The development of seaweed farming as a sustainable coastal management method in Indonesia: an opportunities and constraints assessment

A. Zamroni, K. Laoubi & M. Yamao
Graduate School of Biosphere Science, Hiroshima University, Japan

Abstract

Indonesian coastal areas are continually experiencing pressures that affect their sustainability. Beginning in the 1980s, the Indonesian government has introduced numerous development programs to address this problem. One type of program is seaweed farming projects. The aim of these projects is to provide the fishing community with alternative, environmentally-friendly fishing activities, as well as improving its livelihood. The objective of this paper is to assess the opportunities and constraints of seaweed farming projects with regard to sustainable coastal management in Indonesia. This study was conducted in the South Sulawesi province of Indonesia (the largest producer of seaweed in the country) by administering semi-structured and structured questionnaires to 200 fishermen. The results demonstrate that seaweed farming, mainly of the species *Eucheuma cottonii*, has become the main means of livelihood for these fishermen. As a result, destructive fishing has been considerably reduced and awareness has increased regarding the need to conserve the mangrove areas that protect the coastal ecosystem from degradation. Seaweed farming plays an important role in improving the socioeconomic conditions of fishers' communities, such as increasing their income and enhancing family and community participation, particularly that of women. However, constraints hinder the development of this activity. These constraints include diseases and post-harvest difficulties, problems of farm ownership, shifts in the monsoon season and marketing limitations. The marketing system that is in place has provided important services. One of the most important of these services is the quick delivery by middlemen of investment funds and money for daily

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operational expenses. These loans are made without interest charges. The middleman role is perceived as an important link that allows seaweed farmers to sustain their activities. However, this system has created a heavy dependence on the middlemen and, as a result, allowed the development of a business monopoly. Finally, the study concludes that the development of seaweed farming can promote the sustainability of the fishery sector and of coastal areas, as well as render fishery livelihoods more stable and secure.
Keywords: seaweed farming, coastal management, coastal development, sustainability.

1 Introduction

Indonesia's coastal zones constitute one of the major ecosystems of the area's biosphere and are important for their biodiversity [1]. Nevertheless, these coastal zones have experienced several stresses that affect their sustainability. These stresses stem from environment degradation and resource depletion in coastal regions (e.g., mangrove and coral reef damage), land-based marine pollution, overfishing, conflicting utilization of marine space, insufficient capacity in local governments and a lack public participation [2].

Since the 1980s, the Indonesian government has implemented a range of policies and projects aimed at sustaining coastal zones. Among these projects are efforts to develop various kinds of sustainable, environmentally-friendly aquaculture, such as seaweed farming. Seaweed farming can play a significant role in nutrient recycling [3], as well as increase local biodiversity and food security for coastal and island communities [4]. An additional advantage of seaweed farming is its beneficial effect on ecology and climate change. By trapping carbon, seaweed farming could be a tool in the carbon credit system that is being developed. Seaweed farming also removes nitrogen and phosphorus nutrients from local waters, and could therefore also be eligible for nutrient credits in an eutrophication-reduction system [5]. In the realm of social policy, seaweed farming is a sustainable form of aquaculture that has particularly benefited women and has contributed to government-sponsored poverty alleviation programs [6]. As an alternative means of livelihood, seaweed farming is crucial to the implementation of a system of sustainable ecosystem management [7].

However, the development of Indonesian seaweed farming is affected by various factors, including the availability of socio-economic, resources, public policy, and technology. Developing policies and programs to enhance sustainable coastal management requires an assessment of the constraints and opportunities that characterize the situation of coastal communities. This paper's objective is to assess the constraints and opportunities associated with the development of seaweed farming. This paper will also provide recommendations for increasing the sustainability of this farming activity and, thereby, for improving sustainable coastal management in Indonesia.

