Systematic study on key factors influencing establish automobile electronics industry clustering

From talent program perspective

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Abstract

Purpose – The purpose of this paper is to analyze the trends of global automobile industry toward energy saving and smart application. The automobile industry has its own special supply, safety and reliability system. It combined with the legislations that progressive safety driving leads to increase automobile electronic (AE) facilities and enlarges the proportion of the electronic control for vehicles. Based on matured communication and semiconductor industries in Taiwan, the government assists these hi-tech industries in entering the AE domain by clustering relevant enterprises with assembly supply chains. Flagship IC packaging and LCD panels enterprises are located in the Kaohsiung Industrial Park which possesses advantages for the clustering of AE industry.

Design/methodology/approach – In this paper, a systematic investigation on establishing AE industry cluster in Kaohsiung Industry Park (KIP) is presented. First, 42 electrical and electronics enterprises are site visited and interviewed for operation and management preferential demands. Second, problems encountered in enterprises' operation are identified through expert weight method. Third, the main factors involved in the operational management are then analyzed based on five flagship enterprises in KIP. The integration of industrial–university–government resources and assistance is demonstrated. Finally, the establishment of an innovative talents cultivation model is illustrated.

Findings – The developed systematic talent program is proposed to resolve the urgent demands in recruiting talents, operational costs and new products development.

Originality/value – This paper satisfies needs of research enterprise management. The establishment of an innovative talents cultivation model is illustrated.

Keywords Automobile electronics, Experts weighting method, Industry cluster, Systematic talent programme, Kaohsiung Industry Park

Paper type Research paper

Introduction

In the past, Taiwan's manufacturing industry focused on the improvement of production efficiency and relied on import for the key product and critical technology which result in lack of brand strength, limited market coverage and low added value. For the past decade, the foundation for economic growth can be solidified through the upgrading of traditional industry and the enhancement of manufacturing service competence. Nowadays, Taiwan has been optimizing the industrial structure by cultivating emerging technologies and forming the new comparative advantages of the industries by developing soft power (IDB, 2017a, b). Taiwan Government vigorously assists enterprises to transform/upgrade new techniques by providing academia and research institute mentors for the traditional

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manufacturing industry. More value added and high-end products have been marketing due to intelligent manufacturing.

Automobiles are evolving along an axis of lightweight, cleanness, electrification and intelligence. In general, automobile electronics (AE) are categorized into two groups: electric control integrated with mechanical components, such as engine control, stand-alone electronics, such as GPS. AE consists of car body and panel, engine and power train, power electronics, chassis and suspension, security and safety and infotainment. As the progress of electronic control technology, mechanical control in vehicles has been gradually replaced by semiconductor components. AE devices provide various features, for instance, carputer, electronic control unit, blind spot detection (BSD), collision avoidance system, internet of vehicle and telematics, etc. Vehicle-used chipsets market is undergoing a large scale of global growth with the driving information and safety driving (Hsiao, 2017). Drivers are much more concerning with the safety of the vehicle than its performance, entertainment and energy saving. Meanwhile, the legislation on the safety compliance advances the development of safety technology. The USA, EU and Japan already carried out mandatory requirements on anti-lock braking system (ABS), electronic stability control and tire pressure monitoring system (TPMS). In EU, a prescriptive requirement on autonomous emergency braking system for anti-rear-end collision is under legislated (Wu, 2017). Therefore, there is a definite demand for the enhancement on autonomous cars or self-driving cars technology.

Although Taiwan's semiconductor industry possesses some advantages in respect of microcontroller system, power electronics module and sensor technology, its mastery of AE manufacturing and testing standards is still behind the world-renowned corporations, such as Infineon, Micron, ON semiconductor, STMicroelectronics, etc. Taiwan AE industry is looking forward to upgrading techniques specialized in vehicle to everything (V2X), durability against harsh environment and AEC qualification (Zhao and Shi, 2010). The advantage of Taiwan's industry consists in the supply of semiconductor components, in particular, of security and infotainment. Taiwan's industry is characterized by its capacity for design and manufacture of vehicle parts, and the quality of system integration of full-car has been well recognized in the international market. Taiwan's AE industry has been developing rapidly and the export volume of integrated system is increasing yearly (Automotive Research and Testing Center, 2016). Most Taiwan factories earn the advantage of flexible manufacturing in small volume-large variety production. Owing to the limited domestic market scale, most AE products are manufactured and exported to the target wholesale markets in the USA and EU (Chen, 2018).

