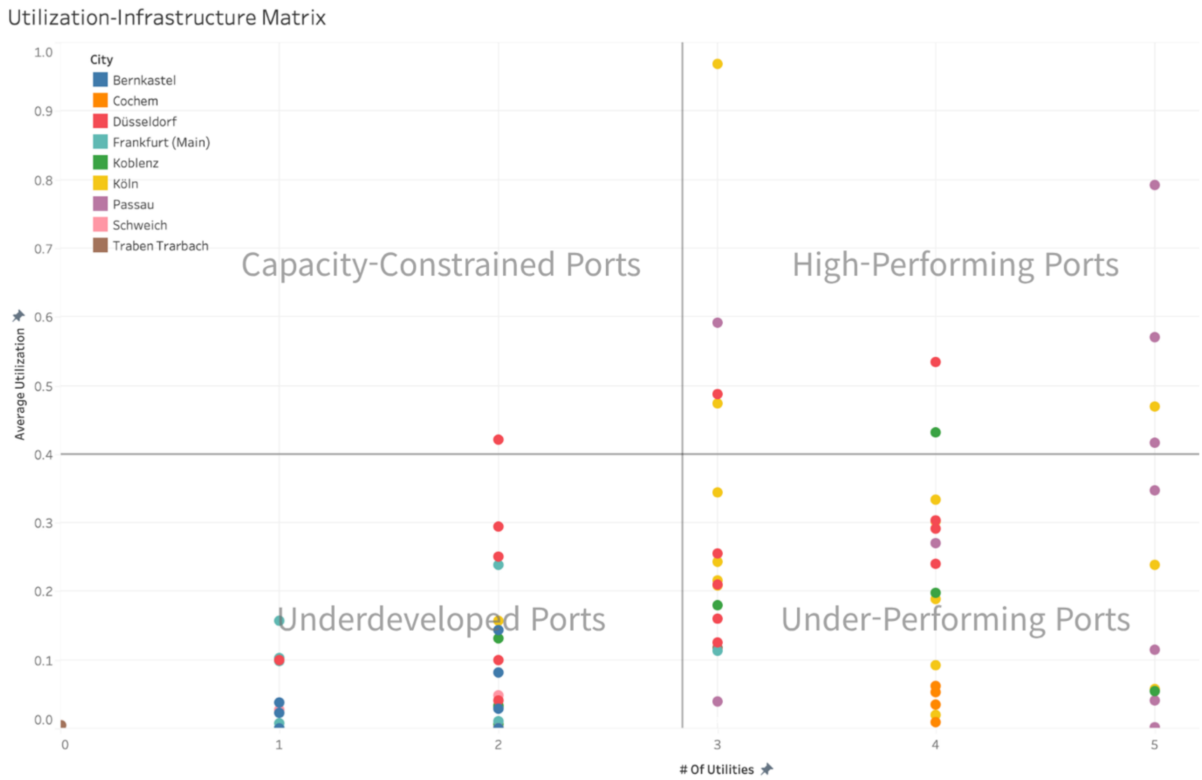

Figure 10. Utilization-Infrastructure Matrix - Port level

The findings of this study point to a port system that is deeply heterogeneous, in infrastructure quality, utilization levels, and commercial attractiveness. Instead of viewing the Rhine-Main-Danube-Mosel network as uniformly capacity-constrained, investment strategies should take into account this heterogeneity. The team suggests a port-level utilization-infrastructure matrix as the main diagnostic tool to direct targeted action. This matrix plots each port by its observed utilization rate against its service bundle score (number of offered amenities out of five). Each of the four distinct port typologies from the matrix require unique investment logic and finance mechanisms.

6.2.1 Capacity-Constrained Ports

The most pressing need for targeted capital investment is those with high utilization but inadequate infrastructure. This pattern is observed in Düsseldorf, where there is a clear commercial demand at these ports, but there are not enough facilities to serve it effectively, which causes operational friction for the operators and their vessels. Infrastructure improvements include adding service amenities, lengthening quays, or enhancing access channels. For green infrastructure components such as shore power, public funding instruments are available through two channels. First, EU Connecting Europe Facility (CEF) Transport grants, available to ports on the TEN-T inland waterway corridor, support investments that advance the network's connectivity, sustainability, and capacity objectives. TEN-T is the EU's framework for developing and upgrading strategic transportation infrastructure across member states, covering road, rail, air, and inland waterway corridors. Ports along the designated TEN-T inland waterway corridors, including the Rhine, Main, Danube, and Mosel, are eligible for EU CEF Transport grants (European Commission, n.d.). Second, European Investment Bank (EIB) offers concessional loans covering up to 50% of a project's total cost, prioritizing climate action and environmental sustainability (European Investment Bank, n.d.). Together, both funding instruments make shore power a particularly strategic entry point for accessing public financial support.

6.2.2 High-Performing Ports

Ports with both high utilization and strong infrastructure do not need immediate investment but serve as useful benchmarks. Understanding what combination of location, services, and pricing characterizes these ports can inform decisions on where to direct upgrade elsewhere in the network. When assessing investments for capacity-constrained and underperforming ports, UW can record these ports as replication models.

6.2.3 Under-Performing Ports

Ports with strong infrastructure but low utilization are especially evident in Köln, Düsseldorf and Passau, where ports with similar service bundles and pricing to their highly utilized neighbors record utilization near zero. Instead of a capital gap, this pattern suggests an information and coordination failure. Here, the appropriate instrument is intra-city call redistribution, combining two complementing methods. First is formalizing the existing booking system into a structured platform, enabling UW to actively direct reservations toward underutilized ports rather than allowing demand to concentrate on well-known ones. Second is the scheduling redistribution incentives, such as preferential booking terms or fee discounts for operators using nearby underused ports, providing the financial incentive to change behavior. Together, these tools can unlock existing capacity at a low capital cost.

In addition, guaranteeing accurate and complete port listings in operator fleet planning tools is a low capital intervention that can further reduce barriers to redistribution.

6.2.4 Underdeveloped Ports

Ports with low utilization and weak infrastructure are not the priorities for capital investment at this stage. For ports in regions that are less busy, including Cochem, Traben, Bernkastel, and Schweich, underutilization reflects broader demand patterns and regional positioning rather than competition for space or infrastructure deficiencies. Capital investment in these regions carries higher risk and is less likely to generate sufficient returns to attract private finance. The priority here is demand creation before infrastructure justification. Short-term operator subsidies financed through EU Regional Development Funds (ERDF) that temporarily reduce the cost or risk for operators willing to trial itineraries including underused Mosel River ports can be an option. If a trial generates enough passenger interest, operators can continue without subsidy (European Commission, n.d.). A complementary approach is the integration of these ports into existing seasonal cruise products, for example, extending Rhine Christmas market cruises by one or two stops along the Mosel, which distributes some traffic from saturated Rhine ports to underused Mosel ones. This requires coordination between UW, cruise operators, and regional tourism bodies rather than capital investment in new infrastructure.

6.2.5 Data Infrastructure Investment

The regression findings and utilization patterns identified in this study point toward a structural gap not only in physical infrastructure but also in the information systems that govern vessel scheduling and port allocation. Building on the digitalization literature reviewed in Section 2.4, this study recommends the development of a centralized port management system as part of United Waterways' operational infrastructure.

Spanning all port typologies, system-wide data infrastructure investments are recommended. The manual extraction methodology required by this study reflects a systemic gap in port-level utilization monitoring across the IWT network. IoT-enabled port monitoring systems integrated with AIS data can generate continuous, port-level utilization records. This will strengthen the evidence base for future investment decisions and enable accurate and up to date Booking Difficulty Rankings based on empirical utilization data.

Such a system would serve 3 interrelated functions: First, it would operationalize the Booking Difficulty Rankings by making real-time availability visible to UW's scheduling team, reducing scheduling failures that BDR 1 ports currently experience. Second, it would create the data infrastructure that this study lacked, continuous port-level utilization records that would enable longitudinal regression analysis rather than reliance on three snapshot weeks. Lastly, it would allow UW to actively redistribute vessel calls toward underutilized but serviceable ports, consistent with the recommendation in Section 6.2 to activate existing capacity before expanding it. *(Annex F: Prototype Dashboard - United Waterways dock booking and port management platform)*

Hervas-Peralta et al. (2019) demonstrate that terminal operating systems can increase port capacity by reducing scheduling delays and improving coordination across port operations precisely the inefficiency this study observes at ports like Köln and Düsseldorf where adjacent ports show divergent utilization despite similar infrastructure. A prototype of such a system was developed as part of this project to demonstrate feasibility and inform the design requirements that UW would need to specify for full implementation if considered.

6.3 Areas for future research and data improvement

6.3.1 Geographic and temporal extension of the data set

The present study's empirical base - 83 ports observed across three specific weeks in 2025 reflects the constraints of manual data extraction rather than an ideal research design. A single week in April, July and November captures directional seasonal variation but cannot account for year-on-year volatility, weather-driven disruptions or the gradual ramp-up and wind down of cruise seasons at either end. Extending observation to full seasonal cycles, ideally across multiple years, would substantially improve the reliability of any regression-based inference. Equally important is the geographic coverage: the 98 ports of interest in Luxembourg, France and Switzerland remain unexamined, yet these corridors form part of the same operational network and may exhibit utilization dynamics quite different from the German cluster studied here. Without this broader dataset, conclusions about investment prioritization risk overfitting to a geographically concentrated and methodologically constrained sample.

6.3.2 Regional heterogeneity in the determinants of utilization

The regression results point to bunker fuel availability as the primary driver of utilization in spring and summer with shore power gaining relative importance in November yet these aggregate findings obscure considerable variation at the city level that warrants closer attention. It is not self-evident, for instance, why the shore power coefficient behaves differently across Düsseldorf, Koblenz, and Passau, given that all three cities host ports on the same river system and operate under broadly comparable regulatory conditions. The answer likely lies in a combination of factors that cross-sectional regression cannot easily disentangle: local emissions ordinances, difference in the vessel types that regularly call at each port, proximity to urban residential areas where overnight noise and air quality complaints may prompt operators to connect to shore power and the competitive pressure exerted by nearby alternative berths. Region-specific analyses that incorporate these contextual variables including land transport connectivity, proximity to cultural and tourist infrastructure and municipal environment policy would add explanatory depth that the current quantitative framework cannot provide on its own.