2 Methodology

A survey was conducted in South Sulawesi Province in the eastern part of Indonesia to provide data for the study. Two districts, Takalar and Jeneponto, were chosen for sampling. The survey covered four villages, one village in Takalar District and three villages in Jeneponto District. These villages are representative of coastal communities on the Laikang Bay that contain active fishermen. Laikang Bay connects these two districts, which influence one another (see figure 1).

Figure 1: Map of Laikang Bay South Sulawesi Province.

South Sulawesi Province, Indonesia is located in the southernmost part of Sulawesi Island (formerly *Celebes*). South Sulawesi is located between S 0°12' – 8' and from E 116°48' up to E 122°36', while Makassar City (the capital city of South Sulawesi Province) is located from S 5° 30' 18" up to S 5° 14' 49" and from E 119° 18' 97" up to E 119° 32' 3". The average daily temperature in Makassar fluctuates between 22°C and 33°C.

Takalar District is located on the south side of South Sulawesi Province. This district has a land area of 566.51 km^2 and is located between S 5°3' and S 5°38' and from E 119°22' up to E 119°39'. It is bounded by Gowa District on the north, Gowa District and Jeneponto District on the east, Flores Sea on the south and Makassar Strait on the west (Takalar Marine and Fisheries Service Office-(TMFSO) and Narayana Adicipta Persero, 2007, unpublished). Takalar District is about 42 km from Makassar City, the capital city of South Sulawesi Province. Interviews and other data collection activities were conducted in Laikang Village, located in the Managarabombang Sub-District of Takalar District, 16 km from Takalar City and 63 km from Makassar City.

Laikang Village is one of the 12 villages of Mangarabombang Sub-District in Takalar District. It has an area of 19.6 km^2, equal to 19.57% of Mangarabombang Sub-District (±100.14 km^2). The village population is

approximately 4,139, or 12% of the total population of Mangarabombang Sub-District (35,526 people); the population density of Laikang Village is about 211 people/km^2. Laikang Village is about 15.7 km from the capital city of the Mangarabombang Sub-District and 23.3 km from the capital city of the Takalar District (TMFSO and Narayana Adicipta Persero, 2007). Administratively, Laikang Village consists of six sub-villages: Laikang, Puntondo, Boddia, Turikale, Pandala, and Ongkoa.

Jeneponto District is located in the western part of South Sulawesi Province. It is also a coastal area and stretches for about 95 km in the southern region, covering an area of 74,979 hectares or 749.79 km^2. South Sulawesi is located between S 5^{0}16'13" and S 5^{0}39'35" and between E 12^{0}40'19" and E 12^{0}7'51". It is bounded by Gowa District on the north, the Flores Sea on the south, Takalar District on the west and Bantaeng on the east. Jeneponto District consists of 9 districts and 105 villages. The population of Jeneponto District in 2004 was 324,927, consisting of 158,043 men and 166,884 women. There were 18,943 fishermen, fish farmers and seaweed farmers.

Data collection was conducted in August and September 2010 from a total sample of 200 farmers who practiced seaweed farming. Samples were obtained from four villages, with 100 samples collected from Laikang Village, 40 from Garassikang Village, 40 from LP Bahari Village and 20 from Ujunga. The samples were selected randomly. Interviews were conducted by using structured and semi-structured questionnaires. In-depth, face-to-face interviews were also carried out to obtain more detailed information regarding seaweed farmers and their socio-economic environment.

The data collected were analyzed using the statistical tool SPSS 18. Descriptive statistics were used to derive the distribution of frequencies, means, percentages, and standard deviations. In addition, a Strengths, Weaknesses, Opportunities and Threats (SWOT) matrix was used to identify constraints and opportunities in seaweed farming.

3 Results and discussion

3.1 Socio-economic characteristics of seaweed farmers

As shown in Table 1, all seaweed farmers involved in this study were male (100%), with an average age of 37.04 years. Their level of formal education was low, averaging 2.42 years. This is typical of coastal communities, which frequently have a low education level. In this study, 22.5% of seaweed farmers had never received a formal education. The seaweed farmers in Laikang Bay are of the Makassar ethnic group.