At the moment, 42 enterprises involving in electronics industry (including IC, electronics components, mechanical and electrical parts, information and audio-visual products, household appliances and other trades) in Kaohsiung Industry Park (KIP). Flagship IC packaging and LCD panels industries are located in KIP, which possesses advantage for the clustering of AE industry in Taiwan. Some of enterprises have been received the automobile quality certification of ISO/TS 16949 and AEC-Q104, respectively. This would imply that the manufacturing quality and packaging/testing for fabrication of AE products are steadily pushing forward in the park. Therefore, this study focuses on site visiting and interviewing, identifying enterprises' demands and establishing an innovative talent cultivation model.

Systematic study is divided into four stages. Stage 1 deals with interviews with the enterprises, and gathering and sorting out of their demands. Stage 2 describes the expert interviews the understanding of the main problems arising from the operation and management of the enterprises within the scope of electronics and electrical domain. Stage 3 emphasizes the importance ranking of all demands using expert weight method. Stage 4 establishes the innovative talent cultivation model.

This paper is organized as follows: the first section presents Introduction, followed by Literature review, Research methods and Cases study, and the last section deals with Conclusion and suggestions.

Literature review

Zhao and Shi (2010) reported that three main respects and future developments in autonomous cars define the major AE sub-systems including telematics, electric vehicle control and motor control system and safety assistant driving system. Among which, the critical semiconductors contain vehicle-used micro-controller unit, power device and image sensors.

Denso, the largest electronic system supplier in Japan, specializes in sales of car-mounted satellite navigation system, such as NAVIRA and NAVISTANT, a PDA socket-type apparatus combining both software and hardware. Besides, Denso is also developing new AE products, such as antenna controller and electronic toll collection. This is a typical instance demonstrating the AE manufacturer leading Japan Government project intelligent transport systems with AE products (Shi, 2006).

Frost and Sullivan (2012) carried out an investigation on the advanced video driving assisting system available in North America and Europe. After assessing the rear-view camera, driver monitoring, BSD, surround view and infrared night-vision system, they pointed out that the demands for AE products in North America and Europe in 2018 would be video and image systems, which has been confirmed. In 2020, autonomous cars can be achieved by integrating GPS, V2X, light detection and ranging (LIDAR) and BSD systems. According to a survey on vehicle new technology, the main consumption demand is the integration of vehicle-used electronics, navigation system, safety and advanced sound system (J.D. Power and Associates Reports, 2018).

As the relevant legislations on vehicle safety are becoming more rigorous, the USA, EU and Japan are the three most active countries in this respect. Technologies applied in ABS, TPMS and dashboard camera are well developed and mandatorily listed in the automobiles. More often than not, the traffic legislations in the USA and EU play the roles of benchmark around the world. Once these regulations are implemented, it is estimated that there would be more countries passing mandatory legislations on vehicle safety. This would drive the demand for the entire vehicle safety driving system in the global market (Liao *et al.*, 2013).

Taiwan External Trade Development Council, TAITRA (2018) and Society of Automotive Engineers pointed out that the market of AE in the USA will have a huge demand for the talents referred to this field.

According to a survey on talent supply in IC design, panel interface, communication, cloud computing and big data enterprises, difficulty encountered in talents recruitment is industry innovation (National Development Council, 2018). For instance, entry-level engineers in software design, electronics engineering and system analysis require college graduate with two to five years working experience.

Ministry of Labor (2018) pointed out in the Survey on Existing Condition of the Labor Shortage and Countermeasures that manufacturing industry exists a huge demand for the professionals in the domain of electronics, optical products and electronic components. The survey also revealed that enterprises have encountered difficulties in recruiting new staff, which are caused by "the applicant's skills fail to meet the job requirements" and "the scope of business and the working environment have no attraction to the applicants." The difficulty confronted by the employers is that the applicant's skills fail to meet the job requirements. For youths age from 15 to 29, unmatched expertise or skills results in plight of job seeking. The analysis indicated that there exists a gap between the supply of higher education and the demand of industry, i.e. learning-applying mismatch.