6.3.3 Within-city variation in dock-level performance

Perhaps the most practically significant finding to emerge from this study is that high and low utilization docks frequently sit within meters of one another inside the same city, share similar service profiles and yet attract markedly different levels of vessel traffic. This pattern is visible in Passau, Frankfurt, Köln and Düsseldorf, and it resists easy explanation through infrastructure variables alone. Dock pricing, service availability and physical capacity are largely observable; what is harder to observe and what future research should attempt to measure are the informal mechanisms through which operators develop preferences for particular docks. Scheduling conventions embedded in the voyage planning platform, the visibility and accessibility of a dock from the waterway approach, integration with passenger transfer services and the quality of information available to skippers making last-minute decisions may all play a role. Addressing these questions would require qualitative methods that complement the quantitative approach taken here: structured interviews with vessel operators and port managers, systematic site visits to document physical accessibility and signage conditions and examination of how booking behavior at the operator level relates to the utilization patterns recorded from vessel tracking data. The practical payoff is considerable, if micro-geographic disparities within cities are driven by informational or logistical factors rather than capacity gaps, redistribution of demand may be achievable without any capital expenditure.

6.4 Conclusion

This research sought to identify the most promising strategies for strengthening the docking infrastructure across identified PoIs by analyzing port utilization data. Keeping in mind the reduced sample size from 221 to 83 and noting utilization patterns over direct causal relationship, the regression findings offer a basis for extending the analysis beyond the observed sample. The two drivers most consistently associated with utilization, bunker fuel during peak season, and shore power during colder months, can be applied as a screening lens across the remaining ports even without direct utilization data. Combined with the available service information already documented within UW's database, each unexamined port can be tentatively positioned within the utilization-infrastructure matrix on its services bundle score and corridor characteristics. This is not a substitute for empirical observation but rather provides a practical starting point for prioritizing which ports warrant closer attention as the river network expands.

To make prioritization more reliable, implementation of a centralized port management system integrated with real-time AIS data and IoT-enabled dock monitoring would be of high value. It has been backed up in this study that systems such as this increase port capacity by reducing scheduling delays and coordination failures that have been repeatedly observed in idle ports alongside congested neighbors, booking difficulty driven by institutional intuition rather than calculated scarcity and utilization patterns that shift not because demand changes but because operators default to familiar ports of interest. A system that makes real-time availability visible across the full network would address those inefficiencies directly, redistribute vessel calls more evenly, and generate the continuous utilization records that future investment decisions across all 221 ports of interest will require.

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ANNEX

A. English version of survey

United Waterways X Geneva Graduate Institute: Port Utilization Data Gathering

All data collected in this form will be managed in strict accordance with the General Data Protection Regulation (GDPR) and relevant European data protection laws. All business or sensitive information will be anonymized and securely stored. The data will be used solely for the purposes of academic research on inland waterways and sustainable transportation logistics. Only authorized researchers will have access to the collected information. Respondents have the right to access, amend or request deletion of their data at any point. No identifying information will be shared with third parties, and results will be reported only in aggregated form to ensure confidentiality and privacy.

We are coordinating with United Waterways in partnership with the Geneva Graduate Institute to gather port utilization data from inland river ports in European waterways. This data will be analyzed and used to help inform infrastructure improvements and draw conclusions on best practices to improve port utilization and build capacity.

PLEASE NOTE 📝

You may either:

- **complete the questions below**

OR

- **submit a file at the end of the survey with the applicable data**

The name, email, and photo associated with your Google account will be recorded when you upload files and submit this form

* Indicates required question

Company *

Your answer

Port Location *

Your answer

Please provide utilization data for one week in April. What are the specific dates for the data you are providing?

Example: 06 - 12 April 2025

Your answer

How many hours (or what % of the time) was the port occupied for this specific week in April (either specific times or total number of hours)

Example: In week 06 - 12 April 2025, the port was occupied for 100 out of 168 hours. OR ~ 59.52% of the time. OR from time XX:XX - XX:XX on X day

Your answer

Please provide utilization data for one week in July. What are the specific dates for the data you are providing?

Example: 13 - 19 July 2025

Your answer

How many hours (or what % of the time) was the port occupied for this specific week in July (either specific times or total number of hours)

Example: In week 13 - 19 July 2025, the port was occupied for 126 out of 168 hours. OR ~ 75% of the time. OR from time XX:XX - XX:XX on X day

Your answer

Please provide utilization data for one week in November. What are the specific dates for the data you are providing?

Example: 23 - 29 November 2025

Your answer

How many hours (or what % of the time) was the port occupied for this specific week in November (either specific times or total number of hours)

Example: In week 23 - 29 November 2025, the port was occupied for 78 out of 168 hours. OR ~ 46.43% of the time. OR from time XX:XX - XX:XX on X day

Your answer

Do you have any other information you would like to add?
If data is unavailable, can you suggest any sources or contacts where we might retrieve the information needed?

Your answer

Please upload any supplementary data here

Upload 1 supported file. Max 100 MB.

Add file

B. French and German versions of survey

[DE] United Waterways X Geneva Graduate Institute: Erhebung von Daten zur Hafennutzung

Alle in diesem Formular erhobenen Daten werden unter strikter Einhaltung der Datenschutz-Grundverordnung (DSGVO) und der einschlägigen europäischen Datenschutzgesetze verwaltet. Alle geschäftlichen oder sensiblen Informationen werden anonymisiert und sicher gespeichert. Die Daten werden ausschließlich für akademische Forschungszwecke im Bereich Binnenwasserstraßen und nachhaltige Transportlogistik verwendet. Nur autorisierte Forscher haben Zugriff auf die erhobenen Informationen. Die Befragten haben jederzeit das Recht, auf ihre Daten zuzugreifen, sie zu ändern oder deren Löschung zu beantragen. Es werden keine identifizierenden Informationen an Dritte weitergegeben, und die Ergebnisse werden nur in aggregierter Form berichtet, um Vertraulichkeit und Datenschutz zu gewährleisten.

Wir arbeiten mit United Waterways in Zusammenarbeit mit dem Geneva Graduate Institute zusammen, um Daten zur Hafennutzung von Binnenhäfen in europäischen Wasserstraßen zu sammeln. Diese Daten werden analysiert und verwendet, um Infrastrukturverbesserungen zu unterstützen und Schlussfolgerungen zu bewährten Verfahren zur Verbesserung der Hafennutzung und zum Kapazitätsaufbau zu ziehen.

BITTE BEACHTEN SIE 📝

Sie können entweder:

- **die folgenden Fragen beantworten**

ODER

- **am Ende der Umfrage eine Datei mit den entsprechenden Daten einreichen**

United Waterways X Institut Universitaire de Genève : Collecte de données sur l'utilisation des ports

Toutes les données recueillies dans ce formulaire seront gérées dans le strict respect du règlement général sur la protection des données (RGPD) et des lois européennes applicables en matière de protection des données. Toutes les informations commerciales ou sensibles seront anonymisées et stockées de manière sécurisée. Les données seront utilisées uniquement à des fins de recherche universitaire sur les voies navigables intérieures et la logistique du transport durable. Seuls les chercheurs autorisés auront accès aux informations recueillies. Les répondants ont le droit d'accéder à leurs données, de les modifier ou d'en demander la suppression à tout moment. Aucune information permettant d'identifier les personnes ne sera communiquée à des tiers, et les résultats ne seront communiqués que sous forme agrégée afin de garantir la confidentialité et le respect de la vie privée.

Nous collaborons avec United Waterways, en partenariat avec l'Institut universitaire de Genève, afin de recueillir des données sur l'utilisation des ports fluviaux intérieurs dans les voies navigables européennes. Ces données seront analysées et utilisées pour aider à améliorer les infrastructures et tirer des conclusions sur les meilleures pratiques visant à améliorer l'utilisation des ports et à renforcer les capacités.

VEUILLEZ NOTER 📝

Vous pouvez soit :

