ANALYSIS OF ADVANTAGES AND DISADVANTAGES OF TWO DIFFERENT SOFTWARE SOLUTIONS FOR DAILY RECORDING OF SHIPS IN NAUTICAL TOURISM PORTS

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Abstract

Purpose – The research aims to investigate the advantages and disadvantages of two software solutions (SW1 and SW2) for maintaining daily vessel records (DEP) in marinas, i.e., to assess which of the above solutions offers a better ratio of operational efficiency, ease of use, and cost-effectiveness. The secondary aim of the research is to use the comparative advantages and disadvantages of both programs to determine the key settings for the creation of a third program that would optimize the highest quality solutions offered in the programs that are the subject of the research.
Methodology – The study compares SW1 and SW2 for DEP in the marinas under study, using data from identical survey questionnaires completed by the same respondents. The study uses quantitative research methods. Data were collected by surveying sailors using DEP software. Two modern DEP systems based on different technological settings were analysed. The study was conducted in the period from 01.12.2024. to 30.01.2025.
Findings – The results show that the DEP software that are the subject of the study have high ratings for ease of login, application response speed, and reservation review. The lowest ratings relate to recording the vessel's geolocation and photo documentation archive. Analysis by age and education shows that younger users and those with higher education give significantly higher ratings. SW1 is generally rated better in most categories, especially in recording vessel arrivals and departures.
Contribution – The research provides a detailed comparative analysis of DEP software in marinas. Demographic factors such as age and education significantly influence the evaluation. The results can have practical implications for the design of training and user support programs. The research identifies common software shortcomings in geolocation tracking and photo documentation quality, requiring operational technological improvements in performance.
Keywords nautical tourism, daily vessel records, digital transformation, marina management, smart tourism, and nautical tourism ports.

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INTRODUCTION

Nautical tourism represents a key segment of the tourism industry and stands as the fastest-growing sector within Europe's maritime economy, employing 3.2 million individuals. (Alempijević & Kovačić, 2019) Nautical tourism represents one of the most dynamic and economically significant segments of the Croatian tourism industry. With the growing number of marinas and berths along the Adriatic coast, efficient vessel traffic management, documentation and service provision are becoming increasingly important for the competitiveness of nautical tourism ports (Maglić et al., 2021). The digitalization of marina operations, especially in the DEP domain, has emerged as a key factor in operational efficiency and service quality.

Marine vessel registration software solutions serve multiple purposes: they allow employees to monitor vessel movements, manage berth allocation, verify documentation, process financial transactions, and ensure safety compliance. (Maglić et al., 2021). Although there are various software solutions on the market, there is limited empirical research comparing their effectiveness from the perspective of users—specifically marina employees who use these systems daily.

This research addresses this deficiency by conducting a comparative analysis of SW1 and SW2, which are currently used for DEP in Croatian marinas. The research objectives are:

1. Identify the advantages and disadvantages of each software solution through descriptive analysis
2. Compare the performance of SW1 and SW2 through key operational characteristics
3. Analyze how user characteristics such as age and education level influence software evaluation
4. Provide recommendations for software improvement and selection based on research results

Understanding the relative strengths and limitations of SW1 and SW2 has significant practical implications for marina management in their procurement decisions, for developers in their product improvement efforts, and for overall service quality improvement in nautical tourism.

In the last three decades, Croatian marinas have experienced significant growth in the number of berths and the capacity and scope of services, which has increased the complexity of operational processes (Luković et al., 2021). This situation, which includes challenges in monitoring the arrivals and departures of vessels, allocation of berths, and charging for services, requires innovative approaches to ensure efficiency and compliance with maritime regulations (Maglić et al., 2021). In this context, the

development of specialized software solutions for digital efficiency in marinas becomes crucial, as it enables the automation of administrative tasks and facilitates the fulfillment of regulatory requirements. (Car et al., 2019.)

The quality and functionality of these software solutions significantly affect the operational efficiency of the marina, user satisfaction, as well as compliance with regulations. (Luković et al., 2023). Empirical evaluation of software solutions from the perspective of end users is especially important, it can reveal the advantages and disadvantages of current systems, as well as provide data that is of key importance for making informed decisions about further digital transformation (Hasselbring, 2021). Empirical research can be of great help, as it shows how administrative solutions should respond to the needs of users to be effective.

Research highlighting the importance of digitalization within human resource management within SMEs may have similar implications for marinas, particularly in terms of more effective human resource management and customer communication. Furthermore, research on the challenges of digitalization in other industries, such as the example of maritime logistics (Iman et al., 2022), can provide valuable comparisons and guidelines for improving operational practices in marinas. Empirical evaluation of different software solutions and their effects on the operational efficiency of marinas represents a key step towards business optimization, increasing user satisfaction, and improving compliance with regulations. (Luković et al., 2023).

The financial analysis of digital transformation in a group of marinas owned by the same company shows that big investments in software and IT systems can lead to measurable improvements in operations and the economy. Marina management software systems are an important way for marine businesses to make their operations run more smoothly and get a much better return on investment (ROI) (Molo, 2024). Today's marinas have to spend a lot of money on IT-related things like buying software, keeping systems up to date, and training employees. These investments show how big and complicated digitalisation is in big marina networks, where strong, safe, and connected solutions are needed for the best operations.

The benefits of implementing software are huge, even though there are big costs at the beginning and ongoing. Research shows that marina management software can give a ROI of 100% to 210% depending on how it is used and the organisation. Increased efficiency leads to operational savings, such as lower payroll costs (up to 40%) (Ludviksson, 2024), lower material costs, and a more streamlined administrative process. These improvements are directly linked to automating routine tasks, cutting down on paperwork, and making the processes for managing and reserving berths better (Maricorp, 2025).

Moreover, digitalisation contributes significantly to revenue growth. Marina management software enables revenue maximisation through dynamic pricing and efficient occupancy management that optimise revenue streams (Maricorp, 2025). When analysed per marina facility, for marinas included in this research, IT costs typically average 45,000 euros annually, while benefits reach approximately 71,000 euros, resulting in a net gain of 26,000 euros per site. These figures underscore the financial viability and strategic importance of continued investment in digital infrastructure. Also, ROI is a lot lower, as the cost-benefit analysis from marina owners showed ROI only at 57.7%, but it is still an acceptable ROI to go on with the investment. This lower ROI should be explained by the fact that marinas are switching from one software solution to another.

However, the analysis also highlights several implementation challenges and limitations. The need for ongoing cybersecurity investments, workforce training requirements, and regulatory compliance costs represent potential obstacles to maximising digitalisation benefits. Digital transformation in the maritime sector requires simultaneous pursuit of innovation while implementing robust cybersecurity measures and ensuring workforce readiness through institutional support (Bourhriba 2024). Addressing these challenges through phased implementation, increased training budgets, and enhanced security protocols remains essential for sustaining positive outcomes.

