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Development of a Green Procurement Method for Eutrophic and Anoxic Coastal Areas

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Abstract: Understanding the intertwined common challenges of the sea-land chain by treating the pollution problems of eutrophic and anoxic coastal ecosystems resulting from land-based and other pollution sources, is essential for the green procurement of products and services in wastewater management. The research activities took place under the aegis of project, “Blue-Greenway,” and field results were obtained in Greece, Romania and Cyprus. The most efficient method to address these challenges is via a dual approach, (a) short-term restoration measures in the sea part of the chain, and (b) land measures for identifying green products & services in wastewater management. According to the baseline best practices in the field describing the linked agriculture-eutrophication issue, everyday farming activities such as tilling, use of pesticides and fertilizers can give rise to contamination of soil and water supplies. Toxic pollutants from land-based sources are found in fresh and marine waters, ranging from agricultural nutrients, such as organic compounds, to pharmaceuticals. The main output of the present research was to design, build and operate a unified platform, hosting all the necessary tools for an efficient, sustainable electronic procurement method, aiming to bring together public-private operators who are active in the field of green public procurement. The unified platform has been used by relevant target groups to provide innovative solutions for improving the environmental status of eutrophic and anoxic coastal ecosystems based on the identification of general specifications & standards to govern green eProcurement models and green criteria, leading to the development of an integrated procurement model.
Keywords: Eutrophication; Anoxia; Land pollution; Water pollution; Green; Procurement; Toolkit; Agricultural; Wastewater; Fertilizers.

1. Introduction

The sea-land chain [1, 2] faces significant challenges that are due to the pollution problems of eutrophic and anoxic coastal ecosystems. Eutrophication, primarily caused by excessive nutrient runoff from agricultural activities [3], urban areas, and industrial discharges, poses a severe threat to coastal waters. The influx of nutrients, such as nitrogen and phosphorus, stimulates the overgrowth of algae, leading to algal blooms. As these algae decompose, oxygen levels in the water decrease, creating hypoxic or anoxic conditions [4]. This process, known as anoxia, can have devastating effects on marine life, causing fish kills and disrupting the balance of ecosystems [5]. The interconnectedness of land-based activities and coastal waters intensifies the challenge, necessitating a holistic approach to address the root causes of eutrophication. Global environmental problems are associated with excess nutrients, including eutrophication, coastal hypoxic zones and nitrate contaminated groundwater [6]. Although global attention has focused on water quantity, water-use efficiency and allocation issues; poor wastewater management has created serious water-quality problems, reducing the quantity of water that is safe to use [7].

Further, the sea-land chain encounters difficulties in mitigating pollution from a range of land-based and other sources. Runoff from agricultural lands carries pesticides, fertilizers, and sediments into coastal waters, exacerbating eutrophication and impacting the health of marine ecosystems. Urban areas contribute pollutants through stormwater runoff [8], industrial discharge, and improperly treated sewage. Integrated coastal management strategies are crucial to managing these pollution sources effectively. Collaboration between governments, industries, and communities is essential in implementing sustainable practices, enforcing regulations, and developing innovative solutions to reduce the impact of land-based pollution on coastal ecosystems. A comprehensive and coordinated effort is required to protect the delicate balance between land and sea.

Best practices in the field describe the linked agriculture-eutrophication issue in which everyday farming activities such as tilling and ploughing, disposing of slurries and farmyard manures, and the use of pesticides [9], veterinary medicines and fertilizers can give rise to contamination of soil and of water supply. Also, toxic pollutants from land-based sources are found in both fresh and marine waters, ranging from agricultural nutrients and industrial chemicals such as organic compounds and heavy metals to personal-care products and pharmaceuticals.

The green component of this work seeks to design, build and operate a unified platform, which hosts all e-procurement tools, aiming to bring together public and private operators [10], enterprises/SMEs and all relevant stakeholders, such as Academia/Higher Education and research organizations, which are active in the field of green public procurement. The needs and requirements for the platform are defined through capacity and stated-preference analysis of users' choices. This results in identifying the green means of fostering demand-driven transnational eco-innovation via new processes, moving away from negative local practices.

Addressing these, the unified platform is designed to provide innovative solutions for improving the environmental status of eutrophic and anoxic coastal ecosystems (EACEs). The design follows the earlier research results in other fields of application and includes i) a transnational network of public/private operators in e-procurement ii) a knowledge database, which delivers a well-organised online library of best practices, tools and methods, related to innovative solutions, iii) a solution database, which includes green solutions (products/services) offered by enterprises/SMEs in the market, to be used by public authorities in tenders, iv) a Life Cycle Costing (LCC) Tool to facilitate the wide application of a life cycle perspective for producing the most cost-efficient solutions, v) a Tender Database developed for all stakeholders in EU&A management tenders, and vi) a methodology for the development of electronic green public procurement (eGPP) criteria, based on the identification of general specifications & standards to govern green eProcurement models, and green criteria for products/services to be procured. These steps lead to development of an integrated procurement model.

Sustainability and transferability achievements are drawn from interaction between the project and its target groups through its online tools and pilots that have been achieved with the demonstration and use of the Unified e-procurement toolkit. The project changes the current situation by taking up the green/blue method in coastal ecosystem restoration and in wastewater management, and transferring these principles across regions/nations. These research activities and results took place under the aegis of the "Blue-Greenway" project [11].

