Using the Analytic Hierarchy Process technique to explore the influence factors on business and industrial liaison systems for technical institutes and universities

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ABSTRACT: This research aims to investigate the effectiveness of factors that might influence business and industrial liaison system (BILS) in technical institutes and universities. This study used the techniques of the Analytic Hierarchy Process (AHP) to solicit opinions from 20 deans of Research and Development (R&D) affairs from technical institutes and universities in high achievement BILS and 11 valid questionnaires were adopted. The results show that *the teachers' abilities and qualifications* is the most important factor on the object level. The second is *cooperative enterprise and BILS program*. On the attributes level, the top five factors of technical institutes and universities in BILS (in descending order of weight) are *the teachers' participation in BILS*, *the teachers' familiarity with research topics*, *the teachers' research abilities*, *recognition of academia and industry for mutual needs* and *the teachers' familiarity with the companies*.

INTRODUCTION

Under the impact of industrial globalisation in recent years, companies are facing fierce industrial competition and need new ideas and a value creation system to enhance industrial value urgently. Thus, developed nations value business and industrial liaison system (BILS), and emphasise that the cooperation between business and academia can not only enhance the application of research findings, but also facilitate industrial growth and enhance national competitiveness [1]. After the teachers gain practical experience through BILS, they can deliver the latest industrial techniques to the students. It could not only improve instructional quality, but could also allow the students to have the skills and professional abilities in their future workplaces [2].

In order to maintain the competitive advantages of the industries in Taiwan, the Ministry of Education has probed into the industrial demands, enhanced the cooperation between industrial circles and schools. Moreover, it provides the environment for validating the transformation of technical results, solves the problems of technical transfer, and leads to BILS between universities and enterprises [3]. However, currently, there is a significant gap between the talents cultivated by universities and the manpower demands of industry. From the schools' perspective, the causes include a lack of channels and sources of information with regard to industry manpower shortages; the long time it takes to increase and adjust the departments in the schools and to try to meet the needs of ever-changeable industries; curriculum planning that does not match the needs of industry, and cannot reflect market; having instructional facilities that aim to cultivate the students' basic professional knowledge and ability that cannot immediately be updated to meet the production devices and techniques of companies; and most of the teachers of professional subjects do not have practical work experience and, therefore, cannot effectively pass on to students the professional knowledge and abilities needed by industry [4].

Chen indicated that the promotion of BILS would not only allow companies to use the research manpower of academia to enhance their R&D capacity, but would also make academia recognise business demands, integrate current facilities and manpower and provide the specific plans for improvement in order to assist companies with R&D. With cooperation, they could complement each other and obtain the benefits [5]. Yu suggested that in order to match school instruction with the technical manpower demands of business, BILS is applied to allow the teachers and the students to participate in the production and R&D in the business field [6]. Thus, teachers' instruction and students' learning would meet the needs of the business circle, which could use the plentiful resources of the schools, such as teachers and facilities and develop various management or production related techniques and projects. Thus, by instituting BILS, universities can recognise social demands in modern time instead of being narrow-minded, and the talents cultivated would, thus, satisfy the needs of business. However, what are the factors that influence the BILS performance of technical institutes and universities? This question is the motive of this study.

In brief, this study aims to probe into the factors and rank on BILS performance in technical institutes and universities to function as the criterion for technical institutes and universities and the related government divisions with regard to BILS and policy planning. Based on the research purposes, the questions of this study are as follows: What are the factors on BILS performance of technical institutes and universities? What is the rank of these critical factors on BILS performance of technical institutes and universities?

LITERATURE REVIEW

The Teachers' Abilities and Qualifications Relating to BILS

Many studies have demonstrated that the teachers' background has an influence on the performance of BILS [7]. The factors include the attributes of the schools, positions, educational background, professional background, age, service years, work experience and departments, which affect the teachers' participation in BILS. The research of Hsiao et al indicated that comparing experienced teachers with inexperienced ones suggests that the participation in BILS has an influence on the effect of BILS [8]. Hans demonstrated that the teachers are idealistic and impractical. Thus, companies are not willing to cooperate with them [9]. Chen commented on the difficulty of promoting BILS in agriculture and fishery in Penghu. The teachers are not willing to participate and due to the instructional work load, they do not have time to be involved in BILS [10].