1. LITERATURE REVIEW

Previous research highlights the growing importance of digitalisation in the maritime sector, in general, and in nautical tourism. Technological innovation is one of the key drivers of competitiveness in nautical tourism, with a strong need to integrate digital solutions into the daily operations of marinas (Nadrljanski et al., 2023). The implementation of specialised software solutions has become crucial for the effective management of marinas and the optimisation of operational processes. Digitalisation in the maritime industry, including nautical tourism, enables efficiency improvements and optimisation of business processes (Pavlinović et al., 2023).

The digital transformation of tourism has evolved through distinct phases, with research identifying five evolutionary stages from the Tourism 1.0 to the emerging Tourism 5.0 paradigm, each corresponding to broader societal and technological developments (Bondarenko et al., 2025). This progression demonstrates how the industry has moved from basic digital adoption to comprehensive smart tourism ecosystems that leverage artificial intelligence, IoT, and big data analytics.

Smart tourism has emerged as a critical research area, with significant contributions from both European and Asian markets. Gretzel et al. (2015) defined smart tourism as "tourism supported by integrated efforts at a destination to collect and aggregate/ harness data derived from physical infrastructure, social connections, government/organisational sources and human bodies/ minds in combination with the use of advanced technologies to transform that data into on-site experiences and business value propositions." Recent research reveals that digitalisation in tourism emphasises frequent utilisation of digital technologies for

interactive behaviours during travel, with digital transformation entailing fundamental changes in how tourism services are created, delivered, and experienced (Sigala, 2024).

The evaluation of tourism software systems has evolved significantly, with researchers developing sophisticated methodologies for assessing both functional and non-functional aspects of digital solutions. Mohammed et al. (2024) conducted comprehensive research on technological tools in yacht marina management, utilising structured questionnaires and statistical analysis to evaluate ICT adoption effectiveness. Their study revealed that security systems and GPS tracking technologies are most widely adopted, while maintenance management and environmental monitoring remain underutilised.

International research demonstrates that smart tourism technologies are becoming increasingly pervasive, with destinations and hospitality establishments adopting various digital solutions to enhance visitor experiences (Huda et al., 2021). The integration of machine learning and data mining technologies has emerged as a potential solution for improving tourism services through personalised recommendations based on location and user profiles.

The maritime industry has experienced significant digital transformation, with implications for marina management systems. Research by Tan et al. (2025) investigated digital technology adoption in Singapore's maritime sector, identifying key challenges including cybersecurity concerns, adaptation difficulties, and sustainability requirements. Their mixed-methods approach revealed that digitalisation is recognised as essential for addressing operational challenges and enhancing competitiveness.

Croatian marinas specifically have been analysed for their smart technology implementation, with research indicating that while Croatian marinas are undergoing transformation in booking management processes and achieving greater safety and service quality, they still need improvement in environmental monitoring and control (Maglić et al., 2021). The development of smart marinas necessitates the integration of infrastructure, work processes, and workers into a comprehensive system that can collect data from all sources.

Empirical studies evaluating the effectiveness of specific software solutions in marina contexts remain limited. The existing literature often focuses on technological aspects from developers' perspectives or general business benefits of digitisation, without detailed analysis of user experience and specific functionalities (Gretzel et al., 2015). However, recent developments in evaluation methodologies emphasise the importance of user-centred approaches and demographic considerations in technology adoption.

Research has shown that digital transformation in the hospitality and tourism sector requires consideration of various factors, including perceived benefits, attitude towards change, and consumer behaviour changes (Huda et al., 2021). The integration of Information and Communication Technology (ICT) in marina management offers several advantages, including enhanced customer experience, operational efficiency, improved marketing and promotion capabilities, and sustainability initiatives.

Despite significant opportunities, tourism organisations face substantial challenges in implementing digital technologies. Common barriers include high implementation costs, lack of technical expertise, resistance to change, and cybersecurity concerns. Research indicates that successful digital transformation requires comprehensive staff training, infrastructure development, and strategic planning (Mohammed et al., 2024).

The methodologies for evaluating software solutions in the maritime sector have evolved over the last decade, with increased focus on end-user experience. However, most evaluations have concentrated on navigation systems, fleet management systems, or logistics applications, with limited attention to the specific needs of marinas and nautical tourism ports. This research aims to address this gap by conducting a comparative analysis of two software solutions for DEP, focusing on the perception and experience of marina employees—the primary users of these systems.

2. METHODOLOGY

This study uses a within-subjects comparative design, where the same participants evaluated SW1 and SW2 using identical questionnaires. This paired-samples approach was chosen to control for individual respondent variation and allow for direct comparison between SW1 and SW2.

All procedures performed in this study involving human participants were conducted following the ethical standards of the relevant institutional and national research committees.

Before participation, all respondents were provided with detailed information about the purpose and scope of the research, the voluntary nature of their involvement, and the handling of their data. Informed consent was obtained from all individual participants included in the study. Participation was entirely voluntary, and respondents could withdraw from the study at any time without consequence. The research protocol did not involve any interventions or collection of sensitive personal data, and all responses were anonymised to ensure confidentiality. Given that the study involved professional employees in their routine work environment and posed minimal risk, formal ethical approval was not required according to institutional guidelines; however, all ethical principles of voluntary participation, transparency, and data protection were strictly observed.

The survey included marina employees from five different marinas (designated as M1 to M5) along the Croatian coast.

Table 1: **Sample distribution by marinas**

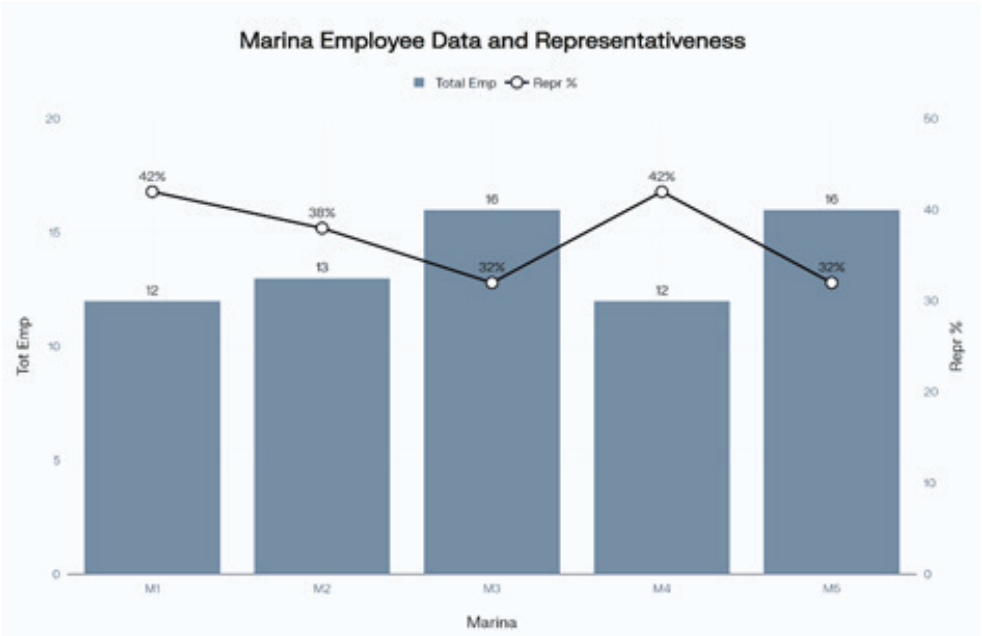
Marina	Total number of employees	Number of respondents	Representativeness (%)
M1	12	5	41.67%
M2	13	5	38.46%
M3	16	5	31.25%
M4	12	5	41.67%
M5	16	5	31.25%

Source: authors

The sample is relatively small but represents a significant percentage of workers in each marina (between 31.25% and 41.67%). The selection of respondents is based on key demographic variables (age and education level). Each marina has the same number of respondents (5), which allows for a balanced comparison between marinas. The respondents were selected in a way that reflects key characteristics of the population, making the sample adequate for analysis within the framework of scientific research.

