Factors affecting the participation of the aquaculture industry in university-industry co-operation

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ABSTRACT: This study aims to probe factors affecting the participation of the aquaculture industry in industry and university co-operation. By adopting the Analytical Hierarchy Process (AHP), this study distributed 42 questionnaires by mails and by on-site visits. Based on consistency testing, 10 valid questionnaires were obtained. Results showed that both scholars and aquaculture businesses suggested that factors at the government level are most influential, which is different from the conclusions of most studies on industry and university co-operation. It shows the significant role of government in fishery development. Therefore, this study suggests that the Taiwanese Government can close the gap between the views of industry and academia by intervention and guidance of policy in order to enhance the intention and outcome of participation of the aquaculture industry in industry and university co-operation.

INTRODUCTION

In recent years, many advanced countries have greatly valued industry and university co-operation, and emphasised that industry-university co-operation can enhance industrial growth and national competitive advantages [1]. Industry and university co-operation has been implemented in Taiwan for years, and there have been many studies on the implementation, outcomes, influence and performance [2]. With the coming of the knowledge economy and the change of industrial structure, how to adjust operational ideas, share resources, develop core competencies, construct partnerships and develop co-operation to enhance competitive advantages becomes the important issue [3]. Teachers can acquire practical experience and share the latest industrial information with students by co-operating with businesses. Moreover, they can enhance instructional quality and ensure students' skills to meet the future workplace [4]. To encourage universities to actively participate in industry and university co-operation, since 2003, the Taiwan's Ministry of Education has included industry and university co-operation as one of the evaluation items for general affairs in universities. Therefore, industry and university co-operation has become an important measure to enhance the competitiveness of universities and construct practical programmes [5]. Industry and university co-operation allows universities to recognise the demands of modern society by cultivating professionals to meet the manpower demands of industry. Does the same benefit hold for the aquaculture industry? This is the first question addressed by this study.

The global fishing industry has nearly exhausted fish stocks and, hence, catches are declining. The United Nations and major fishery countries have placed significant emphasis on the development of the aquaculture industry. Therefore, the catch of the aquaculture industry has been growing annually by 8.8% since 1985 [6]. The Taiwanese Government actively supports the aquaculture industry, and provides related guidance. For instance, in 2008, the Government allotted composite loans (about US$75 million) to aquaculture farmers, offered relief funds (US$1.5 million) for natural disaster to the aquaculture industry, and subsidised half of the increase for power to reduce the operating costs of aquaculture farmers in Taiwan.

This demonstrates the importance to the Taiwanese Government to the aquaculture industry. Techniques of the aquaculture industry and fish breeding in Taiwan are advanced [7]. Industry-school co-operation between universities and private companies can also enhance the complementary effect between industry, government and academia, and maintain the competitive advantages of aquaculture production in Taiwan. However, there are still many aquaculture farmers, who do not cooperate with academia. What are the factors affecting their participation in industry and university co-operation? This is the second question being addressed by this study.

In summary, this study aims to probe into the factors affecting the participation of the aquaculture industry in industry and university co-operation. The findings can serve as references to the government and universities for enhancing the participation of the aquaculture industry in industry and university co-operation, and guide policy direction.

LITERATURE REVIEW

Factors Affecting the Intention to Participate in Industry and University Co-Operation

Industry and university co-operation can measure whether there is a strategic alliance between schools and industry. Jen suggested that in the past, partnerships between companies and universities were mainly by *sponsorships*, in which companies provide funds to solve specific problems [8]. At present, the relationship between companies and universities has evolved into *partnerships*. Although many companies still treat universities as the source of basic knowledge and trained manpower, some of them regard universities as the source of experts and knowledge, as well as of resources lacking in companies [8]. Hans studied 225 small and medium enterprises, and found that the factors that enhance co-operation between universities and industry include: interpersonal interaction and trust, research issues relevant to companies, convenient locations, costs and benefits and flexibility in organising times for co-operation [9]. Chi recognised the internal factors affecting companies' participation in industry and university co-operation, which included the companies' members and their internal organisation. External factors included techniques, laws and facilities [10].