According to the above literature and interviews with experts, this study suggests that the teachers' abilities and qualifications include the teachers' participation in BILS, familiarity with research topics, research abilities, familiarity with the companies, titles, etc.

Corporate Enterprise and BILS Program

Chen demonstrated that a BILS program is one of the factors that has affected industrial collaboration of agriculture and fishery in Penghu [10]. Cheese investigated factories in Britain and Germany, and suggested that the model in Japan is the criterion for successful BILS [11]. In other words, factories should carefully select their long-term partners, and learn from new ideas and the highly cooperative business culture. Thus, these companies could absorb and improve themselves rapidly and effectively, and use external resources. Lin studied the factors affecting teachers' participation in business and academic cooperation in vocational colleges and institutes in central Taiwan, and indicated that industry-academic interaction would influence the performance of BILS [7].

Luh et al raised the concern about the ethical issues relating to human or animal testing, including the evaluation of benefits, agreement, danger control and management, patients' autonomy and maintenance of rights. The ethical issues related to the security of laboratories include the danger of toxic materials for workers and dealing of the radiation waste, etc. The ethical issues related to interest conflict include the obligation of confidentiality, propriety of investments and reciprocally-favoured treatment of contracts, legitimacy of interests, etc [12].

Based on the above literature and interviews with experts, this study indicates that with regard to cooperative enterprise and the BILS program, industries and academia should recognise mutual needs and have good channels of communication. Moreover, the difficulty in implementation of a BILS program, research funds and the cooperation of the companies should also be considered.

School Reputation and Administration Rewards

Raine and Beukman indicated that research in universities is important to the community, such as for creating and using scientific knowledge, attracting knowledge-based companies, providing direct and indirect job opportunities and technical experts [13]. Investigations by Hans found that to improve the effectiveness of BILS, factories and schools should be located close to each other [7]. Lin probed into the factors relating to teachers' participation in BILS in vocational colleges and institutes in central Taiwan and suggested that administration management of the schools and rewards would influence the performance of BILS. Chen found that the technical institutes on offshore islands develop later, and are not as well known. Thus, local companies and the government preferred the better-known schools in Taiwan instead of those in the regions [4]. Based on the academia-industry forum and the interviews with representatives of the companies, Chen generalised the farmers and fishermen's suggestion on the difficulties of BILS in Penghu [10]. The companies are not confident of the schools on offshore islands and the incubation centre could not provide overall services. For most of the farmers, the lack of rewards in schools would affect BILS performance. Monjon and Waelbroeck indicated that companies tend to upgrade their techniques by applying innovative knowledge acquired from overseas schools [14]. Misko et al suggested that the vocational education system must construct a solid administration mechanism, develop a close relationship with business, enhance the students' quality, absorb new skills and have sufficient funds [15]. Chen indicated that the technical institutes on offshore islands should construct the rewards for budget, facilities, teacher promotion and curriculum, and enhance the teachers' practical ability so that the teachers would be willing and could participate in BILS [4].

Based on the above literature and interviews with experts, this study suggests that school reputation and administration rewards should include educational authority treating the performance of BILS as the item in the evaluation. School rewards for the teachers who participate in BILS, school reputation and scale, integrated ability and promotion of R&D affairs in schools and the support of the board of directors or presidents are also relevant.

METHODOLOGY

The Analytic Hierarchy Process technique (AHP) includes three levels: the goal level, the object level and the attribute level. According to the teachers' abilities, companies, BILS program, school reputation and locations, school administration and organisation suggested by Chen [5], and after interviewing a director in a technology R&D centre of a university of technology and a director from an innovation incubation centre, this study generalised the factors on BILS into three facets: the teachers' abilities and qualifications, corporative enterprises and BILS program, and school reputation and administration rewards. This study further developed an AHP questionnaire.

