

A framework of penta-helix model to improve the sustainable competitiveness of the wine industry in Baja California based on innovative natural resource management

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Abstract. This paper presents an innovative natural resource management framework for the wine industry based on the Penta-Helix Model and Open Innovation features. As an initial activity, a particular survey was designed in order to be applied to a lot of companies to determine the necessities perception related to the elements of sustainable competitiveness. In fact, the evaluation of sustainable competitiveness is the key to the innovate framework proposed. Considering the results related to the elements of sustainable competitiveness (i.e. natural capital, social capital, intellectual capital and governance efficiency), a flow chart for innovative natural resource management as a first stage is proposed as part of a complete framework called Penta-Helix stakeholder management. In particular, water availability and quality is the most important challenge detected related to natural resource management.

1 Introduction

Nowadays, the principal idea of any enterprise is to increase its competitiveness. In order to reach that, the sustainability concept is an important requirement that considers the environmental, social and economic impacts based on the science, development and innovation in a multidisciplinary way [1, 2]. In the traditional way, sustainability, as a process, usually used the closed innovation model, which considers only the internal ideas (i.e. ignore ideas outside the company) within a limit corporative. Also, the closed innovation model presents some features that making so difficult to reach to certain sustainable competitiveness, e.g. invest a lot of money in internal research and development, needs many employees and resources, among others [3-5]. In order to clarify, the sustainable competitiveness concept considers the evaluation and continuous improvement of different parameters such as natural, social and intellectual capital, resource management and governance efficiency. The conventional competitiveness concept is similar to the sustainable competitiveness, but the difference between them is related to the time when a certain competitiveness level is ensured. In order to clarify, the conventional competitiveness concept is defined for short terms, while the sustainable competitiveness term has to ensure that successful exists in the long term [6-9]. The aforementioned is an important issue that affects mainly small and medium-sized enterprises. On the other hand, open innovation is a suitable model to support sustainable

competitiveness based on the synergic activities between the company and external stakeholders (e.g. using Penta-Helix Model). Thus, open innovation is based on the import and export of knowledge, processes, techniques, best practices and models to improve and accelerate the innovation to provide sustainable competitiveness [10, 11]. Furthermore, sustainable competitiveness has to consider resource management, particularly, natural resources. In fact, inadequate natural resources management can cause the most problematic and non-reversible scenarios not only for the companies but also for the communities [12-14]. Thus, natural resource management is highly affected by the efficiency of sinergical work and the processes, i.e. although there are institutions that appear to be interested in the management of natural resources, if the collaboration processes are not clear and previously defined and accepted, it is very difficult to achieve success in the natural resource management projects and therefore, in the level of sustainable competitiveness desired. Because the open innovation model is suitable to be applied in any company and sector, and considering that viticulture and enology sectors (i.e. Wine Industry sector) in Baja California, Mexico, has an important role at a national and international level, this paper proposes a framework to improve the sustainable competitiveness of the Wine Industry in Baja California based on innovative natural resource management.

2 Theoretical background

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Considering the aforementioned, the general resource management concept has to consider a lot of internal and external parameters needed to optimize the resources in order to promote sustainable competitiveness without affecting the environment, society and financial aspects. In particular, for Wine Industry, natural resources are very important inputs to any process, for example, water availability is an important issue that has to be optimized based on adequate management based on the public & private participation, technology available, experience & knowledge, among others (see Figure 1) [15]. Obviously, there are exists a lot of natural resources needed that have to be considered and management (e.g. land, soil, plants, and animals) by the Wine Industry in order to promote complete sustainable competitiveness. However, natural resources are not just inputs for any process, it can be said that natural resources are the main resources, not only for the processes but for the entire context in which the processes are carried out, that is, for people, communities, environment, among others [16].