2. Materials and methods

Numerous scientific studies [12] have delved into the challenges facing the *sea-land chain*, particularly in addressing the pollution problems associated with eutrophic and anoxic coastal ecosystems [13, 14]. Research has highlighted the complex interplay between land-based activities and the deterioration of marine environment [15, 16]. Investigations consistently underscore the role of anthropogenic factors, such as agricultural runoff, urban development, and industrial discharges, in fueling eutrophication. Advanced modeling techniques and satellite imagery have been employed to track nutrient flows, and analyze the spatial and temporal dynamics of coastal pollution, providing valuable insights for targeted interventions [17]. These studies emphasize the need for interdisciplinary approaches that combine ecological, hydrological, engineering and social sciences to understand the intricate relationships between land and sea.

In addition to pinpointing the sources of pollution, scientific inquiries have focused on developing innovative solutions to mitigate the impacts on coastal ecosystems. Remediation strategies, including nutrient management practices in agriculture [18], green infrastructure in urban planning [19], and advanced wastewater treatment technologies [20], have been explored. Bioremediation and restoration efforts have gained attention, with researchers investigating the potential of certain organisms to absorb excess nutrients and promote ecosystem recovery [21]. These studies contribute to the evolving body of knowledge essential for policymakers, conservationists, and communities in making informed decisions for preserving the health and resilience of coastal ecosystems within the sea-land chain.

In crop production, management measures for reducing the risk of water pollution that is due to organic and inorganic fertilizers and pesticides include limiting and optimizing the type, amount and timing of applications to crops. Farmers can improve nutrient management practices by applying nutrients (fertilizer and manure) in the right amount, at the right time of year, with the right method and with the right placement. Also, farmers can control the frequency and intensity the fields are tilled. This can help improve soil health, and reduce erosion, runoff and soil compaction, and therefore the chance of nutrients reaching waterways through runoff. The collaboration of a wide range of users, stakeholders and organizations across an entire watershed is vital to reducing nutrient pollution to water and air. Farmers can play an important leadership role in these efforts when they engage with their government, farm organizations, conservation groups, educational institutions, non-profit organizations and community groups, especially when supported by a Green Public Procurement (GPP) framework [22].

Green Public Procurement (GPP) aims for a better environment as a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured. GPP is still a voluntary instrument, i.e., Member States and public authorities can determine the extent to which they implement it. Green purchasing also has the potential to substantially influence the market. By promoting and using GPP, public authorities can provide industry with incentives for developing green technologies and products. In certain sectors, public purchasers command a significant share of the market (e.g. public transport, construction, energy refurbishment, health services, education) and so their decisions have considerable impact [23, 24].

Public procurement (PP) principles are at the foundation of public procurement. They govern the management of public procurement, and set the framework for a code of conduct for public procurement practitioners and all other officials, directly or indirectly associated with the public procurement process. A practitioner must have a clear understanding of public procurement principles and know how to apply them to guide day-to-day decision-making. The PP practitioner manages public funds, is bound by an ethical code of conduct, and is accountable for what (s)he does or fails to do when managing those funds. Transparency, integrity, economy, openness, fairness, competition, and accountability are fundamental principles of public procurement.

Further, buyers and suppliers need to understand the structure of the procurement process, the minimum timescales required, the processes which govern those timescales, including framework agreements, selection and award criteria, the evaluation process and the standstill process. The procurement cycle helps buyers to understand the process, which it breaks into the following 13 sections [25]:

1) Define Business Needs and Develop Specification
2) Market Analysis and Make or Buy Decision
3) Develop the Strategy and Plan
4) Pre-Procurement Market Testing
5) Develop Documentation and Detailed Specification
6) Supplier Selection to Participate in Tender
7) Issue Tender Documents
8) Bid and Tender Evaluation and Validation
9) Contract Award and Implementation
10) Warehouse, Logistics and Receipt
11) Contract Performance and Improvement
12) Supplier Relationship Management
13) Asset Management

The current research develops *green procurement criteria*, which cover products and activities that can have an impact on the increase of nutrients in marine coastal waters leading to eutrophication. Practices and products can be assessed regarding the extent to which they are green or sustainable with the use of Green Criteria which may be specified in regulations, standards or ecolabels. Two distinct types of criteria are applied, namely *process-based* and *performance-based* criteria. It is often argued that performance-based criteria are more effective as they specify *quantitative thresholds* (e.g., effluent volume, pollutant concentration in effluents or the environment), which are meant to secure the good status of the environment. Nevertheless, setting numerical thresholds often is based on incomplete data, a series of assumptions and the results of model simulations which can include inaccuracies, not guaranteeing improvement in environmental status. Therefore, in this work performance criteria are only used for soil improvers, where adequate information exists [26, 27]. For the greater part we use process-based criteria, which may assume the existence of a *process threshold*, i.e., if an appropriate process is followed, improvement in performance and thus improved status of the environment can be expected. Based on the analysis of existing standards and regulatory requirements, best practices and best-fit available technologies, a framework for the definition of green criteria of products deriving from agriculture and aquaculture operations has been defined [28]. The framework serves as the basis for the development of green procurement criteria for relevant products with particular emphasis on the reduction of eutrophication impacts and risks. The green criteria that have been developed are divided in two main categories, focusing on agriculture and aquaculture.