This study then listed the factors relating to the BILS performance of technical institutes and universities, and constructed a variable hierarchical framework. The goal level is the factor on BILS performance; the object level includes three evaluation constructs: the teachers' abilities and qualifications, corporate enterprises and the BILS program, school reputation and administration rewards; the attribute level includes 15 attributes, such as the teachers' participation in BILS. The AHP framework shows in Figure 1. Based on the above factors of the object and attribute levels, the scale includes five levels - absolutely significant, very significant, relatively significantly, slightly significant, and significant (1, 3, 5, 7 and 9 points). Moreover, there are four levels (2, 4, 6 and 8 points) among five basic scales.
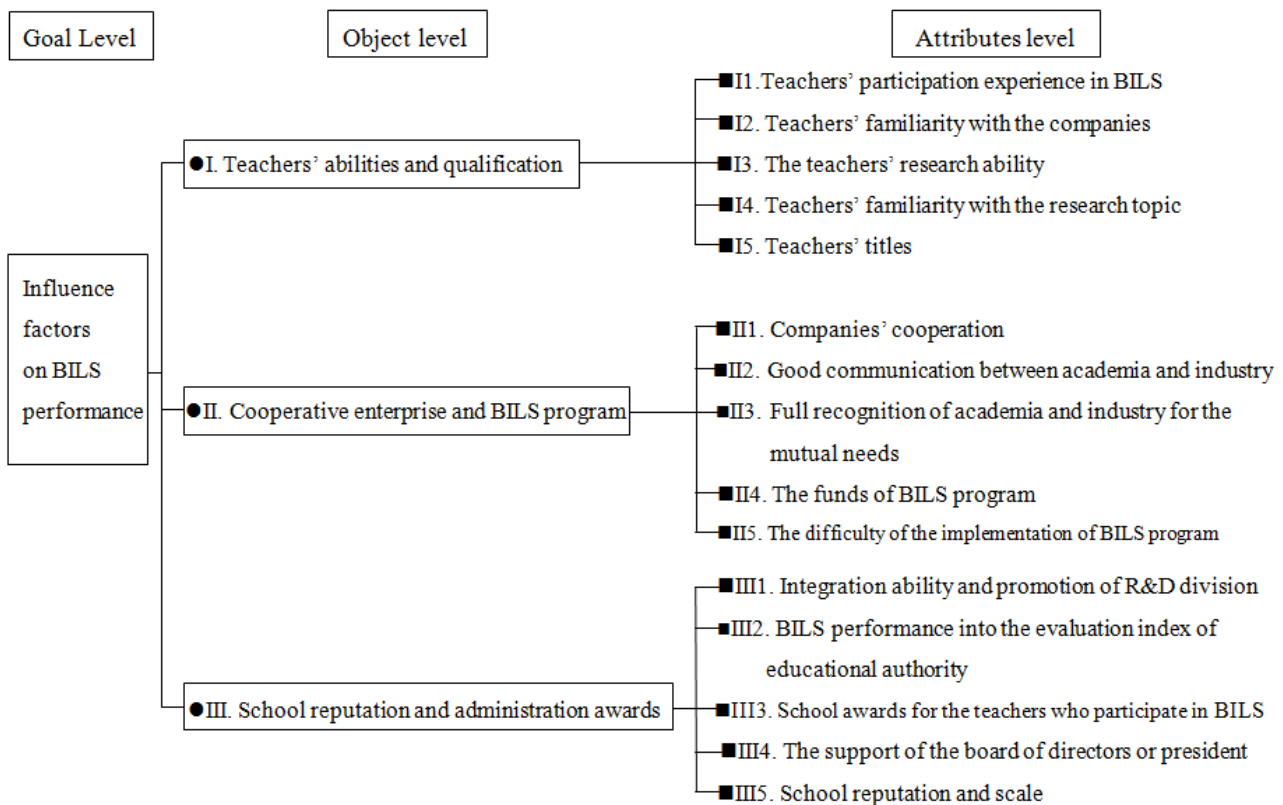

Figure 1: The AHP framework of influence factors on BILS performance.

The subjects of this study were deans of R&D affairs from 20 schools among 31 public and private technical institutes and universities with top performance on three constructs in the business and academic cooperation performances of technological university and institute in 2006 [16]. After follow-up, 15 questionnaires were returned. The data were analysed with Expert Choice 2000 software. After eliminating four questionnaires with an inconsistency index of over 0.1, there were 11 valid questionnaires for further analysis.

