XXII ENGEMA
Encontro Internacional sobre Gestão Empresarial e Meio Ambiente

ISSN: 2359-1048
Novembro 2020

INTEGRATED WATER-ENERGY-FOOD NEXUS QUALITY MANAGEMENT SYSTEM MODEL: PROPOSAL FOR AGRO-INDUSTRIAL COMPANIES

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Research Proposal:

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Coimbra – 2020

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ABSTRACT

Water, energy and food are key-elements for a sustainable life for human-beings, therefore managing correctly these resources is an important concern, including here companies' actions. In this context, these elements must be analyzed together in order to better understand how one action on one side can impact in another area. This approach is often called water-energy-food (WEF) nexus, propelled in 2011 by Hoff (2011) in Bonn, Germany, and after spread also in the World Economic Forum (2011). It means that these three elements are intrinsically joint together and decision-makers should be aware that one action in one direction can impact in other directions. Many approaches have been developed in this area since 2011. However, as far as it is known, there is no available analysis of this issue under the context of a company level and there is no recognized international tool regarding integrated quality management systems tools together with WEF nexus. Thereby, this project aims to build an integrated sustainable model, based on Water-Energy-Food nexus quality management system for agro-industrial production companies. Based on the literature review, this appears to be the first attempt to integrate quality management systems with agro-industrial production concerning WEF nexus in a company perspective. For that purpose, this project will be developed in 5 different steps: 1st Literature review; 2nd Assessing sustainability standards applied to WEF nexus for agro-industrial production; 3rd – Select criteria to be used in the new method; 4th - Validate the method, with a specialist panel and 5th – Application of case studies. It is suggested to apply this quality management system model in companies located in Portugal, the United States of America, Brazil, China, and Kenya. In this sense, we would have an overview of an international tool that can be used to turn companies into a more sustainable perspective. Therefore, it can be a relevant contribution to this research field enabling the comparison of integrated systems which are implemented in different companies' contexts.

Key-words: WEF nexus; Sustainability; Quality Management Systems; Agro-industrial companies

1 – Introduction

In a context of depletion of many essential resources, assessment tools are required to adequately qualify the relationship between sustainable Water-Energy-Food (WEF) nexus in order to identify and evaluate the trade-offs and synergies that would need to be considered as human economies continue to grow.

Understanding WEF nexus can lead for more integrated sustainable planning, development, policy-making, monitoring and evaluation related to the productive sectors. Consequently, this approach should be considered when developing actions.

According to Shannak, Mabrey and Vittorio (2018) there is a limited number of models and frameworks that address all WEF together and there is even less a number of models and frameworks with diverse methods and transdisciplinary approaches in analyzing the WEF nexus.

Hence, there is no universally recognized methodology for nexus analysis which brings together both quantitative analysis and qualitative reasoning in relation to the impacts of the provision of a product or a service (Al-Ansari et al., 2015).

Indeed, interdisciplinary research is essential for effective management of WEF systems. While the various science disciplines have long histories of working independently in components of the WEF nexus, future research should integrate physical, agro ecological, and social sciences with economics (Scanlon et al., 2017).

Nevertheless, different measures for overcoming issues related to the WEF nexus will vary by adopting diverse perspectives, which steer in different directions (Weitz et al., 2017). All the examples available concerning the adoption of WEF perspectives are about governmental, sectorial, cross-national or national analysis (Kaddoura and Khatib, 2017; Al-Ansari et al., 2015; Flamini, 2014; Rasul, 2014; Bazilian et al., 2011; Hoff, 2011), and not placed at the level of a specific organization.

The movement to sustainable agricultural systems is gaining increasing support and acceptance within the agro-industrial sector, along with the acknowledgment that a 'systems' perspective is essential in order to understand the sustainable path impacting in many societies (Notarnicola et al., 2012).

It's essential as we design our modeling tools to analyze the WEF nexus to incorporate several dimensions beyond the WEF sectors, such as political, social and economic contexts, in order to reach nexus thinking and therefore address complexity of the multi-sectoral resources (Shannak, Mabrey and Vittorio, 2018).