In Laikang Bay, fishermen rely on a variety of livelihood activities, including capture fisheries, seaweed farming, seaweed cultivation combined with fishing, seaweed farming in combination with public services and a combination of seaweed farming with other non-fishing activities. This picture confirms the contention by Le Tixerant *et al.,* [8] that human activity in maritime areas depends on the socioeconomic context in which the activity evolved. In this

Table 1: Socio-economic data on seaweed farmers in Laikang Bay.

Variable	Frequency	%	Mean	S.D
Age (years)			37.04	9.6
≤ 25	17	8.5		
26 – 40	115	57.6		
41 – 60	68	34		
Gender (male/female)			1	0
Male	200	100		
Female	0	0		
Education			2.42	2
Elementary school	105	52.5		
Junior high school	41	20.5		
Senior high school	9	4.5		
None	45	22.5		
Marital status			2	0
Single	0	0		
Married	200	100		
Widow	0	0		
Ethnicity			2	0
Bugis	0	0		
Makassar	200	100		
Javanese	0	0		
Main Income Generating Activity			4.02	2.9
Seaweed culture	92	46		
Seaweed culture + capture fishing	74	37		
Seaweed culture + public officer	4	2		
Seaweed culture + non-fishing	30	15		
Number of family members (persons)			1.86	0.34
≤ 2	27	13.5		
3 – 5	173	86.5		
Income per month (IDR)			1.44	0.5
≤ 500,000	115	57.5		
501,000 - 1000,000	83	41.5		
>1000,000	2	1		
Number of seaweed plots (1 plot=100 m x 30 m)			1.32	0.46
≤2	137	68.5		
≥3	63	31.5		

1 USD = 9,013 IDR (Indonesian Rupiah), November 2010

Field survey 2010

study, some seaweed farmers (46%) conducted seaweed farming as their sole economic activity. Meanwhile, other farmers (37%) combined seaweed farming with fishing, which is possible because the method for farming *Eucheuma cottonii* does not require the expenditure of much time after planting. Farmers check their farm three to four times a week after fishing is completed. This situation accords with understanding supplied by Carneiro [9], which argues that livelihood interventions are a supplementary form of income that enhances a household's economic resilience.

Most fishermen continue to earn low incomes from their work. Some fishermen (57.5%) earned an income below 500,000 Indonesian rupiah (IDR) per month, whereas others (41.5%) had incomes between 501,000 and 1000,000 IDR per month. These figures represent total incomes. The fishermen use their incomes to support their families. They have, on average, 1.86 children per household.

Seaweed farmers in Laikang Bay in both the Takalar and Jeneponto Districts possess 1.32 seaweed plots per farmer on average, where the size of one plot is equal to 100 meters x 30 meters. Most of the farmers (68.5%) have fewer than two plots. However, farm ownership is highly variable, depending as it does on the economic means of the individual farmer (Table 1).

3.2 The critical role of marketing in seaweed farming sustainability

The survey results reveal that the existing marketing system for seaweed farming plays an important role in sustaining seaweed farming activities. In Takalar village, seaweed farmers sell seaweed in dried form to traders/middlemen at the village level. These traders then sell the product to traders at the district level, who, in turn, sell it to wholesalers who have warehouses in Makassar/Ujung Pandang, or to a processing company there. The usual age of harvestable seaweed is 45 days. However, seaweed farmers may harvest seaweed at 20 days, 25 days and 30 days, or even at 15 days. Such harvesting is undertaken when disease affects the seaweed, which can result in damage to, or the death of, those plants. Diseased seaweed can still be sold, but at lower-than-normal prices. Wholesalers receive shipments of seaweed from traders who have become frequent partners. Shipments from seaweed traders are still dried for a day or more until the water content reaches 34%. Seaweed is not considered to be of suitable quality if the water content is greater than 40% and dirt constitutes more than 5%. In such cases, the seaweed will either be rejected or be bought at reduced prices by wholesalers. The trust factor is important between wholesalers and traders with strong business ties. Wholesalers exist because they are able to provide a more effective and efficient distribution system than any other participants in the market [10]. The marketing structure of seaweed in Takalar is illustrated in figure 2 below.

