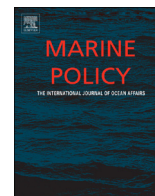




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The development of marine biotechnology in Oman: Potential for capacity building through open innovation

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ABSTRACT

This study examines the current state of the art in the emerging and strategically important marine biotechnology sector in Oman, which has a long coastline, rich marine heritage and strong fishing industry. In a knowledge-based economy, the ability to innovate is a key factor for increasing organisational competitiveness and this may be achieved using open innovation. This is the use by firms of external knowledge, ideas and technology to innovate. In this study, the extent of open innovation in Omani marine bioindustry companies has been studied by examining data from the top sixteen companies ranked by number of employees. The results indicate that the extent of openness in these companies is higher towards market side activities. In addition, the use of open innovation to increase collaboration between companies, Universities and government research institutes needs to be significantly strengthened.

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1. Introduction

Oman's economy is mainly based on revenues from oil and gas, which accounts for about 86% of government income [1] although economic diversification efforts by the government continue. It is therefore important to explore more dynamic and alternative economic activities in order to reduce dependency on fossil fuels [2]. Resource driven economies like Oman's should adopt dynamic and innovative economic strategies to increase their competition in the global economy [3]. The development of Oman's agriculture and fisheries sectors is one of the main priorities of the current five year development plan [4]. Examining alternative sectors that can reduce dependence on vulnerable areas such as declining fishing, to potentially more resilient sectors including marine biotechnology can offer a new competitive dimension to a country's portfolio of economic investment. High technology rich industries can make increasingly important contributions to sustainable economic growth as well as the generation of new jobs [5]. Globally, marine biotechnology plays an important role in meeting societal challenges and in supporting economic growth by applying recent advances in marine science and technology [6,7].

The marine ecosystem of Oman is characterised by great productivity and biodiversity exemplified by its coral reefs [8,9] and high fish diversity [10]. There are also many species of unique and diverse marine microalgae, diatoms, sponges, corals and invertebrates. Marine microbial diversity also represents an important biotechnological resource [11]. Many of Oman's marine resources have so far not been intensively investigated for their biotechnological potential.

Marine biotechnology can be defined as the use of marine biological resources as the target or source of biotechnological applications. This includes marine organisms, or parts thereof, used as feedstock, for example as food, fuel, materials or bioactive compounds [6]. Furthermore, the term "marine biotechnology" has been used widely in the international literature to also embrace fisheries activities and fish processing [12]. This study focuses on the traditional forms of marine biotechnology such as fish and seafood production and processing [13]. It will also establish a baseline for the measurement of marine biotechnology progress in Oman.

The aim of this study is to provide an overview of current marine bioindustry activities in Oman; to collect empirical data on production and innovation activities of key companies and to survey support organisations which could help bring about more directed and deliberate uptake of open innovation strategies. This will also provide a stronger context – specific background for marine policy makers to aid in increasing the development and sustainability of this sector by enhancing its competitiveness. Here we define marine

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bioindustries as companies which are active in selling products/processes based on marine organisms.

2. Open innovation

Both academic and business communities have shown significant interest in open innovation which is often a key management priority [14–16]. The concept of open innovation is built upon early Schumpeterian perspectives of the role of innovation in increasing economic competitiveness and his emphasis on the process of ‘creative destruction’ [17]. It is also built upon the earlier work by von Hippel about the importance of collaboration with users [18–20], suppliers and other external organisations [21] as sources for innovation. Related to this, scholars of innovation have also studied the role of a company’s investment in R&D and its role in the generation of new knowledge [22].

Open innovation can be defined as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively” [15]. It can be divided into two dimensions, inbound and outbound open innovation. This study is focussed on inbound open innovation which is defined as the internal use of external knowledge, while outbound open innovation refers to external exploitation of knowledge internal to the firm [23]. There are many benefits of an open innovation strategy which include the use of complementary resources through external collaboration, thus potentially increasing the company’s scientific and technological knowledge and information [24]. External sourcing of technology can enable companies to build novel competencies that would be difficult to achieve using only internal competencies. The commercialisation capability of companies can also be enhanced by collaborating with universities, investing in research and development and external technology sourcing [25]. Inbound open innovation can be measured by using two dimensions – breadth and depth [26]. These terms have also been used to describe the two variables of a network for promoting innovation [27]. Breadth describes the number for different types of external partners or information sources involved in the innovation process. This can include suppliers, customers, competitors, consultants, research institutes and universities [28]. The depth dimension of innovation networks is focused on the extent to which deep integration between the firm and its external partner exists.