2 – Objectives

For that reason, the main objective of this PhD research is to build an integrated sustainable model, based on Water-Energy-Food nexus quality management systems for agro-industrial production companies.

Based on the literature review, this appears to be the first attempt to integrate quality management systems with agro-industrial production concerning WEF nexus in a company perspective. It can be a relevant contribution to this research field, enabling the comparison of integrated systems which are implemented on different companies' contexts.

The current research intends to contribute to fulfill this scientific "gap" and deals, ultimately, with the question of how companies can use and assess an integrated model regarding WEF nexus for agro-industrial production. Moreover, they can plan their activities and operations in order to avoid wastage of resources while increasing sustainability for agro-industrial production.

In order to address the above-mentioned issues, this study aims to answer the following four questions/ objectives:

1 – What are the quality and sustainability standards that can be used to ensure WEF security and safety in a company perspective?

2 – Is it possible to have a model with WEF nexus perspectives that can be used to assess quality of companies and their processes?

3- Is it possible to apply this new tool in different types of agro-industrial production companies?

4 – How can we improve the management systems by using this new model?

3 - Literature Review

3.1 – Water-energy-food nexus approach

Water, food and energy systems are rapidly growing in demand with different regional availability and strong interdependences amongst themselves and both the human and natural environments (Bazilian et al., 2011).

These elements are vital for human well-being, poverty decline and sustainable expansion (FAO, 2014). In this context, ensuring their security is a crucial activity which concerns every individual in the world.

Water security is a severe challenge. Nowadays, approximately 54% of the fresh water reservoirs are being used and it is estimated that by 2025 there will be 1.8 billion people living in areas of absolute water scarcity and two thirds of the world population under conditions of water stress. It is also expected this will raise further uncertainties in climate change and population growth (United Nations-Water, 2007).

The interest in energy security is based on the notion that an uninterrupted supply of energy is critical for a functioning economy. Many countries have inadequate and unreliable energy supply which limits the possibilities for increased food production and water security (Rasul et al., 2014). There is an unbalanced distribution of energy sources across countries and this leads to energy dependency in some regions. Therefore, providing energy security is especially important for energy-importing countries (Bilgili et al., 2017).

One out of nine people in the world go hungry every day according to The State of Food Insecurity section in the World report (FAO, 2014). Considerable progress has been made but despite this, notable differences exist across different regions and 805 million people remain affected by chronic hunger, 165 million children are stunted (with levels as high as 58 % of the child population in some countries) and over 2 billion people are affected by micronutrient deficiency (IFPRI, 2014; FAO, 2014).

To enhance Water, Energy and Food security, it is needed to increase the efficiency and to reduce trade-offs while building synergies and improving public and private governance. For that reason, in 2011 the WEF nexus approach was incorporated into international discussions on sustainable development (Hoff, 2011 and Wef, 2011).

According to the Climate, Energy and Tenure division of Food and Agriculture Organization (FAO) of the United Nations, WEF nexus means that the three sectors - water security, energy security and food security - are inextricably linked. Actions in one area have impact on the others (Flammini et al., 2014). Moreover, the integration between them should extend to the governance structures, but this creates the challenge of how to improve co-ordination throughout (Pahl-Wostl, 2017).

The first perspective on the nexus focuses on risk and security, and it is based on the idea that failing to account for interrelations between nexus segments could worsen the resource scarcity, which can eventually also induce conflicts (Weitz et al., 2017). In addition, there are rare people who can be experts in all the above three areas, and this frequently leads to an inefficient management done by decision makers (Bazilian et al., 2011)

The Sustainable Development Goals (SDGs) adopted by all United Nations members states, propelled in the United Nations Sustainable Development Solution Network (UN-SDSN, 2015) offers a suitable framework to the concerns about WEF. At least, among 17 SDGs, three are specifically dedicated to this nexus approach: 1 – For water security (SDG 6 – Ensure availability and sustainable management of water and sanitization for all); 2 - For energy security (SDG 7 – Ensure access to affordable, reliable, sustainable and modern energy for all); 3 - For food security (SDG 2- End Hunger, achieve food security and improved nutrition and promote sustainable agriculture).