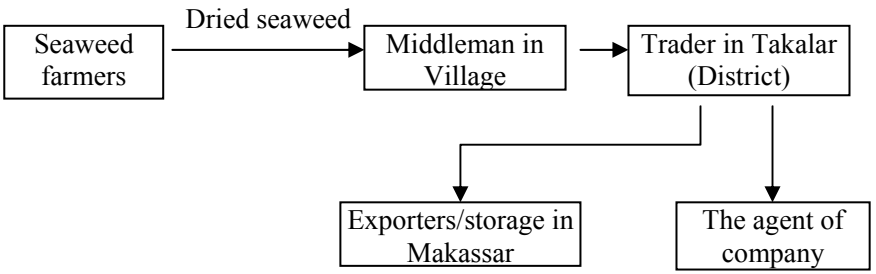

Figure 2: Marketing pattern of dried seaweed at Takalar district.

Fishermen at the village level who cultivate seaweed can also serve as middlemen. The company's agent referred to in the marketing chain is not an employee of a processing company or an exporter, but someone who is appointed by the company to purchase raw materials. The pattern of seaweed marketing in Takalar, as described above, is similar to that in Gorontalo, Southeast Sulawesi. In Gorontalo, dried seaweed is sold to a local trader, who then sells it to a wholesaler, processing company, or exporter [5]. Roy [11] emphasizes that, in order to expand the market, each part of the chain may need information on the seaweed's characteristics and on consumer preferences.

3.2.1 The middleman's role

According to Ju et al., [12], intermediaries begin by choosing the best goods, then buy the goods from producers and sell them to consumers. In the current study, middlemen were described as buying dried seaweed from farmers containing a moisture content of 60%. The purchase price for dried seaweed is 4000 IDR/kg. Middlemen located in farming areas, and traders in some areas, are members of the seaweed farmers' group; some even serve as heads of groups. After a significant amount of seaweed is collected, it is then sold to middlemen who live in the district and then sold to the warehousing or processing enterprises in Makassar. This procedure was confirmed by Gadde and Snehota [13], who argue that middlemen bridge the production-consumption gap.

This study finds that some seaweed farmers are closely affiliated with particular traders/middleman. Consequently, they sell their produce to those middlemen (see Figure 3).

Figure 3, below, shows that seaweed farmers go directly to middlemen to borrow money. These funds are used for restarting the planting cycle and are allocated either for seaweed seed stock or for equipment needed to repair the seaweed farm. This loan is made without any collateral. In return, seaweed farmers must sell their product exclusively to the middleman who made the loan. In these cases, middlemen do not fix a time limit for debt repayment. However, the dried seaweed bought from farmers is more similar to cash paid immediately to the middleman rather than to delayed payment, as is the case with seaweed farmers in Fiji [14]. Seaweed farmers do derive some benefits from this

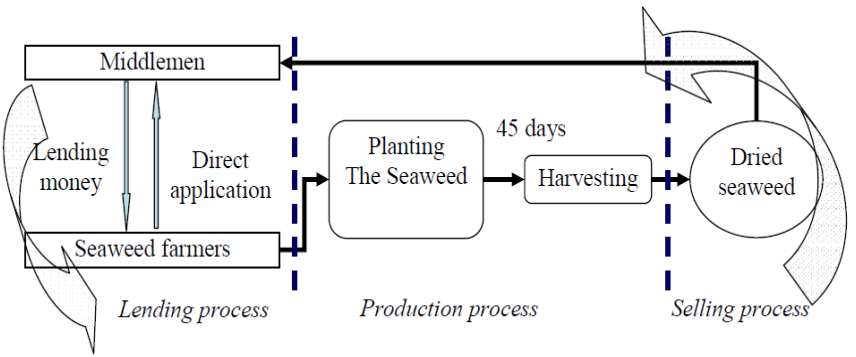

Figure 3: Relationship pattern between middlemen and seaweed farmers.

