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Perspectives of Including Aquaponics in Environmentally Preferable Procurement (EPP) Process for Supporting Green Economy

Drogeanu Răzvan
silurusmarketsrl@gmail.com
Magean Răzvan
silurusmarketsrl@gmail.com
SC Silurus Market SRL, Romania
Petrea Ștefan-Mihai
Stefan.petrea@ugal.ro
Dunarea de Jos University of Galati, Romania
Cristea Dragoș
dragoscristea@yahoo.com
Dunarea de Jos University of Galati, Romania
Neculiță Mihaela
neculitam@yahoo.fr
Dunarea de Jos University of Galati, Romania

In order to respond positively to fish market demands and to improve its sustainability, the aquaculture sector need to be upgraded with techniques and technologies that can be included in the segment of environmentally preferable procurement (EPP) or green procurement products. Since both aquaculture and agriculture are considering key food production industrial sectors, implementing integrated systems as aquaponics, which combines both and generates more sustainability, must be considered. However, know-how information must be disseminated among the fish farm owners, as well as potential investors. Aquaponics ready-to-use packages must be considered in order to facilitate the integration within EPP process.

Keywords: green economy, environmentally preferable procurement, aquaponics, sustainability, profitability.

1. Introduction and general considerations

According to Veleva (2001), the *green consumption* should be enforced by responsible consumption. Akehurst et al. (2012) analysed which are the main determinants of the ecologically consume behavior (ECCB) and the main influencers of the effective green purchase behavior (GPB), considering ECCB and green purchase intention (GPI). Their study proved that the consumers with high ECCB have also high GPI and also, that ECCB has a positive impact on GBP. Also, according to Akehurst et al. (2012), high ecological consciousness leads to a smaller gap between GPI and GPB. Different from the previous studies, Brahim et al. (2019) emphasizes that purchasing, including green purchasing, come secondary to consumption decisions. Normally, consuming a product can lead to a certain involvement, which should imply that the motivations are also important to be analysed. Ping and Xin (2015), are updating in their study the supplier selection model suggested by de Boer, in order to establish long-term green purchasing relationships between multi-stakeholders (suppliers and manufacturers). Jing (2019) focuses on identifying what do consumers value more in green purchasing. Starting from the fact the consumers are a critical element for sustainable development, his study results shows that environmental impact information are a critical element on green purchasing, while social impact does not. Basically, this proved that the consumers are aware of the importance of a product's social sustainability performance, but this information does not change their willingness to pay price premium. In respect to consumers, Jaiswal et al. (2018) studies, based on an attitude – intention – behavior model, the relationship of cognitive able to influence green purchase intention.

The literature identifies many drivers that cause the organizations to adopt green practices (Wu et al., 2012; Zhu et al., 2012), the same drivers which can also influence individuals within organizations. Booi (2011) publishes one of the first studies on green purchasing attitude-behaviour inconsistencies, where he reviews 53 empirical articles from 2000 to 2011. He identifies different motives, facilitators and barriers, for consumer's environmental concern and products functional attributes, representing the two major determinants of consumer green purchase behavior.

Focusing from private to public sector, Qinghua (2013) presents the fact that green public procurement (GPP) practices should be recognized as effective policy tools for sustainable production and consumption. Currently, it can be noticed that GPP practices adoption, especially in developing countries, is still an issue. In order to understand GPP issues, Qinghua (2013) developed a conceptual model, based on data collected from 193 Chinese government officials, which hypothesizes moderation effects of GPP knowledge on the relationships between GPP drivers and practices. As presented in Qinghua (2013), developed countries spend over 10% of gross domestic product on their public procurement. As such, Testa et al. (2012) mentioned that in this context, green public procurement (GPP) should be one approach to further environmental policy. The dynamics of GPP popularity did not registered a highly upward trend, fact which limited studies due to the fact that most of the attention was focused on private sector green purchasing. As emphasized by Ho et al., (2010), most studies were qualitative. According to few quantitative survey-based studies, as Nissinen et al., (2009), Walker and Brammer (2009). Marron (2007) and Zsidisin (2001), cost were identified as a barrier for green acquisitions.