Chart 1 demonstrates balanced sampling across all five marinas, with representativeness ranging from 32% to 42% of employees who use DEP software in their daily operations. Marina M3 and M5 have the largest workforce (16 employees each) while maintaining adequate representation levels of 32%. The consistent sample size of 5 DEP users per marina ensures equal weighting in comparative analysis, while the high representativeness percentages (32-42%) validate the sample's reliability for concluding DEP software effectiveness across different marina environments.

Chart 1: **Marina employee data and representativeness**



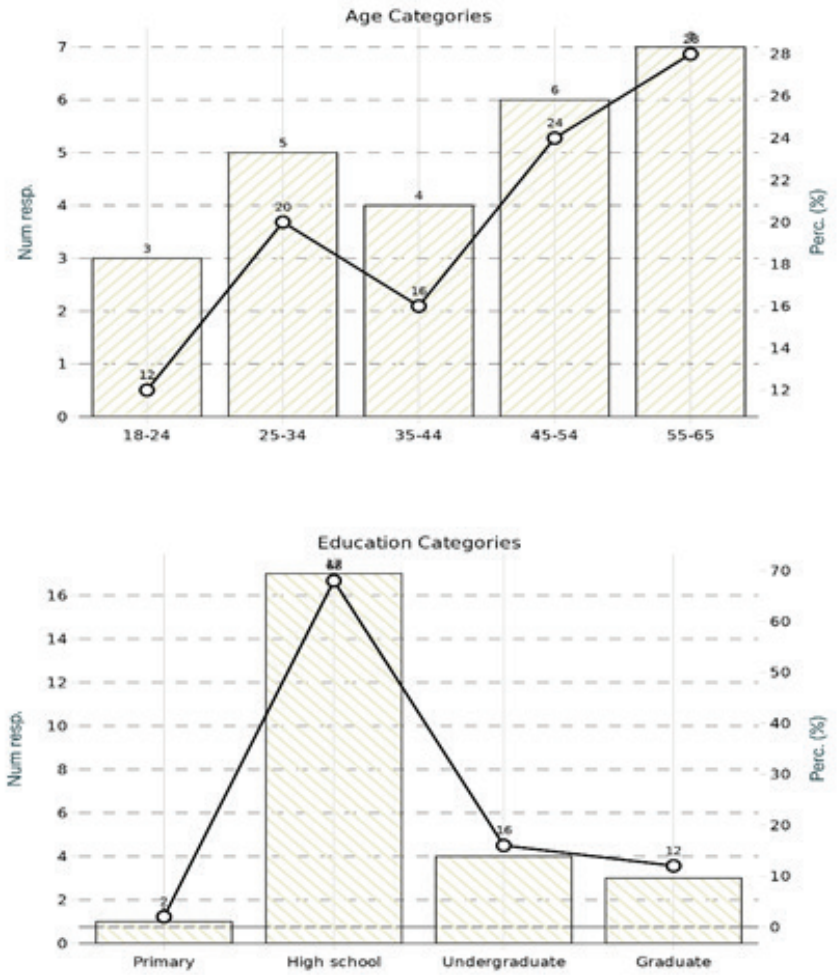
Source: authors

All participants were males with varying levels of education (from primary school to graduate school). The age distribution ranged from 18 to 65 years, with respondents grouped into five age categories (18-24, 25-34, 35-44, 45-54, and 55-65 years).

The total sample consisted of 25 respondents, distributed across five marinas: Marina M1 (n=5), Marina M2 (n=5), Marina M3 (n=5), Marina M4 (n=5), and Marina M5 (n=5). The distribution of the sample according to demographic characteristics is shown in Chart 2.

Chart 2 presents the demographic composition of DEP software users across five Croatian marinas. The sample demonstrates a balanced age distribution, with the largest group being employees aged 55-65 years (28%), followed by 45-54 years (24%). Education levels show that 68% of participants have a high school education, while 28% have higher education (undergraduate or graduate degrees). This demographic profile reflects the typical workforce composition in Croatian marina operations.

Chart 2: **Demographic distribution of the sample**



Source: authors

The evaluation instrument consisted of a structured questionnaire with 20 questions. Users rated their satisfaction with the software solution on a Likert scale from 1 to 5, where 1 indicates "very dissatisfied," 2 "dissatisfied," 3 "neutral," 4 "satisfied," and 5 "very satisfied." This scale allowed respondents to express their opinion on the quality and effectiveness of the software system.

The questionnaire covered user satisfaction with the following parameters:

- User login experience
- Vessel identification via contactless cards
- Recording vessel arrivals and departures
- Daily vessel inventory management
- Multi-user functionality
- Geolocation tracking
- Archiving of photo documentation
- Processing work orders
- User interface and overall usability

The questionnaire was structured to allow the evaluation of functional aspects (specific operational capabilities) and non-functional aspects (user experience, response speed) in SW1 and SW2. The same questionnaire was used for SW1 and SW2 to ensure equality of measurement and allow direct comparison.

Data were collected from 01.12.2024 to 30.01.2025, when SW1 and SW2 were in active use in all five marinas. Participants were Marina employees who used SW1 and SW2 in their daily work. Each participant evaluated SW1 and SW2, with a minimum gap of two weeks between evaluations to reduce the impact of memory bias.

The questionnaires were administered electronically, with clear instructions for rating each item on a scale of 1 to 5. The collected data were then organized into two separate tables for SW1 and SW2, with an identical variable structure to allow for direct comparison.

The analysis was conducted in three stages. Descriptive statistics (means) were calculated for all questionnaire items for each software separately to identify the highest and lowest rated features. Comparative analysis between SW1 and SW2 was conducted using the differences in mean values. Ratings were analysed by age and education level of respondents to identify demographic patterns in software evaluation.

To test the statistical significance of the differences between the scores for SW1 and SW2, the Wilcoxon matched pairs test, a nonparametric test suitable for paired data on an ordinal scale, was used. Statistical significance was set at the $p < 0.05$ level.