A nexus approach can support the transition to sustainability, by reducing trade-offs and generating additional benefits that outweigh the transaction costs associated with stronger integration across sectors. Such gains should appeal to national interest and encourage governments, private sectors and civil society to engage (Hoff, 2011).

The challenge to manage water, energy and food without efficient and synergistic actions may increase the risk of shortages. Consequently, one opportunity to improve the sustainable use of these sources is by investigating the water-energy-food nexus (Biggs et al., 2015).

3.1.2 – WEF nexus Models, Systems, tools and Indicators.

The connections among water, food, and energy security are complex. Methods to design efficient, equitable, and sustainable policies that respect this nexus face numerous challenges. Using a nexus approach to steward water resources sustainably in energy supply chains and food supply chains is seen as a promising approach (Allan et al., 2015).

The main challenge of modeling this nexus is the sheer complexity of studying the three resources and their dynamic interactions simultaneously in a single model (Hussey and Pittock, 2012; Perrone and Hornberger, 2014). The literature is replete with attempts to model one or two resources while documenting the difficulties with this approach (Siddiqi and Anadon, 2011).

Successfully simulating a model of these three resources requires in-depth understanding of resource relationships and interconnections across multiple scales. Additionally, creating a common equivalent basis to evaluate these three resources forms a major difficulty This also assumes that researchers can overcome the constraints of data availability and the lack of robust tools for analysis (Bazilian et al. 2011).

According to Chang et al. (2016) to achieve robust WEF nexus tools an integrated and flexible analytical framework with spatial- and temporal-specific constraints should be considered.

The literature about the WEF nexus expresses great ambitions to achieve policy coherence and overcome the unintended consequences of uncoordinated policy between different sectors (Weitz et al., 2017). For that purpose, quality management systems can be a helpful tool.

The literature review presented in this thesis project has been done according to Garcia and Freire (2017). Therefore, we present a review of the literature addressing WEF nexus approaches for the assessment of real case studies. An online search was performed in Web of Knowledge and other scientific search engines (Science Direct, Springer Link, and Wiley Online Library). Additionally, references in the literature identified were used to locate new literature. Peer-reviewed publications and scientific reports written in English were also considered.

The keywords used for the literature search included a combination of synonyms of the terms "water-energy-food nexus" or "water energy food nexus" ("WEF nexus"; "FEW nexus"), and "WEF nexus analysis" ("WEF nexus", "WEF nexus model", "WEF nexus tools," "WEF nexus approaches").

The database search resulted in 240 articles (with duplicates), and it was defined that only articles in English would be included. The time period adopted was from 2011 to 2018, since the concept of water-energy-food nexus was propelled (Hoff, 2011). The systematic review was performed by one reviewer using Microsoft Excel spreadsheets and The Mendeley software as support tools.

The Mendeley software helped to prevent the duplication of papers included by the people who carried out the systematic review. On the other hand, in the Excel spreadsheets, the data considered relevant at each of the stages were recorded. In the preliminary selection reading of titles and abstracts was performed in order to identify if the articles were related to the research objective and also duplicates, resulting in a total of 73 articles that were selected. The review protocol and the data collected in this and subsequent stages were collected according to Vieira and Amaral (2016).

3.1.2.1 Content evaluation

In this step, the introduction and conclusion section of the articles were read, and based on its contents a few questions were answered in order to decide if the article should continue in the research. These questions are presented in Table 1 and regarding the group 1 of questions all answers should be yes, and when considered the group 2 at least one answer should be positive. After this step 46 articles remained in the review.

3.1.2.2 Data extraction, cross search and results synthesis

The remaining articles were fully read and citations related to regulations, methodologies, tools, barriers and strategies were extracted, as presented in Table 1. The cross search happened when an article not previously identified was cited, so it was submitted to the step-in item 3.1.2.1 in order to assure its validity for the review. After this stage, the 34 articles of the systematic review were selected. For the synthesis of results and posterior analysis, it was adopted an aggregative approach (De Medeiros et al., 2014) in order to condensate citations extracted according to research questions.

As a result, it is possible to say that the number of studies using WEF nexus Approach has been growing during the years as can been seen at Figure 1.