Misko et al suggested that schools must have good administration, develop close relations with industry, enhance the quality of students, absorb new skills and have sufficient funds [11]. Chen found that companies or governmental institutions of offshore islands prefer well-known schools in Taiwan, and are not willing to cooperate with schools on the same island [12]. Chen and Tsao used R&D directors of 31 universities that had excellent performance in industry and university co-operation in Taiwan as subjects. Results showed that factors affecting the participation of universities in industry and university co-operation include teachers' experience in industry and university cooperation, teachers' familiarity with research topics, teachers' research capacity, full understanding of industry and academia regarding mutual needs, and teachers' familiarity with the companies [13]. Chi determined the internal factors affecting schools' participation in industry and university cooperation, and considered members and the internal organisation. As well, Chi considered the external factors for universities *viz* funds, laws and facilities [10].

In recent years, the Government has actively promoted *industry and university co-operation* or *co-operation of industry, government and academia*. Taiwan's Ministry of Education even includes *performance of industry and university co-operation* as one of its items for evaluating universities. Therefore, research outcomes of universities enhance economic development and society's progress [14]. Chi recognised the factors that affect the Government's promotion of industry and university co-operation. In order to maintain national competitiveness, the Government need a high-tech R&D capability at universities, and large R&D funds from companies. The Government's understanding of laws and a common consensus on policy will influence the promotion of industry and university co-operation [10].

Views of Industry and Academia on Industry and University Co-Operation

Hans suggested that school teachers are idealists, which may reduce a company's intention to cooperate [9]. Shiu indicated that university researchers are not used to competition and, hence, do not demand efficiency and usually cannot meet the deadlines of a company. When a company changes its research direction the researchers cannot respond immediately [15]. Lin investigated university teachers in central Taiwan, and found that industry-school interaction influences the outcome of industry and university co-operation [16].

In 1993, Cheese studied British and German factories, and suggested that in order to succeed with industry and university co-operation, companies should follow the Japanese approach by carefully selecting long-term partners. Companies should be active in learning, and have a highly flexible corporate culture to effectively interact with external resources [17]. Shiu indicated that many large-scale companies suggested that core R&D capacity only exists within companies, and the research process must be carefully controlled by R&D managers.

As a result, companies prefer internal R&D, rather than industry and university co-operation [15]. Ku et al studied the views of industry, and concluded that *schools are theory-oriented, and they cannot effectively solve practical problems*, t*here are no partner schools nearby* and *lack of channels* are the top three factors resulting in ineffectiveness of industry and university co-operation [18]. According to conferences of industry, government and academia, and interviews with companies, Chen generalised the difficulties of the agricultural and fishery industry and university co-operation in Penghu, and suggested that the industries lack confidence in schools on the offshore islands, and the incubation centres of these schools cannot provide overall service demands [19].

METHOD

Following the literature review, presented in this study is a hierarchical framework of factors affecting the participation of aquaculture industry in industry and university co-operation, as shown in Figure 1. The first level is the goal level, which relates to the intention of the aquaculture industry to participate in industry and university co-operation; the second level is the objective level, which includes five evaluation dimensions: companies internal factors (CIF), companies external factors (CEF), schools internal factors (SIF), schools' external factors (SEF) and government factors (GF); the third level is attributes level, which includes 16 attributes.