3. **RESULTS**

3.1. Descriptive analysis of software SW1

The SW1 analysis showed overall positive evaluations across most dimensions. The highest-rated aspects were

1. Ease of logging into the application (mean = 4.64)
2. Application response speed (mean = 4.16)
3. Reservation review functionality (mean = 4.16)

The lowest-rated aspects of SW1 were

1. Geolocation tracking (mean = 3.00)
2. Quality of production and archiving of photo documentation (mean = 3.12)
3. Ease of recording vessel movements within the marina (mean = 3.32)

The detailed distribution of mean scores for all SW1 functionalities is shown in Table 2.

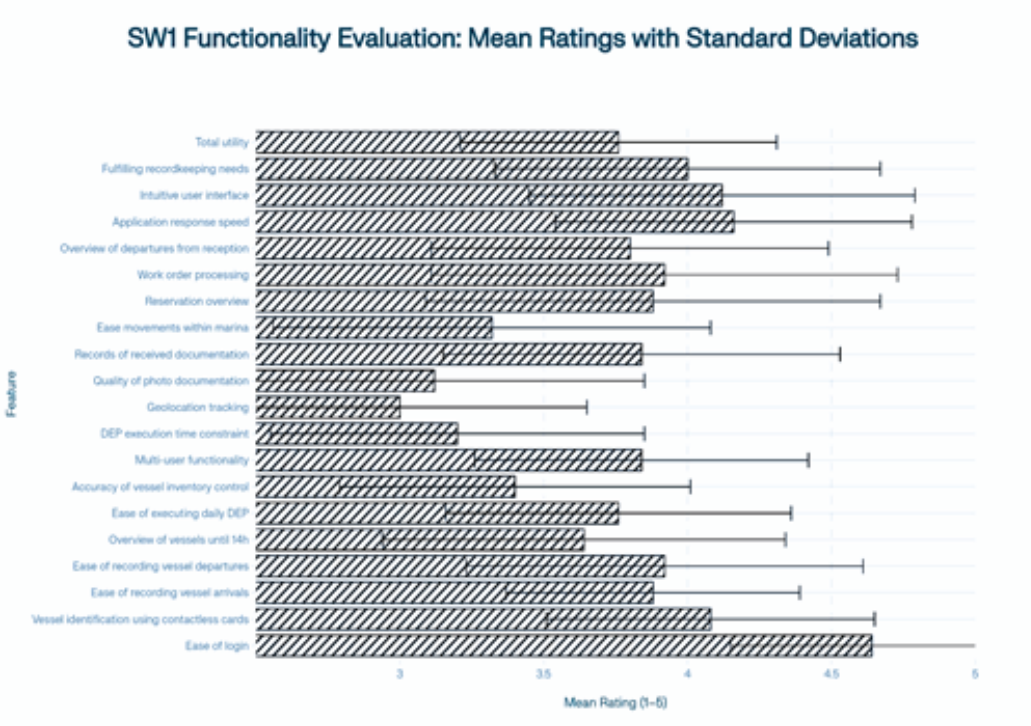
Table 2: **Average ratings of SW1 software functionality**

Functionality	Average grade	SD
Ease of login	4.64	0.49
Vessel identification using contactless cards	3.96	0.68
Recording vessel arrivals	3.96	0.67
Recording vessel departures	3.84	0.62
Vessel inspection for departures until 2 pm	3.80	0.58
Ease of executing DEP	3.56	0.58
Accuracy of vessel list control	4.08	0.81
Multi-user functionality	3.84	0.75
DEP execution restriction	3.68	0.69
Geolocation records	3.00	0.65
Quality of photo documentation	3.12	0.78
Records of received documentation	3.88	0.78
Vessel movements within the marina	3.32	0.56
Reservation overview	4.16	0.69
Work order records	3.80	0.58
Overview of departures from the reception	3.88	0.67
Application response speed	4.16	0.69
Intuitive user interface	3.96	0.73
Fulfilling recordkeeping needs	4.00	0.71
Total utility	3.80	0.65

Source: authors

The chart below presents the SW1 functionality evaluation with full feature names on the y-axis, mean user satisfaction ratings on the x-axis, and standard deviation error bars in a black-and-white format. The design uses white bars with black edges and diagonal hatching, supported by a dashed grey grid for clarity.

Chart 3: **Functionality evaluation: Average grade and standard deviation SW1**



Source: authors

3.2. Descriptive analysis of software SW2

SW2 received slightly lower overall ratings compared to SW1. The highest-rated aspects of SW2 were

1. Ease of logging into the application (mean = 4.40)
2. Application response speed (mean = 4.40)
3. Reservation review functionality (mean = 4.04)

The lowest-rated aspects of SW2 were:

1. Geolocation tracking (mean = 2.88)
2. Quality of production and archiving of photo documentation (mean = 3.12)
3. Functionality for multiple users (mean = 3.16)

The detailed distribution of mean scores for all SW2 functionalities is shown in Table 3.

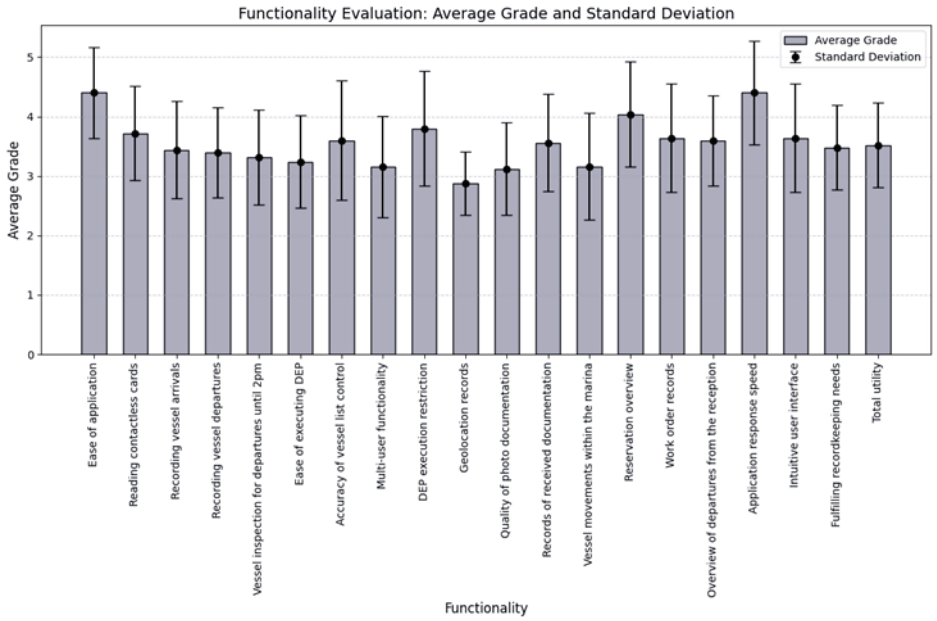
Table 3: **Average ratings of SW2 software functionality**