- **répondez aux questions ci-dessous**

OU

- **soumettre un fichier à la fin de l'enquête avec les données applicables**

C. Master PoI Excel with Amenities Excerpt

4		City		Dock Name		Dock Provider	*******Google maps link*********	River	Max ship length	Max # of ships	Loading	Bunker Fuel	Shore Power	Garbage & Sewage	Water Supply	Price	Type of Price
5	104	Alken	2	KD Steiger (nicht für FGKS)	0	Köln-Düsseldorfer	https://www.google.com/maps?q=50.24841,7.446741	Mosel	110	1	yes	no	no	no	no		
6	105	Alken	2	KD Landebrücke 2	0	Köln-Düsseldorfer	https://www.google.com/maps?q=50.246395,7.446405	Mosel	110	1	yes	no	no	no	no	580	Pro 24h
7	138	Alken	3	TBA	1	River Advice AG	https://www.google.com/maps?q=0,0	Mosel			no	no	no	no	no		
8	139	Alken	3	Freier Liegeplatz	1	WSA Mosel-Saar-Lahn	https://www.google.com/maps?q=48.576366,7.444607	Mosel	135	1	yes	no	no	no	no		
9	108	Andernach	2	KD Steiger	1	Köln-Düsseldorfer	https://www.google.com/maps?q=50.442167,7.401611	Rhein	110	1	yes	yes	no	yes	yes		
10	109	Andernach	2	Stadtsteiger 1	1	Andernach.net GmbH	https://www.google.com/maps?q=50.442145,7.407608	Rhein	135	1	yes	yes	no	yes	yes	180	0-2 h
11	110	Andernach	2	Stadtsteiger 2 (Bollwerk)	1	Andernach.net GmbH	https://www.google.com/maps?q=50.442024,7.405698	Rhein	135	2	yes	yes	yes	yes	yes	180	0-2 h
12	111	Andernach	2	Andernach	1	Andernach.net GmbH	https://www.google.com/maps?q=50.442145,7.407608	Rhein	135	2	yes	yes	yes	yes	yes	165	0-2 h
13	53	Basel	1	St. Johann 2	1	Schweizerische Rheinhäfen	https://www.google.com/maps?q=47.568533,7.583505	Rhein	110	2	no	no	yes	yes	yes	600	Pro 24h
14	54	Basel	1	St. Johann 1	1	Schweizerische Rheinhäfen	https://www.google.com/maps?q=47.567433,7.583527	Rhein	135	2	no	no	yes	yes	yes	600	Pro 24h
15	112	Basel	2	Plattform 1 Klybeck	1	Schweizerische Rheinhäfen	https://www.google.com/maps?q=47.578946,7.5857	Rhein			no	no	no	yes	yes	600	Pro 24h
16	113	Basel	2	Plattform 2 Klybeck	1	Schweizerische Rheinhäfen	https://www.google.com/maps?q=47.57996352,7.58582	Rhein	110	2	no	no	no	yes	yes	600	Pro 24h
17	114	Basel	2	Dreiländereck	1	Schweizerische Rheinhäfen	https://www.google.com/maps?q=47.587276,7.588832	Rhein	135	2	no	no	yes	yes	yes	600	Pro 24h
18	115	Basel	2	Steiger Klybeckquai	1	Schweizerische Rheinhäfen	https://www.google.com/maps?q=47.580909,7.586011	Rhein	135	2	no	no	yes	yes	yes	600	Pro 24h
19	140	Basse-Ham	3	Port de Plaisance	1	SPL Moselle Nord Plaisance	https://www.google.com/maps?q=49.38553,6.222993	Mosel			no	no	no	no	no	175	Pro
20	141	Beilstein	3	Viking	1	Viking Technical GmbH	https://www.google.com/maps?q=50.109691,7.238021	Mosel	110	1	yes	no	no	yes	no		
21	28	Bernkastel	1	Böschung Kues	1	WSA Mosel-Saar-Lahn	https://www.google.com/maps?q=49.9139,7.071108	Mosel		2	yes	no	no	yes	no		
22	29	Bernkastel	1	KD Landebrücke (ex	1	Köln-Düsseldorfer	https://www.google.com/maps?q=49.919058,7.072758	Mosel	110	1	yes	no	no	yes	no	580	Pro 24h
23	30	Bernkastel	1	Viking (früher Kolb)	1	Viking Technical GmbH	https://www.google.com/maps?q=49.912318,7.071653	Mosel	135	1	yes	no	no	yes	no		
24	31	Bernkastel	1	KD Kues 2	1	Köln-Düsseldorfer	https://www.google.com/maps?q=49.912877,7.070005	Mosel	135	1	yes	no	no	no	no	525	Pro
25	32	Bernkastel	1	KD Kues 1	1	Köln-Düsseldorfer	https://www.google.com/maps?q=49.91201,7.068855	Mosel	110	1	yes	no	no	no	no		
26	33	Bernkastel	1	KD Landebrücke Danielmeier	1	Köln-Düsseldorfer	https://www.google.com/maps?q=49.918269,7.073313	Mosel	85	1	yes	no	no	no	no	375	Pro 24h
27	142	Bernkastel	3	TBA	1	River Advice AG	https://www.google.com/maps?q=0,0	Mosel			no	no	no	no	no		
28	143	Bernkastel	3	Schutzhafen	1	Feenstra Rijn Lijn bv	https://www.google.com/maps?q=49.909006,7.060717	Mosel	110	1	yes	no	no	no	yes	525	Pro 24h
29	116	Bonn	2	KD Landebrücke Bundeshaus	1	Köln-Düsseldorfer	https://www.google.com/maps?q=50.719481,7.12802	Rhein	135	1	yes	no	no	no	no		
30	117	Bonn	2	KD Landebrücke Nr. 1	1	Köln-Düsseldorfer	https://www.google.com/maps?q=50.735927,7.108429	Rhein	110	1	no	no	no	no	no		
31	118	Bonn	2	KD Landebrücke Nr. 2	1	Köln-Düsseldorfer	https://www.google.com/maps?q=50.736922,7.108059	Rhein	135	1	yes	no	no	no	yes		
32	119	Bonn	2	BPS 1	1	Bonner Personen Schiffahrt	https://www.google.com/maps?q=50.731173,7.11036	Rhein	135	1	yes	no	no	no	no	350	Pro 24h
33	120	Bonn	2	BPS 2	1	Bonner Personen Schiffahrt	https://www.google.com/maps?q=50.731117,7.110424	Rhein	135		yes	no	no	no	no	350	Pro 24h
34	55	Breisach	1	Croisi Europe	1	Croisi Europe	https://www.google.com/maps?q=48.024544,7.580681	Rhein	135	2	yes	no	no	yes	no	250	0-4 h
35	121	Breisach	2	Anleger 3	1	RHEINHAFEN BREISACH	https://www.google.com/maps?q=48.036508,7.569966	Rhein	135	2	yes	no	no	yes	no	650	Pro
36	122	Breisach	2	Anleger 1	1	RHEINHAFEN BREISACH	https://www.google.com/maps?q=48.033089,7.570989	Rhein	135	2	yes	no	no	yes	no	650	Pro
37	144	Brodenbac	3	KD Steiger	1	Köln-Düsseldorfer	https://www.google.com/maps?q=50.227917,7.445093	Mosel	110	1	no	no	no	no	no		
38	34	Cochem	1	Stadt Steiger 1	1	Verbandsgemeindeverwalt	https://www.google.com/maps?q=50.148384,7.169325	Mosel	135	2	yes	no	yes	yes	yes	390	Pro 24h
39	35	Cochem	1	Viking Steiger	1	Viking Technical GmbH	https://www.google.com/maps?q=50.151521,7.169777	Mosel	135	2	yes	no	yes	yes	0.4 litre		
40	106	Cochem	2	Stadt Steiger 2	1	Verbandsgemeindeverwalt	https://www.google.com/maps?q=50.149334,7.169464	Mosel	135	2	yes	no	yes	yes	yes	390	Pro 24h
41	107	Cochem	2	Stadt Steiger 3	1	Verbandsgemeindeverwalt	https://www.google.com/maps?q=50.150452,7.169647	Mosel	135	2	yes	no	yes	yes	yes	390	Pro 24h
42	145	Cochem	3	Stadt Steiger (tba)	1	Verbandsgemeindeverwalt	https://www.google.com/maps?q=0,0	Mosel			yes	no	yes	yes	yes		
43	146	Cochem	3	TBA	1	River Advice AG	https://www.google.com/maps?q=0,0	Mosel			no	no	no	no	no		
44	56	Düsseldorf	1	**Rhein Cargo Steiger 1**	1	RheinCargo GmbH & Co.	https://www.google.com/maps?q=51.237519,6.769397	Rhein	135	1	yes	no	yes	no	yes	750	Pro 24h
45	57	Düsseldorf	1	**RSR 1**	1	RsR Schiffahrt AG	https://www.google.com/maps?q=51.22908,6.77062	Rhein	135	1	yes	no	yes	yes	no	530	0-2 h
46	58	Düsseldorf	1	**Rhein Cargo Steiger 3**	1	RheinCargo GmbH & Co.	https://www.google.com/maps?q=51.239136,6.768576	Rhein	135	1	yes	no	yes	yes	yes	750	Pro 24h
47	59	Düsseldorf	1	**Rhein Cargo Steiger 4**	1	RheinCargo GmbH & Co.	https://www.google.com/maps?q=51.253462,6.745863	Rhein	135	1	yes	no	yes	no	no	750	Pro 24h
48	60	Düsseldorf	1	**Rhein Cargo Steiger 5**	1	RheinCargo GmbH & Co.	https://www.google.com/maps?q=51.254028,6.743784	Rhein	135	1	yes	no	yes	no	no	750	Pro 24h
49	61	Düsseldorf	1	**BPS**	1	Bonner Personen Schiffahrt	https://www.google.com/maps?q=51.23261369,6.77056	Rhein	135	1	yes	no	no	yes	no	600	Pro 24h
50	62	Düsseldorf	1	**Rhein Cargo Steiger 2**	1	RheinCargo GmbH & Co.	https://www.google.com/maps?q=51.238313,6.769013	Rhein	135	1	yes	no	yes	no	no	750	Pro 24h
51	63	Düsseldorf	1	**Viking 2 Rheinufer**	1	Viking Technical GmbH	https://www.google.com/maps?q=51.235736,6.770295	Rhein	135	1	yes	no	yes	yes	yes		
52	123	Düsseldorf	2	**RSR 2**	1	RsR Schiffahrt AG	https://www.google.com/maps?q=51.23057,6.77084	Rhein	135	1	yes	no	yes	yes	no	530	0-2 h
53	124	Düsseldorf	2	**KD Steiger 4 Schnellenburg**	1	Köln-Düsseldorfer	https://www.google.com/maps?q=51.253534,6.745863	Rhein	135	2	yes	no	no	yes	yes		
54	125	Düsseldorf	2	**KD Landebrücke**	1	Köln-Düsseldorfer	https://www.google.com/maps?q=51.245866,6.762782	Rhein	135	1	yes	no	yes	yes	yes		
55	126	Düsseldorf	2	**KD Landebrücke**	1	Köln-Düsseldorfer	https://www.google.com/maps?q=51.24686,6.76144	Rhein	135	1	yes	no	yes	yes	yes		
56	127	Düsseldorf	2	**Liegeplatz 8 (Messe)**	1	RheinCargo GmbH & Co.	https://www.google.com/maps?q=51.23444,6.770485	Rhein			yes	no	no	yes	no	600	Pro 24h
57	128	Düsseldorf	2	**Altstadtufer**	1	RheinCargo GmbH & Co.	https://www.google.com/maps?q=51.225428,6.769823	Rhein	135	1	yes	no	no	no	no	600	Pro 24h
58	129	Düsseldorf	2	**RSR Messe**	1	RsR Schiffahrt AG	https://www.google.com/maps?q=51.2546426,6.741811	Rhein	135	2	yes	no	no	no	yes	450	0-2 h
59	130	Düsseldorf	2	**KD Steiger 5 Schnellenburg**	1	Köln-Düsseldorfer	https://www.google.com/maps?q=51.254051,6.743762	Rhein	135	2	yes	no	no	yes	yes		
60	17	Frankfurt	1	Nizza Werft, Nr. 3	1	HFM	https://www.google.com/maps?q=50.105751,8.673577	Main	110	1	no	no	no	no	0.00225	552	Pro 24h
61	18	Frankfurt	1	Nizza Werft, Nr. 2	1	HFM	https://www.google.com/maps?q=50.105001,8.672338	Main	135	1	no	no	no	no	0.00225	552	Pro 24h
62	19	Frankfurt	1	Viking	1	Viking Technical GmbH	https://www.google.com/maps?q=50.107924,8.678785	Main			yes	no	no	no	no		
63	20	Frankfurt	1	Nizza Werft, Nr. 4 (früher 5)	1	HFM	https://www.google.com/maps?q=50.10666,8.675627	Main	135	1	no	no	no	no	0.00225	218	0-2 h
64	21	Frankfurt	1	Nizza Werft, Nr. 6	1	HFM	https://www.google.com/maps?q=50.108378,8.680181	Main	135	1	no	no	no	no	0.00225	218	0-2 h
65	22	Frankfurt	1	Nizza Werft, Nr. 5	1	HFM	https://www.google.com/maps?q=50.107452,8.677472	Main	135	1	no	no	no	no	0.00225	552	Pro 24h
66	23	Frankfurt	1	Hoechst Primus Linie	1	Hoechst Primus Linie	https://www.google.com/maps?q=50.09959239,8.55137	Main			yes	no	no	no	no		
67	24	Frankfurt	1	Leonhardswerft	1	HFM	https://www.google.com/maps?q=50.107587,8.677878	Main			yes	no	no	no	no	218	Part-day
68	25	Frankfurt	1	Nizza Werft, Nr. 1	1	HFM	https://www.google.com/maps?q=50.104164,8.671027	Main	110	1	yes	no	no	no	0.00225	552	Pro 24h
69	98	Frankfurt	2	Osthafen 20/22	1	HFM	https://www.google.com/maps?q=50.111955,8.719045	Main	135	1	yes	no	no	yes	no	552	Pro 24h
70	99	Frankfurt	2	Osthafen 10/13	1	HFM	https://www.google.com/maps?q=50.10878,8.711365	Main	135	1	yes	no	no	yes	no	218	0-2 h
71	100	Frankfurt	2	Osthafen 17/19	1	HFM	https://www.google.com/maps?q=50.111129,8.716555	Main	135	1	yes	no	no	yes	no	218	0-2 h
72	101	Frankfurt	2	Osthafen	1	HFM	https://www.google.com/maps?q=50.110967,8.717095	Main			yes	no	no	no	no	218	Part-day