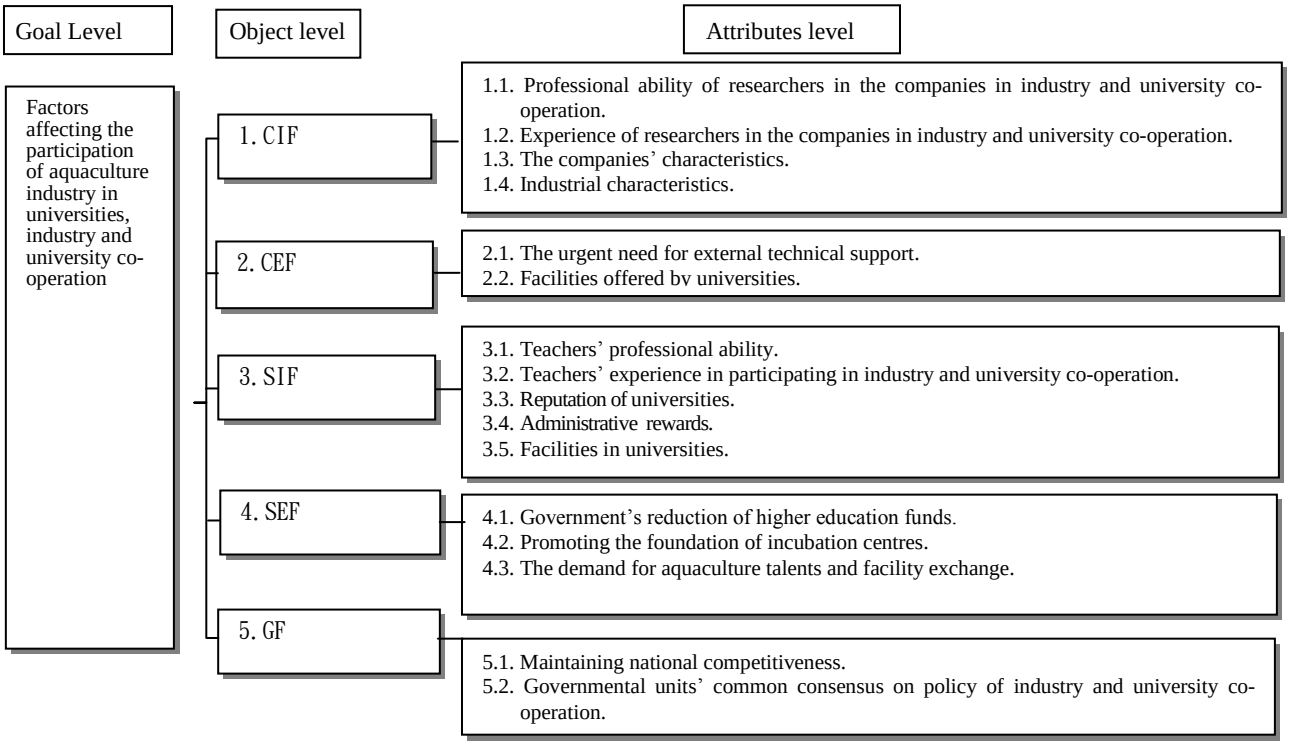

Figure 1: Factors affecting the participation of aquaculture industry in industry and university co-operatio.

The questionnaire for this study was designed using the Analytical Hierarchy Process (AHP). By purposive sampling, the researcher invited 35 representatives from the aquaculture companies and seven chairmen and senior teachers of the departments of aquaculture in universities for a questionnaire survey. A total of 42 questionnaires were distributed, and 15 were returned. The data were analysed by Expert Choice 2000.

The basic scales were based on ratings of written descriptions, including *equally important*, *slightly important*, *relatively important*, *extremely important* and *absolutely important*, with 1, 3, 5, 7 and 9 as the assigned values. In addition to the five basic scales, there were four levels (2, 4, 6 and 8). Scales to the left indicate that the left factors are more important than the right factors; the scales on the right indicate that the right factors are more important than the left factors.

After consistency testing, the researcher eliminated five questionnaires with CI$\geqq$0.1 and, hence, obtained a sample of 10 questionnaires.

RESULTS

Analysis of the First Level (Goal Level)

The evaluation criterion of the goal level is shown in Table 1. This suggests that government factors were the most influential, followed by companies' internal factors, schools' internal factors, companies' external factors and schools' external factors. According to the experts from different backgrounds, scholars or the companies, government factors were the most influential and were ranked number 1.

The finding was different from most studies on industry and university co-operation. It shows the significant role of government in fishery development. Government policies are a key factor in industry-university co-operation in the aquaculture industry. The Taiwanese Government plays a very important role in support and guidance of the aquaculture industry. If government support was lost, the industry-university co-operation programmes would collapse.

Table 1: The first level of AHP analysis.

Evaluation Factors	Companies		Scholars		Overall	
	Weight	Rank	Weight	Rank	Weight	Rank
I. CIF	0.2418	2	0.1528	4	0.2062	2
II. CEF	0.1290	5	0.2010	3	0.1579	4
III. SIF	0.1552	4	0.2248	2	0.1830	3
IV. SEF	0.1957	3	0.1218	5	0.1661	5
V. GF	0.2783	1	0.2996	1	0.2868	1

Analysis of the Second Level (Attributes Level)

The Companies' Internal Factors (CIF)

Regarding companies internal factors as evaluation criteria, the companies characteristics (including the scale of aquaculture, R&D level and the degree R&D) were the most influential, followed by industrial characteristics (including homogeneity of aquaculture industry, colleague competition and an industry's intention to upgrade), experience of researchers in companies in industry and university co-operation, and the professional ability of researchers in the companies in industry and university co-operation. Regarding the experts with different backgrounds, the results suggest that the experience of internal researchers of companies was the most influential factor in industry and university co-operation, whereas scholars treat the companies' characteristics as the priority. On the whole, companies value the participation experience of internal researchers, and scholars regard the companies' size in aquaculture and the level of R&D as the most critical factors of industry and university co-operation. It demonstrates that to enhance outcomes of industry and university co-operation of aquaculture industry, the gap between the views of industry and academia should be reduced.