Still, GPP regulations should encourage governments to purchase green products even if the cost is higher than non-green alternatives. In many cases this is not true due to the fact that governmental purchases require lowest price bid selection. Currently, there are green products subsidized by government, like electrical cars or green energy solutions for houses. Xie (2009) shows that for many years Chinese central government provides price subsidies for public offices or organization that purchased green vehicles. Green growth and green procurement are characteristic for EU policy, the main purpose being to ensure that Europe's economic growth is environmentally sustainable. For a long time, the contracting authorities did not take into account the environmental value of the goods, services and works. However, the political and economic context has changed, with the advent of the concept of sustainable development that meets the needs of the present, without compromising the ability of future generations to satisfy their own needs and with the need to consider environmental issues in the elaboration of all other policies (in parallel with economic and social aspects).

European Union (EU) have some of the highest environmental standards in the world and have set objectives according to which environment policies shall support the EU economy to become more environmentally friendly, to protect natural resources, as well as the health of people living in the EU. However, countries are facing with serious challenges, like climate change, unsustainable production and various forms of pollution. Thus, EU environmental policies and legislation protect natural habitats, keep air and water clean, ensure proper waste disposal, and improve knowledge about toxic chemicals and help businesses move toward a sustainable economy. The EU environment policy is based on articles 11 and 191-193 of the Treaty on the Functioning of the European Union. Within the article 191, combating climate change is an explicit objective of EU environmental policy. Sustainable development is an overarching objective for the EU, which is committed to a 'high level of protection and improvement of the quality of the environment' (Article 3 of the Treaty on European Union).

2. Economic impact of green procurement.

One of the purposes of GPP it is also mitigating climate change by enhancing social environment effect, securing industry competitiveness by stimulating innovation in existing and new industries, and increasing the effectiveness of government spending and social welfare by diffusion of green products (according European Commission, 2012; 2011; Yoon et al., 2009). It results a *win-win* strategy, meaning a policy strategy which aims decoupling of economic growth and environment damage from usage of resources and stimulates economic growth with environment-friendly way. (UNEP, 2011; Marron, 2003). Now, the developed countries implement both supply-side and demand-side innovation policy in order to accomplish innovation, merging both environment-friendly and economic growth, fostering green industries. Therefore, each developed countries, in order to achieve these goals, uses public procurement policy for the products which are energy efficient and environment-friendly (Yeong, Shin, Lee 2016).

3. Principles of green procurement

According to European regulations, there are two types of criteria that are used in public procurement: basic criteria and complex criteria. The basic criteria are used by the contracting authorities of the Member States. Complex or extended criteria are used when wanted to purchase the best ecological products on the market. These criteria create tools for regulating green public procurement. The purpose of the European regulations was transposed in the Romanian legislation as well and concerns the promotion of competition between economic operators, the guarantee of equal treatment and non-discrimination for all economic operators, ensuring the transparency and integrity of the public procurement process, ensuring the efficient use of public funds by applying the award procedures by the contracting authorities. Regarding the principles underlying the award of the public procurement contract, these are non-discrimination, equal treatment, mutual recognition, transparency, proportionality, efficiency of use of funds and assuming the responsibility.

4. Barriers

The entry into the green procurement market is also conditioned by the existing barriers. The main barriers refer to access to information - need more information on sustainable procurement, being difficult to define sustainability criteria and address social issues. The next barrier is related to tools or better known as lack of tools, guidelines and manuals. The lack of sustainable procurement policies and strategies, lack of collaboration and policies focused on cost effectiveness represent also important barriers. In the less developed countries, there is a risk of limiting competition and demand resistance to sustainable procurement by internal customers. These countries deal with short-term cost increases, training needs and funding issues, barriers that slow the implementation of green acquisitions as aquaponics systems (Tarțiu et all, 2018). In general, the sustainable procurement implementation is in the early stages in Romania. Studies have identified several barriers such as the lack of economic incentives, high costs associated with capitalization, the lack of adequate legislation for the creation of new markets for innovative products and poor collection systems. However, there are opportunities related to green products development in Romania. Firstly, the European legislative framework that will be implemented, the specialized workforce in innovative domains or related domains, and as regards aquaponics, the existence of traditions in the fish and aquaculture area can be considered fundamental advantages.