relationship: 1) seaweed farmers can quickly obtain loans, 2) there is no interest charge on loans, 3) the farmers get the assurance that they will sell their harvest and 4) the farmers get cash payments. This is similar to the situation in Kenya, wherein middlemen act both as direct links to the external market and as the source of credit for fishermen [15].

In this study, the relationship between the middleman and seaweed cultivation is based on the viability of the seaweed business. The double role middlemen play cannot alone guarantee a sustainable business, although the middleman is assured of the availability of dried seaweed from the farmers who borrow capital from him. This means that middlemen and seaweed farmers are implicitly "tied" to one another in a mutually beneficial relationship. Day [16] emphasizes the value of such relationship building when there are only a few valuable customers who engage in large transactions. However, the relationship between middlemen and fishermen/seaweed farmers is being transformed, in the long term, into a trade monopoly at the local level.

3.3 Constraints and opportunities analysis

Fishermen face several constraints in pursuing their livelihoods. Changes in the monsoon season and its cycles are, at this time, a major problem in the development of seaweed cultivation. Long market channels and income distribution continue to remain major obstacles in Laikang Bay's seaweed business. A lack of financial capital is the difficulty fishermen most often experience, especially when they begin planting. Seaweed farmers use various tactics to resolve this problem. Instead of formal financial institutions, which they rarely utilize, fishermen usually borrow money from the family, relatives, friends and brokers (middlemen) in the village. This type of borrowing occurs because small-scale fishers still have problems in accessing financial capital from formal financial institutions, such as commercial banks. In addition, there are problems with the availability of seaweed seedlings, the quality of the seed, land tenure, a disease that attacks the seaweed plant and the post-harvest process. Price fluctuations are now perceived as a minor problem.

Recently, the most critical problems affecting seaweed development are associated with marketing and breeding. Seaweed farmers have not received many economic benefits from the current marketing of dried seaweed. These marketing problems, allegedly, are associated with institutional problems, network marketing, and a communications gap between producers and consumers when the seaweed is not produced in accordance with standards established by the processing industry and exporters. These problems allow the industry to buy seaweed at low prices. Middlemen can act as an alternative, advantageous way to reduce market frictions [17]. The accessibility and risks of the product market depend on market structure, size, expected demand levels and the nature of competition [18]. These constraints generally indicate that cooperation among seaweed stakeholders is not strong or well developed. Smith and Renard [19] suggest that, in order to expand fishers' income-generating activities, they should apply a strategy based on integrated technology, ecology, sociology and economics.

Table 2: Matrix of SWOT for sustainable seaweed farming in Laikang Bay.

Internal / **External**	**Strengths:** - Carrying capacity of the coastal environment still supports farming activity - Self-motivation of fishermen to cultivate seaweed - Farming methods (investment and costs) are still affordable for fishermen. - Seaweed farming is the main source of income supporting fishermen's expenditures. - Production of seaweed tends to increase annually.	**Weaknesses:** - Lack of capital for developing seaweed farming - Diseases, such as ice-ice - Farming patterns depend on the monsoon seasons - Changes/shifts in the monsoon seasons - Long market chain - Lack of income management - Lack of financial capital - Seed availability and quality - Farm ownership - The price of dried seaweed fluctuates - Post-harvest process
Opportunities: - Local government policies support seaweed as a leading product - Establishment of a seaweed processing company - The demand for dried seaweed has increased - National policies support seaweed farming as an alternative livelihood - National business agency and private companies encourage the development of seaweed processing. - Market opportunities	**S – O strategy** • Expand the potential farm area in an optimal and environmentally friendly manner to meet the market demand for seaweed	**W – O strategy** • Encourage seaweed farmers to improve their knowledge of business management, including aspects of finance, farming methods and post-harvesting processes. • Improve knowledge of quality standards as well as of market demand.
Threats: - Climate change - Profit-taking actions - Decreasing environmental quality - No standard price for dried seaweed	**S – T strategy** • Develop alternative models of farming methods to minimize risks • Prohibit activities that could reduce the quality of seaweed	**W – T strategy** • Build public understanding and awareness of environmental protection • Build a farm utilization model