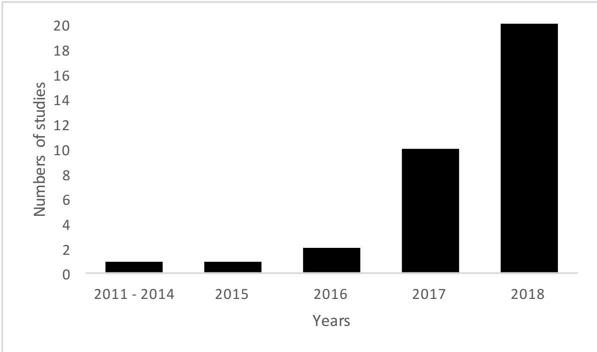

Fig 1 – Histogram of the number of studies published from 2011 to 2018 which apply a WEF nexus approach.

About the published journals, the most published was Applied Energy (6 times) followed by Journal of Cleaner production (4 times), followed by Environmental Science & Policy (3 times). Advances in Water Resources, Energy Policy, Science of total Environment, Water and Resources, Conservation and Recycling was cited 2 times in his review. Finally, Agricultural Water management, Applied Water Science, Biomass and Bioenergy, Ecohydrology & Hydrobiology, Ecological Indicators, Environmental Modelling & Software, Environmental Science & Technology, Global Environmental Change, Journal of Hydrology and Sustainability were cited 1 time in this review.

About the origin of the researches published as first author, the result shows that the research about WEF nexus is spread all over the world, with the higher frequency located in United Kingdom as shown at figure 2.

Figure 2 – Authors Origin Frequency

3.1.2.3 Definition of WEF nexus

According to this literature review Hussein, Menon and Savic (2018); Ziv et al. (2018); Kan (2018); Karabulut et al. (2018); Bijl (2018); Harwood (2018); Schlör, Venghaus and Hake (2018); El-Gafy (2017); Zhang and Vesselivoc (2017); Hang (2017) and AbdelHady, Fahmy and Pacini (2017) used the definition propelled by Hoff (2011). It says that WEF nexus implies that water availability, energy production/consumption and food security are inextricably linked, consequently actions in any one area have impacts in one or both of the others. Moreover, WEF nexus aims to achieve "improved water, energy and food security" through "integrated management and governance across sectors and scales.

Bellezoni et al. (2018); White (2018); Kaddoura and Khatib (2017) and Li, Huang and Li (2017) used the definition propelled by the World Economic Forum (2011). Focusing on the promotion of inseparable links between the use of resources to provide basic rights to food, water and energy security, the 2011 World Economic Forum has postulated the 'nexus thinking'. It was also highlighted that there are inseparable linkages between the use of resources and the universal human rights to water, energy, and food security. There is a complex network of interactions between these relationships, therefore it is paramount to a nation's successful development and growth.

Including the aforementioned WEF nexus supply pressures, along with a growing understanding of the interlinkages between the three scarce resources, it is also important to emphasize the need to manage them jointly and more efficiently (Basheer et al., 2018). Hence, this approach refers to a new paradigm for environmental governance whereby these interdependencies are systematically analyzed in a holistic framework to identify management policies that can integrate diverse cross-sectorial goals (Dhaubanjar, Davidsen and Bauer-Gottwein, 2017). Finally, it is capable to integrate management and governance across sectors and scales, thus supporting the transition process towards sustainability (Vito et al., 2017).

3.1.2.4 Case Study, Coverage, Place of analysis and Objectives

Based on the literature review, 23 articles presented a case study and 11 articles haven't done any study case. In these case studies, it was selected the coverage of this research, the place of analysis and objectives. About the coverage and the place of analysis from 23 articles, the majority were city analysis, followed by international analysis, national, regional and Production phase analysis. Regarding the objectives, all of them wanted to have an overview about the situation in order to propose actions and policies with a positive impact based on a new tool or indicator.

3.1.2.5 WEF nexus Models, Systems, tools and Indicators and Main Findings

WEF Nexus models, Systems, tools, indicators and approaches capture the essence of the concept. While they do so in different ways, all the tools work towards the Nexus' ultimate purpose of creating sustainable population and economic growth using integrated decision making. Kaddoura and Khatib (2017) showed that further consensus amongst tool developers needs to be developed to progress the modelling direction of the Nexus Approach.