The agriculture section consists of three subcategories, i) Soil improvers, ii) Pesticides and iii) Wastewater management, which include correspondingly the following green criteria: i') General constituents/sources of soil improvers used for fertilization, Hazardous materials, Allowed Materials, Physical contaminants, PAH (polycyclic aromatic hydrocarbons), Performance, Health risk & Organic matter and dry matter; ii') Pest control methods, Less Hazardous Chemical Synthesis, Designing Safer Chemicals, Design for Degradation, Inherently Safer Chemistry for Accident Prevention & Safer Solvents and Auxiliaries; iii') Discharge of Wastewater in the form of effluents & High organic load in wastewater.

The aquaculture section consists of six subcategories, i) Environmental Protection Measures, ii) Aquaculture feed, iii) Efficiency of feeding practices, iv) Aquaculture Management Practices, v) Environmental Integrity and vi) Responsible Manufacturing Practices, which include correspondingly the following green criteria: i') Waste water management & Solid waste treatment; ii') Certifications, Assessment of suppliers, Materials and additives & Monitor of the impacts fishery on the marine environment; iii') Fish-feeding practices, Feed characteristics & Anaesthetics/Vaccines; iv') Animal Healthcare, Food Safety & Aquaculture facilities and operations; v') environmentally responsible manner; vi') Structure and Facilities, Intake of Raw Fishery Material, Maintenance and Contractors, Process Control Arrangements, Hygiene, Cleaning, and Disinfection, Loading and Transport, Hazard Analysis Critical Control Point (HACCP) systems, and Marine Ingredients Specifications.

Based on the developed green procurement criteria, an e-Procurement tool has been developed which supports green purchasing decisions relevant to the reduction of nutrient releases to the environment and protection of marine and coastal areas from eutrophication. The tool supports a potential buyer in preparing green specifications for the purchasing of relevant products; in this research focusing on agricultural and aquaculture products. The tool foresees to provide 1) the required documentation to support the definition of appropriate green specifications and 2) an evaluation mechanism which will enable the buyer to assess alternative offers from potential suppliers to make meaningful comparisons and beneficial purchasing decisions. It is important that the user can efficiently and effectively access and use the databases and functions of the tool such that its application is cost efficient [29]. It is also important that the procurement tool supports the potential suppliers in evaluating their own products against green criteria requirements as well as in identifying shortcomings and the means to overcome them. Therefore, the tool libraries and databases incorporate material regarding products and services upstream in the supply, i.e., products and services that serve as suppliers to the agriculture and aquaculture sectors [30].

A key support function integrated in the platform concerns the set of standardized, verifiable green criteria and tender evaluation mechanism which aims to facilitate the comparative assessment of competing products and services within a procurement procedure. Scientific justification and verifiability of the green criteria and evaluation methodology of competing offerings is of paramount importance to any procurement, otherwise any purchasing decision will be susceptible to challenge and litigation. Indeed, complaints against decisions based on evaluation results are frequent, even in procurement processes that do not involve green requirements.

The cycle of a tender process includes four phases (Figure 1): *1. Identification and description of the requirements* constitutes the primary purchase application, which includes the detailed definition of product/service specifications. Supplementary requirements are also incorporated such as schedule of supply, installation and commissioning processes and after sales support. It is good practice that expected capital expenditures (CAPEX) and operating expenses (OPEX) costs are calculated, and a budget is defined by the corresponding department, to ensure the viability of the project. It is also common practice that the budget is communicated in the publication of the Tender. *2. Research regarding the suppliers* includes the definition of the conditions required for selecting a potential supplier, the identification of potential suppliers, and the purchase analysis. *3. The selection and award* processes of the Tender involve the way in which the procurement is conducted, the definition of the criteria for evaluation of the suppliers' offers, terms of execution of tender, and terms of payment. Once evaluation is completed, the selection of tenderer is finalized, and the contract preparation and signature procedures are implemented. *4. Procurement processing* includes the administration of the contracts with the suppliers, the management of supplies and stocks, the financial arrangements with the supplier, and the measurement of supply efficiency [31, 32].

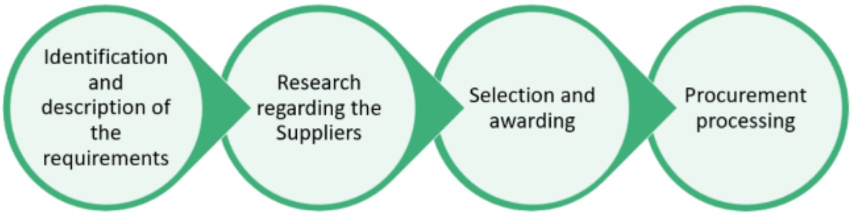

Figure 1. The phases of a tender supply cycle

2.1 eGPP toolkit

(a) Transnational network

Identification of the needs and requirements of the users has led to the development of five basic tools, which construct the eGPP toolkit. The first tool is the *transnational network* that was developed as part of this research to bring together public and private operators who are working on e-procurement, green growth and blue growth. The network aims to support the improvement of environmental status of participating ecosystems and of the Eutrophication & Anoxia (EU&A) management sector, and to support stakeholders and users in ensuring their deep engagement and sustainability of the green outcomes. This network is a steppingstone to achieving the transferability of the results. The transnational network (TN) functionalities can be summarized as: Register as part of the TN; List/search all members by multiple criteria; View details of each member; View documents posted by other members and upload your own; Contact members through an embedded form in the member's profile (TN instance is illustrated in Figure 2).