D. Data Extraction Excel Excerpt

PASSAU - Altstadt Nr. 05 (Max # of ships: 1)														
April 6-12					July 6-12					November 16-22				
Vessel	Arrival	Departure	Duration	UTILIZATION	Vessel	Arrival	Departure	Duration	UTILIZATION	Vessel	Arrival	Departure	Duration	UTILIZATION
VIKING EMBLA	6 April 19:57	7 April 11:30	15:33:00	9.26%	VIKING TOR	6 July 4:49	6 July 16:38	11:49:00	7.03%	[redacted]			0:00:00	0.00%
ILZ	10 April 7:31	10 April 9:16	1:45:00	1.04%	VIKING GULLVEIG	6 July 19:38	July 7 16:25	20:47:00	12.37%				0:00:00	0.00%
VIKING TOR	11 April 19:02	12 April 11:26	16:24:00	9.76%	SCENIC JEWEL	7 July 18:35	8 July 19:02	24:27:00	14.55%				0:00:00	0.00%
			0:00:00	0.00%	FRANCE	9 July 5:57	9 July 16:32	10:35:00	6.30%				0:00:00	0.00%
			0:00:00	0.00%	VIKING LOFN	10 July 18:40	11 July 16:32	21:52:00	13.02%				0:00:00	0.00%
			0:00:00	0.00%	VIKING EMBLA	12 July 5:47	12 July 18:45	12:58:00	7.72%				0:00:00	0.00%

PASSAU - Altstadt Nr. 13 (Max # of ships: 1)														
April 6-12					July 6-12					November 16-22				
Vessel	Arrival	Departure	Duration	UTILIZATION	Vessel	Arrival	Departure	Duration	UTILIZATION	Vessel	Arrival	Departure	Duration	UTILIZATION
VIKING EGIL	6 April 0:00	6 April 11:45	11:45:00	6.99%	SWISS PEARL	6 July 4:34	6 July 17:01	12:27:00	7.41%	VIKING VAR	Nov 16 5:31	Nov 16 17:15	11:44:00	6.98%
AMAVERDE	6 April 5:08	6 April 9:48	4:40:00	2.78%	VIKING AEGIR	6 July 9:01	7 July 12:18	27:17:00	16.24%	VIKING VILI	Nov 16 6:22	Nov 16 16:24	10:02:00	5.97%
AMALEA	6 April 12:30	6 April 20:11	7:41:00	4.57%	VIKING VILHJALM	7 July 9:52	7 July 19:29	9:37:00	5.72%	VIKING ATLA	Nov 18 14:22	Nov 18 17:15	2:53:00	1.72%
CELINA	7 April 6:02	7 April 19:02	13:00:00	7.74%	SCENIC JEWEL	7 July 12:02	7 July 17:52	5:50:00	3.47%	VIKING INGVI	Nov 18 18:25	Nov 19 12:20	17:55:00	10.66%
VIKING NJORD	7 April 14:30	9 April 15:49	49:19:00	29.36%	AVALON PASSION	7 July 20:31	8 July 11:34	15:03:00	8.96%	VIKING GULLVEIG	Nov 20 9:03	Nov 20 13:27	4:24:00	2.62%
VIKING INGVI	8 April 17:41	9 April 11:28	17:47:00	10.59%	VIKING NJORD	7 July 20:21	8 July 19:39	23:18:00	13.87%	AMAMORA	Nov 21 7:39	Nov 21 11:03	3:24:00	2.02%
DANUBE 1	9 April 12:42	9 April 13:42	1:00:00	0.60%	JOY	8 July 15:12	8 July 16:41	1:29:00	0.88%	VIKING AEGIR	Nov 22 6:40	Nov 22 20:20	13:40:00	8.13%
ARIELLE ROYAL	10 April 7:13	10 April 14:45	7:32:00	4.48%	AMADEUS IMPERIAL	9 July 10:27	11 July 9:18	46:51:00	27.89%				0:00:00	0.00%
SAVOR	10 April 15:07	10 April 16:41	1:34:00	0.93%	APT SOLARA	11 July 5:01	July 11 19:51	14:50:00	8.83%				0:00:00	0.00%
VIKING JARL	11 April 6:40	11 April 12:21	5:41:00	3.38%	MONARCH QUEEN	11 July 11:43	11 July 16:13	4:30:00	2.68%				0:00:00	0.00%
AMAMORA	11 April 6:39	11 April 8:48	2:09:00	1.28%	ARIANA	12 July 5:34	12 July 13:05	7:31:00	4.47%				0:00:00	0.00%
SAVOR	11 April 18:32	12 April 11:33	17:01:00	10.13%	COMPASS EMPRESS	12 July 7:55	12 July 13:01	5:06:00	3.04%				0:00:00	0.00%
COMPASS EMPRESS	12 April 6:39	12 April 13:34	6:55:00	4.12%	APT SOLARA	12 July 15:09	12 July 23:59	8:50:00	5.26%				0:00:00	0.00%
VIKING GULLVEIG	12 April 17:54	12 April 23:59	6:05:00	3.62%				0:00:00	0.00%				0:00:00	0.00%

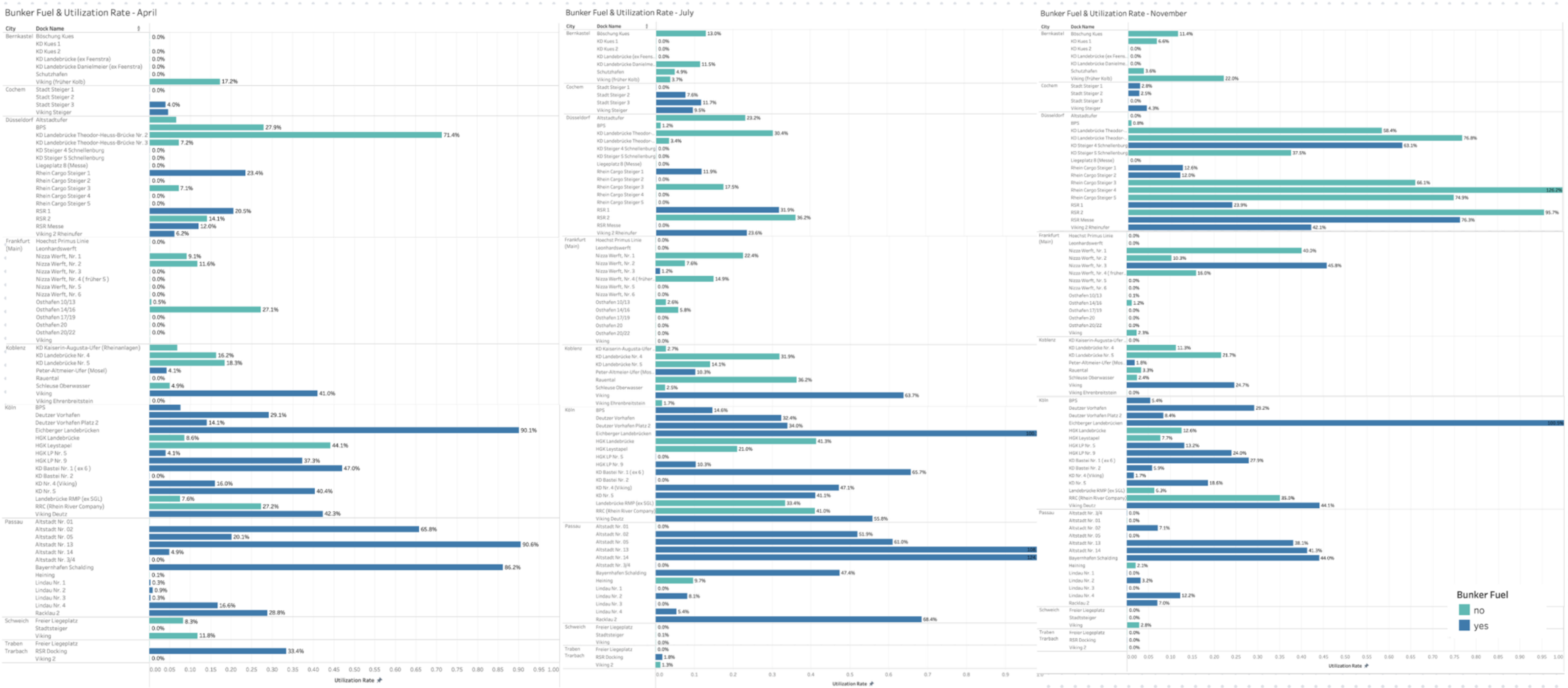
PASSAU - Altstadt Nr. 14 (Max # of ships: 1)														
April 6-12					July 6-12					November 16-22				
Vessel	Arrival	Departure	Duration	UTILIZATION	Vessel	Arrival	Departure	Duration	UTILIZATION	Vessel	Arrival	Departure	Duration	UTILIZATION
ILZ	8 April 8:12	8 April 9:04	0:52:00	0.52%	SCENIC AMBER	6 July 4:50	6 July 20:14	15:24:00	9.17%	TRAVELMARVEL CAI	Nov 16 0:16	Nov 16 7:23	7:07:00	4.24%
AMAMORA	11 April 6:40	11 April 8:56	2:16:00	1.35%	SS MARIA THERESA	6 July 17:24	7 July 13:36	20:12:00	12.02%	AMALEA	Nov 16 16:52	Nov 16 19:28	2:36:00	1.55%
COMPASS EMPRESS	12 April 6:31	12 April 11:36	5:05:00	3.03%	JOHANN STRAUSS	7 July 5:41	7 July 11:24	5:43:00	3.40%	VIKING EMBLA	Nov 16 20:43	Nov 17 11:00	14:17:00	8.50%
			0:00:00	0.00%	AMAMAGNA	7 July 12:50	7 July 20:19	7:29:00	4.45%	MONARCH QUEEN	Nov 18 4:31	Nov 18 11:37	7:06:00	4.23%
			0:00:00	0.00%	VIKING NJORD	7 July 16:34	7 July 19:55	3:21:00	1.99%	AMAVERDE	Nov 18 13:28	Nov 18 20:58	7:30:00	4.46%
			0:00:00	0.00%	VIKING JARL	7 July 20:17	8 July 15:44	19:27:00	11.58%	TRAVELMARVEL VE(	Nov 19 6:33	Nov 19 9:33	3:00:00	1.79%
			0:00:00	0.00%	VIKING BALDUR	8 July 5:15	8 July 15:49	10:34:00	6.29%	AMASONATA	Nov 20 12:58	Nov 20 21:53	8:55:00	5.31%
			0:00:00	0.00%	VIKING VILHJALM	8 July 17:40	9 July 11:43	18:03:00	10.74%	VIKING EGDIR	Nov 21 6:55	Nov 21 17:24	10:29:00	6.24%
			0:00:00	0.00%	VIKING VAR	9 July 6:03	July 9 12:04	6:01:00	3.58%	VIKING JARL	Nov 21 7:33	Nov 21 12:58	5:25:00	3.22%
			0:00:00	0.00%	APT SOLARA	9 July 13:52	9 July 16:04	2:12:00	1.31%	SILVER	Nov 22 9:25	Nov 22 12:20	2:55:00	1.74%
			0:00:00	0.00%	SCENIC JEWEL	10 July 4:30	11 July 11:28	30:58:00	18.43%				0:00:00	0.00%
			0:00:00	0.00%	VIKING EGIL	10 July 7:02	July 10 11:38	4:36:00	2.74%				0:00:00	0.00%
			0:00:00	0.00%	SS BEATRICE	10 July 9:52	12 July 14:05	52:13:00	31.08%				0:00:00	0.00%
			0:00:00	0.00%	VIKING VILI	12 July 16:14	12 July 23:59	7:45:00	4.61%				0:00:00	0.00%
			0:00:00	0.00%	VIKING VAR	12 July 18:05	12 July 23:59	5:54:00	3.51%				0:00:00	0.00%