3.1.2.5.1 Indicators:

Indicators are always used to perform WEF nexus analysis. Saladini et al. (2018) selected 12 indicators to monitor the Mediterranean area called Partnership for Research and Innovation in the Mediterranean Area (PRIMA), based on the Sustainable Development Goals. Hussien, Memon and Savic (2018) use a new risk based approach to assess the impacts on water, energy and food consumption. Bijl (2018) proposed physical indicators to show the differences in terms of absolute magnitude of production and the distance and volume of physical trade. Schlör, Venghaus and Hake (2018) created indices based on the UN-Habitat City Prosperity Index, but specifically integrate the nexus-relevant indices with a weighted equity index. El-Gafy (2017) proposed six indicators to be applied as a tool to quantify the nexus and help in drawing strategies in the area of the crop production system. AbdelHady, Fahmy and Pacini (2017) proposed three output indicators: agriculture, aquaculture and net energy production are selected to assess the value of different ecosystem health conditions under three water management scenarios. As a result, they developed the proposed tools which can help to increase sustainability actions for the researched area.

Basheer et al. (2018) studied a daily model developed for the Blue Nile river analysis that simulates the major hydrological processes, irrigation water requirements, and water allocation to hydro-energy generation and irrigation water supply. Ethan Young and Sungwook (2018) proposed a model based on the pooled calibration with multiple targets of streamflow, water depth, and hydropower generation, and providing an interactive web-based visualization too designed to facilitate the communication with decision makers about our findings. The results showed that a contribution of a combination of indicators should explain better the WEF nexus analyses.

Bieber et al. (2018) developed a tool combining agent-based modelling - to simulate and forecast resource demands on spatial and temporal scales - with resource network optimization, which incorporates capital expenditures, operational costs, environmental impacts and the opportunity cost of food production foregone (OPF). The results highlighted the vulnerability of Ghana's power generation infrastructure and the need for diversification. Feed-in tariffs and investment into supporting infrastructure and agriculture intensification will effectively increase the share of renewable energy and reduce carbon emissions.

Vito et al. (2017) proposed an index-based methodology that is intended to assess the key elements that characterize irrigation practices and related water resources exploitation. The results mainly highlighted that economic land productivity is a key driver of irrigated agriculture, and that groundwater is highly affordable compared to surface water, thus being often dangerously perceived as freely available.

Strasser et al. (2016) proposed a Transboundary River Basin Nexus Approach (TRBNA) methodology which was developed to support this work, and which in practical terms involves carrying out a nexus assessment of selected basins based on indicators. Hang et al. (2016) showed a process systems engineering tool combined with the concept of resource accounting using exergy for the design of such local production systems. As a result, it demonstrates the advantages of an integrated design of a system making use of local resources to meet its demands over a system relying on centralised supplies and a design without considering integration opportunities between subsystems.

Daher, Mohtar (2015) presented a new water–energy–food (WEF) Nexus modelling tool (WEF Nexus Tool 2.0) based on that framework which offers a common platform for scientists and policy-makers to evaluate scenarios and identify sustainable national resource allocation strategies. Bazilian et al. (2011) use the proposed conceptual framework as a foundation for defining the relations that exist between the three systems called WEF framework. The WEF Nexus Tool 2.0 and WEF framework provided a first building block that needs to continue evolving in order to provide better the needed analytics for such complex questions involving systems that are tightly interconnected and highly dynamic in a non-stationary world of constantly changing externalities.

3.1.2.5.2 Input – output approach

Bellezoni et al. (2018) applied an economic-ecologic Input-Output (IO) framework to develop a water-energy-food (WEF) nexus analysis in the Goias state of Brazil. The results highlighted that The WEF nexus analysis is a valuable tool on guiding the sustainable management of natural resources considering water, energy, land use and GHG emissions as goals to the same policy.

White (2018) used a transnational inter-regional input-output approach to analyze WEF nexus connections. This analysis demonstrates a mismatch between regional water-energy-food availability and final resource consumption and the lack of attention for environmental impacts in national economic growth strategies.