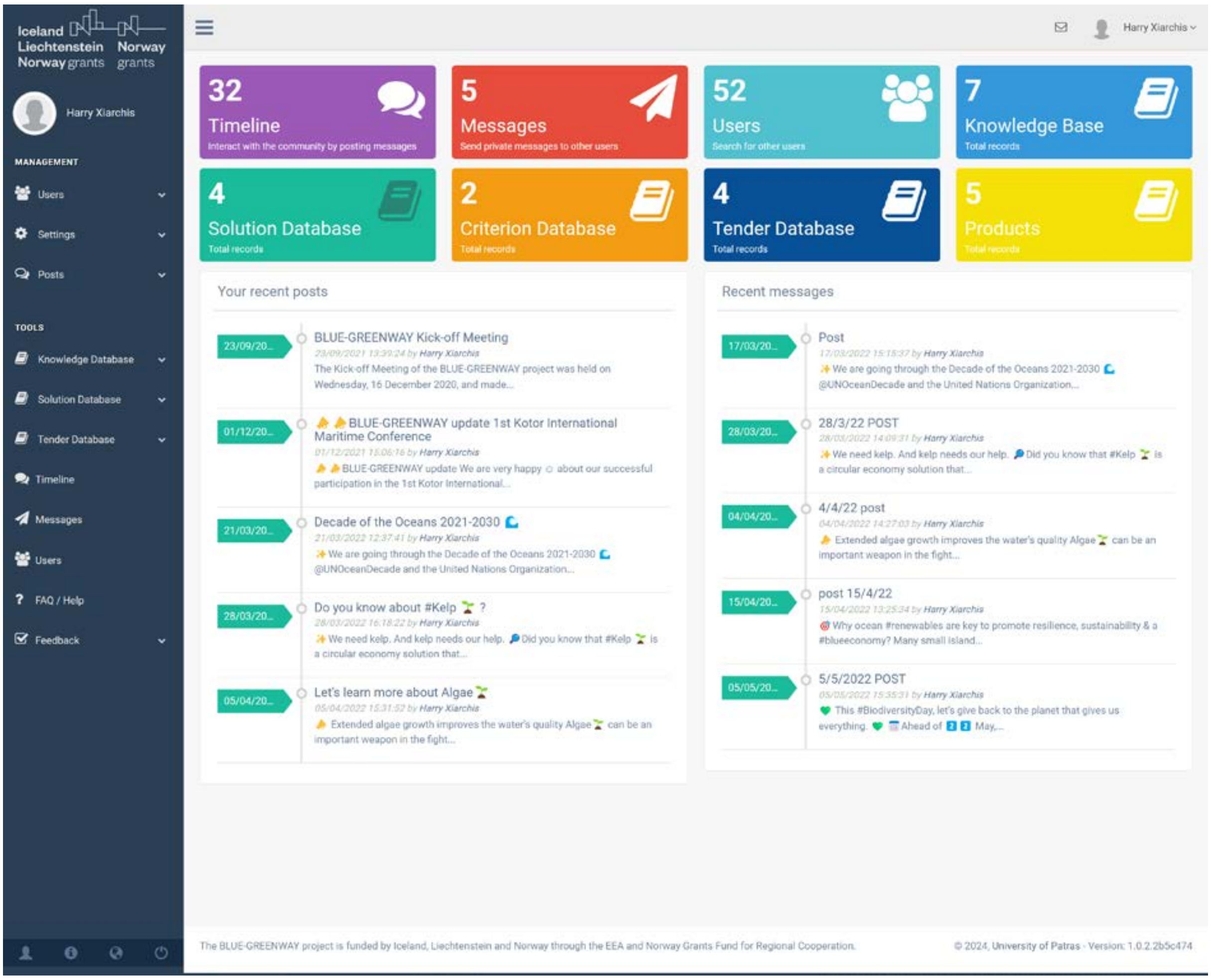

Figure 2. Transnational network interface [33]

(b) Knowledge database

The second tool, which represents the foundations of the toolkit along with the TN, is the Knowledge Database (KD) which delivers a well-organized online library of best practices, tools and methods, related to innovative solutions for improving the environmental status of eutrophic and anoxic coastal ecosystems (EACEs). In this way, the database enhances the support to the improvement of the environmental status in EU&A supported ecosystems and management sector. The Knowledge Database (KD) functionalities can be summarized as: Register to the KD; List/search all knowledge elements by multiple criteria; View details of each knowledge; Upload/Edit new knowledge (KD instance is illustrated in Figure 3).

In the context of the knowledge database, a case study is considered featuring a comprehensive repository in which the title can be inserted. The resource could be dedicated to the agriculture, aquaculture or wastewater management sector and serves as a reservoir of insights aimed at fostering sustainable practices. The database encompasses the availability for a detailed description of various methodologies, technological innovations, and best practices tailored to enhance environmental stewardship within the agriculture industry. The main results provide a succinct summary of successful case studies, research outcomes, and industry advancements. Key areas covered include the distribution of aquaculture products, primary production methods (creation, collection, or extraction of raw materials), retailing strategies, secondary production processes, suppliers, and waste management practices. This valuable knowledge is accessible globally, spanning several countries, with information updated annually in English or other languages. Its applicability extends to a diverse range of users, including international bodies, regional organizations, and local municipalities. Users can access the database through the provided URL, and its status is marked as active, ensuring ongoing relevance and accessibility. Additionally, supporting files, such as research papers and case studies, can be uploaded to enhance the depth and breadth of the knowledge repository.

