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Key Training Items Search of Manufacturing Assessment Based on TTQS and GA-SVM

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Abstract: In Taiwan, the Government designed a system called Taiwan Train Quali System (TTQS), which helps the enterprises to build up a quality control and training system for strengthening their competition and rising up the performance. In order to help the enterprises to focus on the important assessment items, there were some researchers using the GA-SVM algorithm to find the key training items of TTQS for the business growth. However, those researches were only for the analysis result of all industries, also they were not have further consideration about the characteristics of the individual industry and the classification according as the turnover growth rates, which can not directly relate to the assessment result of TTQS. Thus, the proposed paper amended the analysis based on the TTQS assessment scores and also further aimed at the key training items of manufacturing, which decreases money wasting and speed up the efficiency training. According to the experimental results, the manufacturers should focuses on the training plan and its purpose, the training monitor and performance must be caution as well, to helping the enterprises can choose their priority items to modify by their industry characteristics.

Key words: Training quality, TTQS, genetic algorithm, support vector machine

INTRODUCTION

In Taiwan, in order to strengthen the enterprises competition and rise up their operation, human resource training is always the main point. Bureau of Employment and Vocational Training (BEVT) allowanced the enterprises and the organization to train the personnel and helped to upgrade their manpower for the competitive ability. Moreover, BEVT would ensure those enterprises training quality and outcome, also referred to the international standard, like England IIP (Alberga *et al*., 2007) and ISO 10015 Quality Standard (ISO, 1999; Lin *et al*., 2010) in addition referred to the policy and culture of Taiwan workplace training, they specially designs a system called Taiwan Train Quali System (TTQS) (Huang *et al*., 2010; Wong *et al*., 2010; Yeh, 2012). This system helps the enterprises to build up the standard and institutionalization of training quality and management to carry out enforcement, supervision, investigation and maintaining a better training result to achieve the policy purpose of cultivate and strengthen manpower and raises up the competition of the industries. According to BEVT standard, TTQS subsumed five training processes: Plan, Design, Do, Review and Outcome (PDDRO), total 21 assessment items, the content lists on Table 1 (Huang *et al*., 2010). It also means that TTQS separated the training processes into PDDRO five managements and devised its managements suitable for its assessment items and used these 21 assessment items to exam enterprises training quality, it gives each item the score of one to five and total is 105, if the score not reaches above 53, then the enterprise training quality is "Fail" on TTQS, otherwise, it meets the four level as "Golden award, Silver award, Bronze award, Pass", which to evaluate the enterprise training efficiency by quantifying. TTQS supplies to the enterprises a reference

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Table 1: Training processes and assessment items in Taiwan Train Quali system

Training processes	Assessment items
Plan	Disclosure of the vision, mission and strategy of organization and defining business objectives and organizational needs
	Defining training policy
	Defining types or areas of core training
	Training quality system and documented quality manual
	Application of competency analysis related to training processes
	Conformance of training plan to achievement of business objectives
	Competence of personnel performing work affecting training quality and coordination of training-related competency
Design	Criteria for selecting training products or services
	Participation process of the interested parties
	Combining training to needs and objectives
	Systematic design of training plans
	Standardization of purchasing procedures for training-related products and services
Do	Trainee, materials, instructor and teaching methods' proper plans
	Transfer the learning result to the working enviroument
	Classification and documentation of training records and level of management information system implementation
Review	Evaluation report and periodic integrated analysis
	Monitor of execution process and corrective actions
Outcome	Diversity and integrity of training outcome evaluation
	Working performance of trained employees
	Organization diffusion effect of training
	Special training achievements

of standard processes (Huang *et al*., 2010; Wong *et al*., 2010; Yeh, 2012).