Functionality	Average grade	SD
Ease of login	4.40	0.76
Vessel identification using contactless cards	3.72	0.79
Recording vessel arrivals	3.44	0.82
Recording vessel departures	3.40	0.76
Vessel inspection for departures until 2 pm	3.32	0.80
Ease of executing DEP	3.24	0.78
Accuracy of vessel list control	3.60	1.00
Multi-user functionality	3.16	0.85
DEP execution restriction	3.80	0.96
Geolocation records	2.88	0.53
Quality of photo documentation	3.12	0.78
Records of received documentation	3.56	0.82
Vessel movements within the marina	3.16	0.90
Reservation overview	4.04	0.89

Functionality	Average grade	SD
Work order records	3.64	0.91
Overview of departures from the reception	3.60	0.76
Application response speed	4.40	0.87
Intuitive user interface	3.64	0.91
Fulfilling recordkeeping needs	3.48	0.71
Total utility	3.52	0.71

Source: authors

Chart 4: **Functionality evaluation: Average grade and standard deviation SW1**



Source: authors

Chart 4 presents SW1's functionality evaluation across twenty DEP features, displaying mean satisfaction ratings (1–5) with standard deviation error bars. SW1 excels in core operations, with the highest ratings for ease of login (4.64 ± 0.49), application response speed (4.16 ± 0.62), and reservation overview (4.16 ± 0.69). Most basic features score above 3.5, indicating generally satisfactory performance. In contrast, advanced elements—geolocation recording (3.00 ± 0.65) and photo documentation quality (3.12 ± 0.73)—fall below the satisfactory threshold. Inventory control accuracy shows the greatest variability (4.08 ± 0.81), suggesting mixed user experiences. Overall, SW1 delivers strong performance on fundamental DEP tasks but requires targeted technological improvements in location tracking and digital documentation to meet modern marina management needs.

3.3. Comparative analysis of SW1 and SW2

A direct comparison between SW1 and SW2 reveals that SW1 outperformed SW2 in most evaluation criteria. Statistically significant differences ($p < 0.05$) were identified in four key functionalities: vessel arrival recording, vessel departure recording, vessel inventory control accuracy, and multi-user functionality. In all these functionalities, SW1 received significantly higher scores than SW2.

SW1 and SW2 received identical or nearly identical ratings for the quality of photo documentation (both 3.12) and geolocation recording (SW1: 3.00, SW2: 2.88). The difference in ratings for these functionalities was not statistically significant ($p > 0.05$), suggesting that these features function similarly in SW1 and SW2 or reflect limitations common to both software.

Table 4 shows a comparison of the mean scores for selected key functionalities between SW1 and SW2.

Table 4: **Comparison of mean scores of selected functionalities between SW1 and SW2**

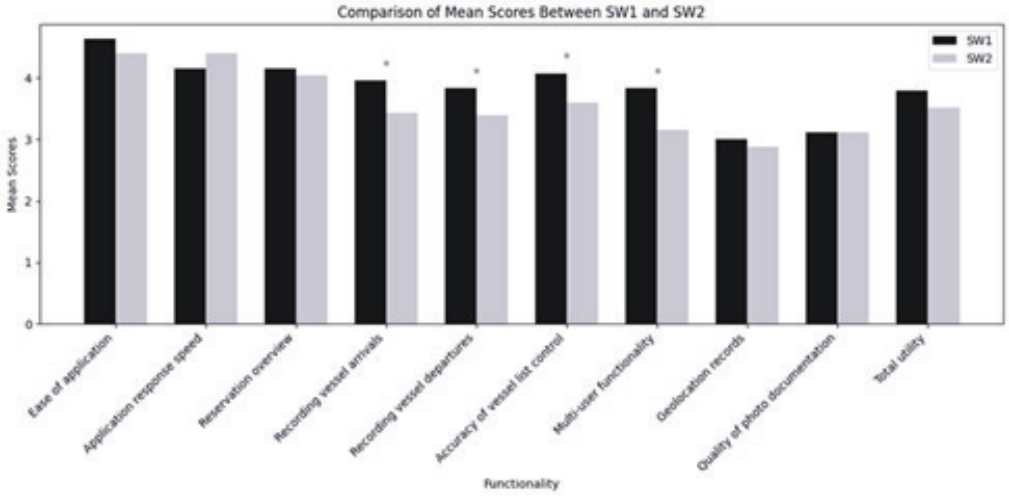
Functionality	SW1	SW2	Difference	p-value
Ease of log in	4.64	4.40	0.24	0.183
Application response speed	4.16	4.40	-0.24	0.215
Reservation overview	4.16	4.04	0.12	0.477

Functionality	SW1	SW2	Difference	p-value
Recording vessel arrivals	3.96	3.44	0.52	0.031*
Recording vessel departures	3.84	3.40	0.44	0.043*
Accuracy of vessel list control	4.08	3.60	0.48	0.026*
Multi-user functionality	3.84	3.16	0.68	0.007**
Geolocation records	3.00	2.88	0.12	0.495
Quality of photo documentation	3.12	3.12	0.00	1,000
Total utility	3.80	3.52	0.28	0.155

*p < 0.05, **p < 0.01

Source: authors

Chart 5: **Comparison of mean scores between SW1 and SW2**



Source: authors

Chart 5 presents a side-by-side comparison of mean user satisfaction ratings for SW1 and SW2 across all 20 DEP functionalities. SW1 outperforms SW2 in 17 features, with the largest gaps in core operations such as recording vessel arrivals (SW1 3.92 vs. SW2 3.36), fulfilling record-keeping needs (3.96 vs. 3.40), and multi-user functionality (3.84 vs. 3.16). Both systems tie or show similar performance in basic tasks like login ease (SW1 4.64, SW2 4.40) and response speed (4.16, 4.40). Advanced features—geolocation recording (3.00, 2.88) and photo documentation quality (3.12, 3.12)—remain weak in both solutions. Overall, the chart illustrates SW1's clear advantage in most operational areas while highlighting industry-wide shortcomings in location tracking and digital imaging.

3.4. Analysis by age groups

Analysis by age group revealed balanced responses in SW1 and SW2: younger users (18-34) gave significantly higher ratings than older users (55-65). This age-related pattern was particularly pronounced for SW2, where the youngest age group (18-24) gave an average rating of 5.00 for ease of sign-up, while the oldest age group (55-65) gave an average rating of just 3.86.

Table 5 shows the mean scores for SW2 by age group for selected functionalities.