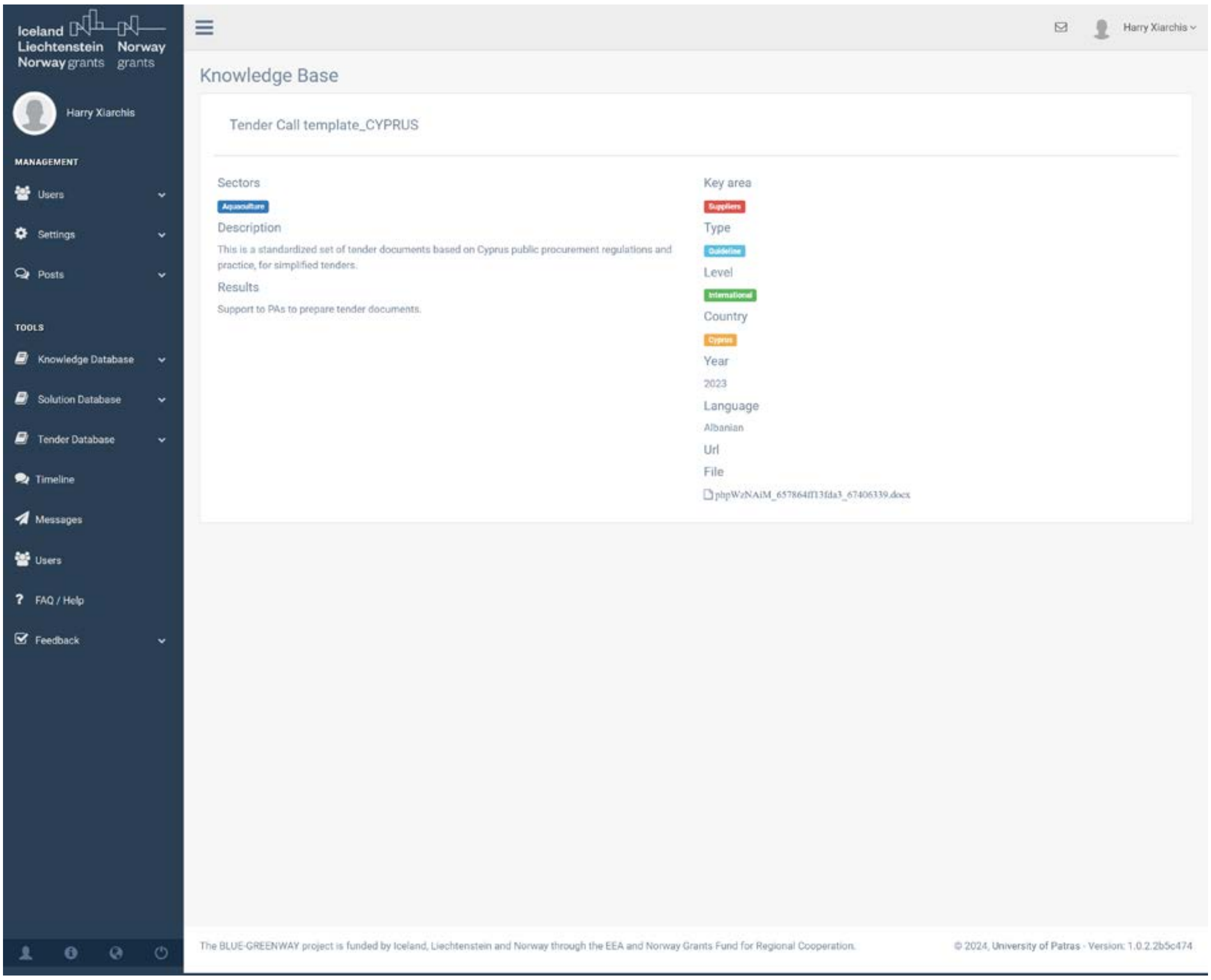

Figure 3. Knowledge Database interface

(c) Solution database

The third tool is the Solution Database (SD), which includes green solutions (products/services) offered by SMEs in the market, to be used by Public Authorities (PAs) to support eutrophication & anoxia procurement implementation. This is expected to improve the environmental status of eutrophic and anoxic coastal ecosystems in the supported areas of Environment, Energy, Climate Change & Low Carbon Economy. The Solution Database (SD) functionalities can be summarized: Register to the SD; List/search all solutions by multiple filters; View details of each solution; Upload green solutions (products/services) to be used by public authorities; Add green criteria to the solutions (SD illustrated in Figure 4).

In the context of our solution database, a case study is considered for an innovative agriculture, aquaculture or wastewater management solution. The sustainable technology solution can be categorized according to the availability for providing a detailed description highlighting its advanced processes and eco-friendly features. The units for this solution can be measured in: pieces, meter, kilogram, box, liter, ton; showcasing its adaptability to various scale applications. Availability is denoted by a numerical value, ensuring efficient tracking and management. The solution is actively visible for all users in the database. The Life Cycle Costing (LCC) file can be uploaded for comprehensive cost analysis. Moreover, this solution can adhere to green criteria, including a detailed description, tender standard, standard reference, value description, and a rating scale ranging from very low to very high, emphasizing a commitment to environmental sustainability.