Actually the enterprises are difficult to look after those 21 assessment items in the limited operation resources, in the meantime, by the view from the enterprises operation effects, the limited resources first be used on the important business items. Therefore, Huang *et al*. (2007, 2010) and Chen *et al*. (2012) continued to apply the GA-SVM algorithm (Chen *et al*., 2005) which is a combination from the Genetic Algorithm (GA) (Leardi *et al*., 1992; Coley, 1999; Konak *et al*., 2006) and Support Vector Machine (SVM) (Aggarwal *et al*., 2010; Fan *et al*., 2008; Hsu and Lin, 2002; Ichihashi *et al*., 2011; Martens *et al*., 2009), they used it to select the combination of assessment items, found the most important items to influence the enterprises operation effects and be the prior execution of the enterprises and to a better training target, on the one hand it led in a training standard for the training process basis, on the other hand it supplied the reference of express quality working procedure.

However, those researches only for the general overall analysis, they can not display characteristics from the different industries. At the same time, Huang *et al*. (2010) proposed the optimal combination of key training items which are based on the enterprises turnover growth rate. However, there are so many reasons of affecting turnover growth rate, like long-term capital expenditure, high price facilities investment, economic environment and more. Therefore, it was not objective to evaluate by one-year turnover growth rate. Thus, this study proposed a data reduction method based on TTQS and GA-SVM and used it to find the key training items of industry such as manufacturing by the TTQS assessment scores and be the training index of manufacturing to achieve the purpose of the first priority to invest resources and promote manpower management quality.

Besides, according to TTQS assessment standard and scores, TTQS assessment can be five levels as Golden award, Silver award, Bronze award, Pass and Fail. The proposed study not only confirm whether the assessment scores achieve Pass level but also analyzed the assessment difference from the five levels and found out the key training items affecting scores and verified the enterprises usually easy to neglect or not easy to achieve the assessment items of training, then supply them a better training plans and the reference of execution, help them to improve the training quality and strengthened the effect of manpower training.

Next, the proposed paper discussed, respectively about optimal combination researches of TTQS assessment items (Huang *et al*., 2010) and the application of GA-SVM algorithm (Chen *et al*., 2005), to comprehend about TTQS assessment items applying in researches of human resources management and to be the reference basis; in the meantime, to explained the data analysis tools in this study to handle the design plan as the following sections.

OPTIMAL COMBINATION RESEARCH OF KEY TRAINING ITEMS

According to the data dimension, there are 21 assessment items in TTQS, it means the data would have 21 dimensions, thus it would be more complicated when analyzing and also affects the efficacy of analysis. Also, in these 21 assessment items, they are not only belonged to five management procedures of PDDRO but also there are the features of interdependent and compliance between the parts of different management procedure items. Therefore, when the enterprises are practicing the training program, except executed every trainings following the training processes of PDDRO, they also should understand the relationship of connecting items, in which the training effects can be reflected onto TTQS assessment.

In reality, it is difficult for the enterprises trainers to efficiently and rapidly controlled all the assessment items and also easy to ignore the procedure which go beyond in the connecting assessment items, then caused the situation of confusion and discordance. Thus, there are some researchers studying the connection of the enterprises training and operation result and expecting to find the key training items of TTQS (Chen *et al*., 2012; Huang *et al*., 2010) by using the analysis methods of science. One way it can reduce the level of dimension in data analysis; another way, it can directly find the priority items improving for the training of enterprises, therefore, the proposed paper provided, respectively the study of the data columns selection applying in selection of TTQS assessment items.

At the moment this kind of TTQS assessment selection methods only have a initial analysis to the data, which means that using the tools to the columns for selection analysis and further discussing the selected columns combination to find the TTQS assessment items (Huang *et al*., 2010) effecting point of the enterprises turnover growth rate and connecting them with the enterprises operation results and training effects, then explaining their relationship. In this method, it only evaluate one-year turnover growth rate, it can not be objective to study if it has positive relations between a long-term operation result and the training result. Also from the general assessment, it only provides a rough training referent and can it be suitable for the different industries are still an issue for further discussion. In this study, the TTQS assessment scores are according as to further study the key training items in individual industry training and uses the suitable analysis to the industries important training assessment items and analyzed the differences from the different assessment levels to find the key training items promoting the enterprises training results.