As the global automobile industry is advancing toward electrification, electronization and intelligentization, the demand for the development of critical techniques in AE and electric vehicle becomes more urgent. Of which, interdisciplinary talents in the domain of batteries, power control modules and integration of the charging facilities are active demand. Besides, skilled research engineers and international marketing professionals are hard to recruit. Moreover, recruiting oversea talents is an alternative solution for these serious manpower shortage enterprises (IDB, 2018).

National Development Council (2018) pointed out that both human resources and financial in Taiwan's industry are insufficient to further development. IDB (2017a, b) believed that integration of education-job match is still the major focus attracting the industry attention. This survey reported that the threshold working experience for crucial positions is mainly two years. Evidently, new graduates hardly fulfill the requirements of critical job due to lack of practical experience. Consequently, enterprises have to employ foreign worker and oversea high-level talents.

Wei *et al.* (2017) reported that operation and management demands were different for enterprises located in export processing zones and industrial areas. The enterprises in the export processing zones (KIP) focus on recruiting talent, while employees training is the major concerned in the industrial areas. In respect of the assistance from government resource, all enterprises expressed an urgent demand for sourcing and introducing new technology. Enterprises recognized that the government assistances are techniques upgrading and practical training programs. However, most enterprises have not established intensive collaboration with the neighboring universities and research institutes. This would result in little resource for technique upgrading and talent recruitment.

The USA, Germany and Japan are the leading countries across the world in respect of the vehicle manufacturing technology and have become the major markets for AE products. Market demands in these developed countries would speed up the global promotion of AE manufacturing. Supported by Taiwan Government, enterprises of information and communication technology (ICT) energetically stepped into the global AE industry ecosphere. Based on a consolidated foundation in ICT, enterprises are able to develop the AE ecosystem; however, enterprises are falling behind in the development of AE industry cluster in Taiwan. The AE products require reliability in the harsh environment which is different from regular ICT products. Due to licensing by original international factory, it is suggested that stand-alone electronics, driver information, infotainment, security and safety systems would be the pitching-in level, followed by engine power train and chassis suspension. The 2020 Taiwan Industry Development Strategy defines that vehicle industry will be developing in the direction of intelligent EV, electric scooter, autonomous, etc. The ICT industry is encouraging and evolving toward the direction of intelligent AE system applications (Liao *et al.*, 2013).

Research method

Systematic studies including site visit and interview, expert weight method and talent cultivation model are demonstrated in Figure 1.

Site visit and interview enterprises in KIP

The purposes of site visit and interview with enterprises are identify enterprise preferential demands, collaborate with university in new techniques development, apply for government resources. The interviewees are mainly operation and management supervisors, such as

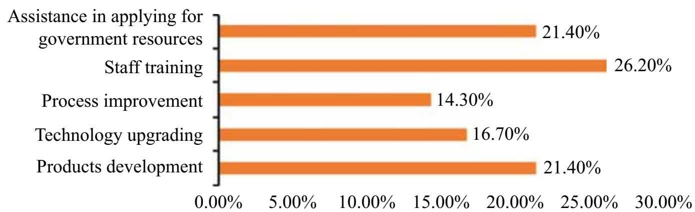


Figure 1. University capability and expertise

senior managers, engineering technique directors and R&D directors. On account of the differences in capital scale, number of employees, business classification and aggregated distribution, the in-depth interview focused on the existing and potential problems for future development. A comprehensive analysis for 42 electrical and electronics enterprises in KIP was conducted to classify the overall problems (innovation, management, recruiting, manufacturing, marketing, environment protection, industrial safety). The interview quantitative indexes are obtained from the study of the operation and management.

Most enterprises are comparatively cautious in protecting their techniques and intelligence properties. Questionnaire leaving blank or incompletely response to the question would impact the reliability and the validity of analysis. In this study, enterprises information are confidential and only effective questionnaires are analyzed.

Expert weight method

Bao *et al.* (2018) proposed the experts weighting method, in which representative, authoritative, earnest and responsible experts who were familiar with the scoring criteria conducted evaluations and provided appropriate scores within the specified range. In this method, a score is assigned to represent the importance of a variable according to the evaluation by experts on the basis of their professional knowledge, then, the importance of each variable i is divided by the importance of another variable j to obtain the degree of override of variable i over variable j. Suppose that the total number of variables is s, then, the number of ratios would also be s, and thus the mean importance of variable i could be estimated.