RESULTS

Factors that Influence BILS Performance at the Object Level of AHP Analysis

Based on AHP, this study found that the teachers' abilities and qualifications (weight 0.4647) is most important performance index, followed by cooperative enterprise and BILS program (weight 0.3855) and school reputation and administration rewards (weight is.1498). These are shown in Table 1. This means that the teachers' abilities and

qualifications is the most influential factor for BILS performance of technical institutes and universities. A school reputation and administration award is the least significant. Thus, the key to an effective BILS relates to the teachers rather than the schools. Only the enhancement of the teachers' abilities and qualifications would improve the BILS performance. Strengthening the teachers' abilities and qualifications, allowing technical institutes and universities to recognise the demands in modern society and cultivating the talents for the ever-changing industrial scene are the important issues for schools.

Table 1: The object level of AHP analysis.

Evaluation Attributes	Weight	Rank
I. The teachers' abilities and qualifications	0.4647	1
II. Corporate and BILS program	0.3855	2
III. School reputation and administration rewards	0.1498	3

Factors that Influence BILS Performance at the Attributes Level of AHP Analysis

Teachers' Abilities and Qualifications Facet

If using the teachers' abilities and qualifications as the main criterion, the comparison of the importance rating with the attributes level found that the teachers' participation experience in BILS is the most important (0.2760). This is followed by the teachers' familiarity with the research topic (0.2338), the teachers' research ability (0.2152), familiarity with the companies (0.2069) and the teachers' titles (0.0681). These are shown in Table 2. The result shows that the teachers' participation experience in BILS is the priority. Technical institutes and universities and the teachers should both enhance this aspect. The second is the teachers' familiarity with research topics and the teachers should also strengthen this.

Table 2: Teachers' abilities and qualification analysis.

Evaluation Attributes	Weight	Rank
I1. Teachers' participation experience in BILS	0.2760	1
I2. Teachers' familiarity with the companies	0.2069	4
I3. The teachers' research ability	0.2152	3
I4. Teachers' familiarity with the research topic	0.2338	2
I5. Teachers' titles	0.0681	5

Cooperative EnterpriseaAnd BILS Program Facet

If the cooperative enterprise and BILS program is taken as the main criterion, the comparison of the importance rating with the attributes found that full recognition of academia and industry for the mutual needs is the most significant one (0.2577), followed by good communication between academia and industry (0.2217), the difficulty of the implementation of BILS program (0.1894), the funds available to the BILS program (0.1722), and lastly, companies' cooperation (0.1590). These are shown in Table 3. The result shows that when academia and industry recognise mutual needs, they are more likely to realise the purposes of BILS. Continuous communication could enhance the performance of the collaboration.

Table 3: Corporate and BILS program analysis.

Evaluation Attributes	Weight	Rank
II1. Companies' cooperation	0.1590	5
II2. Good communication between academia and industry	0.2217	2
II3. Full recognition of academia and industry for the mutual needs	0.2577	1
II4. The funds of BILS program	0.1722	4
II5. The difficulty of the implementation of BILS program	0.1894	3

School Reputation and Administration Rewards Facet

If school reputation and administration rewards is used as the main criterion, the comparison of the importance rating with the attributes found that BILS performance into the evaluation item of educational authority is the most important (0.2845), followed by the school rewards for the teachers who participate in BILS (0.2337), school reputation and scale (0.1724), integration ability and promotion of R&D affairs (0.1615) and the support of the board of directors or presidents (0.1479). These are shown in Table 4. The result shows that BILS performance in the evaluation index of educational authority would facilitate the BILS. In order to have better performance in the evaluation, technical institutes and universities should fight for BILS, and reward the teachers who join in BILS. The teachers are thus motivated and BILS performance of the schools will be enhanced.

Table 4: School reputation and administration rewards analysis.