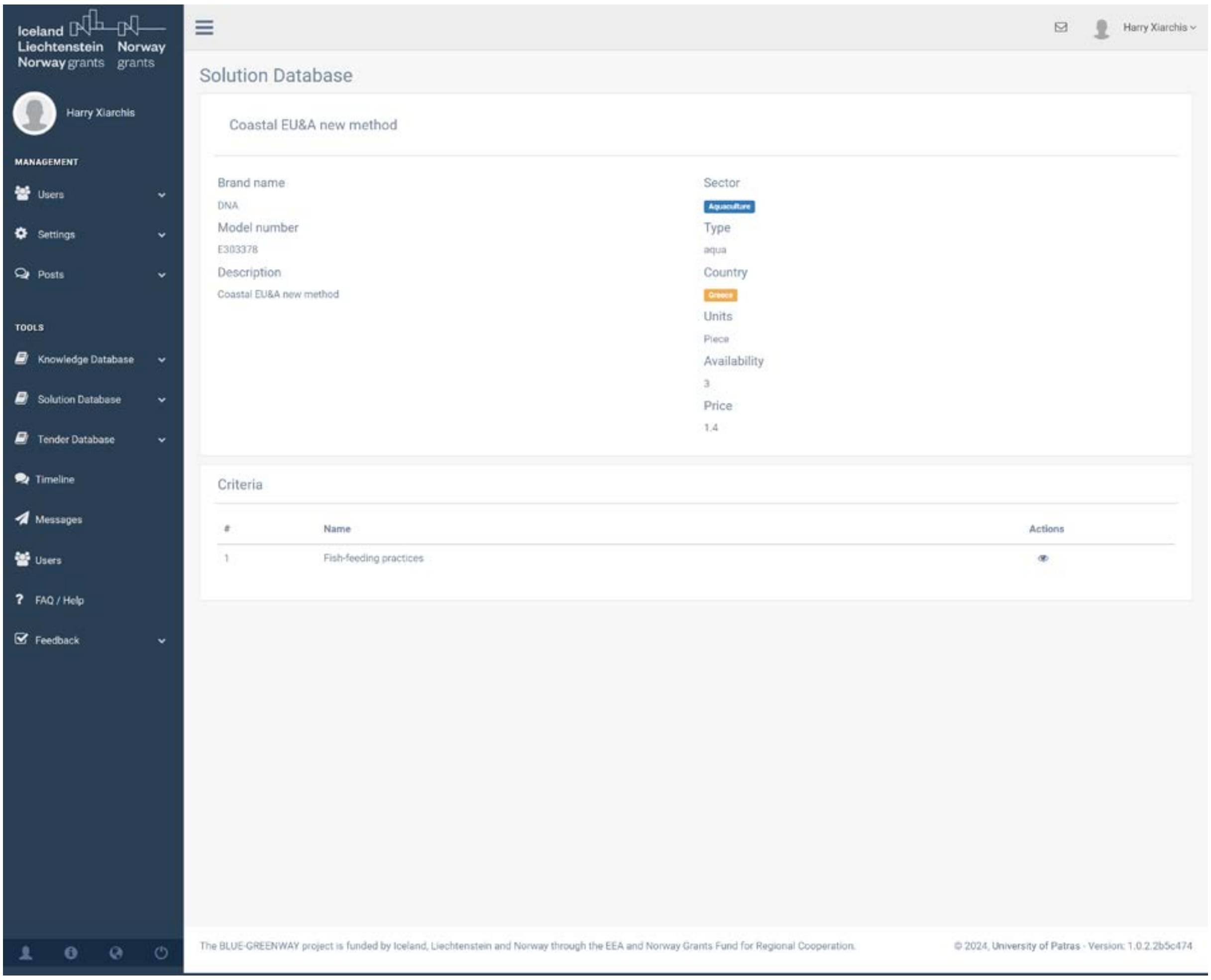

Figure 4. Solution Database interface

(d) Life Cycle Costing tool

The fourth tool is the eco-innovative Life Cycle Costing (LCC) tool that aims to aid public procurers select the most cost- and energy-efficient solution. The LCC Tool has been developed to facilitate the wide application of a life cycle perspective for producing most cost-efficient solutions. Calculating LCC gives an overview of future expenditures and identifies more cost-efficient and sustainable solutions. In this regard, this approach considers all life cycle stages, from raw material extraction ('cradle') up to the use phase and end of life phase ('grave'). LCC methodology could best be used during the design process while there is still a chance to refine the design, and ensure a cost reduction. LCC takes into account purchase price and all associated costs, including delivery, installation, insurance; operating costs, including energy, fuel and water use, spares, and maintenance; end-of-life costs (such as decommissioning or disposal) or residual value (i.e. revenue from the sale of product). The Life Cycle Cost analysis implementation interface is illustrated in Figure 5.

The LCC tool provides a comprehensive assessment of costs and benefits over the study period of a proposed improvement, e.g. a 20-yr period. In our work, users can input specific data, including initial expenses encompassing investment costs, such as land acquisition/construction and equipment for the method's facilities; and anticipate future expenditures, including operation costs, maintenance and repair costs, and replacement costs. The tool factors in a discount rate entry to account for the time value of money, ensuring a realistic appraisal of future cash flows. On the benefits side, the LCC tool considers added value, including residual value, waste value, as in some methods transforming waste into valuable resources adds environmental sustainability and other pertinent benefits. The comparative analysis enables stakeholders to make informed decisions by weighing the long-term economic implications of conventional versus innovative approaches, a valuable resource for strategic planning and sustainable development initiatives.

(e) Tender database

The fifth and last tool is the tender database, in which Public Authorities can publish tenders searching for innovative solutions to improve the environmental status of eutrophic and anoxic coastal ecosystems (EACEs). SMEs can provide offers of relevant green products and services to these tenders fulfilling the required criteria.