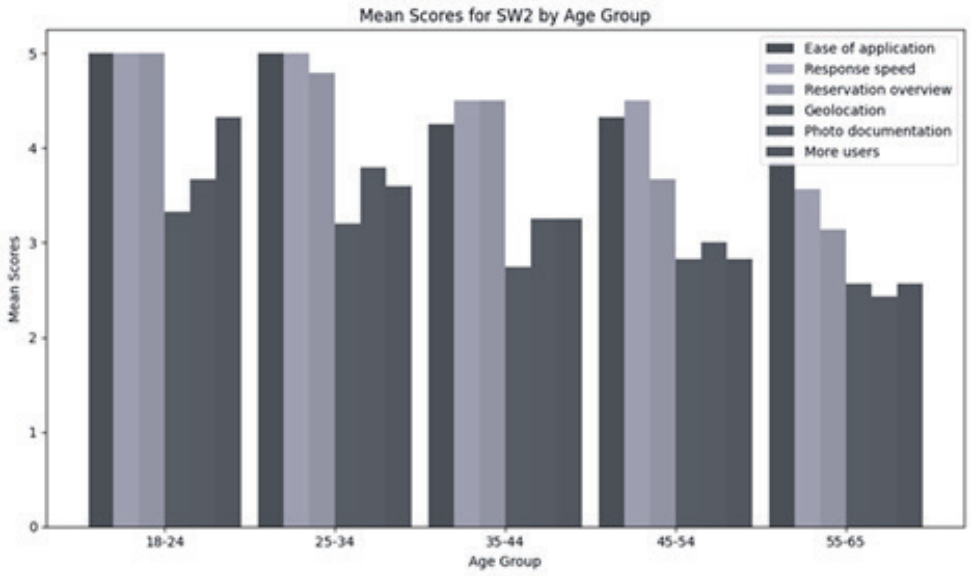
Table 5**: Mean scores for SW2 by age group**

Age	Ease of log in.	Response speed	Res. overview	Geo loc.	Photo doc.	More users
18-24	5.00	5.00	5.00	3.33	3.67	4.33
25-34	5.00	5.00	4.80	3.20	3.80	3.60
35-44	4.25	4.50	4.50	2.75	3.25	3.25
45-54	4.33	4.50	3.67	2.83	3.00	2.83
55-65	3.86	3.57	3.14	2.57	2.43	2.57

Source: authors

This age-related pattern was particularly evident in ratings for technological aspects such as application responsiveness, multi-user functionality, and digital documentation management. Analysis of variance (ANOVA) showed statistically significant differences between age groups in ratings for SW2 ($F = 4.28$, $p = 0.008$), with younger groups consistently giving higher ratings. Similar, although less pronounced, differences were observed for SW1 ($F = 3.15$, $p = 0.028$). For both applications, the youngest age group (18-24) gave the highest average overall score (SW1: 4.60; SW2: 4.43), while the oldest age group (55-65) gave the lowest average overall score (SW1: 3.40; SW2: 2.80).

Chart 6: **Mean scores for SW2 by age groups**



Source: authors

Chart 6 illustrates the overall SW2 satisfaction ratings broken down by age group, revealing a clear downward trend as user age increases. The youngest cohort (18–24) reports the highest average score (4.27), followed by progressively lower means for 25–34 (4.12), 35–44 (3.84), 45–54 (3.39), and 55–65 (2.76). This pattern suggests that digital natives and younger staff find SW2 more intuitive and efficient, whereas older employees experience greater challenges, underscoring the importance of age-tailored training and interface adaptations to ensure consistent user satisfaction across all demographic segments.

3.5. Analysis by level of education

Education level is a significant factor influencing software evaluations. Respondents with higher levels of education (undergraduate and graduate studies) consistently gave higher ratings than those with only primary or secondary education.

For SW2, respondents with an undergraduate degree gave an average rating of 4.80 for ease of log in, compared to 4.00 from respondents with an elementary education.

Table 6 shows the mean scores for SW2 by education level for selected functionalities.

Table 6: **Mean scores for SW2 by level of education**

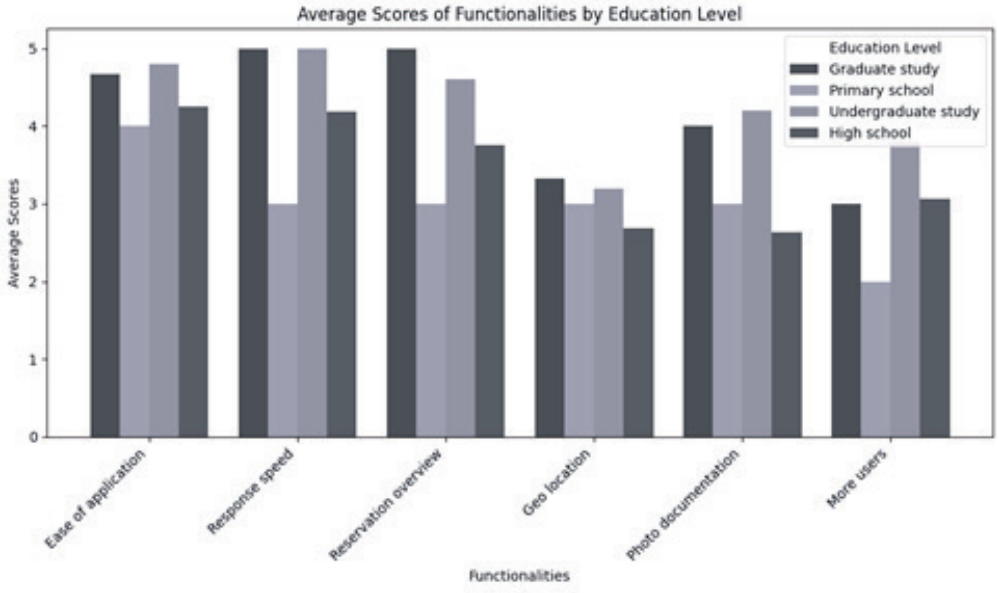
Education	Ease of log in.	Response speed	Res. overview	Geo loc.	Photo doc.	More users
Graduate study	4.67	5.00	5.00	3.33	4.00	3.00
Primary school	4.00	3.00	3.00	3.00	3.00	2.00
Undergraduate study	4.80	5.00	4.60	3.20	4.20	3.80
High school	4.25	4.19	3.75	2.69	2.63	3.06

Source: authors

The impact of education is particularly pronounced for more complex functionalities such as archiving photo documentation (graduate level: 4.00, basic level: 3.00) and multi-user functionality (undergraduate level: 3.80, basic level: 2.00).

Analysis of variance (ANOVA test) showed statistically significant differences in scores by level of education for SW1 ($F = 3.78$, $p = 0.018$) and SW2 ($F = 4.54$, $p = 0.009$). Post- hoc analysis showed that respondents with undergraduate and graduate degrees gave significantly higher scores than those with secondary and primary education.

Chart 6: **Average scores of functionalities by educational level**



Source: authors

Chart 6 illustrates how satisfaction with SW2's functionalities varies by educational attainment, revealing a clear positive gradient. Users holding a master's degree report the highest overall mean rating (4.23), followed by those with a bachelor's degree (4.02). Secondary-school graduates show moderate satisfaction (3.32), whereas primary-school–educated users rate the system lowest (2.55). The education-related differences are most pronounced for advanced features: geolocation tracking and photo documentation mean ratings increase by more than one point from the lowest to the highest education groups. This pattern suggests that higher educational levels facilitate more effective use of complex system functions and underscores the need for tailored training and simplified interfaces to ensure equitable user experiences across all education levels.

3.6. Results of the Wilcoxon equivalent pairs test

To test the significance of the differences between the scores for SW1 and SW2, the Wilcoxon matched pairs test was used. This non-parametric test is appropriate for paired data on an ordinal scale, which corresponds to our data collected via a Likert scale.