5. Goverment, corporation and consumer.

Public authorities are big consumers in Europe, spending about 16% of the EU's Gross Domestic Product (an amount equivalent to half of Germany's GDP). The economic operators in aquaculture domains may be the first to channel themselves towards the conversion to organic production. European funds in the fisheries domains and in aquaculture promote an efficient aquaculture from the point of view of resource utilization. The disadvantage of these funds being implemented in Romania is represented by the contribution of the private companies that must be 50%, a very large amount for an area where the state does not grant subsidies as in agriculture. The purpose of the financial stimulation of this sector is the protection and restoration of aquatic biodiversity, the improvement of the aquaculture ecosystems and the promotion of a resource-efficient aquaculture.

Regarding consumers, the need for information is essential. The terminology is relatively new in Romania, and aquaponics and aquaponic systems barely enter on the market. Therefore, private consumers must be convinced by the opportunity, efficiency and profitability of green acquisitions not only from an economic point of view but also from a sustainable development point of view.

6. Aquaponics production systems as part of green procurement network: The aquaponics integrated systems full package description

Climate change is one of the most important global issues, with considerable impact on food production sector. Therefore, in order to respond positively to fish market demands and to improve its sustainability, the aquaculture sector need to be upgraded with techniques and technologies that can be included in the segment of environmentally preferable procurement (EPP) or green procurement products.

Aquaculture sector had increase in the last decades, since it is considered that till 2048 most of fish stocks will decrease dramatically, more that 75% of total worldwide fish stocks being overexploited nowadays (Cristea V., 2019). Modern aquaculture is mostly based on recirculating aquaculture production systems (RAS), which are considered intensive and more sustainable production systems, capable of rearing fish in high stocking densities. Integrated multi-trophic aquaculture (IMTA) is both conceptually a simple idea and also highly appealing to regulators: the waste products from one food production process (in this case, fin-fish production) is acquired and assimilated by other organisms and converted into valuable products. This process both eliminates waste and increases the productivity of the food production system (Troell et al. 2003, Neori et al. 2004, Chopin et al. 2006). Aquaponics is considered both a water bioremediation technique which reduces the water replacement rate and a sustainable food production method which implies the use of nutrients resulted from fish grow, for obtaining a second culture (vegetable biomass) production. In order to achieve those goals, both technical and technological solutions were developed and optimized, in order to make a product named "aquaponics system" that can be integrated to already existing fish farms. Thus, an aquaponics system that is meant to be integrated in an already existing fish production system is considered an environmentally preferable procurement (EPP) or green procurement, considering that it reduces the environmental impact of aquaculture by its water conditioning capacity, justify by its bioremediation capability, and also, it assures a continuous entire year vegetable production, with limited to none impact on the environment.

Since both aquaculture and agriculture are considering key food production industrial sectors, implementing integrated systems which combines both and generates more sustainability and profitability should be considered a high priority. Thus, as a result of a social study made by Barrington et. al, 2010, 90 % of general public responders and 89 % of industry responders considered those systems, known as integrated multi-trophic aquaculture systems (IMTA), as a successful venture. According to the same study (Barrington et. al, 2010), the implementation of IMTA systems is considered to reduce the environmental impact and therefore, to improve waste management in aquaculture, to improve food quality, to increase food production, employment opportunities and community economies. Also, by increasing public demand for more sustainable products can raise consumer awareness about the environmental and social implications associated (IGPN, 2010). In order to apply the multi-trophic production concept which, link aquaculture and agriculture, full pack integrated aquaponics systems, together with the technological rearing solution for both fish and plants biomass, must be encourage to enter into the market as part of green procurement network.

The integration of aquaponics techniques and technologies assures a better quality of the technological water, limiting the operational costs with water conditioning and improving the sustainability of intensive aquaculture activity. Also, the second purpose of using aquaponics is to assure a second plants biomass crop production, besides fish biomass, improving the annual incomes of fish farm.