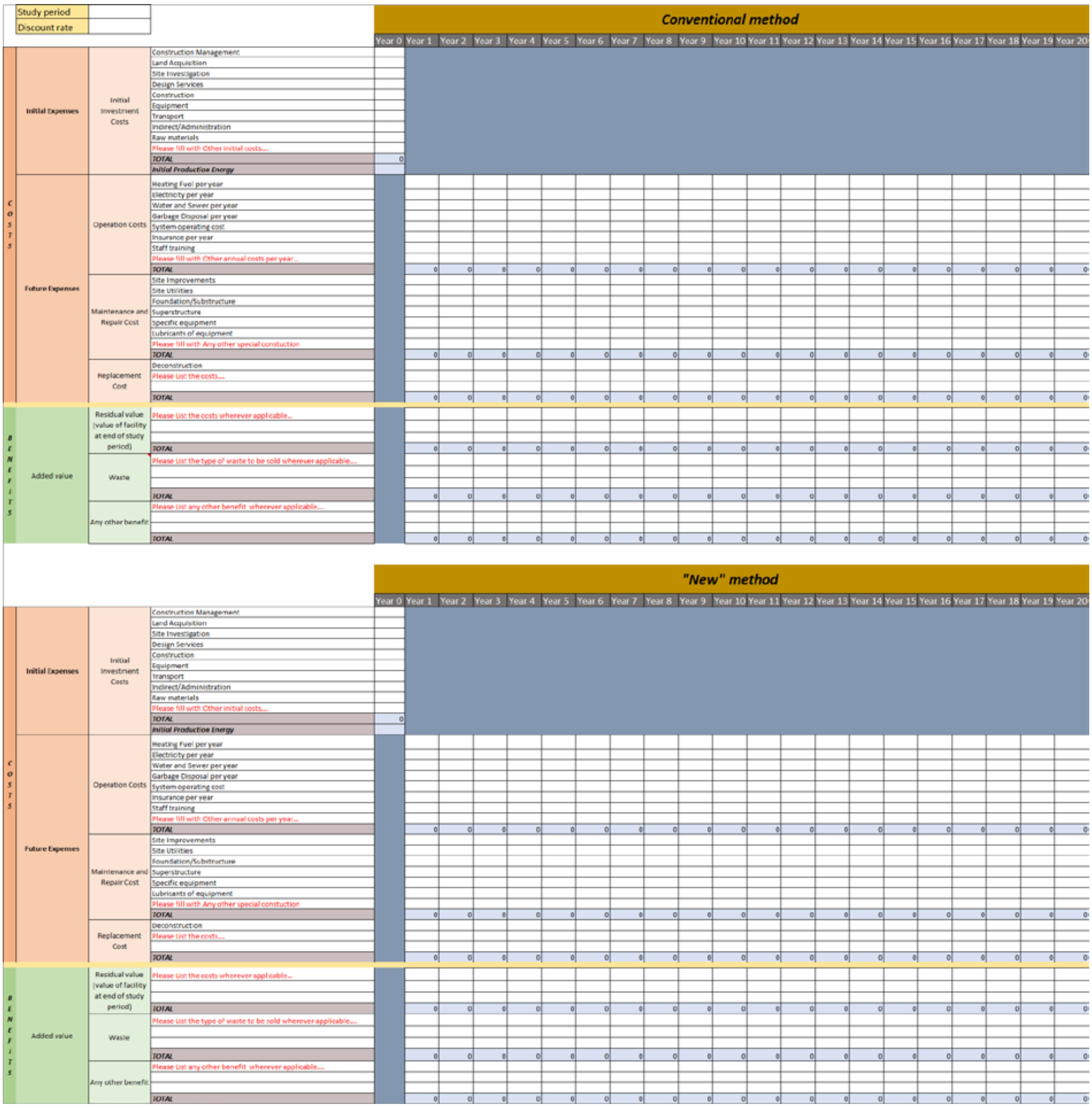

Figure 5. Life Cycle Cost analysis

3. Results and discussion

The main results were drawn mostly from the Pilots of the e-GPP toolkit application, and the localisation and open demonstration in real-life conditions of the toolkit in three countries, Greece, Cyprus & Romania. The target group of this evaluation process includes the Public Authorities (PAs), Higher education & Academia, research organizations, environmental sector policy makers and Small & Medium Enterprises (SMEs) involved in transferring and capitalization activities. The technical evaluation results derived from the use of a set of Key Technical Performance Indicators and threshold values that were identified by the research team in order to allow meaningful testing of the key functionalities of the databases for Public Authorities and Small and Medium Enterprises.

The technical evaluation of the system is based on two characteristics that have been identified as most important by the stated-preference model: a) the *reliability* of system operations, and b) the *time response* of the system to user requests. The two characteristics were quantified through technical indicators, which represent the key functions of the databases for the technical parameters in accordance with the threshold values. As an example, the time needed for adding a knowledge element, was estimated to 0.34 sec. and can be marked as successful, comparing with the threshold value, which has been defined at 5 sec. according to the standards of the user tolerance when preparing a task in a platform. Public Authorities (PAs) and Small and Medium Enterprises (SMEs) have access to different functions of the databases; thus the indicators were adapted to the needs of each of those categories of user. In particular, the technical indicators for the PAs are focused on the registration process, add knowledge/tender function, edit/update knowledge/tender function, filter-search tool function, list of tool function, view tool function and time needed for implementing these functions.