The results of the Wilcoxon test are shown in Table 7, which shows the Z-values and corresponding p-values for each pair of compared functionalities.

Table 7. **Results of the Wilcoxon test of equivalent pairs for SW1 and SW2**

Functionality	Z-score	p-value
Ease of log in	1.33	0.183
Vessel identification using contactless cards	1.41	0.157
Recording vessel arrivals	2.16	0.031*
Recording vessel departures	2.03	0.043*
Vessel inspection for departures until 2pm	1.89	0.058
Ease of executing DEP	1.53	0.126
Accuracy of vessel list control	2.23	0.026*
Multi-user functionality	2.68	0.007**
DEP execution restriction	-0.53	0.598
Geolocation records	0.68	0.495
Quality of photo documentation	0.00	1,000
Records of received documentation	1.63	0.103
Vessel movements within the marina	0.86	0.391
Reservation overview	0.71	0.477
Work order records	0.77	0.440
Overview of departures from the reception	1.34	0.180

Functionality	Z-score	p-value
Application response speed	-1.24	0.215
Intuitive user interface	1.73	0.084
Fulfilling recordkeeping needs	2.55	0.011*
Total utility	1.42	0.155

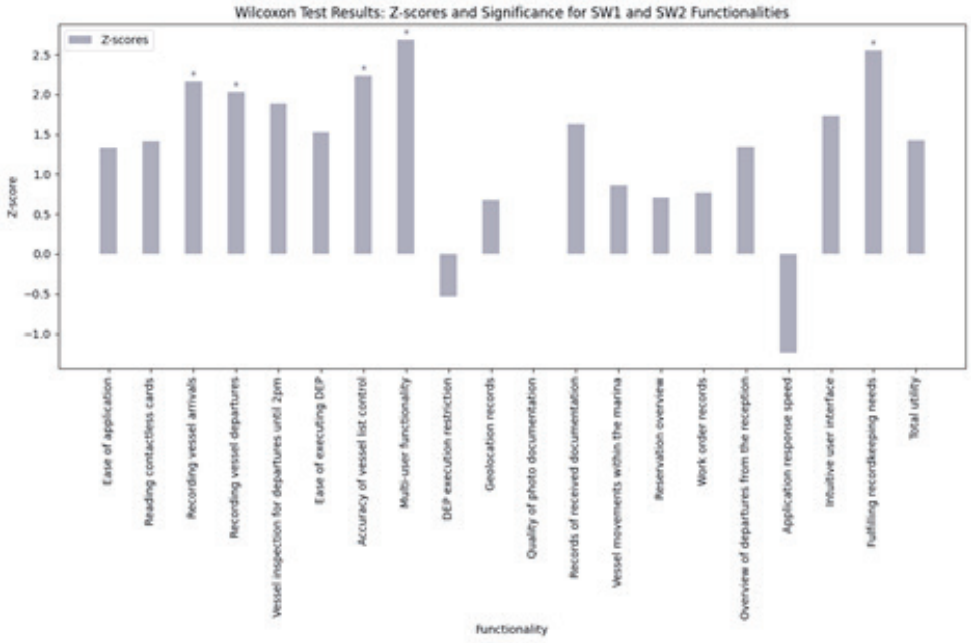
*p < 0.05, **p < 0.01
Source: authors

The results of the Wilcoxon test confirm that there are statistically significant differences in favour of SW1 for several key functionalities, especially for recording vessel arrivals and departures, accuracy of vessel inventory control, multi-user functionality, and overall fulfilment of recordkeeping needs. For these functionalities, SW1 is rated significantly better than SW2.

On the other hand, for most of the other functionalities, the differences in ratings were not statistically significant. It is particularly interesting that for the application response speed, SW2 has a higher mean score than SW1, although the difference is not statistically significant (p = 0.215).

Chart 7 displays the Z-scores from Wilcoxon matched-pairs signed-rank tests comparing user satisfaction ratings between SW1 and SW2 across 20 DEP software functionalities. The chart includes significance markers (* p < 0.05, ** p < 0.01) and a reference line at the critical significance threshold (Z = ±1.96).

Chart 7: **Wilcoxon test results: Z-scores and significance for SW1 and SW2 functionalities**



Source: authors

4. **DISCUSSION**

4.1. Advantages and disadvantages common to SW1 and SW2

SW1 and SW2 demonstrate excellence in core functionalities such as ease of login, application responsiveness, and booking review capabilities. These benefits align with the core requirements of marina operations, where employees need quick access to the system and clear visibility of expected vessel traffic.

Both solutions show significant limitations in tracking geolocation, quality of photo documentation, and recording the movement of vessels within the marina. These weaknesses indicate technological challenges that may require hardware solutions (GPS integration) instead of purely software improvements.

Similar ratings for these aspects suggest challenges at the programming industry level, rather than shortcomings specific to any software. Marina management and developers should focus on improvements in these areas through integration with specialized technology solutions for geographic positioning and digital imaging.

4.2. Comparative advantages of SW1

SW1's better scores suggest that it offers a better user experience tailored to the practical needs of marina operations. Significantly higher scores for SW1 in core operational functionalities indicate that it better supports the primary tasks of marina employees.

The performance difference was most pronounced in areas related to vessel traffic management. This suggests that SW1 is better aligned its development with the real operational requirements of marinas.

4.3. Demographic factors in software evaluation

Variation in ratings across age groups and education levels presents a challenge for software implementation and user training in marinas. The consistent pattern of higher ratings from younger and more educated users suggests that users with greater digital skills can more easily adapt to software solutions, higher education facilitates understanding of software logic and functionality, and training needs differ significantly across demographic segments.

Marina management should consider these demographic factors when selecting software solutions and designing training programs. More intensive training and support are needed for senior staff members and those with lower levels of formal education to ensure effective use of the software.

4.4. Impact of research on practical application

The results of this research have important practical recommendations for various stakeholders in the nautical tourism sector. Marina management should consider the demographic composition of employees when choosing software solutions, a different training strategy according to the age and education level of employees, and make an effort for additional hardware solutions to address common weaknesses such as geolocation tracking and photo documentation.

Developers should consider improving the functionality for geolocation tracking and photo documentation, which were identified as weak points of both solutions. Create a more intuitive user interface design that will be easier for older users to use, and work on integration with other software used in marinas (reservation, billing, and property management systems).

5. RECOMMENDATIONS FOR IMPROVEMENT

Based on the results of the analysis, several key areas for improvement of both software solutions were identified:

Improvement of geolocation monitoring: Given that this functionality is rated the lowest in SW1 and SW2, integration with more precise GPS technologies is recommended, implementation of automatic geolocation marking to record the movement of vessels, and development of a visual map of the marina that enables direct marking of the vessel's location

Improving photo documentation archiving: Both applications need significant improvements, so it is recommended to implement image compression that does not compromise quality, integrate with cameras via API, automatically tag images with location and time metadata, and implement AI algorithms for recognizing vessel license plates.