Override is defined as follows: the ratio of the importance values of variables i to j is called the override of variable i over variable j. According to this definition, if the override of variable i over variable j is higher than 1, then the importance of variable i is higher than that of variable j; conversely, if the override of variable i over variable j is less than 1, then the importance of variable i is lower than that of variable j.

The implementation steps are described as follows:

(1) Taking variable 1 as the benchmark, n experts are invited to score the importance of s variables, and the importance relationship matrix β is established:

$$\beta = \begin{bmatrix} 1 & \beta_{12} & \cdots & \cdots & \cdots & \beta_{1s} \\ 1 & \beta_{22} & \cdots & \cdots & \cdots & \beta_{2s} \\ \vdots & & & & & \\ \vdots & & & & & \\ \vdots & & & & & \\ 1 & \beta_{n2} & \cdots & \cdots & \cdots & \beta_{n2} \end{bmatrix}. \quad (1)$$

(2) According to the professional knowledge of each expert, the first variable is given a "100" as the perfect score to make a matrix X:

$$\mathrm{X} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ \vdots \\ x_n \end{bmatrix}. \quad (2)$$

(3) Multiply the matrix β by a matrix to make a matrix for the scores of the variables T:

$$T = \beta \cdot X = \begin{bmatrix} A_1 & A_2 & \ldots & \ldots & \ldots & A_s \\ B_1 & B_2 & \ldots & \ldots & \ldots & B_s \\ \vdots & & & & & \\ \vdots & & & & & \\ \vdots & & & & & \\ S_1 & S_2 & \ldots & \ldots & \ldots & S_s \end{bmatrix}. \quad (3)$$

(4) Matrix T the first row of elements, divided by the columns after the other rows to construct the matrix $\hat{T}$.

(5) This s matrix $\hat{T}$ after the n columns of elements are added, they are arranged in a matrix T*.

(6) Do this T* matrix transposed into a matrix $T^{r'}$.

(7) Will $T^*/T^{r'}$ get the matrix TT, matrix TT can understand the relationship between the variables.

Each variable r overrides variable j to some degree (t_{rj}), though it also possesses a degree of being overridden by variable j (t_{jr}), thus (t_{i1}/t_{1i}, t_{i2}/t_{2i}, …, t_{is}/t_{si}), $i = 1, \ldots, s$. The elements in this vector could be expressed as variable i divided by the degree to which variable i overrides variable j. The sum of the elements in each i column is calculated, with a greater value indicating a higher importance for the variable ith in relation to the other variables.

Innovative talents cultivation model

As mentioned before, the integration of education-job match is the major concern and two-year practical experience for crucial positions is required in the industry (IDB, 2017a, b). Apparently, the new graduates are difficult to apply the main jobs to the industry owing to lack of practical experience. Insufficient skilled R&D and techniques in Taiwan is the Achilles' heel for industry to conduct technology upgrading and transformation. This indicates that the higher level research talents cultivated by universities are not ready to work in the industry and new developed technologies are not able to successfully introduced into the industry. In respect of technology, new products development and manufacturing process are still the main issues for techniques breakthrough which can be outsourcing from universities and research institutes.

Preliminary results are demonstrated that the following

Enterprises' demands. Site visiting and interviewing allow enterprises identify the critical problems encountered in the operation and management. Enterprises' demands from universities, research institutes and the government were also explored in this research.

Universities–enterprises–research institutes collaboration.

(1) Independent study: based on the enterprise's proposal, teachers and students conduct the independent project. Some of manufacturing-oriented projects require enterprise–university–research institute joint cooperation. Through the presentation of study results, suitable trained students may be picked up by the employers.

(2) Internship in enterprise: enterprises provide practice site for student internship and apprenticeship, students gain the working experience and enterprises resolve the labor shortage (both short term and long term).

(3) Factory tour: in-depth visiting for students to experience the workplace and job searching.

(4) Expert lecture: industry experts and foreign scholars are invited to the campus to deliver speech related to the trends of AE technology.

(5) Industry–academy forum/seminar: specific topic of technology development, business trend, government policy and talent in AE industry are presented.

