Research on Knowledge-Based Optimization Model for Top Management Team

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***Abstract*—Configuration of top management team (TMT) has very important impact on its efficiency. Extant literature in the research of TMT mainly concentrates on the relationship between TMT characteristics and firm level performances as well as the process mechanism, but rarely on methods for team member selection and TMT configuration. This paper is aimed to address the research gap and design a knowledge-based optimization model for TMT configuration, using multi-objective optimization model. First of all, the relationship between TMT characteristics and its performance is systematically reviewed and a multiple-dimensional evaluation system is proposed to analyze TMT efficiency. Secondly, a multi-objective optimization model of TMT configuration is established by multiple linear regressions. Thirdly, knowledge management techniques are integrated to build the knowledge-based multiple-objective optimization model for TMT configuration. Finally, an experimental system based on our model is applied in a stationery company and achieved great success.**

***Index Terms*—Top Management Team (TMT), knowledge-based optimization, knowledge management system, TMT configuration**

I. INTRODUCTION

Top Management Team (TMT) is the team composed of top managers in an enterprise who assume the responsibility for strategy management and decision making. Top managers generally refer to General Manager and those senior managers who directly reporting to them such as Marketing director, R&D director, etc [1] [2].

Modern business environment is becoming more dynamic and complex than ever before, which poses significant challenges to the quality of top management teams [3]. In order to quickly adapt to the dynamic and complex changing environment, TMT must be a dynamic team with different configurations at different development stages in different business environments [4]. An empirical survey has shown that over 70% mistakes made in business operations could be attributed to the mistakes of decision making by TMT, and the essential problem is not any specific incompetent manager, but the lack of group-thinking players with complementary knowledge and capability in TMT [5]. Therefore, an optimized configuration of TMT can abate the risk of decision mistakes [5].

The research on optimization of TMT configuration starts from the seminal work of "upper echelons" by Hambrick and Mason in 1984[6], which argued that both strategic choices and organization performance are associated with the characteristics of TMT. In the following two decades, a substantial body of literature has studied TMT and mainly focus on three aspects: (1) The cause-effect relationship between TMT characteristics and the financial performance and strategy choices of firms; (2) The moderating effects of mediators such as team incentives, power, integration, discretion and team processes; (3) The impacts of environmental factors, such as customers, competitors, policies of financial markets, and board of directors. However, only a small number of studies have paid due attention to team member selection and TMT configuration optimization. Furthermore, the findings of TMT studies have not been systematically applied to create practical solutions. Fortunately, knowledge management literature provides a very helpful means to design optimized TMT configuration, and advancement in knowledge management system (KMS) enables us to create a knowledge-based information system as a practical solution for industrial firms.

Therefore, our paper is aimed to address the research gap on TMT configuration by borrowing the literature from knowledge management. A multi-objective optimization model of TMT configuration is first established by multiple linear regressions based on six major TMT characteristics from the extensive review. In addition, knowledge management techniques are integrated to build the knowledge-based TMT configuration optimization model. Finally, we build up an

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information system based on our model and test it on a stationery company and achieved great success.

II. THEORETICAL BACKGROUNG

A. Review on Relationships between TMT Characteristics and Performance

The relationship between the characteristics of TMT configuration and organizational performance has always been the most popular and debatable research inquiry ever since the seminal work by Hambrick and Mason in 1984. The "Upper-Echelons" argument attributed major influence on organizational outcomes such as strategies and performance to two psychological characteristics of firm leaders such as cognitive base and value [6]. Hambrick further refined the two characteristics and combined them with another for constructs, namely aptitudes, skills, knowledge and demeanor of top managers [1]. Subsequently, many efforts have been made to identify new variables omitted from the original framework or argue the different level of importance of existing constructs. Carpenter et al revisited the research on characteristics of TMT configuration and summarized the extant theoretical constructs into 9 aspects, namely skills, cognitions, behavioral propensities, access to information, access to resources, human capital, social capital, relative status within TMT or across firms and heir apparent [7].