Companies' External Factors (CEF)

Regarding companies' external factors as an evaluation criterion, the urgent need for external technical support was the most important factor, followed by facilities offered by universities. As to the experts of different backgrounds, the companies regarded the facilities offered by universities as the most important factor, whereas scholars considered the companies' urgent need for external technical support as the most important factor. These views are extremely different.

Schools' Internal Factors (SIF)

Regarding schools' internal factors, facilities in schools was the most important factor, followed by teachers' professional ability, teachers' experience of participating in industry and university co-operation, administrative rewards and the reputations of schools. As to the experts with different backgrounds, the companies valued teachers' professional ability the most. Scholars significantly value research facilities of the schools. The companies regarded the teachers' professional ability as the most important factor; while scholars valued research facilities in schools. Therefore, to participate in aquaculture industry and university co-operation, teachers should enhance their professional ability, and the schools should also enhance their research facilities. Thus, the teachers would no longer have an excuse to avoid participating in aquaculture industry and university co-operation.

Schools' External Factors (SEF)

Regarding schools' external factors, the demand for aquaculture talents and facility exchange was the most influential factor, followed by policies promoting the foundation of incubation centres and the Government's reduction of higher education funds. According to the experts of different backgrounds, the companies valued demand for aquaculture talents and facility exchange the most important factors; scholars considered demand for aquaculture talents and facility exchange as the most important factors. Therefore, the companies and scholars shared the same priority, and the demand for aquaculture talents and facility exchange was the most important of the schools external factors.

Government Factors (GF)

Regarding governmental factors, governmental units' common consensus on policy for industry and university co-operation was the most influential factor; the second one was maintaining national competitiveness. According to the experts of different backgrounds, the companies consider governmental units common consensus on policy for industry and university co-operation the most important factor, while scholars valued the maintenance of national competitiveness.

Analysis of Overall Attributes

Regarding the analysis of the overall attributes, weights were calculated by multiplying the weights of the second level (objective level) and the third level (attributes level). Table 2 shows the top five factors are governmental units common consensus on policy for industry and university co-operation, maintenance of national competitiveness, urgent need for external technical support, demand for aquaculture talents and facility exchange and companies characteristics. According to the experts of different backgrounds, the companies considered the following as the top three factors: governmental units' common consensus on policy for industry and university co-operation, maintaining national competitiveness and demand for aquaculture talents and facility exchange. Scholars viewed the top three factors as: maintaining national competitiveness, urgent needs for external technical support, and governmental units common consensus on policy for industry and university co-operation.

Governmental factors were included in the top two factors for companies and scholars. As Chi suggested to maintain national competitiveness, the Government needs a capacity for high-tech R&D in universities and large R&D funds

rely on the companies support [10]. For fishermen, who are a minority group, government is their most significant support. Therefore, agricultural institutions and educational officers should have a common consensus of policy for industry and university co-operation, and support schools R&D in the aquaculture industry to enhance the participation of the aquaculture industry in industry and university co-operation.

Table 2: All attributes of AHP analysis.