(6) Problems-solving competition: Taiwan Vehicle Electronics Consortium (TVEC) is invited to co-host the competition. Enterprises from KIP assigned the topics and scored the results, students solved the problem with creativity and implementation. A nationwide "Vehicle Electronics Creativity Competition" has been held for the past six years. Some of talent students receive many offers from the flagship enterprises.

Staff on-the-job training. Employee on-the-job training and advanced technique training programs collaborated with university–research institute are developed in KIP. A tailor-made master program called "Industry Technology Graduate Program in Automotive Electronics" is also organized to enhance the employees' knowledge and skills in AE domain.

Case study. This section consists of four parts. Part 1 presents the site visit and interview results with 125 enterprises and special focus on 42 AE associated enterprises in KIP. Enterprise preferential demands, university capability and expertise and government resources are carefully investigated. Part 2 discusses the demands change of the five interviewed enterprises from 2016 to 2018. Part 3 marks the major critical problems encountered in the operation by focusing on the 21 industrial experts. Part 4 defines the establishment of an innovative talent cultivation model:

(1) Site visit and interview AE associated enterprises in KIP:

- Enterprises' preferential demands.

  Table I lists enterprises' preferential demands in five classifications: in R&D innovation, 28.4 percent focus on development of new products; in management and talents, 45.8 percent on recruitment of talents; in manufacturing, 43.5 percent on yield rate control and improvement; in marketing channel, 30.9 percent on marketing strategy; in environmental protection or industrial safety, 40.6 percent on energy saving and carbon reduction.

Classification	Item	Times	Percentage
R&D innovation	Application of new materials	19	25.7
	Development of new products	21	28.4
	Design of new process	17	23.0
Management and talents	Recruitment of talents	27	45.8
	Patents	8	13.6
	Staff on-the-job training	16	27.1
Manufacturing	Automation of manufacturing facilities	24	38.7
	Yield rate control and improvement	27	43.5
	Testing and simulation analysis	9	14.5
Marketing channel	Establish brand image	12	21.8
	Channel expansion	13	23.6
	Marketing strategy	17	30.9
Environmental protection or industrial safety	Energy saving and carbon reduction	26	40.6
	Green production	19	29.7
	Safety environment implementation	13	20.3

Table I. Enterprises' preferential demands

- University capability and expertise.

  Figure 2 illustrates university capability and expertise for staff training (26.20 percent), products development (21.4 percent) and assistance in applying for government resources (21.4 percent).

- Government resources.

  Figure 3 shows government resources for technique support (30.9 percent), tax credit of investment accounts (18.2 percent), establishment of products standard (10.9 percent) and increase foreign worker quota (10.9 percent).

(2) Demands of five interviewed enterprises from 2016 to 2018.

Five enterprises have agreed to take interviews from 2016 to 2018. A renowned IC packaging and testing flagship enterprise, T-Company specializes in the packaging of integrated circuit boards and the relevant testing service. T-Company has received TS 16949 certification and the products have been applied to various applications, such as mobile communication, touch control IC, USB 3.0, cameras and cell phone memory cards, medical supplies and vehicle-used sensors, etc.

Figure 4 presents the demands of the T-Company: new process design in R&D and innovation, talent's recruitment in management and talent, yield rate control