Aquaponics systems use phytoremediation as method for improving water quality and therefore, minimizing the water use, respectively water exchange rate. Reducing water exchange rate generates a decrease in operational costs. Thus, a secondary vegetable culture that takes most of its necessary nutrients from the technological water, without generating additional costs, improves the profitability potential of the recirculating systems (Timmons et al., 2002). Water consumption within an integrated recirculating system represents 1% of the consumption recorded in the case of classical aquaculture production systems, which generates an increase in their applicability in arid and semi-arid areas, where a significant demand for fish and vegetable products can be recorded (Diver, 2006). The existence of production cycles throughout a calendar year has the consequence of practicing affordable prices, regardless of season. The growth rate of aquaponic obtained plant biomass is superior to those recorded in the case of classical and even hydroponic crop systems, depending on the cultivated plant species (Rakocy et al., 2013; Timmons et al., 2002). The quality of the plant biomass, the fact that it is obtained by exclusively organic production methods and in areas where the development of agriculture is almost impossible due to the existence of limiting factors, as well as a visible maintenance process more accessible, compared to the classical production methods, are important assets in the context of the current market economy. As such, the integration of hydroponic crops within the recirculating systems generates additional income that provides economic support at the local level (Blidariu and Grozea, 2011).

As a green purchase product, aquaponics integrated systems full package consists in three sub-packages, as follows: technical component, technological component, knowledge hub software component.

The technical component contains tools that are used for the construction of a certain design of hydroponics modules, together with other auxiliary parts that facilitates the integration of these modules into already existing aquaculture system, for establishing the new created aquaponics system. The technological component contains an already tested set of plants rearing technologies, together with the proper operational management guide, that assures certain plant biomass productions, in relation with the already applied fish rearing technology from the aquaculture production systems where the aquaponics is desired to be integrated. The knowledge hub component consists in an informatic software that is designed in order to offer, for the aquaponics user, different economic predictions generated by various technologies that are suitable to be applied. Also, the knowledge hub has the possibility to be upgraded by the help of aquaponics users that have the option to upload their technological performances online, in the hub.

Three aquaponics techniques can be generally distinguished in aquaponics: deep water culture (DWC), nutrient film technique (NFT) and substrate technique, each with their own particularities. The DWC technique consists in placing floating supports for plants growth, most often made of polystyrene, on the water surface. Therefore, these techniques require a low investment cost and also, low operational costs, but it requires high nutrients supplementation (when necessary) and also, complex water recircuiting systems, as large volumes of water are recirculated. The NFT technique consists in the use of pipes with a diameter between 15 and 30 cm through which a continuous layer, with variable thickness, of technological water with nutritional load is recirculating (Timmons et al., 2002). The substrate technique consists in using a series of media growth beds for double purpose, plants growth and bioremediation. This technique assures both a mechanical and biological filtration of the technological water, but requires a high investment cost.

The production technologies that are part of aquaponics integrated systems full package assure a free pesticides production in order to obtain consumers safety high quality products. Also, the plant biomass assures a certain technological water treatment capacity through their phytoremediation capacity, therefore assuring a sustainable utilization of natural resources. Thus, aquaponics production technologies can be categorized as clean technologies that, due to scale economics, can record a low production cost, therefore helping consumers to shift to environmentally friendly products.

The aquaponics hub offers the possibility predict certain outcomes by using various aquaponics integrated systems techniques and technologies. Also, details related to the environment effort will be highlighted by presenting the water treatment capacity of aquaponics integrated modules. Aquaponics knowledge hub is web based software that could simplify informational integration of relevant aquaponics data that was obtained from different researches. Such software would be extremely useful for those wanting to start investing in a new system or to validate an already existing research. As such, the Aquaponics hub was developed as a helper regarding the operational intricacies of an aquaponics project. The aquaponics hub architecture should offer support for tasks such as: presenting an overview of different aquaponics systems; helping in the organization and management of aquaponics business, sustaining a marketing strategy by identifying most profitable plants to be produced, identifying operational and system architectural insights on system scalability, supporting the financial strategy by providing concrete values for variable costs, economic indicators, energy consumption, incomes.