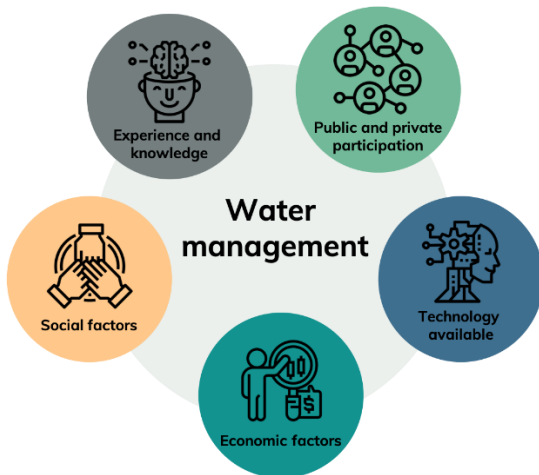


Fig. 1. Elements of the water management process.

As shown in Figure 1, the public and private participation is an important aspect in order to promote particularly the water management, but also this kind of participation is needed to any aspect related to the sustainable competitiveness. In fact, these participations are part of the open innovation model while in closed innovation model it is not presented. Regarding the Institutional Development (ID) as an element of sustainable competitiveness, allowing the grow stronger of "communities", in our case, the Wine Industry. Nowadays, in general, the Penta-Helix Model based on an open innovation model should to allowing better synergical works and a stronger framework to collaborate for natural resource management projects in comparison with Tripe and Quadruple Helix Models [17]. However, these processes required a strong culture for collaboration and innovation, which means that this is a challenge [18, 19]. Thus, Figure 2 shows the Penta-Helix Model that can be used for the Wine Industry to promote sustainable competitiveness taking into account environmental science and development as an important aspect for any project. Because the Penta-Helix Model consists of many elements with different features and dynamical, it requires

an innovate management process that permits us to define the "What", "How", "Where" and "When", respect to the natural resources. Thus, the process used is called Penta-Helix stakeholder management. It is important to mention that the Penta-Helix Model is more difficult to manage that the Triple and Quadruple helix models.

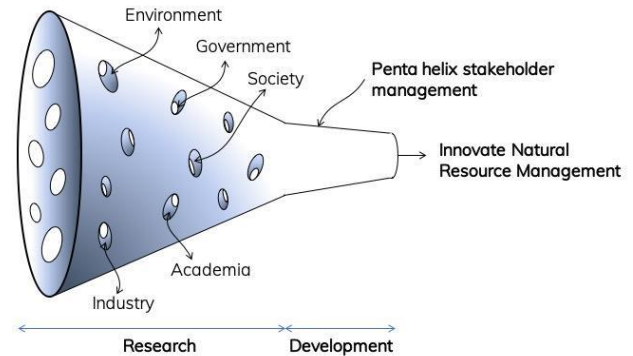


Fig. 2. Penta-Helix Model elements as base for an innovative natural resource management.

Figure 2 shows the general diagram of the Penta-helix stakeholder management, which includes Research & Development & Innovation (R&D&I) activities. In particular, all the elements of the Penta-Helix Model (i.e. environment, industry, government, academia, and society) working together based on the Penta-Helix stakeholder management framework in order to reach the particular and general proposals related to the natural resource management. In fact, the success of innovative natural resource management is based on this framework that establishes the rules and processes. In addition, all the elements of the Penta-Helix Model, except the Environment, have to work in a bidirectional way, importing and exporting ideas and best practices to a particular natural resources management project. However, as mentioned, the Environment only contributes to importing, because it is not allowing to change de natural behavior of natural resources.

3 Methodology

The sector of research in this publication is the Wine Industry located in Baja California state, Mexico. In particular, 65 companies (although there are 120 companies in the Wine Industry sector) in the sector were evaluated using a general survey designed and applied at different moments for diverse objectives, among them the one related to the natural resources. Thus, at this moment, this survey was used in order to obtain preliminary results of the natural resource management status, so later it will be necessary to apply the instrument for all the companies of the sector. After the application of the survey, the data collected were carefully examined in order to determine findings, key issues and challenges. Also, this survey analyzed the mentioned parameters related to sustainable competitiveness as a basis for proposing innovative natural resource management. It is important to clarify that some companies that answered the survey already have some applications based on high-end technology as support to

competitiveness and conventional natural resource management. For example, Figure 3 shows a drone that monitors remotely the crops as a key to the E-Agriculture process and also for natural resource management. Also, Figure 4 shows the semi-automated drip irrigation system. In addition, Figure 5 shows a particular insect (ladybug) as part of the biological control of pests in crops (to do not chemicals like pesticides and insecticides), sometimes the ladybug appears naturally in the crops, but they are most usually that appear as a laboratory result.