GA-SVM ALGORITHM

GA-SVM algorithm was proposed by Chen *et al*. (2005) using the character of GA which searching the optimal combination (Konak *et al*., 2006; Sivanandam and Deepa, 2007) to combine SVM classification algorithm (Hsu and Lin, 2002; Furey *et al*., 2000), which to get the tool of optimal columns combination, Fig. 1 shows the process details of the GA-SVM algorithm. After users input the dataset and column features, GA-SVM algorithm first get the feature column of dataset which values are initialized of chromosome and by the encoding of chromosome to create different combination columns of sub-dataset. And then to combine the predicted accuracy (Delen *et al*., 2005; Herranz *et al*., 2010) of classifiers as LIBSVM (Chang and Lin, 2009; Ichihashi *et al*., 2011), CLC (Chen *et al*., 2006), KNN (Dunham, 2003; Kai *et al*., 2002) and mySVM (Ruping, 2000) and have them to be the fitness function of chromosome evaluation to create fitness value of each chromosome and used it to evaluate if their chromosome is good or bad. Before the conditions of satisfaction ceased, it continually passed through the evolution procedure of the selection, crossover and mutation to find the highest categories predicted accuracy of the combination columns for the selecting key combination columns.

Through the optimal combination searching of GA-SVM algorithm can effectively reduce dataset columns; also can use it to find the important columns affecting classification predicted accuracy and be the main column of dataset in classification predicted analysis to reduce the complexity of dataset.

In this study, the proposed method used the GA-SVM algorithm to find the key training items affecting TTQS assessment scores, to ensure the differences from the different assessment levels, in order to analyze these key training items affecting the promotion of relations and effect to the enterprises training results.

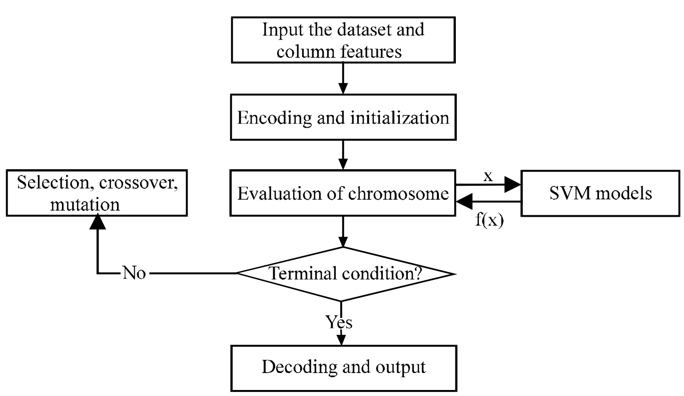

Fig. 1: Process flow diagram of GA-SVM algorithm, x: Chromosome, f(x): Fitness value

DATA REDUCTION METHOD FOR KEY TRAINING ITEMS SEARCH

The comprehensive mentioned above, the proposed method proposed for the efficiently applying on TTQS assessment items to help enterprises promoting the effect of training and analyzed the characters of industries to understand the first priority investing resources during the training, it especially designs a type of data reduction method to reduce the complication of data analysis and its operating procedure are list as Fig. 2, it finds out the key training items affecting training effect for the enterprises who can understand the directions to focus on and strengthening the training, to achieve the resources concentration and the purpose of setting a strategy fast. The data reduction method designed by this study illustrated as following:

Step 1: Information collecting and defined classification categories: This method constructed to classifying by using TTQS assessment levels and selecting assessment scores from a certain industry, further to study the effect of training and the correlation of industries characters

Step 2: Set the classification algorithm and parameter of GA-SVM: GA-SVM tool supports four types of classification algorithms, it can use different information characters to select the suitable classification algorithm and refer to each characters of classification algorithm simultaneously to set parameter and achieve the best classification and predicted results

Step 3: Find the optimal columns combination quantity: By setting parameter and analysis of GA-SVM tool can find the optimal columns combination from the different quantity and convenience for the users to invest the resources to find the suitable columns combination quantity; also can analyze different quantity of columns combination for the enterprises training effect