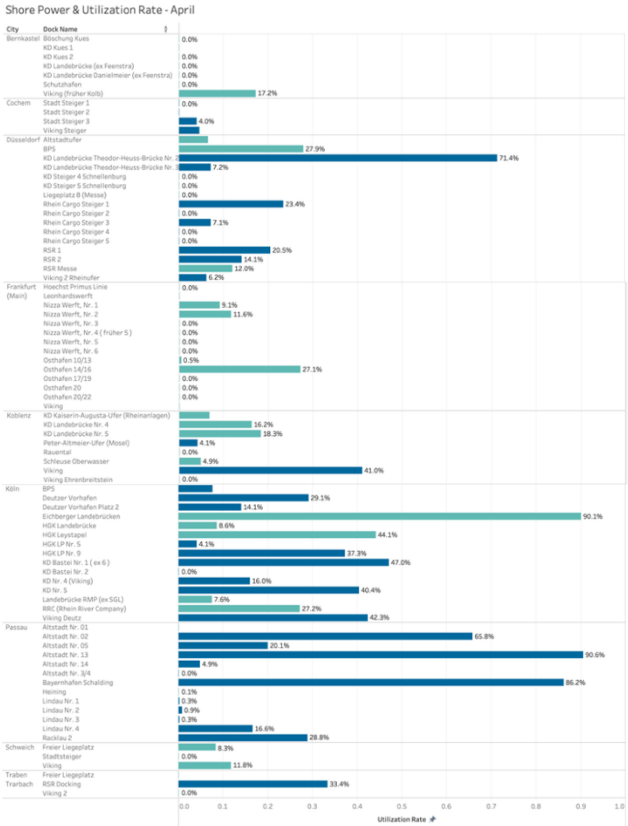
PASSAU - Racklau 2 (Max # of ships: 2)														
April 6-12					July 6-12					November 16-22				
Vessel	Arrival	Departure	Duration	UTILIZATION	Vessel	Arrival	Departure	Duration	UTILIZATION	Vessel	Arrival	Departure	Duration	UTILIZATION
AVALON IMPRESSION	6 April 0:00	6 April 1:10	1:10:00	0.69%	VIKING GULLVEIG	6 July 0:00	6 July 1:34	1:34:00	0.93%	A ROSA BELLA	Nov 17 9:43	Nov 17 15:08	5:25:00	3.22%
A ROSA RIVA	6 April 4:25	6 April 14:04	9:39:00	5.74%	VIKING AEGIR	6 July 0:00	6 July 3:57	3:57:00	2.35%	A ROSA RIVA	Nov 20 6:19	Nov 20 14:47	8:28:00	5.04%
A ROSA BELLA	6 April 4:50	6 April 13:54	9:04:00	5.40%	A ROSA FLORA	6 July 2:43	6 July 14:31	11:48:00	7.02%	A ROSA BELLA	Nov 21 5:29	Nov 21 15:10	9:41:00	5.76%
AVALON IMPRSSION	6 April 19:57	April 7 11:02	15:05:00	8.98%	A ROSA RIVA	6 July 4:15	6 July 15:00	10:45:00	6.40%				0:00:00	0.00%
VIKING INGVI	7 April 5:20	7 April 17:05	11:45:00	6.99%	A ROSA BELLA	6 July 4:49	July 6 8:43	3:54:00	2.32%				0:00:00	0.00%
SILVER	7 April 8:32	7 April 14:10	5:38:00	3.35%	RIVER CONCERTO	6 July 7:52	6 July 16:00	8:08:00	4.84%				0:00:00	0.00%
A ROSA DONNA	10 April 4:42	10 April 14:23	9:41:00	5.76%	CARMEN	6 July 9:42	7 July 5:26	19:44:00	11.75%				0:00:00	0.00%
AROSA MIA	10 April 4:53	10 April 14:03	9:10:00	5.46%	EMERALD SKY	6 July 19:31	7 July 6:04	10:33:00	6.28%				0:00:00	0.00%
SILVER	12 April 5:56	12 April 19:58	14:02:00	8.35%	JOHANN STRAUSS	6 July 14:20	7 July 5:26	15:06:00	8.99%				0:00:00	0.00%
AMAMAGNA	12 April 6:27	12 April 10:00	3:33:00	2.11%	VIKING VE	6 July 19:15	7 July 16:19	21:04:00	12.54%				0:00:00	0.00%
PRINZESSIN KATHARINA	12 April 8:05	12 April 16:10	8:05:00	4.81%	BUNKER SERVICE 1	July 8 13:19	9 July 5:52	16:33:00	9.85%				0:00:00	0.00%
			0:00:00	0.00%	A ROSA MIA	July 10 5:49	10 July 7:38	1:49:00	1.08%				0:00:00	0.00%
			0:00:00	0.00%	A ROSA DONNA	10 July 6:12	10 July 7:10	0:58:00	0.58%				0:00:00	0.00%
			0:00:00	0.00%	MONARCH QUEEN	11 July 17:06	12 July 23:59	30:53:00	18.38%				0:00:00	0.00%
			0:00:00	0.00%	VIKING EGIL	11 July 0:32	12 July 23:59	47:27:00	28.24%				0:00:00	0.00%
			0:00:00	0.00%	VISTANOVA	July 12 5:50	12 July 15:57	10:07:00	6.02%				0:00:00	0.00%
			0:00:00	0.00%	SWISS CROWN	12 July 7:55	12 July 14:56	7:01:00	4.18%				0:00:00	0.00%
			0:00:00	0.00%	PRINZESSIN KATHARINA	12 July 8:31	12 July 17:03	8:32:00	5.08%				0:00:00	0.00%

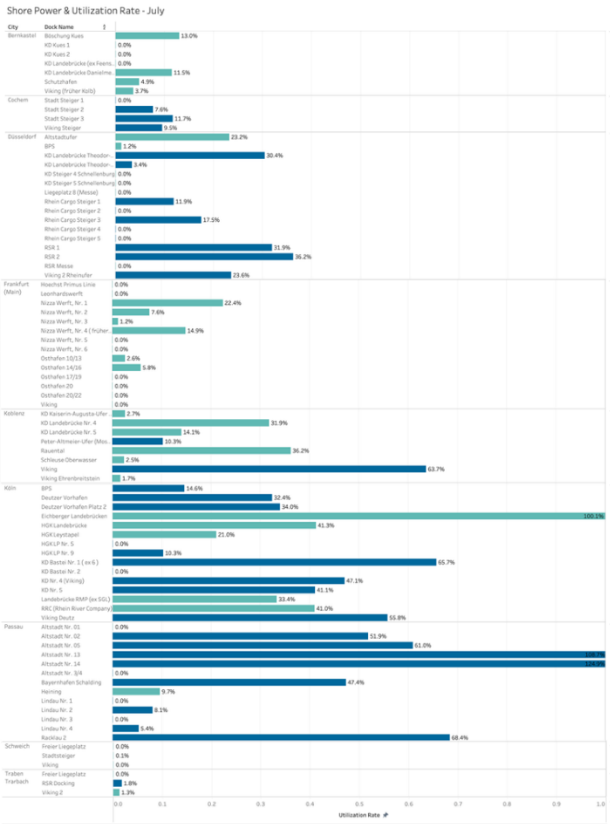
E. Cleaned Data Ranked by average utilization from 0%