Evaluation Attributes	Weight	Rank
III1. Integration ability and promotion of R&D division	0.1615	4
III2. BILS performance into the evaluation index of educational authority	0.2845	1
III3. School rewards for the teachers who participate in BILS	0.2337	2
III4. The support of the board of directors or president	0.1479	5
III5. School reputation and scale	0.1724	3

Factors that Influence BILS Performance of All Attributes of the AHP Analysis

The priority ratio of evaluation attributes were multiplied by that of the criteria, to obtain the weight of all attributes. This is shown in Table 5. The top five attributes were shown to be the teachers' participation in BILS, the teachers' familiarity with research topics, the teachers' research abilities, recognition of academia and industry for mutual needs and the teachers' familiarity with the companies. The result shows that four of the top five attributes are related to the teachers' abilities and qualifications. Thus, BILS performance of technical institutes and universities significantly relies on these factors. The result can break through the companies' traditional preference for well-known schools. They should select the suitable teachers for BILS.

Table 5: All attributes of AHP analysis.

Evaluation Attributes	(1)Object weight	(2)Attributes weight	(3)Relative Weight (3)=(1)*(2)	Rank
I1. Teachers' participation experience in BILS	0.4647	0.2760	0.1283	1
I4. Teachers' familiarity with the research topic	0.4647	0.2338	0.1086	2
I3. The teachers' research ability	0.4647	0.2152	0.1000	3
II3. Full recognition of academia and industry for the mutual needs	0.3855	0.2577	0.0993	4
I2. Teachers' familiarity with the companies	0.4647	0.2069	0.0961	5
II2. Good communication between academia and industry	0.3855	0.2217	0.0855	6
II5. The difficulty of the implementation of BILS program	0.3855	0.1894	0.0730	7
II4. The funds of BILS program	0.3855	0.1722	0.0664	8
II1. Companies' cooperation	0.3855	0.1590	0.0613	9
III2. BILS performance into the evaluation index of educational authority	0.1498	0.2845	0.0426	10
III3. School rewards for the teachers who participate in BILS	0.1498	0.2337	0.0350	11
I5. Teachers' titles	0.4647	0.0681	0.0316	12
III5. School reputation and scale	0.1498	0.1724	0.0258	13
III1. Integration ability and promotion of R&D division	0.1498	0.1615	0.0242	14
III4. The support of the board of directors or president	0.1498	0.1479	0.0222	15

CONCLUSIONS AND RECOMMENDATIONS

The teachers' ability and qualification is the most important influence on BILS performance, followed by cooperative enterprise and BILS program and school reputation and administration rewards. The top five attributes are the teachers' participation in BILS, the teachers' familiarity with research topics, the teachers' research abilities, recognition of academia and industry for mutual needs and the teachers' familiarity with the companies. Four attributes among the top five are related to the teachers' abilities and qualifications. The result means that the enhancement of the teachers' abilities and qualifications would improve the BILS performance. The result also can break through the companies' traditional preference for well-known schools. They should select suitable teachers for BILS.

The research finds that the teachers' abilities and qualifications significantly influence BILS performance of technical institutes and universities. Thus, it is suggested that technical institutes and universities should help to improve teachers' abilities and qualifications. For instance, experienced teachers could guide the inexperienced ones to participate in BILS to increase their relevant experience. Moreover, the teachers should also be familiar with the research topics to be reliable for the companies.

The research finding reveals that the recognition of academia and industry for mutual needs is one of the critical factors relating to BILS performance. Thus, it is suggested that each party should carefully probe the needs and abilities of each other during the discussion stage, and communicate and examine the issues in the implementation stage to avoid future conflict and enhance BILS effectiveness.

The research finding indicates that school rewards for the teachers who join in BILS are significant. Thus, it is suggested that technical institutes and universities should construct the rewards system so that the teachers would be more willing to participate in BILS.

Deans of R&D affairs were the only subjects for this study and, therefore, other factors on BILS of technical institutes and universities may have been neglected. Thus, future studies could probe into the views of the supervisors in other divisions in schools, the teachers or industrial supervisors, and compare the results with those obtained in this study.

This study focused on technical institutes and universities with high BILS performance and, therefore, it neglected the views of lesser-performing schools. Thus, future studies can probe the schools with inferior BILS performance, and compare the result with those obtained in this study.

This study did not probe BILS performance of academic universities. Future studies could examine this aspect and compare the result with those obtained in this study.

ACKNOWLEDGEMENTS

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