Field survey, 2010

Despite these constraints, fishermen have the capacity to improve their livelihood activities. This study shows that the factors that can strengthen and further develop those activities include decreasing the amount of fish harvested, promoting and benefiting from seaweed cultivation as an alternative source of

livelihood, tapping support from local governments and taking advantage of opportunities in the market. These factors are of basic interest to fishermen who engage in seaweed farming as an alternative means of livelihood.

In the future, at least some these factors will represent viable opportunities. First, the demand for raw material has increased year by year, in both domestic and foreign markets. Second, the policies of the national government support the development of seaweed farming. Third, the Government of Indonesia (GoI) encourages private companies and national business agencies to develop seaweed processing. However, climate change, profit-taking, the erosion of the environmental and the lack of standard prices for dried seaweed pose threats to fishermen in their quest to take advantage of these opportunities (see Table 2).

The Indonesian government should encourage all stakeholders, particularly local governments, to assume greater roles in this realm. The private sector wishes to play a role in diversifying the production of seaweed. Informal leaders can use their power to encourage local people to engage in the management of local resources.

4 Conclusion

The results of this study show that seaweed farming, mainly of the species *Eucheuma cottonii*, has become the main livelihood for fishers in the studied area. Fishing has been replaced by seaweed farming as the main source of income, a trend that can be seen in the increasing number of seaweed farms along the coastline of Laikang Bay. As a result, destructive fishing has declined considerably and awareness has increased regarding the need to preserve the mangrove areas that protect the coastal ecosystem from degradation. Seaweed farming plays an important role in the socioeconomic condition of fishing communities. Such farming increases income and stimulates family and community participation, particularly that of women. However some constraints hinder the development of this activity, such as disease, post-harvest difficulties, farm ownership, shifts in the monsoon season, and marketing constraints. In addition, the availability and quality of seaweed seeds, issues surrounding farm ownership, predatory behavior and imperfections in post-harvest methods are also obstacles. However, farmers can overcome these obstacles. Positive factors include the lack of restrictions on the development of coastal areas, the availability of successful farming methods and the price of dried seaweed.

The dependence of fishing communities on seaweed farming as a primary source of household support has spurred the quick development of seaweed farming. This has led to increasingly vigorous farming activity in the coastal areas. The density of seaweed plots and the unclear status of land ownership have sparked conflicts among rival claimants to farms. Therefore, a re-assessment of farm-ownership and a determination of the carrying capacity of the coastal environment in Laikang Bay are needed to maintain the balance between the environment and the social benefits of seaweed farming.

The marketing system has provided benefits, such as speedily supplying investment and daily operational funds, without interest, to seaweed farmers

through the efforts of middlemen. Middlemen are perceived to be very important to sustaining seaweed farming. However, this situation has created a heavy dependency on middlemen and, consequently, also created a monopoly. Nevertheless, the activities of middlemen will be necessary to the operation of the dried seaweed supply chain in Laikang Bay as long as the local and central governments cannot facilitate the creation of an effective alternative market chain at the local level.

Finally, the study concludes that the development of seaweed farming can promote the sustainability of the fishery sector and coastal areas and make the livelihood of fishermen more stable and secure.

References

[1] Sukardjo, S., Integrated coastal zone management (ICZM) in Indonesia: a view from a mangrove ecologist. *Southeast Asian Studies,* (40), 2. pp. 200-218, 2002.