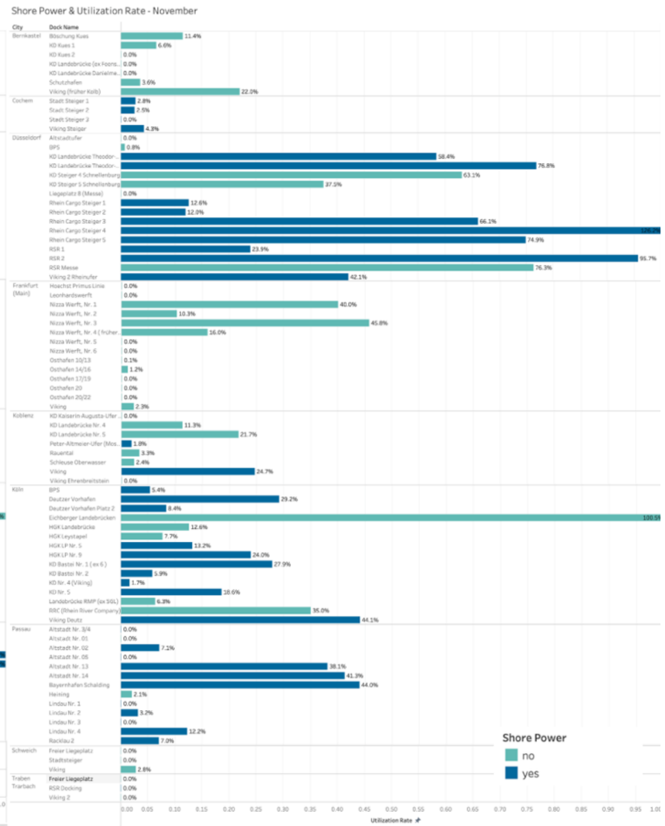
Dock_id	City	Prio	Dock_Name	River	ship_length	max_ships	Loading	Bunker_Fuel	Shore_Power	Garbage_Sewage	Water_Supply	Price	UTR_april	UTR_july	UTR_nov	Average UTR per dock
29	Bernkastel	1	KD Landebrücke (ex	Mosel	110	1	1	0	0	1	0	580	0.00%	0.00%	0.00%	0.00%
31	Bernkastel	1	KD Kues 2	Mosel	135	1	1	0	0	0	0	525	0.00%	0.00%	0.00%	0.00%
127	Düsseldorf	2	Liegeplatz 8 (Messe)	Rhein	135	1	1	0	0	1	0	600	0.00%	0.00%	0.00%	0.00%
21	Frankfurt	1	Nizza Werft, Nr. 6	Main	135	1	0	0	0	0	1	218	0.00%	0.00%	0.00%	0.00%
22	Frankfurt	1	Nizza Werft, Nr. 5	Main	135	1	0	0	0	0	1	552	0.00%	0.00%	0.00%	0.00%
23	Frankfurt	1	Hoechst Primus Linie	Main	135	1	1	0	0	0	0		0.00%	0.00%	0.00%	0.00%
24	Frankfurt	1	Leonhardswerft	Main	135	1	1	0	0	0	0	218	0.00%	0.00%	0.00%	0.00%
98	Frankfurt	2	Osthafen 20/22	Main	135	1	1	0	0	1	0	552	0.00%	0.00%	0.00%	0.00%
100	Frankfurt	2	Osthafen 17/19	Main	135	1	1	0	0	1	0	218	0.00%	0.00%	0.00%	0.00%
102	Frankfurt	2	Osthafen 20	Main	135	1	1	0	0	1	0	218	0.00%	0.00%	0.00%	0.00%
8	Passau	1	Altstadt Nr. 3/4	Donau	135	1	1	1	1	1	1	820	0.00%	0.00%	0.00%	0.00%
13	Passau	1	Altstadt Nr. 01	Donau	135	1	1	1	0	0	0	820	0.00%	0.00%	0.00%	0.00%
170	Traben	3	Freier Liegeplatz	Mosel	135	1	1	0	0	0	0	0	0.00%	0.00%	0.00%	0.00%
39	Schweich	1	Stadtsteiger	Mosel	135	1	1	0	0	0	0		0.00%	0.10%	0.00%	0.03%
7	Passau	1	Lindau Nr. 3	Donau	135	2	1	1	1	1	1	816	0.29%	0.00%	0.00%	0.10%
1	Passau	1	Lindau Nr. 1	Donau	135	2	1	1	1	1	1	816	0.29%	0.00%	0.00%	0.10%
41	Traben	1	Viking 2	Mosel	135	1	0	0	0	0	0		0.00%	1.34%	0.00%	0.45%
132	Koblenz	2	Viking Ehrenbreitstein	Rhein	135	1	1	1	0	0	0		0.00%	1.69%	0.00%	0.56%
19	Frankfurt	1	Viking	Main	135	1	1	0	0	0	0		0.00%	0.00%	2.30%	0.77%
34	Cochem	1	Stadt Steiger 1	Mosel	135	2	1	0	1	1	1	390	0.00%	0.00%	2.77%	0.92%
99	Frankfurt	2	Osthafen 10/13	Main	135	1	1	0	0	1	0	218	0.45%	2.65%	0.06%	1.05%
80	Köln	1	KD Bastei Nr. 2	Rhein	135	1	1	1	1	1	0	580	0.00%	0.00%	5.86%	1.95%
32	Bernkastel	1	KD Kues 1	Mosel	110	1	1	0	0	0	0		0.00%	0.00%	6.63%	2.21%
167	Schweich	3	Freier Liegeplatz	Mosel	135	1	1	0	0	0	0	0	8.31%	0.00%	0.00%	2.77%
143	Bernkastel	3	Schutzhafen	Mosel	110	1	1	0	0	0	1	525	0.00%	4.91%	3.56%	2.82%
131	Koblenz	2	KD Kaiserin-Augusta-Ufer	Rhein	135	1	1	1	0	0	0		6.81%	2.66%	0.00%	3.16%
152	Koblenz	3	Schleuse Oberwasser	Mosel	135	1	1	1	0	0	0		4.88%	2.47%	2.40%	3.25%
106	Cochem	2	Stadt Steiger 2	Mosel	135	2	1	0	1	1	1	390	0.00%	7.65%	2.53%	3.39%
33	Bernkastel	1	KD Landebrücke	Mosel	85	1	1	0	0	0	0	375	0.00%	11.49%	0.00%	3.83%
9	Passau	1	Heining	Donau	135	4	1	1	0	1	0	0	0.11%	9.66%	2.09%	3.96%
62	Düsseldorf	1	Rhein Cargo Steiger 2	Rhein	135	1	1	0	1	0	0	750	0.00%	0.00%	12.00%	4.00%
11	Passau	1	Lindau Nr. 2	Donau	135	2	1	1	1	1	1	816	0.90%	8.13%	3.19%	4.07%
38	Schweich	1	Viking	Mosel	135	1	1	0	0	1	0		11.81%	0.00%	2.79%	4.86%
107	Cochem	2	Stadt Steiger 3	Mosel	135	2	1	0	1	1	1	390	3.98%	11.72%	0.00%	5.23%
36	Koblenz	1	Peter-Altmeier-Ufer (Mosel)	Mosel	135	6	1	1	1	1	1	405	4.09%	10.29%	1.84%	5.41%
78	Köln	1	HGK LP Nr. 5	Rhein	135	1	1	1	1	1	1	612.46	4.07%	0.00%	13.19%	5.75%
35	Cochem	1	Viking Steiger	Mosel	135	2	1	0	1	1	1		4.61%	9.54%	4.29%	6.15%
28	Bernkastel	1	Böschung Kues	Mosel	135	2	1	0	0	1	0		0.00%	12.97%	11.43%	8.14%
74	Köln	1	BPS	Rhein	110	1	1	1	1	1	0	500	7.59%	14.60%	5.44%	9.21%
18	Frankfurt	1	Nizza Werft, Nr. 2	Main	135	1	0	0	0	0	1	552	11.63%	7.58%	10.26%	9.82%
128	Düsseldorf	2	Altstadtufer	Rhein	135	1	1	0	0	0	0	600	6.54%	23.21%	0.00%	9.92%
61	Düsseldorf	1	BPS	Rhein	135	1	1	0	0	1	0	600	27.95%	1.17%	0.76%	9.96%
20	Frankfurt	1	Nizza Werft, Nr. 4 (früher 5	Main	135	1	0	0	0	0	1	218	0.00%	14.93%	15.96%	10.30%
103	Frankfurt	2	Osthafen 14/16	Main	135	1	1	0	0	1	1	218	27.14%	5.85%	1.16%	11.38%
3	Passau	1	Lindau Nr. 4	Donau	135	2	1	1	1	1	1	816	16.64%	5.35%	12.21%	11.40%
40	Traben	1	RSR Docking	Mosel	135	1	1	0	1	1	0	220	33.38%	1.83%	0.00%	11.74%
130	Düsseldorf	2	KD Steiger 5 Schnellenburg	Rhein	135	2	1	0	0	1	1		0.00%	0.00%	37.47%	12.49%
151	Koblenz	3	Rauental	Mosel	135	1	1	1	0	0	0		0.00%	36.20%	3.33%	13.18%
30	Bernkastel	1	Viking (früher Kolb)	Mosel	135	1	1	0	0	1	0		17.23%	3.66%	22.00%	14.30%
17	Frankfurt	1	Nizza Werft, Nr. 3	Main	110	1	0	0	0	0	1	552	0.00%	1.18%	45.78%	15.65%
135	Köln	2	Landebrücke RMP (ex SGL)	Rhein	135	1	1	1	0	0	0	750	7.56%	33.37%	6.34%	15.76%
56	Düsseldorf	1	Rhein Cargo Steiger 1	Rhein	135	1	1	0	1	0	1	750	23.41%	11.86%	12.60%	15.96%
68	Koblenz	1	KD Landebrücke Nr. 5	Rhein	135	2	1	1	0	0	1		18.34%	14.07%	21.66%	18.02%
133	Köln	2	Deutzer Vorhafen Platz 2	Rhein	135	2	1	1	1	1	0	315	14.06%	33.96%	8.42%	18.81%
70	Koblenz	1	KD Landebrücke Nr. 4	Rhein	135	2	1	1	0	1	1		16.24%	31.87%	11.32%	19.81%
76	Köln	1	HGK Landebrücke	Rhein	110	1	1	1	0	0	1	409.59	8.58%	41.28%	12.62%	20.83%
124	Düsseldorf	2	KD Steiger 4 Schnellenburg	Rhein	135	2	1	0	0	1	1		0.00%	0.00%	63.09%	21.03%
72	Köln	1	KD Nr. 4 (Viking)	Rhein	135	1	1	1	1	0	0		16.02%	47.14%	1.67%	21.61%
25	Frankfurt	1	Nizza Werft, Nr. 1	Main	110	1	1	0	0	0	1	552	9.08%	22.44%	40.04%	23.85%
82	Köln	1	HGK LP Nr. 9	Rhein	135	1	1	1	1	1	1	612.46	37.28%	10.33%	24.01%	23.87%
63	Düsseldorf	1	Viking 2 Rheinufer	Rhein	135	1	1	0	1	1	1		6.15%	23.59%	42.10%	23.95%
75	Köln	1	HGK Leystapel	Rhein	110	1	1	1	0	0	1	409.59	44.13%	21.02%	7.73%	24.29%
60	Düsseldorf	1	Rhein Cargo Steiger 5	Rhein	135	1	1	0	1	0	0	750	0.00%	0.00%	74.94%	24.98%
57	Düsseldorf	1	RSR 1	Rhein	135	1	1	0	1	1	0	530	20.51%	31.93%	23.94%	25.46%
5	Passau	1	Altstadt Nr. 05	Donau	135	1	1	1	1	0	1	820	20.06%	60.99%	0.00%	27.02%
126	Düsseldorf	2	KD Landebrücke Theodor-	Rhein	135	1	1	0	1	1	1		7.20%	3.39%	76.85%	29.15%
129	Düsseldorf	2	RSR Messe	Rhein	135	2	1	0	0	0	1	450	11.95%	0.00%	76.34%	29.43%
136	Köln	2	Deutzer Vorhafen	Rhein	135	3	1	1	1	1	0	612.46	29.12%	32.36%	29.21%	30.23%
58	Düsseldorf	1	Rhein Cargo Steiger 3	Rhein	135	1	1	0	1	1	1	750	7.14%	17.47%	66.11%	30.24%
73	Köln	1	KD Nr. 5	Rhein	135	1	1	1	1	0	1		40.36%	41.14%	18.58%	33.36%
81	Köln	1	RRC (Rhein River Company)	Rhein	135	1	1	1	0	1	0		27.21%	40.97%	35.05%	34.41%
6	Passau	1	Racklau 2	Donau	135	2	1	1	1	1	1		28.83%	68.42%	7.01%	34.75%
2	Passau	1	Altstadt Nr. 02	Donau	135	1	1	1	1	1	1	820	65.75%	51.89%	7.14%	41.60%
59	Düsseldorf	1	Rhein Cargo Steiger 4	Rhein	135	1	1	0	1	0	0	750	0.00%	0.00%	126.17%	42.06%
69	Koblenz	1	Viking	Rhein	135	2	1	1	1	0	1		40.98%	63.67%	24.65%	43.10%
77	Köln	1	KD Bastei Nr. 1 (ex 6)	Rhein	135	1	1	1	1	1	1	710	47.03%	65.70%	27.88%	46.87%
134	Köln	2	Viking Deutz	Rhein	135	2	0	1	1	1	0		42.33%	55.83%	44.09%	47.42%
123	Düsseldorf	2	RSR 2	Rhein	135	1	1	0	1	1	0	530	14.08%	36.22%	95.68%	48.66%
125	Düsseldorf	2	KD Landebrücke Theodor-	Rhein	135	1	1	0	1	1	1		71.41%	30.40%	58.37%	53.39%
12	Passau	1	Altstadt Nr. 14	Donau	135	1	1	1	1	1	1	820	4.89%	124.92%	41.27%	57.03%
10	Passau	1	Bayernhafen Schalding	Donau	135	1	1	1	1	0	0	400	86.16%	47.39%	44.05%	59.20%
14	Passau	1	Altstadt Nr. 13	Donau	135	1	1	1	1	1	1	820	90.57%	108.72%	38.12%	79.13%
137	Köln	2	Eichberger Landebrücken	Rhein	135	2	1	1	0	0	1	955	90.10%	100.07%	100.55%	96.90%