Similar results were obtained by Owen, Scott and Barrett (2018); Martinez-Hernandez, Leach, Yang (2017) and Zhang and Vesselivoc (2017) also using input-output analysis techniques. They identified the most important final products whose large energy, water and food nexus impacts could be used in strategic actions.

Li, Huang and Li (2017) used also input-output models but in this case allied with data envelopment analysis models (DEA). As a result, they had a better explanation about their analyses recommending the use of both techniques.

3.1.2.5.3 Optimization approach:

Jaliloc, Amer and Ward (2018) proposed an empirical optimization model to be developed and applied to identify opportunities for improving the welfare of Tajikistan, Uzbekistan, Afghanistan, and Turkmenistan. Uen et al. (2018) studied multi-objective reservoir optimization schemes and Ziv et al. (2018) studied fuzzy cognitive mapping approaches. Kan et al. (2018) used water quantity simulation and forecasting models in order to improve efficiency of the hydropower energy generation, water supply management, and agricultural irrigation water utilization. Karabulut et al. (2018) propose a synthesis matrix system that describes the complex and closely bound relationship between WEF nexus ecosystems. The proposed methodologies could be a viable approach to promoting the synergistic benefits of the WEF nexus, and the results provided unique insights for stakeholders and policymakers to pursue sustainable urban development plans.

Karan et al. (2018) made a prediction for WEF nexus demand with a stochastic mathematical model. Sušnik (2018) studied a system dynamics modelling approach in order to quantify previously qualitative descriptions of the WEF-GDP approach, while a Monte-Carlo sampling approach was adopted to characterize national-level variability in resource use. Harwood (2018) proposed a methodology to guide the development of models which aim to clarify the concept of WEF nexus as well as address both sustainability and governance issues. Dhaubanjar, Davidsen and Bauer-Gottwein (2017) proposed a disaggregated, linear, multi-objective optimization model. These studies contributed to understanding the relation between WEF nexus elements in such a context.

3.1.2.5.4 Other methodologies

Salmoral and Yan (2018) proposed a Life Cycle Approach application and ready available life cycle inventory (LCI) databases in WEF nexus studies from a food consumption perspective. The results highlighted that this was useful considering potential unexpected changes in trade under recent global socio-political trends.

Romero-Lankao, Bruns and Wiegleb (2018) studied interdependencies and cascading effects are useful to examine the mediating influence of WEF infrastructural systems in mitigating or amplifying the impacts from extreme events. The results reflected on how commonalities and differences in sociodemographic, economic, technological, environmental, and governance configurations relate to different capacities to mitigate risks and adapt.

Hang (2017) proposed an insight-based approach for LIPS design, which consists of two main stages, namely synthesis and integration, guided by a Locally Integrated Production System Onion Model. The new approach could produce a comparable design while offering more valuable insights for decision makers.

Finally, Hussien, Memon and Savic (2017) showed a bottom-up approach that was used to develop the system dynamics-based model. The model estimates WEF nexus demand and the generated organic waste and wastewater quantities. The simulation results showed a good agreement with historical data. Using the model, the impact of Global Scenario Group scenarios was investigated. The results suggest that the ‘fortress world’ scenario (an authoritarian response to the threat of breakdown) had the highest impact on WEF nexus.

3.1.2.6 Conclusions

WEF nexus Models, Systems, tools and Indicators have been applied mostly in a geographical scope targeting countries, river basins and regions. Different purposes guided these studies: assessing current and future scenarios; prospecting new indicators; future actions toward sustainability and even environmental protection. However, scientific literature lacks on how to apply this methodology to local contexts, for instance, households, parks, buildings and mainly industries. Therefore, future research may propose alternative uses for smaller scales, regarding the improvement of sustainable tools and environment for instance for agro-industrial companies.

Several studies used many different approaches: general indicators, input-output models, optimization tools, life cycle assessment, among others. The overall results showed that there is no universal tool that can address all the objectives. Nevertheless, different WEF nexus approaches may lead to different outcomes, so that detailed analysis of new tools is required. In general, a future proposition could use more data and new approaches, such as quality management systems.

3.2 - Quality Management Systems

The fast-economic growth and the globalization over the past two decades have been associated with a significant increase in the dissemination of international management standards in a wide range of economic activities, particularly the quality management system (QMS) based on integrated standards.