These constructs are invisible and very difficult to measure, which are called deep-level constructs throughout the paper. According to suggestions by previous research, these deep-level constructs can be described by surface-level variables which refer to more observable top management demographics. For example, Norburn and Birley conducted an empirical survey in five industries in US to test the relationship between several characteristics of TMT and organizational performance [8]. The characteristics of TMT covered age, gender, education level, number of firms worked for, career experience and tenure of individual team member as well as the size of the TMT. Goll et al did a similar test and found that characteristics such as age, tenure, education, heterogeneity (diversity) of team members have significant relationship with organizational performance [9]. Copious as the studies are on characteristics of TMT, the surface-level variables that have been widely studied could be boiled down to five aspects:

(1) Size of TMT

Earlier studies showed that the larger the size of TMT, the bigger the differences of decisions among TMT members. Some scholars claimed there was a positive relationship between TMT size and TMT efficiency in certain industries [10], while others believed the large size could cause obstacles on communication, conflicts on cognitive frames and emotions, which made negative impacts on TMT efficiency.

(2) Age of TMT members

Generally speaking, people are more likely to resist changes when their ages increase [1]. Old managers tend to avoid risks and rely more on their industrial experience. On the contrary, young managers with less experience may wish to take more challenges for risky decisions. Therefore, TMT is advised to have members with diversified ages to enjoy the complementary benefits and the optimum age diversity would vary according to industry, business nature, size of firms and environments.

(3)Gender of TMT members

Whether gender is a critical characteristic to affect TMT efficiency, many scholars have offered positive answers by analyzing psychological differences between men and women. More female leaders increased the diversity of TMT, and female's styles of leading, decision making, and conflict managing complement the styles of male leaders [11] [12].

(4) Education Level of TMT members

Many studies have been done on TMT education level, and early research found that a TMT member with rich education background was inclined to accumulate more detailed information before making decisions [13]. Education can help managers to better understand the complex situations to a large extent, thus increasing the capability to process a large amount of complicated information [1]. Education background becomes very helpful when making critical decisions for firms [14].

(5) Diversity of TMT members

Over 40% of TMT demography research focuses on diversity of TMT members. TMT with large diversity could embrace and balance many perspectives but has its own problem such as time-consuming in decision making. Some studies found that diversity in education, experience and tenure are closely related to market shares, profits growth or innovative strategies [15] [16] [17].

B. Review on Knowledge Management System

Knowledge management recently emerged as a very popular research area and many scholars jumped onto the bandwagon to interpret the basic concept in a large number of different ways [18]-[21].

Knowledge Management System (KMS) is the information system to actually manage knowledge for organizations [16]. It is very helpful to improvement of organizational learning and working efficiencies [6]. KMS are widely used in three kinds of activities:

(1) Recording best practices and sharing within firms [22] [23]: For example, Davenport's study presented how an insurance firm prevented profits margin decline by adopting a fresh new insurance application process based on a KMS with all the industrial best practices[24].

(2) Establishing Experts' Map: Since some knowledge is tacit rather than explicit in nature, firms could record experts and their professional instead of explicit knowledge itself [24]. Experts with professional knowledge are expected to share their knowledge with other people in need.

(3) Building knowledge network: Knowledge network is a very efficient and effective for knowledge transfer. For example, when Chrysler changed the organizational structure from functional structure to flat structure, they quickly realize a knowledge exchange platform must be set up to avoid knowledge loss. They subsequently built up a "knowledge corner", which essentially is a knowledge network to facilitate knowledge transfer and sharing [5]. Ford built similar knowledge networks to improve knowledge sharing and they found that R&D period of a car has reduced to thirty-six months compared with twenty-four months without knowledge networks. Furthermore, by sharing knowledge with distributors, car delivery period was reduced from fifty days to only fifteen days [2].

Both the five major characteristics of top management team and the three major activities that knowledge management systems are often applied will be used as the foundation for our knowledge-based multiple objective optimization model for TMT configuration. As the final target of TMT configuration is to maximize TMT performance, the first question occurs to our mind is how to define and evaluate TMT performance. .

III. TMT PERFORMANCE EVALUATION AND ITS RELATIONSHIP WITH TMT CHARACTERISTICS

Establishment of objectives is the beginning step of any optimization. Since the final objective of TMT configuration optimization is to improve organizational performance, and TMT efficiency is the critical factor to decide organizational performance, we set TMT efficiency as the objective of our optimization.