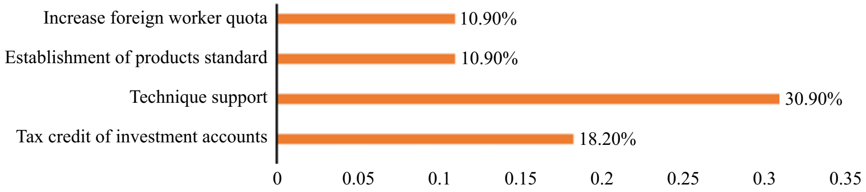


Figure 2.
Government resources

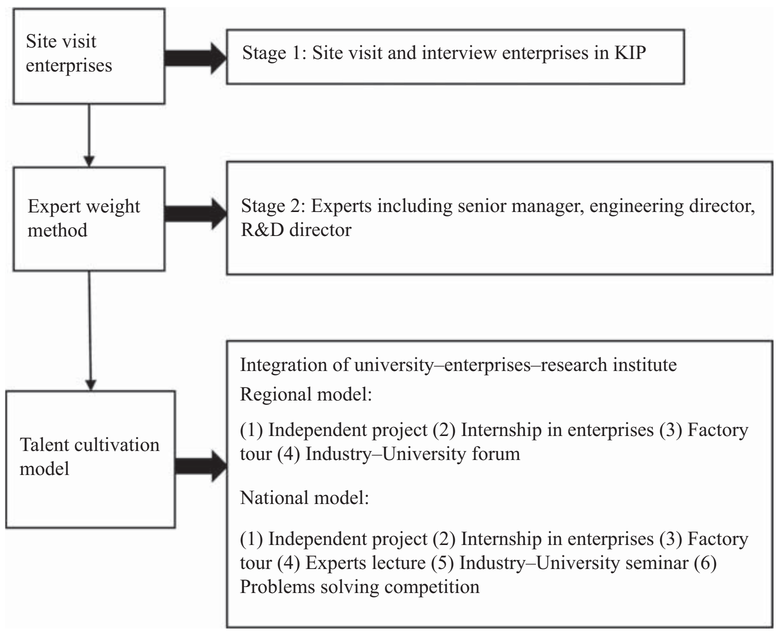
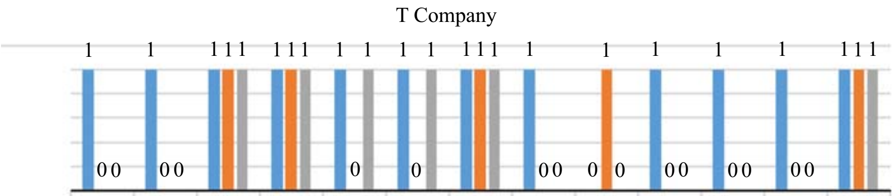


Figure 3.
Systematic studies in this paper



	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	A			B		C			D		E		
2016	1	1	1	1	1	1	1	1	0	1	1	1	1
2017	0	0	1	1	0	0	1	0	1	0	0	0	1
2018	0	0	1	1	1	1	1	0	0	0	0	0	1

Notes: A. R&D innovation: (a) application of new materials; (b) development of new products; (c) design of new process. B. Management and talents: (d) recruitment of talents; (e) staff on-the-job training. C. Manufacturing: (f) automation of manufacturing facilities; (g) yield rate control and improvement; (h) testing and simulation analysis. D. Marketing channel: (i) marketing strategy; (J) logistics management. E. Environmental protection or industrial safety: (k) energy saving and carbon reduction; (l) pollution prevention; (m) safety environment implementation

Figure 4.
T Company

and improvement in manufacturing, safety environment implementation in environmental protection or industrial safety.

Job vacancies in the manufacturing industry are primarily involved in skilled worker, machines operators and assembling workers. Higher lever jobs, such as professionals, technicians and professional assistants, are the second choice. Among the manufacturing industries, computer-based electronic optical products and electronics parts have a greater demand for professionals (Ministry of Labor, Ministry of Education and Ministry of Economic Affairs, 2018). Based on the investigation results of the employment of the young labors aged from 15 to 29, the main difficulty in recruiting new employees lies in the lack of working experiences of the job seekers (Ministry of Labor, 2018).

(3) Main problems arising from the operation and management.

In order to screen out the main problems existing in the electrical and electronic industry 21 experts, such as senior manager, engineering director and R&D director have been in-depth interviewed to point out the critical issues in the operations. Despite a small amount of the questionnaires was distributed, all the experts have extensive experience in the industry. In total, 21 experts have scored the integrated comments on the main problems and listed in Table II.

An importance ranking regarding the demands of enterprise was conducted through expert weight method and a relation matrix was computed. Based on the implementation steps described in expert weight method, first, the importance ranking matrix T was determined in Table III. Table IV presents the transposed matrix of T matrix in Table III.

From Tables III and IV, an importance ranking of expert-given matrix was obtained through expert weight method, as shown in Table V.