[2] Laely Nurhidayah, Toward Integrated Coastal Zone Management in Indonesia: Framework Assessment and comparative analysis. United Nations-Japan Foundation, *Working paper* 28, January 2010.

[3] Sorgeloos, P., Technologies for Sustainable Aquaculture Development, Plenary Lecture II. In R.P. Subasinghe, P., Bueno, M.J., Phillips, C., Hough, S.E., McGladdery & Arthus, J.R.(Eds.) *Aquaculture in the third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium,* Bangkok, Thailand, 20-25 February 2000. NACA, Bangkok and FAO, Rome: pp.23-28.

[4] Kinch, J., Bagita, J., & Bate, M., Exploring the Potential for Seaweed Farming in the Milne Bay Province, Papua New Guinea. *SPC Fisheries Newsletter*, (104). pp. 25-31, 2003.

[5] Neish, I.C., Assessment of the Seaweed value chain in Indonesia. USAID, 2007 Online: http://www.amarta.net/amarta/ConsultancyReport/EN/AMARTA%20Value%20Chain%20Assessment%20Seaweed.pdf.

[6] Bryceson, I., Coastal aquaculture developments in Tanzania: sustainable and non-sustainable experience. *Western Indian Ocean J. Mar. Sci,* (1), 1. pp. 1-10, 2002.

[7] Alder, J., Sloan, N.A., Uktolseya, H., A comparison of management planning and implementation in three Indonesian Marine Protected Areas. *Ocean and Coastal Management,* (24). pp. 179–198, 1994.

[8] Le Tixerant M., Gourmelon F., Tissot C. & Brosset D., Modelling of human activity development in coastal sea areas. *Journal of Coastal Conservation*. Springer, 2010.

[9] Carneiro, G., Marine management for human development: A review of two decades of scholarly evidence. *Marine Policy*, (35), 3. pp. 351-363, 2010

[10] Rosenbloom, B., The Wholesaler's Role in the Marketing Channel: Disintermediation vs Reintermediation. *International Review of Retail, Distribution and Consumer Research*, (17), 4. pp. 327-339, 2007

[11] Roy, A., Market Information and Channel Price Structure. *International Journal of Research in Marketing*, (17). pp. 331 – 351, 2000.
[12] Ju, J., Linn, S. C. & Zhu, Z., Middlemen and Oligopolistic Market Makers. *Journal of Economics and Management Strategy*, (19), 1. pp. 1 – 23, 2010.
[13] Gadde, L.E. & Snehota, I., Rethinking the Role of Middlemen. Paper for IMP, BI, Oslo, 9-11 September, 2001. Online: http://www.impgroup.org/uploads/papers/182.pdf.
[14] Namudu, M.T. & Pickering, T.D., Rapid Survey Technique Using Socio-Economic Indicators to Assess the Suitability of Pacific Island Rural Communities for Kappaphycus Seaweed Farming Development. *Journal of Applied Phycology*, (18). pp. 241 – 249, 2006.
[15] Crona, B., Nystrom, M., C, Folke, C. & Jiddawi, N., Middleman, a critical social-ecological link in coastal communities of Kenyan and Zanzibar. *Marine Policy*, (34). pp. 761 – 771, 2010.
[16] Day, George S., Managing Market Relationships. *Journal of the academy of marketing science*, (28), 1. pp. 24-30, 2000.
[17] Masters, A., Middlemen in Search Equilibrium. *International Economic Review*, (48), 1. pp. 343 – 362, 2007.
[18] Roberts Jr, W. A. & Stekoll, M S., Commercial Potential of Seaweed from St Lawrence Island, Alaska: evaluation of market opportunity. *Journal of Applied Phycology*, (5). pp. 167 – 173, 1993.
[19] Smith, A.H. & Renard, Y., Seaweed Cultivation as a Livelihood in Caribbean Coastal Communities. 2010. Online: http://www.canari.org/seaweedcultivation.pdf.