Moreover, integrated management programs have shown that organizations can become more effective, more efficient, and more responsive, and enjoy better performance outcomes (Rebentisch and Prusak, 2017).

It is an interesting approach for many companies, contributing to an overall improved performance (Chatzoglou et al., 2015). Moreover, standards and collective action can help to guide investments and innovation to minimize negative externalities and share benefits equitably (Hoff, 2011).

Consequently, several studies pointed out that the development of an integrated QMS can be useful for the decision-makers/stakeholders to understand the economic performances or environmental impacts of different productions technologies.

Domingues, Sampaio and Arezes (2016) reported an Integrated Management Systems Maturity Model, a hybrid six-level maturity model that allows the comparison between integrated management systems. The findings were that Integration excellence may be achieved throughout an itinerary encompassing six maturity levels.

Fernandes et al. (2017) developed a theoretical basis for integration of quality management and supply chain management. The findings suggest that the synergies of QM and SCM can promote the integration of approaches which will promote a set of significant organizational benefits.

Nardi et al. (2017) proposed a methodology to view and monitor the economic, social, and environmental impacts of operational and strategic decisions in reverse logistics (RL) industries. The results provide a holistic view of the impact of decisions on the use of economic, social, and environmental resources, enabling direct operational decisions and strategies in the search for a better balance of the triple bottom line.

Carvalho et al. (2017) created a model with a perspective to achieve operational excellence, aiming to offer a broader perspective of this subject. The findings indicate that a more comprehensive perspective on the relationship of the researched factors was achieved.

3.3 – Integration between QMS and WEF nexus

QMS can be integrated with an increasing variety of other subsystems implemented according to other standards and subsystems raised from specific standards designed for specific activity sectors (Sampaio, Saraiva and Domingues et al., 2012; Sampaio, Saraiva and Rodrigues et al., 2011).

In this context, a nexus approach emphasizes also those inter-connections and interdependencies among resources, offering perspectives on how to implement integrated solutions to management of resources (United Nations, 2016).

Quality tools aim to provide decision makers with better or reliable information, for more efficient policy and decision-making in an effort to transition into a Green Economy. Through the Nexus Approach, policies are currently being implemented to optimize synergies and eliminate inefficiencies in order to facilitate sustainable growth (Kaddoura and Khatib, 2017)

In addition, the research on the WEF nexus resources and their impact on the planet are critical to provide affordable and reliable resources in an environmentally sustainable way (Al- Ansari, 2015).

Therefore, integrating QMS with WEF nexus approach can lead to a better understanding in which direction institutions can follow as to their policies and decisions.

3.4 – Agro-industrial Companies

The demand for agricultural and natural and consequently agro-industrial products are continually increasing due to global population growth and overall diet transition to higher food and energy consumption. Meeting society's growing food needs while simultaneously reducing the environmental impact of agriculture is, undoubtedly, one of the greatest challenges of the century (Fernandez-Mena et al.., 2016). In this sense, transforming actions in what we call production with sustainability are needed.

Sustainability is a theme that is present in the academic and non-academic fields, due to the depletion of natural resources and concerns regarding the disparity of wealth and lack of corporate social responsibility (Govindan et al., 2013). One of the major concerns is the agro-industrial and energy sustainability.

Agro-industrial chains commonly face significant and complex challenges in achieving sustainable development, including economic, environmental, and social aspects (Dania, 2018).

Additionally, the public awareness of having healthy and environmental friendly food products raises increasing concerns as well as incentives for most agro-industrial companies to focus on improving the sustainability performance of their supply chains (Matopoulos et al., 2007).

4 - Methodology

Recent advances in nexus modeling and analysis frameworks allow individuals to be an integral part of the science (Aghakouchak et al., 2015; Konar et al., 2016). It is necessary that some principles forming the basis of the methodology become evident throughout the model development: transparency; comprehensiveness and consistency of methodology (Korre et al., 2010).

For the proposed method, it is required an interactive process for the development of the right-based WEF security principles with its relevant criteria based on intensive stakeholder interaction (Mohr et al., 2015).