Evaluation Factors	Evaluation Attributes	Companies		Scholars		Overall	
		Weight	Rank	Weight	Rank	Weight	Rank
1. CIF	1.1.Professional ability of researchers in the companies in industry and university co-operation.	0.0269	14	0.0229	13	0.0261	15
	1.2.Experience of researchers in the companies in industry and university co-operation.	0.0829	4	0.0164	16	0.0512	8
	1.3.The companies' characteristics.	0.0685	6	0.0696	4	0.0726	5
	1.4.Industrial characteristics.	0.0635	7	0.0440	10	0.0563	7
2. CEF	2.1.The urgent need for external technical support.	0.0516	8	0.1574	2	0.0874	3
	2.2.Facilities offered by universities.	0.0774	5	0.0436	11	0.0705	6
3. SIF	3.1.Teachers' professional ability.	0.0328	13	0.0644	5	0.0441	11
	3.2.Teachers' experience in participating in industry and university co-operation.	0.0404	12	0.0411	12	0.0420	12
	3.3.Reputation of universities.	0.0115	16	0.0214	15	0.0151	16
	3.4.Administrative rewards.	0.0260	15	0.0523	7	0.0354	14
	3.5.Facilities in universities.	0.0444	10	0.0456	8	0.0463	10
4. SEF	4.1.Government's reduction of higher education funds.	0.0432	11	0.0447	9	0.0464	9
	4.2.Promoting the foundation of incubation centres.	0.0485	9	0.0227	14	0.0371	13
	4.3.The demand for aquaculture talents and facility exchange.	0.1040	3	0.0544	6	0.0826	4
5. GF	5.1.Maintaining national competitiveness.	0.1105	2	0.1873	1	0.1435	1
	5.2.Governmental units' common consensus on policy of industry and university co-operation.	0.1678	1	0.1124	3	0.1433	2

DISCUSSION

These research findings demonstrated that regarding individual items, scholars and companies have significantly different views. However, they both suggest that governmental factors are very influential for the participation of the aquaculture industry in industry and university co-operation. Therefore, it is suggested that agricultural and educational authorities should develop policy for industry and university co-operation, construct preferential measures and reduce the gap between the opinions of industry and universities. By doing so, schools will become involved in R&D for the aquaculture industry and the companies will be willing to cooperate with academia. In addition, it is suggested that the governmental institutions should enhance their common consensus, and offer more funds to support capacity for R&D for aquaculture departments in universities to enhance the effectiveness of schools participation in industry and university co-operation.

Secondly, this study finds that regarding companies internal factors, companies tended to value the internal researchers experience in participation. Scholars suggested that companies' size of aquaculture and R&D level were the most critical factors for industry and university co-operation. Therefore, it is suggested that related academic departments cooperate with companies for project research, product development, manufacturing improvement and the introduction of new techniques. With the support of Government, they can introduce techniques to enhance the companies' intention and effectiveness in participating in industry and university co-operation. Moreover, related academic departments should value the scale or R&D level of the companies and also participate in industry and university co-operation to assist the companies' development. The companies should actively develop a window for industry and university co-operation, exchange talents and share the resources to enhance the intent and effectiveness of industry and universities in industry and university co-operation.

Thirdly, one must regard the companies' external factors. Companies valued the facilities offered by universities as the most important factor. Scholars treated the companies' urgent demand for external technical support as the most important factor. Regarding internal factors, the companies suggested that teachers' professional ability was the most important factor, while scholars significantly valued the research facilities of schools. Their views were different.

Therefore, it is suggested that they both should try to understand their mutual demands and difficulties, exchange talents and share the resources to result in a win-win situation.

Finally, because the questionnaires were distributed during the 88 flood, when many aquaculture farmers suffered severely, they did not have the time or inclination to fill out the questionnaires. Thus, the return rate was low and the inferences were limited. Future studies could collect further data for in-depth study.

CONCLUSIONS

There are three conclusions from this study. First, regarding analytical results of schools' internal and external factors, as well as companies' external and internal factors and governmental factors, it was found that governmental factors are the most influential, affecting the intention of the aquaculture industry to participate in industry and university co-operation. The result was different from most studies of industry and university co-operation. This demonstrates the importance of the Government's fishery policy. For fishermen, the Government provided the most significant support. The support for governmental policy was the key factor for the participation of the aquaculture industry in industry and university co-operation.

Second, the top five influential factors were: governmental units' common consensus on policy for industry and university co-operation, support for schools R&D for the aquaculture industry, urgent need for external technical support, demand for aquaculture talents and facility exchange and companies' characteristics. Governmental factors were included in the top two factors of companies and scholars. It demonstrated that to enhance effectiveness of industry and university co-operation for the aquaculture industry, governmental policy was critical.

Finally, according to the experts of different backgrounds, the companies' and scholars' views differed regarding industry and university co-operation. Due to these conclusions, this study makes several suggestions. First, factors at the government level are most influential. The results showed the significant role of the Government in fishery development. The Taiwanese Government can close the gap between the views of industry and academia by intervention and policy guidance to enhance the intention and outcome of participation of the aquaculture industry in industry and university co-operation.

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