Open innovation can play an important role in helping companies to overcome significant constraints such as the availability of resources for research and development, and the provision of new technological capabilities. Internationally, successful marine biotechnology companies are characterised by significant collaboration with R&D institutes. There is an increased need for marine biotechnology firms to interact more widely with different sources of external knowledge, including, customers, end users and suppliers [29,30]. Open innovation has the potential to address these challenges and constraints [31–33].

Open innovation practices have been regarded as successful, primarily in industries such as biotechnology [23,25] a sector characterised by the need to use advanced, complex and often new technologies and to undertake extensive inter-organisational collaboration. Academic research on the implementation of open innovation within biotechnology companies has recently increased. For example, open innovation and the drug discovery and development process [34], and for increasing knowledge in the pharmaceutical industry [35]. Bio-pharmaceutical firms use open innovation practices such as licensing agreements, non-equity alliances, and supply/provision of technical and scientific services to acquire new or improved technologies and new knowledge [27]. Other authors [36] study open innovation to capture the full benefit of an external value chain in

biotechnology or to explain a company’s innovation performance [29]. In addition, it has been shown that internal learning and technology innovation capabilities also increase with the adoption of open innovation [37].

Innovation is widely considered to be a key driver for the development of a knowledge based economy. Recent research emphasises the role of a knowledge economy in increasing the sustainable competitive advantage and supporting growth [38,39]. Progress that countries make in innovation is also an indication of their increasing economic competitiveness and it also provides possible pathways to enhance the overall national innovation performance [40].

International rankings of innovation are increasingly being used as a measure of the ability of a nation to sustain productivity, growth and competitiveness for the longer term and to identify new national innovation strategies [41]. National innovation performance is important for Oman in its current stage of development, as it moves towards an innovation driven economy [42] therefore a current assessment of Oman’s national innovation performance is important to allow monitoring of the effects of any measures or policies designed to enhance innovation. One of the key elements in strengthening national innovation performance is the quality of individual company’s operations and strategies. In this study, the adoption of open innovation strategies by marine bioindustry companies in Oman and its impact on their growth and competitiveness was investigated.

2.1. Current assessment of innovation at the national level

In order to manage an innovation strategy on a national level and measure success of funded policies, growing attention is being paid to a number of innovation indices [43]. In this study, two global rankings were used to examine the performance of Oman in an international context. The first one is Global Competitiveness Index (GCI) which is published annually by the World Economic Forum (WEF) and the second one is the Global Innovation Index (GII) by The Business School of the World (INSEAD) in the collaboration of other agencies such as the World Intellectual Property Organisation (WIPO).

2.1.1. Global competitiveness index (GCI)

The World Economic Forum (WEF) is a non-profit, independent international organisation based in Geneva. Founded by Klaus Schwab, in 1971 [44] its main objective is to improve the state of the world by engaging academia, business and governments to shape the global, regional and industrial activities. In 2004, Professor Xavier Sala-i-Martin created a Global Competitiveness Index (GCI) for the first time, which measures national competitiveness by including both macroeconomic variables and micro-economic elements and it has been published yearly since then [45]. Competitiveness is defined as the set of institutions, policies, and factors that determine the level of productivity of a country. GCI measures the different determinants of competitiveness which is considered complex and open-ended by providing a weighted average for many different components of these determinants. These components are grouped into the 12 ‘pillars of competitiveness’. The pillars are organised into three sub-indexes: basic requirements, efficiency enhancers and innovation and sophistication factors, and each category one is critical to a particular stage of a nation’s economic development Table 1.

The focus in this study is on the final data set of the pillars which includes the eleventh pillar ‘business sophistication’ and the twelfth pillar ‘innovation’. Business sophistication is considered an essential factor in enhancing national competitiveness. It is related to higher efficiency in the production of goods and services which leads to an increase in productivity. It is concerned with, the quality of the country’s overall business networks and

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