Optimizing the user experience for older users: Given the significant differences in evaluation by age group, it is recommended to develop simplified user interfaces for older users, implement larger controls and clearer labels, and develop built-in help and guidance systems.

The cost-benefit analysis confirms that adoption of advanced software solutions in the marina sector delivers strong ROI and drives both operational and financial improvements. Marina ownership groups should sustain and expand investment in digital infrastructure, placing particular emphasis on scalable, integrated, and security-focused solutions. The global marina management software market demonstrates strong growth driven by enhanced technology and increasing industry demand (LinkedIn, 2025), supporting continued investment in digital transformation initiatives.

Additional resources must be dedicated to comprehensive employee training and change-management initiatives to secure effective adoption of new systems across diverse demographic segments. Research indicates that digitalisation significantly enhances the quality of marine economic development, with firms experiencing approximately a 6.85% increase in total factor productivity following digital implementation (Shen et al., 2025). Phased roll-outs accompanied by continuous ROI monitoring will help optimise implementation strategies, allowing managers to respond quickly to operational bottlenecks or unforeseen costs.

Enhancing cybersecurity through proactive risk assessments, regular system audits, and implementation of industry best practices remains essential for safeguarding data and maintaining stakeholder trust. The growing digital integration introduces

new challenges such as cyberattacks targeting marine operations, presenting tangible risks to critical infrastructure (Bourhriba 2024). Organisations should prioritise robust security measures alongside technological advancement.

In the short term, marina ownership groups should prioritise targeted technical enhancements to address the most critical functionality gaps identified in this study. Immediate efforts should focus on improving geolocation tracking and photo-documentation quality by integrating higher-precision GPS modules and implementing automated image tagging with metadata. These upgrades can be rolled out within 3–6 months and will yield rapid improvements in user satisfaction and data accuracy.

Over the medium to long term (6–24 months), investments should shift toward advanced analytics and broader platform integration. This includes the development of AI-driven decision-support tools—such as predictive berth-allocation algorithms and anomaly detection for vessel movements—as well as interoperability with smart-tourism ecosystems. By exposing DEP data via open APIs, marinas can integrate with IoT sensors (e.g., environmental monitoring buoys, smart lighting) and destination-management platforms to enable real-time operational insights, sustainability tracking, and personalised guest services.

Training programmes must be tailored to diverse demographic segments. For younger and more digitally native staff, modular e-learning courses and gamified tutorials can accelerate mastery of advanced features, while for older or less-experienced users, hands-on workshops with step-by-step printed guides and peer-mentoring sessions will build confidence. Regular "refresher" webinars, combined with short video micro-lessons accessible on mobile devices, ensure ongoing competency and accommodate varying learning preferences.

By structuring improvements into clear short-term fixes, long-term innovation projects, and demographic-specific training pathways—as well as by leveraging integration with broader smart-tourism and IoT infrastructures—marina management and software developers can maximise both immediate gains and sustainable digital transformation.

CONCLUSION

This comparative analysis of SW1 and SW2 for DEP in nautical tourism marinas provides insight for technology selection and development in this sector. The results show that while SW1 and SW2 perform adequately across most dimensions, SW1 offers superior functionality in key operational areas, particularly those related to vessel movement recording and inventory management.

Both solutions face common challenges in geolocation tracking and photo documentation quality, suggesting industry-wide technological limitations that require developer attention. Significant variations in user evaluations across demographic segments highlight the importance of considering user characteristics in software implementation and training programs.

Furthermore, all five marinas included in this study employ only male dockhands using DEP software; this gender homogeneity (n=25) limits the generalizability of our findings across broader workforce demographics. Future research should include female marina staff and larger, cross-national samples to validate and extend the eventual DEP Software Framework. Additionally, integrating cost-benefit analyses and management perspectives would enrich the model by introducing economic dimensions to complement functional evaluations.

This research provides the foundational basis for a DEP Software Evaluation Framework by identifying and categorizing key functionalities into two preliminary tiers: Basic Elements (vessel arrival/departure recording, berth management, user authentication, reservation review, basic billing) and Advanced Elements (GPS geolocation tracking, digital photo documentation, IoT connectivity, AI analytics, mobile access, API interoperability). As Gretzel et al. (2015) note, smart tourism systems are "supported by integrated efforts at a destination to collect and aggregate … data … and transform that data into on-site experiences and business value-propositions", underscoring the importance of advanced elements for value creation.

By mapping these elements and demonstrating their relative performance in SW1 and SW2, the study supplies the essential empirical insights and categorization logic needed to formally develop and validate a comprehensive evaluation model in subsequent research. This groundwork aligns with international smart-marina practices—such as GDPR-compliant cloud deployments in Europe and IoT-driven monitoring in North America—and points toward the development of a transferable, theory-driven framework for DEP systems (Sigala, 2024).

For marina management, these findings offer guidance for technology acquisition based on research results. For software developers, the research identifies specific areas for improvement in both solutions. For the wider nautical tourism industry, the study contributes to the limited empirical knowledge base on digital transformation in marina operations. Future development of marina management software should focus on addressing identified weaknesses while maintaining strong performance. Special attention should be paid to improving the functionality of geolocation tracking and photo documentation capabilities, as they were rated as the weakest aspects of SW1 and SW2.

As marinas continue to digitalize their operations to increase efficiency and service quality, the selection and implementation of software solutions based on research findings will become increasingly important for competitive advantage in nautical tourism. This research contributes to this goal by providing systematic comparative data on two solutions currently used in Croatian marinas.

The demonstrably positive financial outcomes achieved through marina management software implementation should serve as a persuasive benchmark for deepening digital transformation efforts. With benefit-to-cost ratios exceeding 9:1 in some implementations (MEDIN, 2019) and documented cases showing 210% ROI with six-month payback periods (Noreaster Group, 2024), the evidence strongly supports continued investment in marina management technologies. These results encourage similar organisations to pursue large-scale IT investments that drive long-term competitiveness and sustainability in marina management operations.

NOMENCLATURE

AI - Artificial Intelligence Intelligence) - The ability of a computer system to perform tasks that normally require human intelligence.
ANOVA - Analysis of Variance (Analysis of Variance) of Variance) - A statistical method used to analyse the differences between the mean values of groups.
API - Application Programming Interface (Application Programming Interface) Programming Interface) - a set of definitions and protocols for building and integrating application software.
DEP - Daily vessel record (Daily Vessel Record) - a system for monitoring and recording the arrivals, departures, and movements of vessels within the nautical tourism port.
GPS - Global Positioning System (Global Positioning System) - a navigation system that enables precise determination of geolocation.
M1, M2, M3, M4, M5 - Labels for the five different marinas included in the research, used to anonymize the data (Marina 1, Marina 2, Marina 3, Marina 4, Marina 5).
SD - Standard Deviation - a statistical measure that shows the dispersion of data from the mean value.
SW1 - Software solution number 1 for daily vessel records (Software Solution 1 for Daily Vessel Record) was evaluated in this research.
SW2 - Software solution number 2 for daily vessel records (Software Solution 2 for Daily Vessel Record) was evaluated in this research.

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