F. Bunker and Shore Power Utilization Results

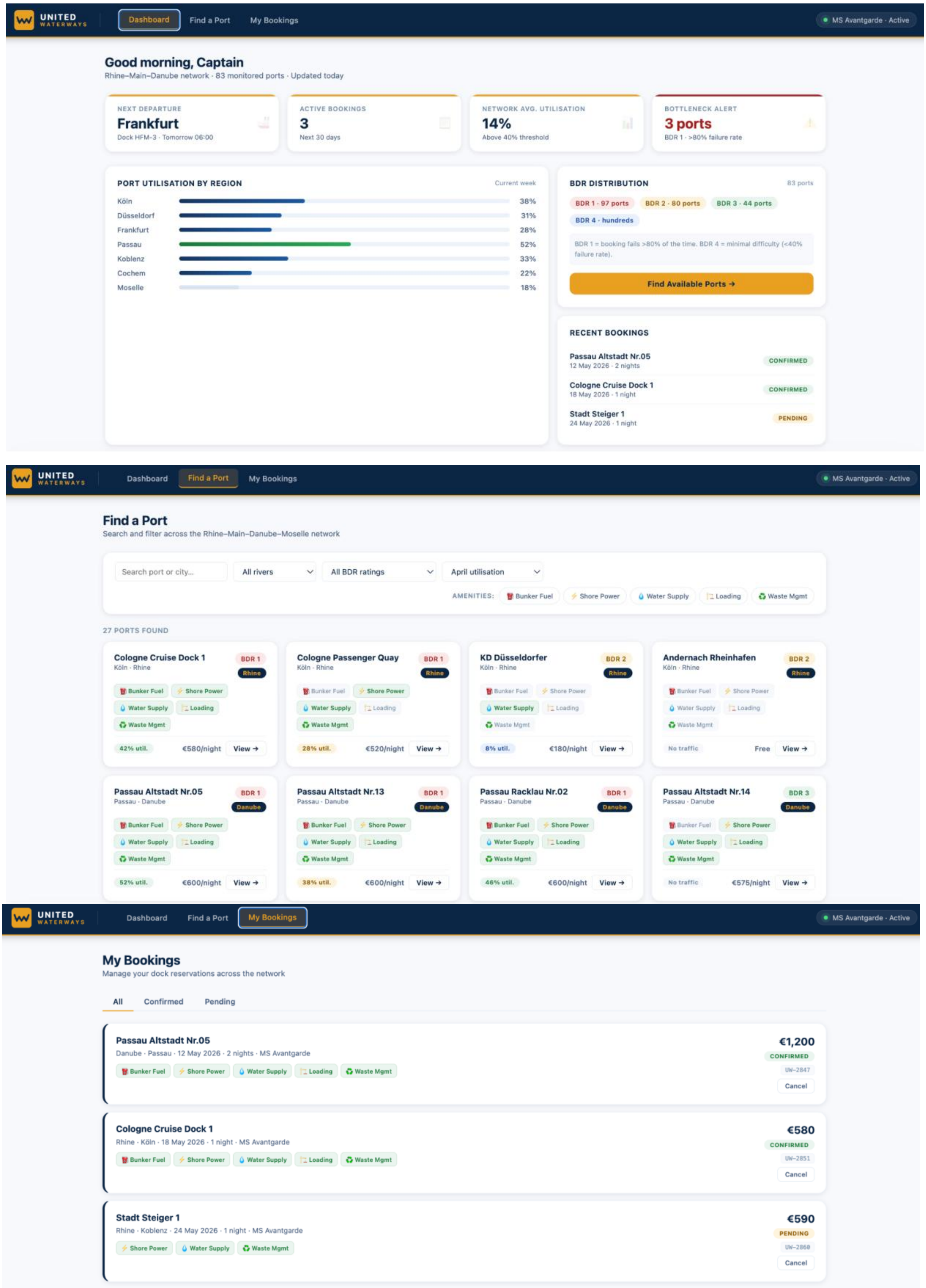



Shore Power & Utilization Rate - April
Utilization Rate


Shore Power & Utilization Rate - July
Utilization Rate

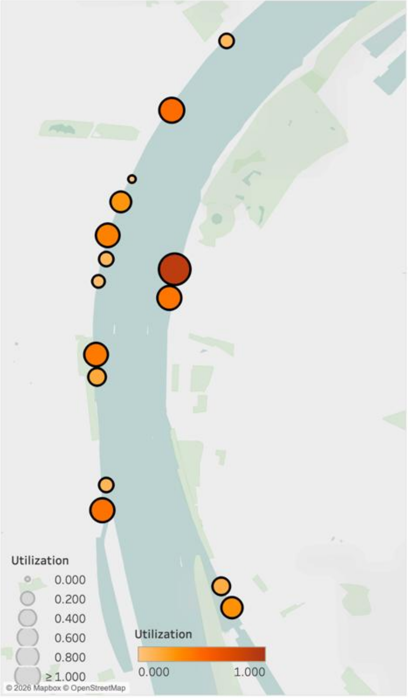

Shore Power & Utilization Rate - November
Shore Power
no
yes
Utilization Rate

G. Prototype Dashboard - United Waterways proposed dock booking and port management platform

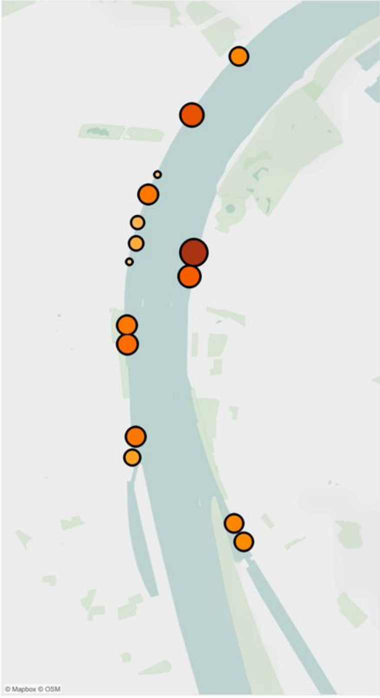


H. Port UTR per city

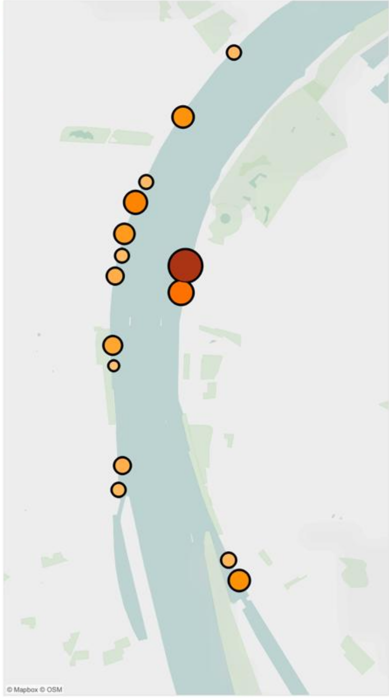
Koln April



Koln July

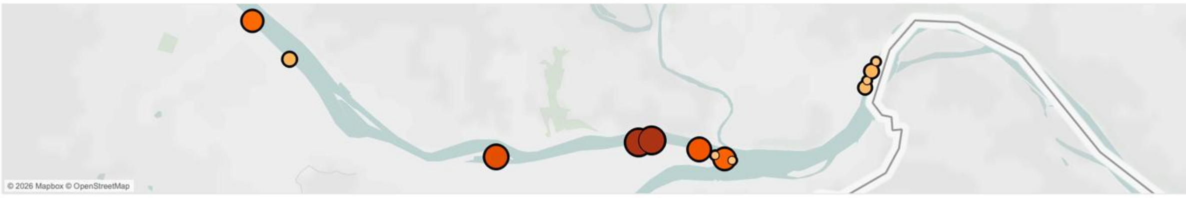


Koln November



Passau April

Passau July

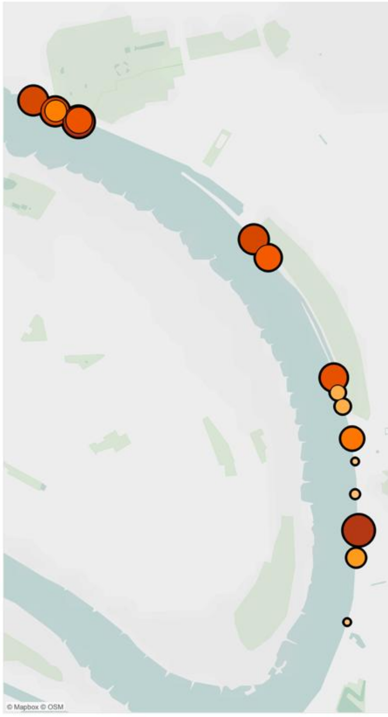


Passau November

Dusseldorf April