Increasing the research quality also means looking for consistency, eliminating bias and a strong and concise definition of the constructs under study, or in other words, referring to the validity and to the reliability of the research project: validity is the extent to which an account accurately represents the phenomena under study, while reliability refers to the degree of consistency and stability of the results (Silverman, 2000).

Validity issues were addressed since literature review efforts started, in the perspective of identifying the precise definitions and boundaries of each concept under study (Quality Management Systems, WEF nexus, Agro-industrial production and sustainability) identifying possible concepts that have an influence on those under study and that could lead to influence in the outputs and defining the limitations in generalizing results from cases with such strong context dependency (external validity).

As for reliability, it is achieved when the researcher is better able to guarantee that another study, using the same procedures and being unbiased, will achieve the same results (Yin, 2009).

It focuses on the consistency and repeatability of the research, supports the effort of guaranteeing consistency between different observers and observations, and looks for the stability of the measures from case to case, confirming that different forms of acquiring data show the same outputs.

In order to maximize the reliability, all procedures followed during this project should be documented and logically justified, and these notes made available in order to clarify as much as possible each step done and allow for its replication. If "dark spots" are left in the listing of the tasks and steps, there will be gaps in the understanding of the procedures and the reliability of the project is severely impacted in a negative way. Finally, systematic revision of the results and analysis will be made to guarantee that the outputs of different data collection methods are providing similar outputs and are thus reinforced by triangulation.

In summary, this research will follow two main following steps:

First step - Create a WEF Sustainable Quality Scoreboard - Based upon a framework that aims to understand, measure and compare macroquality and sustainable performances achieved by different countries. Indicators values and weights will be determined for each country. A score board will be defined classifying countries in Leading, Followers, Moderate and Lagging (Saraiva et al., 2018).

Second Step- Model development:

1st - Literature Review: Including an extensive literature review about WEF security and safety addressing to its measurement, achieving what the main criteria are, and screening as an efficient tool.

2nd – Assessing sustainability standards applied to WEF nexus for agro-industrial production: Review the main standards in WEF security and safety, for example, Good Manufacturing Practices (GMP), Hazard Analysis and Critical Control Point (HACCP), ISO systems 9001, 14001 and 22001, Life-cycle assessment, FSC, UN and Governmental Policy, Models of excellence and many others (Mohr, 2015).

3rd – Select criteria – Based on this research, integrated models will be built that can be applied to agro-industrial formulating standards. The indicators will be grouped by using the factor analysis method to form the indexes (Nardi et al., 2017).

4th – Validate the method – After formulating standards, a consultation process will be initiated to include the feedback on the first draft of the criteria set. Interviews and consultations will take place with experts from certification bodies, standard initiatives, NGOs, ministries, researchers and enterprises discussing the work in progress (stakeholders) (Domingues, Sampaio and Arezes, 2016).

5th – Case studies: Application of this new model in agro-industrial production in order to provide useful information for decision-makers and to provide some suggestions. This tool is initially intended to be developed together with private and public companies from the following countries:

- Brazil – Located in South America, Brazil has a large production of fruits, milk and historically this country has been a world leader on renewable energy from agro-industrial sources production, such as sugarcane and soya (Portugal-Pereira, 2015).
- Italy and Portugal - Located in Europe the agro-industrial sector is characterized by the fact that, in general, it produces non-durable products with low variability of demand in face of changes in the economic cycle, and also that it is a very competitive sector in which the use of trade credit to attract customers and position themselves in the market can be important for new and small businesses (Grau and Reig, 2018).
- The United States of America – Located in North America, U.S. domestic agribusiness is a $2 trillion industry that produces and processes food that usually is sold in the retail market. Producers supply crops and livestock, and processors transform them into edible products (Evans et al., 2015)
- China (Specially Macao) – Located in Asia, Macao relies entirely on imported food. In 2015, This country imported a total of $1.9 billion of agriculture and agri-food products. Consequently, Macao does have competitive agri-food marketplaces where suppliers compete on a global scale (Canada, 2017)
- Kenya – African countries have comparative advantages in the production and export of primary commodities; however, they face many sustainability challenges in the agricultural sector (Banson et al., 2014).

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