A. TMT Efficiency Indicators

Although most research use surface-level variables to present deep-level theoretical constructs and found significant correlations between these variables and organizational performance, the extant literature also discussed the moderating effects of mediators such as team process and incentives. Our optimization model examines the relationship between surface-level variables and deep-level constructs, and use deep-level constructs as indicators of TMT efficiency. Regarding surface-level variables, as discussed in the review section, we would select age, gender, education level, size and diversity of TMT as major variables. In terms of deep-level constructs, we integrate the findings from Carpenter's summary on deep-level theoretical constructs [9], Simon's strategic decision making process and our preliminary interviews with top managers, and choose six constructs to indicate TMT efficiency as follows [5]: the capability of information access, the capability of swift adjustment, the capability of evaluation, the capability of communication, the capability of empowerment, and the capability of innovation.

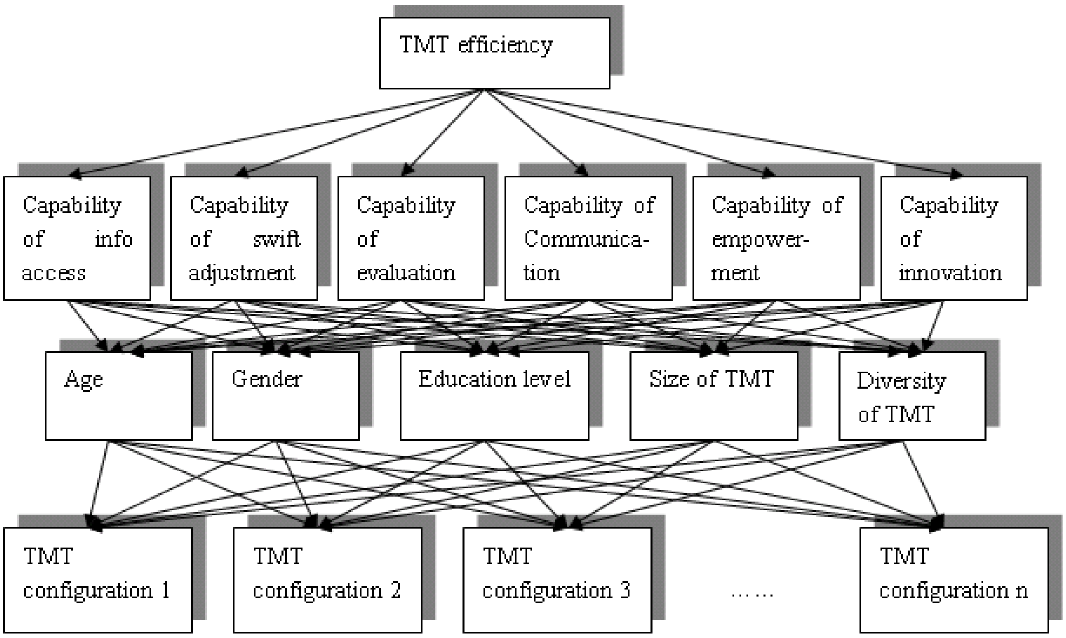

Figure 1. TMT efficiency system

.Based on the five surface-level variables and six deep-level constructs, TMT efficiency system and its relationship with TMT configuration could be shown in Fig.1 with four layers structure.

B. TMT Efficiency Evaluation System

As shown in Fig. 1, the top layer is TMT efficiency, which is a function of six deep-level constructs in the second layer. Each deep-level construct is also a function of five surface-level variables in the third layer. The bottom layer shows various TMT configurations, and each configuration offers five values separately to the five surface-level variables. Hence, for each TMT configuration, the final TMT efficiency could be calculated and compared with peers.

Since each firm has its own objectives and nature of business and located in different environments, the requirements on the level of each dimension of TMT efficiency would also vary. Therefore, TMT efficiency should be evaluated in a multiple dimensions manner and each dimension carries different weights of importance. We design TMT efficiency evolution to be a multi-dimension model where

$$T\_efficiency \equiv < T\_efficiency_1, T\_efficiency_2, ... T\_efficiency_n > \quad (i=1, 2, ..., n) \qquad (1)$$

$T-efficiency$ represents overall TMT efficiency, while $T-efficiency_i$ presents TMT efficiency only in dimension *i* and can be calculated by the functions linking deep-level constructs and surface-level variables.

$$T\_efficiency_i = f(C_1, C_2, \ldots, C_j, \ldots, C_m) \quad (j=1, 2, \ldots, m) \qquad (2)$$

C_j represents one surface-level variable.