In Table V, a ranking was derived from the expert's importance matrix of the main problems encountered in the operation according to the magnitude of the summation of each line. It indicated that "Difficulties in recruiting new staff" is the top priority, "High operation cost" is the second problem needed to be solved and "Development of new products" ranks the 3rd, while "Lack of R&D and technical talents" and "Market

	Difficulties in recruiting new staff	High operation cost	Lack of R&D talents	New product development	Market deployment and competition
1	84	78	70	62	82
2	80	70	60	60	68
3	91	81	72	72	66
4	80	80	80	80	72
5	83	83	83	83	70
6	73	77	77	77	61
7	88	78	78	78	74
8	86	82	74	74	66
9	84	84	84	80	78
10	87	87	74	74	82
11	70	80	79	70	80
12	75	78	78	78	90
13	82	75	68	68	91
14	74	70	78	78	85
15	78	78	71	68	83
16	84	74	78	84	74
17	89	84	84	87	79
18	74	74	89	80	78
19	71	70	80	78	68
20	88	60	75	91	68
21	86	72	70	85	78

Table II. Integrated comments on the main problems from 21 Experts

21	22.32534	22.56944	22.5164	22.77433
19.96148	21	21.28511	21.34911	21.50238
19.85697	20.93703	21	21.03166	21.35038
19.85866	21.07748	21.09605	21	21.45475
19.73537	20.826	21.03435	21.07784	21

Table III. Importance relationship matrix T using expert weighting method

21	19.96148	19.85697	19.85866	19.73537
22.32534	21	20.93703	21.07748	20.826
22.56944	21.28511	21	21.09605	21.03435
22.5164	21.34911	21.03166	21	21.07784
22.77433	21.50238	21.35038	21.45475	21

Table IV. Transposed matrix T^t

1	1.118421	1.1366	1.133832	1.153985	5.542839	0.221	1	Difficulties in recruiting new staff
0.894117	1	1.016625	1.012887	1.032478	4.956108	0.198	2	High operation cost
0.879817	0.983646	1	0.996948	1.015024	4.875435	0.194	4	Lack of R&D and technical talents
0.881965	0.987277	1.003062	1	1.017882	4.890185	0.195	3	Development of new products
0.866562	0.968544	0.985198	0.982433	1	4.802736	0.192	5	Market deployment and competition
					25.0673			

Table V. Importance matrix and ranking using expert weighting method

deployment and competition" rank the 4th and the 5th, respectively. Obviously, lack of manpower and talents are the urgent crisis for enterprises to develop the AE cluster in KIP. However, 21 experts expressed that newly graduated students without any working experience would not be the priority. Headhunting or poaching experienced talents may be another option, and this would result is a deplorable shortage of manpower in such fields. Betray confidential information and criminal prosecution for job-hopper, even worse for employer, were occasionally reported in hi-tech industry.

(4) Innovative model for talent cultivation.

Since recruiting newly graduates without two-year working experience is not the option and headhunting experienced talents would result in opposite effects, enterprises are keen to establish talent cultivation program with academia (university and vocational school) (Yen *et al.*, 2018). From Table V, in addition to difficulties in recruiting new staff, the main problems existing in electronics and electrical industry are high operation cost and development of new products, lack of R&D and technical talents and market deployment and competition. By focusing on AE industry, the innovative talents cultivation model proposed in this study is including the above categories to improve the collaboration between the industry and university.

In accordance with the topic assigned by AE industry, students and professor carried out the independent project and investigated the process technique or new products. The final results would be presented in Industry–University forum/seminar. Moreover, one-year internship in enterprises for vocational school straitened students would activate an increase in manpower in enterprise. Experts deliver lectures in the class would gain the mutual acquaintanceship. The committee in TVEC has urged that the "Problems Solving National Competition" in AE will gather the targeted students and professors at all universities in Taiwan. Experts from AE industry distribute the problems and review the final results.

With these developed roadmaps, students gain more problem-solving skills and working experience in a specific domain and enterprises may pick up those graduates who fulfilled the requirements. In the meanwhile, on-the-job staff may strengthen the AE techniques by taking practical courses, technology forum and workshop. Even more, special class of "Industry Technology Graduate Program in Automotive Electronics" will enable the enrolled employees to study and earn both knowledge and technology. The developed systematic talent cultivation model is illustrated in Figure 5. However, research institute might be collaborated with the university for talent cultivation.

The plan name with explanation in Figure 5 are listed as follows:

(1) Independent project: development of new products, process, techniques in AE industry.