Dusseldorf July

Dusseldorf November



Frankfurt April

Frankfurt July

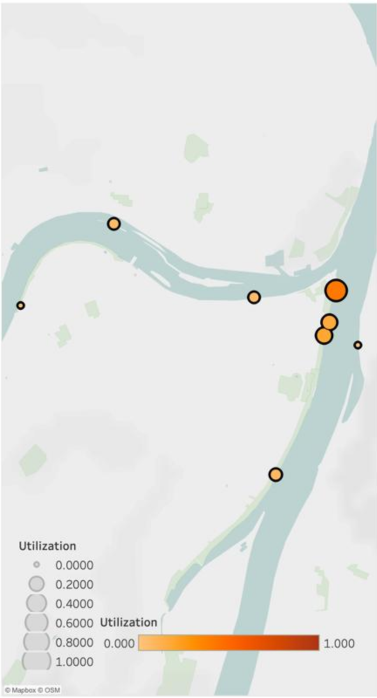
Frankfurt November

Bernkastel April

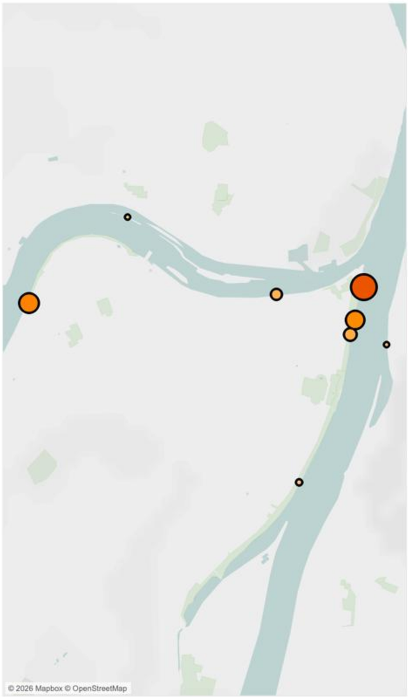
Bernkastel July

Bernkastel November

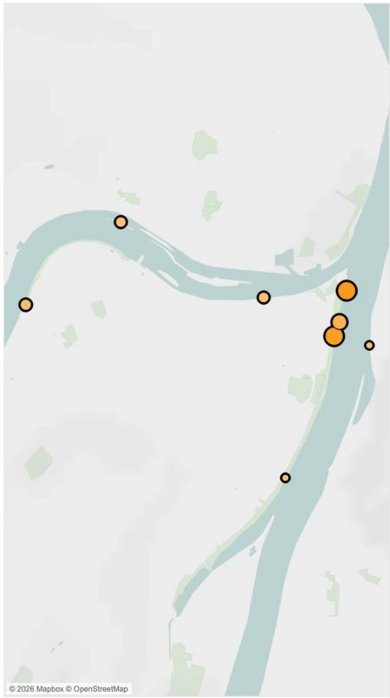
Koblenz April



Koblenz July

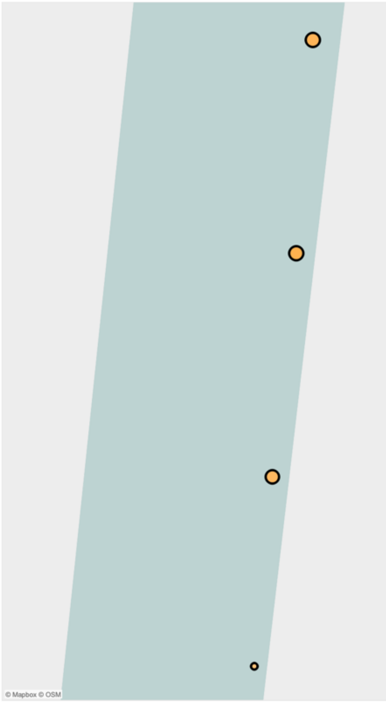


Koblenz November

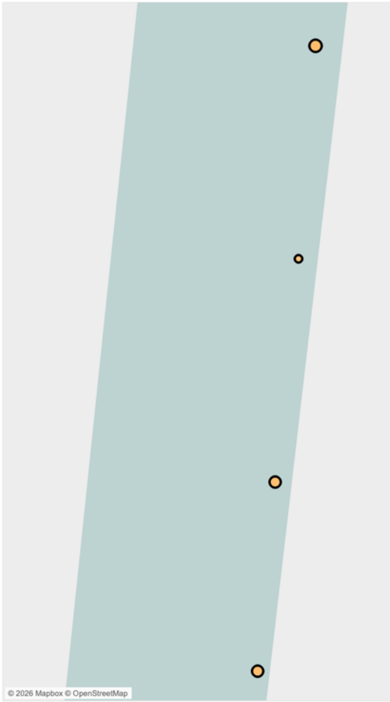


Cochem April

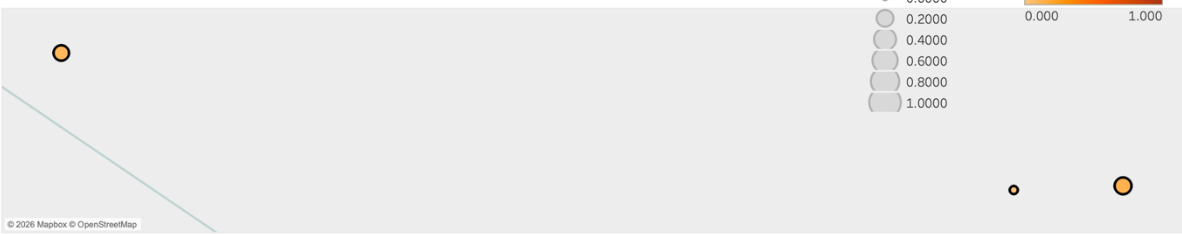
Cochem July



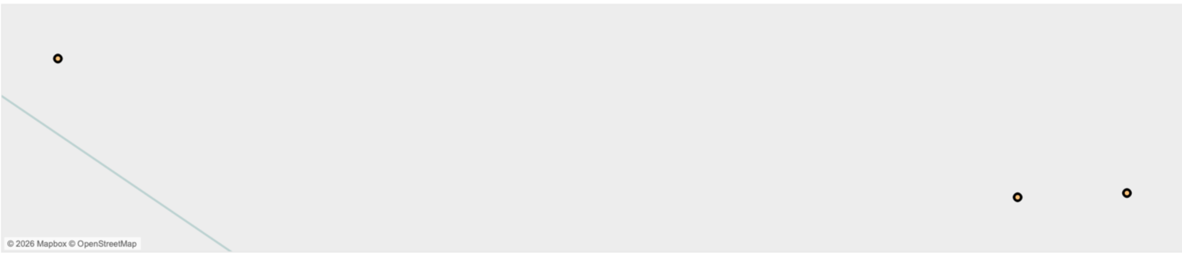
Cochem November



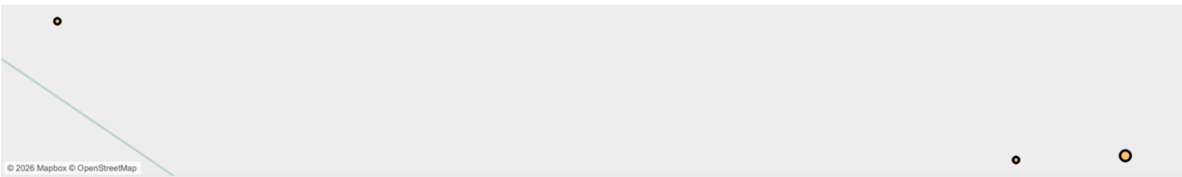
Schweich April



Schweich July

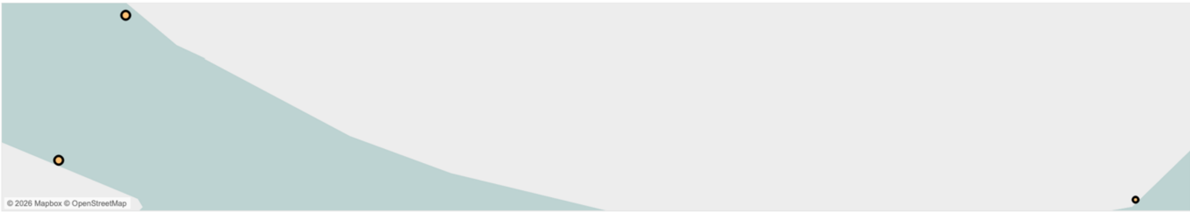


Schweich November



Traben April

Traben July



Traben November