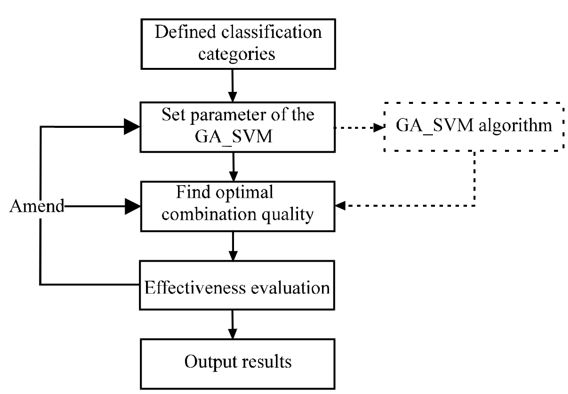

Fig. 2: Data reduction method flow diagram

Step 4: Effectiveness evaluation: To evaluate the combination of TTQS assessment items and confirm the correlation of the each combination columns and business operation. If it achieves the purpose of prediction then ceases, otherwise returns to Step 2

Because of the past researches were focused on the relationship of training resources and business growth (Chen *et al*., 2012; Huang *et al*., 2010) and can only did the overall consistency selection of important columns, it can not distinguish the correlation of the individual industry and training achievement. Therefore, this study uses the complete data analysis process to combined the important columns selecting tool to find the key training items of training, on the one hand to solve the needs of industries; on the other hand can directly relate to the achievement of training to rapidly realize the training effects of individual industry and correlation of assessment items.

EXPERIMENTAL RESULTS AND EFFICIENCY EFFECT ANALYSES

According to the method and experiment proposed from Huang *et al*. (2010), it used the TTQS assessment information of year 2009 and combined the turnover growth rate from the assessed enterprises to analyze the optimal combinations, which showed the experimental results of key training items as the six different quantities 2, 3, 4, 5, 6, 7. However, the experimental information represents the entire industries, it incompletely suitable for the manufacturing. Therefore, except adopted the assessment information from manufacturing for the experiment in this paper, the proposed method also divided the experimental information into two teams according to the levels reached by the assessed scores, then compared them with the experimental statistics from the mentioned method. It is obvious to comprehend the classification difference between using the turnover growth rate proposed by former method and the assessment levels proposed by this study.

In this study, the proposed method selected 365 instances of assessment scores of manufacturing from the assessment database of TTQS in 2011 to be the experiment data. Next, it used the data reduction method designed in the section three and combine GA-SVM tool to display the results and analysis of experiment. Further, this study experiment uses the TTQS assessment scores achieving above “Pass”, “Fail” two categories as the first experiment team and Golden award, Silver award, Bronze award, Pass and Fail five levels as the second experiment team.

At the beginning of experiment, the proposed method did the experimental analysis first from the research of Huang *et al*. (2010). Due to the research of Huang *et al*. (2010) was the information of TTQS assessment before 2010 and its enterprise turnover growth rate are according as the classification and used the research methods to find the optimal combination which are key training items as 3, 4, 14, 18 and 20 (Table 1). In the two experiments in this study, the proposed method chose these five assessment items to proceed the classifying prediction experiment of LIBSVM and the predicted accuracy of the first team was 92.87%; the second team was 83.013%.

Next, the proposed paper used the two experiment teams to be searched as the key training items combination by GA-SVM tool and set it as k = (2,3,4,…,10) then generated the two experimental results listed in Table 2 and 3. Table 2-3 showed the three attributes, respectively represent the k values, the key training items found by the proposed method and the classification predicting accuracy from the key training items proceeded in SVM. The higher accuracy means the training results obviously reacting to the found key training items, these items are the main training items that the manufacturing should focus on.