There are three main perspectives that should be taken into consideration: technical, technological and economical. As such, user is able to specify input characteristics: a specific technique, fish species, and type of aquaponics crops. Based on this input the platform populates project list with all available projects that are satisfying chosen criteria's. The user should be able to see available images associated with the chosen project and also specific project details like: initial fish biomass, feeding rate, crop density and crops individual average yield. For the technical-technological perspective, the software hub is presenting technical data of the selected project, technological data, and significant technical images describing different part or an overall view over the system architecture. Technical data panel contains the aquaponics technique, inlet flow rate, HLR (hydraulic loading rate), HRT (hydraulic retention time), average luminous flux and the artificial lightning in hours per day. Technological data panel contains as main indicators for the selected project: the plant used, the average plant yield, leaf area index (LAI), relative growth rate (RGR), net assimilation ratio (NAR), crop growth rate (CGR), average leaf area ratio (LAR), crop density and duration of production cycle. The economical panel displays financial metrics related to the chosen project like variable costs (labor, seeds, electricity) per year or per production cycle or the main economic indicators (total production cost, gross profit, income tax, net profit, rate of return, rate of profit), electric consumption costs and monthly income. Also, a very important aspect refers to the fact that the aquaponics hub must allow the gathering of historical data storage for parameters like variable costs, monthly income, etc.

7. Aquaponics greening supply chain (raw material, parts supplier)

A product or service has environmental impacts long before and after its procurement and use. Therefore, products or services with as few negative environmental impacts in as many life-cycle stages as possible must have prior when consumers make procurement. Green procurement consists in procurement of products and services that have a lesser or reduced effect on both human health and the environment when compared with competing products or services that serve the same purpose (louisville.edu).

In case of aquaponics integrated systems, raw materials are used only for technical part of the package, since both technological information and aquaponics hub can be accessible online, by introducing the key code found in the package, on the online platform of the package supplier. However, as technical part consists in a series of raw materials that are meant to be used for the specific construction of the system (aquaponics units, aquaponics inlet and outlet structures, plants media growth bed, lighting system with solar panels - if requires, recirculating pumps, plants supports, cork floating plates, taps and pipes). Thus, the aquaponics units, aquaponics inlet and outlet structures, plant supports, taps, pipes and most pumps components must be made from reusable plastic materials. The media growth bed is reusable as it consists in gravel, volcanic rock or light expanded clay aggregate (LECA). The floating plates used in case of DWC aquaponics technique are made of recyclable cork material. Also, the pumps and lighting system must have limited electricity consumption and as source of electricity, solar panels will be used since they can usually make up for the manufacturing carbon footprint within two years and have a lifespan estimated at thirty years.

The technological aquaponics production process assures an entire leafy green vegetable production cycle within 30-45 days, with limited to no water consumption, since aquaculture technological water with high concentrations of nutrients is recirculated in a closed-loop fish – plants production system. Also, if some deficiencies are observed during the production process, organic fertilizers shall be used in order to correct them. The leafy greens seeds must be organic and the seedlings will be developed within the aquaponics systems made by assembling the technical parts of the package. The fact that integrated recirculating aquaponics systems are characterized as relatively closed systems, without nutrient inputs, strengthens their credibility among people with strict ethical and environmental protection beliefs.

8. Conclusion

Aquaponics can represent a solution for improving the sustainability of aquaculture and can facilitate the transition from blue to green aquaculture. However, know-how information must be disseminated among the fish farm owners, as well as potential investors. One of the main problems related to the integration of aquaponics into social spaces is the need of social responsiveness directed to this concept and the availability of citizens to invest time and efforts within this social sustainable concept. However, the green character of aquaponics must be accentuated by considering green bio-materials or bio-seedlings, obtained by applying environmental sustainable technologies. Also, aquaponics ready-to-use packages, distributed among public and private spaces, together with learning materials could facilitate the integration of aquaponics within EPP process.

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