Fig. 3. Drone monitoring the crops.



Fig. 4. Semi-automated drip irrigation system for a particular crop.



Fig. 5. Ladybug insect as a biological control for pests in crops.

4 Result and analysis

As partial results, Figure 6 shows the boxplot graph that represents some principal challenges of the Wine Industry. It is important to clarify that the results shown in Figure 6 are only a representative sample of the overall results. In fact, the principal objective of these results in this paper is making clear that the opinion of the industrial sector related to the challenges is very important as part and input to the innovative natural resource management. As can be shown, optional answer #5 represents the challenge related to water availability and quality, which is associated with natural resource management. In particular, $\approx 58\%$ of the Wine Industry companies perceive that water management is the most important challenge, while $\approx 33\%$ perceive that the funding to improve production and exportation of grapes and wine (optional answer #1) is less important in comparison with the water management. However, the optional answer #1 is not directly addressed by this paper, although it also can be addressed by the Penta-Helix stakeholder management. The other optional answers (challenges) are not mentioned but are related to political, social and economic issues. In the same sense, all optional answer or challenges are inputs to the innovative natural resource management.

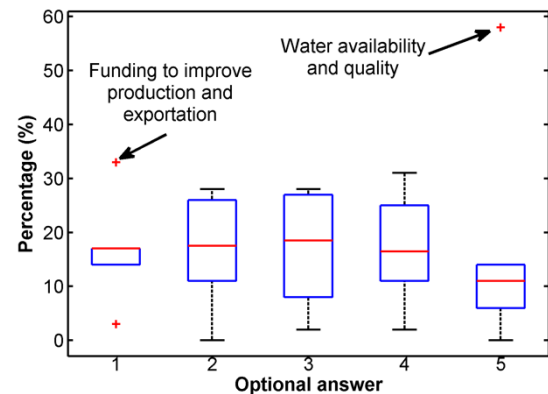


Fig. 6. Analysis of the answers to a particular question related to the principal challenges of the wine industry

Because the survey applied consists of many questions, Figure 7 shows the abstract related to the necessities of the wine industry considering the elements of sustainable competitiveness, i.e. social, natural and intellectual concepts and governance efficiency. In order to clarify the results, Figure 7 considered that a value of 100 % represents an obvious and complete necessity, while low values represent a certain response and technical capacity of the sector. In particular, the natural capital necessity is $\approx 41\%$, the social capital necessity is $\approx 41.6\%$, the intellectual capital necessity is $\approx 45.6\%$ and finally, the governance efficiency necessity is $\approx 44.25\%$. These results permit clarify the actual situation of natural resource management. Firstly, there is a balance of the necessity for all the elements of sustainable competitiveness. But also, the necessity indicators' values are so far from the minimum necessary value (0 %).

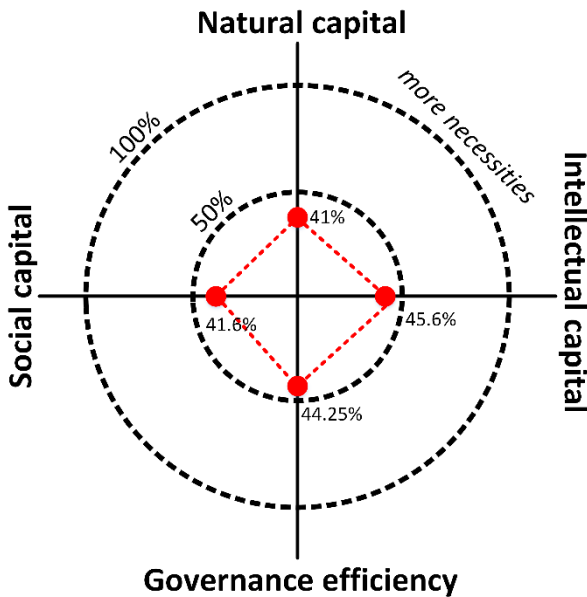


Fig. 7. Necessities radar of the industry considering the elements of sustainable competitiveness.