The evaluation process was performed with the testing method of technical verification, and the certification of the proper functioning of the system software, by performing iterative user trials. The achieved mean value that was calculated from the sum of results of the iterative user trials for each specific indicator is presented indicatively for PAs and SMEs in Tables 1 and 2, respectively [34].

Table 1. Databases Evaluation Results of Key Technical Indicators for PAs Functionalities

Key Technical Indicator	Threshold Value	Achieved Value (after evaluation)
TI-1: Success rate (%) in the “Add knowledge” section	96%	97%
TI-2: Time needed for add knowledge element of TI1	5 sec	0.34 sec
TI-3: Search success rate (%) in the “Filter knowledge list” section, by using keywords/language/sector/key area/type	95%	100%
TI-4: Time needed for the display of TI3 search results	5 sec	0.4 sec
TI-5: Success rate (%) in the “List of knowledge elements” section.	95%	100%
TI-6: Time needed for the display of TI5 list results	5 sec	0.74 sec
TI-7: Success rate (%) in the “View a knowledge element” section	95%	100%
TI-8: Time needed for the display of TI7 “View” results	5 sec	0.32 sec
TI-9: Success rate (%) in the “Edit/Update Knowledge” section	95%	96%
TI-10: Time needed of TI9 Edit/Update knowledge element	5 sec	5 sec
TI-11: Success rate (%) in the “Add tender” section	95%	99.5%
TI-12: Time needed for add tender element of TI11	5 sec	0.34 sec
TI-13: Search success rate (%) in the “Filter tender list” section, by using keywords/sector/type	95%	100%
TI-14: Time needed for the display of TI13 search results	5 sec	0.4 sec
TI-15: Success rate (%) in the “List of tender elements” section.	95%	100%
TI-16: Time needed for the display of TI15 list results	5 sec	0.74 sec
TI-17: Success rate (%) in the “View a tender element” section	95%	100 %
TI-18: Time needed for the display of TI17 “View” results	5 sec	0.32 sec
TI-19: Success rate (%) in the “Edit/Update tender” section	95%	94%
TI-20: Time needed of TI19 Edit/Update tender element	5 sec	5 sec
TI-21: Success rate (%) for user identification (Login)	98%	100%

Table 2. Databases Evaluation Results of Key Technical Indicators for SMEs Functionalities

Key Technical Indicator	Threshold Value	Achieved Value (after evaluation)
TI-1: Success rate (%) in the "Add solution" section	97%	100%
TI-2: Time needed for add solution element of TI1	3 sec	0.34 sec
TI-3: Success rate (%) in the "List of solutions" section	97%	100%
TI-4: Time needed for the display of TI3 list results	3 sec	0.4 sec
TI-5: Success rate (%) in the "View a solution" section	97%	100%
TI-6: Time needed for the display of TI5 view of the solution	3 sec	0.74 sec
TI-7: Success rate (%) in the "Edit/Update solution" section	97%	96%
TI-8: Time needed of TI7 Edit/Update solution	3 sec	4 sec
TI-9: Success rate (%) in the "Add Criterion" section	97%	99.5%
TI-10: Time needed of TI9 add criterion service	3 sec	0.34 sec
TI-11: Success rate (%) in the "Download LCC tool" section	95%	100%
TI-12: Time needed of TI11 download response of the LCC tool service	3 sec	1 sec
TI-13: Search success rate (%) in the "Filter solution list" section, by using keywords/sector/type	95%	100%
TI-14: Time needed for the display of TI13 search results	3 sec	0.4 sec
TI-15: Success rate (%) for user identification (Login)	98%	100%

The implementation of the technical evaluation process and the test results have indicated the potential of the system components to be verified across a range of real-life situations in the pilot testing locations. The verification of the Databases was based on testing their functionalities; from the results, almost all individual functions work satisfactorily, with respect to the threshold values of the key technical indicators. The development and implementation of the eGPP software was based on testing the integrity and reliability of the basic operations of the system. With the completion of laboratory trials, almost all identified deficiencies, failures, and errors were rectified. The technical testing of the eGPP tool during these trials indicated the accuracy of the services offered by the system, from the perspective of the needs and requirements of the user [34].

4. Conclusions

Sustainability and transferability achievements are drawn from interaction between the project and its target groups through its online tools and pilots that have been achieved with the demonstration and use of the unified e-procurement toolkit. The project changes the current situation by taking up the green/blue method in coastal ecosystem restoration and in wastewater management and transferring these principles across regions/nations.

The joint pilot actions that were held can be marked as successful, since the benefits that derived from launching these joint events have an added value for the project implementation by the green approach. Many stakeholders that were part of the target group had gained valuable knowledge and experience about the unified platform on e-procurement and are keen to follow the proposed eGPP method.

The adoption of green electronic procurement practices emerges as a pivotal strategy in the ongoing battle against eutrophication and anoxia issues. By integrating environmentally sustainable criteria into the procurement process for electronic goods, organizations can contribute to the reduction of harmful impacts on aquatic ecosystems. This approach promotes the use of eco-friendly materials, energy-efficient technologies, and responsible disposal methods, thereby curbing the release of pollutants into water bodies. Additionally, the implementation of green electronic procurement fosters a market demand for cleaner production processes that can provide incentives for manufacturers to adopt environmentally responsible practices. Ultimately, this comprehensive approach mitigates the environmental footprint of relevant products, and plays a crucial role in safeguarding water quality, ecosystems, and the overall health of aquatic environments, thereby addressing the multifaceted challenges posed by eutrophication and anoxia.

5. Acknowledgement

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