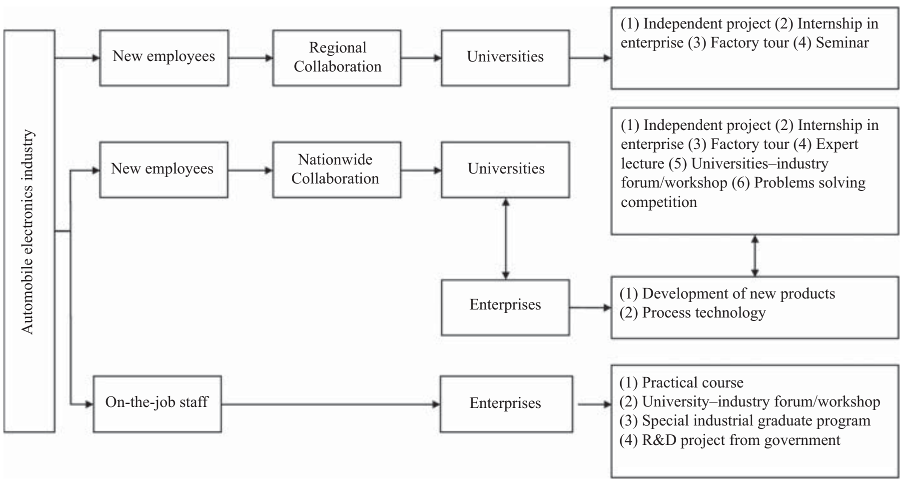


Figure 5.
Schematic illustration of systematic talents cultivation model

(2) Seminar: discussion on technology trends in AE industry.
(3) Factory tour: in-depth visiting enterprises' workplace.
(4) Internship in enterprise: enterprises provide one-year practical training for vocational school students.
(5) Expert lecture: invite experts/scholars in AE (both domestic and abroad) to deliver keynote speech.
(6) Technology forum: discussion on AE market and products supply chain.
(7) Problems-solving competition: conduct a creative and innovative problems-solving nationwide competition of smart AE products.
(8) Practical course: AI technology in AE applications (big data, deep learning, machine vision and V2X).
(9) Workshop: discussion on AE techniques from industry–academy–research institute.

Conclusion and suggestions

Conclusion

In this paper, 42 enterprises from KIP expect to solve their preferential problems: development of new products, recruiting new staff, yield rate control and improvement, marketing strategy, energy saving and carbon reduction. Enterprise would like to collaborate with universities for assistance and expertise in staff training, products development and government R&D projects. For government resources, technique support is the most urgent demand, furthermore, tax credit of investment accounts, establishment of products standard and increase foreign worker quota are also enterprises' demands.

This research focused on the electronics and electrical enterprises seeking to develop AE industry cluster in KIP. The main problems encountered in operation and management have been carefully investigated by using expert weight method. It is found that difficulties in recruitment is the major concern, followed by high operation cost, development of new products, lack of R&D talents, and lastly by marketing deployment and competition.

It should be noted that networking and long-term collaboration are the key factors for facilitation of an industry cluster. It is also found that little interaction between enterprise and academia-research institute would result in less new techniques development. External resources from academia, research institute and vocational training institute could be introduced to resolve problems and a denotative referential proposal has been reported to the KIP Administration Office.

Technology developed in AE industry mainly relies on skilled R&D and experienced talent. In this paper, the interviewed enterprises involving in the upstream and downstream sectors of intelligent AE are components of vehicle-used panel, IC, sensors (tire pressure, temperature and humidity), motor control, power module, etc. In connection with enterprise–university–research institute–government resources, this research proposes a systematic talent cultivation model to improve yield rate, process quality and new products development. Technique upgrading and transformation for AE enterprises and supply chain would be gradually formed a cluster in KIP.

Suggestions

For the past decade, advancing in technology progress results in enlarging gap between universities and industry. The unemployment problem on youth, especially for new graduates is the highlight in Taiwan. These peculiar situations have been attracted many researchers' attention. An integration of the enterprise–university–research institute–government resources has been proposed to deal with the problems. However, the proposed methods still depend on industry demands. As R&D talents cultivation is the key element to AE industry, the government is expected to assist in techniques upgrading, talents recruitment and learning-applying match. Based on the innovative talent cultivation model developed in this paper, it is suggested that future researches should pay more attention to talents shortage in AE industry.

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