According to the experimental results on Table 2-3, the proposed method got optimal assessment items combination which are different from the Huang *et al*. (2010) when k = 5, it is because that the industries data range and the data classification bases are different and also related to the implementing time of TTQS. Further analyzing the five key training items as 3, 4, 14, 18 and 20 from the mentioned research, most of them belonged to the training core and results of enterprises. Due to the early implementation of TTQS, the enterprises were not familiar to the training quality system and can not effectively build up the training management system, so that there was easily to have a gap on the training operation and the results of analysis. Furthermore, the research was the overall information analysis, it can not reveal the characters of individual industry. At the same time, also checked the classifying predicted accuracy from each experiment, in the first experiment, when k = 5 or bigger than 5, the classifying predicted accuracy was more accurate then the research; in the second experiment, when k = 2, the accuracy was more accurate then it. This showed that TTQS training assessment can not directly react the turnover growth rate in a short-term, it meant the correlation still need to be confirmed.

Continually, the proposed method analyzed the results of used manufacturing assessment data, when k = 5 from the first experiment team, accuracy rate arise to 2.19 compared to k = 4 and when k>5, it did not get higher raising, therefore, to used k = 5 to analyze the assessment items combination. According to the result of the first experiment k = 5 and generated five assessment items as 5, 6, 8, 15 and 16, the main points were the design of training plan and the organized executive monitor, this showed the training instructors had different understanding on the purpose of training and the operation, also it may be about the culture of manufacturing. Other, from the result of the second experiment k = 5 and the five assessment items as 3, 12, 16, 18 and 19, except item 16 which represents the evaluation report and periodic integrated analysis, the rest of four items are focus on the training results assessment and effect. This meant if the manufacturing has to get the better achievement on the TTQS, they should have the training operating management and also have to focus on the assessment of training results and effects to show the outstanding achievement.

Last, according to the accuracy of the two experiment teams, the first team gained the better accuracy because they only separated into two categories, compared the first team to the second team which separated into five categories, the first team can have better classification predicted accuracy. At the same time, also found out that the bigger k value the higher accuracy from the two experiment teams. This is because the experimental classification is based on assessment scores, thus the more assessment items analyzed by classification; they can be easier to react their characters. No matter how many key training items are found, the classification predicted accuracies of these two experiments were all

Table 2: Experimental results of key training items with different k from first team

k	Key training items										Accuracy (%)
2	5	8									90.95
3	1	5	20								92.05
4	1	5	10	17							92.87
5	5	6	8	15	16						95.06
6	1	2	8	15	16	20					95.61
7	1	2	12	15	16	17	20				95.89
8	1	2	8	9	11	14	15	17			96.43
9	2	3	4	5	8	10	11	15	17		97.26
10	2	4	10	11	12	14	15	17	19	20	96.98

Table 3: Experimental results of key training items with different k from second team

k	Key training items										Accuracy (%)
2	12	17									80.00
3	15	17	20								83.83
4	8	11	14	19							87.67
5	3	12	16	18	19						86.84
6	3	5	12	17	18	20					89.58
7	1	3	10	15	16	17	20				90.13
8	1	3	5	7	12	16	18	19			90.13
9	1	2	6	7	8	9	12	15	19		91.50
10	3	4	7	11	14	15	17	18	19	20	91.50

achieved above 90% and 80%. The most important point is to find the key training items for the manufacturing to make improvement, so that they can still use their characters and the limited resources to select the better assessment items.

CONCLUSION

In this article, the proposed method used TTQS assessment items and scores to aim at the assessment data of manufacturing to study the relationships of the training result and the characters of manufacturing. Through the GA-SVM algorithm to find the manufacturing training key performance index as the important improvement items, the enterprises can focusing on the key training items and decreasing the wasting investment and promoting the training achievement. Through the experiment and the analysis, when the manufacturers hold the training, they must focus on the connection of training plan and purpose and also they must be cautious on the monitor of training and assessment effect, to get the better training assessment scores of TTQS and the great effect of training results. Besides, from the experimental result, it is known that to classify by using TTQS assessment scores, it can get the better classification predicted accuracy in different quantity of the item combinations and help the enterprises to think of their characters and resources to select the primary items.

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