In addition, based on these results, the actual natural resource management presents important challenges, being the first challenge the reduced importance for the natural resources management of the wine industry sector. Also, the opinion of the sector is that particular intellectual capacitation is required, e.g. technical capacities for viticulture mainly, but none related to natural resource management. Social capital element also is a challenge related to sustainable competitiveness, because the wine industry has to consider the attributes of people and organizations (related to the Penta-Helix Model) that influence their responses to sustainable competitiveness. Respect to governance efficiency evaluation ($\approx 44.25\%$), which is related to transparency, inclusiveness, fairness, legitimacy, integration, capability, accountability and adaptability of the government, it is important that the wine industry sector and the government define the best innovative practices in order to promote governance arrangements.

5 Innovation framework proposed

The conventional framework of the Penta-Helix Model is actually not clearly defined. In fact, this is the principal reason because this model is not complete efficiency at all. Thus, our framework proposes to begin with an initial process that is not clear in traditional natural resource management, in fact, to our best knowledge it is the more evident cause of failing to reach sustainable competitiveness, which is related to the incorrect initial diagnostic of necessities and challenges. Figure 8 shows the initial flow chart process proposal for innovative natural resource management. As the first stage, it important that all the elements of the Penta-Helix Model provide official and realistic documentation related to the actual natural resource management. Next, all the stakeholders have to deeply analyze this information in

order to clarify the findings, advantages, challenges, and other important aspects related to the efficiency of the natural resource management model analyzed. As the final stage of this flow chart, Penta-Helix stakeholder management establishes a final report that will be as input for the next flow charts processes.

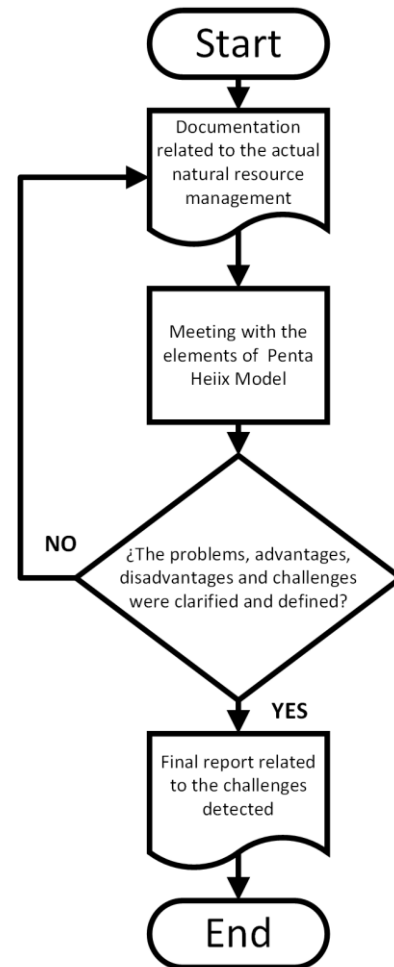


Fig. 8. Initial flow chart proposal for innovative natural resource management.

6 Conclusions

Innovative natural resource management is a principal need in order to promote sustainable competitiveness based on environmental science and development working together with different stakeholders. It is clear that in-deep investigation related to natural autochthonous resource management is needed using an improved method because the personal staff of the wine industry is focused mainly on productivity. Also, because the sustainable competitiveness concept is relatively new, the sector is more comfortable with the conventional competitiveness concept. Hence, the proposal showed in this paper allows establishing a framework based on Penta-Helix Model that should permit to increase the efficiency related to natural resource management projects, such as management of water treatment residuals, recycling & reuse, Industrial wastewater treatment, groundwater management, renewable sources of energy-energy savings among others.

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