There are many methods to make multiple objective evaluation system into a single but comprehensive evaluation indicator, such as Analytic Hierarchy Process (AHP) and Linear Weighting Method (LWM). We use the LWM to reduce the complexity of application. We assign different weights to the $T-efficiency_i$ and the overall $T-efficiency$ could be presented as:

$$T\_efficiency = \sum_{i=1}^{n} w_i T\_efficiency_i \quad (w_1 + w_2 + ... w_n = 1) \qquad (3)$$

w_i is the weight of $T\_efficiency_i$ in the overall $T-efficiency$. The objective of TMT configuration is to maximize the value of $T-efficiency$. Therefore,

$$Max\,(T\_efficiency) = Max\,(\sum_{i=1}^{n} w_i T\_efficiency_i), \quad \text{when } w_1 + w_2 + ... w_n = 1 \qquad (4)$$

Among the five surface-level variables and six deep-level constructs, age and gender are easily quantifiable while factors such as education level, different types of capabilities have to go through rigorous methods to quantify. We apply AHP-Fuzzy-Pattern Recognition (AFP) method to solve the problem of quantification and evaluation of variables not matter they are subjective or objective, precise or fuzzy. Since the evaluations of six deep-level constructs are subjective responses from evaluators, we also perform reliability and validity test to improve the results. Because the weight carried by each $T\_efficiency_i$ is dependent on the specific environment and strategies adopted by an individual firm, w_i could be decided by internal expert's opinion based on Delphi Method, which is particularly advantageous to make business prediction without sufficient reference.

In order to quantify the relationship between TMT efficiency indicators ($T\_efficiency_i$) and surface-level variables (C_j), multiple linear regression has been carried out as follows:

$$\begin{cases} T\_efficiency_1 = \beta_{10} + \beta_{11}C_1 + \beta_{12}C_2 + ... + \beta_{1m}C_m + \varepsilon_1 \\ T\_efficiency_2 = \beta_{20} + \beta_{21}C_1 + \beta_{22}C_2 + ... + \beta_{2m}C_m + \varepsilon_2 \\ .... \\ T\_efficiency_n = \beta_{n0} + \beta_{n1}C_1 + \beta_{n2}C_2 + ... + \beta_{nm}C_m + \varepsilon_n \end{cases} \qquad (5)$$

C. Multiple Linear Regression Analysis on TMT Efficiency

In order to analyze the final relationship between TMT efficiency and surface-level variables, as well as access to the knowledge and best practices of configuration optimization, we surveyed 403 firms from Shanghai, Zhejiang and Jiangsu, China, and conducted in-depth case studies of some firms with best TMT efficiency [25]. Those firms and their information were provided by local governments as their representative samples. Questionnaire data were obtained all from CEOs and other senior managers. The multiple linear regression analysis based on the questionnaires laid the foundation to the establishment of our multi-objective optimization model. The questionnaire was first designed based on our preliminary case studies of firms in different industries with different size. The reliability test by SPSS 11.5 shows Cronbach's α is 0.861, which indicates our questionnaire is consistent and highly reliable. There are six deep-level and six surface-level variables to measure in our questionnaire as shown in Table 1 (first three columns).

TABLE 1
DESCRIPTIVE ANALYSIS

Variables	Name of Variables	Values of variables	Min	Max	Mean	Std. Deviation
C_1	Age	Average age of TMT	25	55	40.7573	6.79449
C_2	Gender	Suppose Male=1, Female=0; calculate the average of TMT	0.25	1	0.8073	0.17253
C_3	Education Level	Suppose high school and below=1, diploma=2, Bachelor=3, Master=4, PhD and above=5; calculate the average of TMT	1.25	5	3.2893	0.68563
C_4	Size of TMT	Number of persons in TMT	1	40	7.9286	7.47401
C_5	Difference in age	Standard deviation of age	0	12.58	4.7848	3.39913
C_6	Difference in education level	Standard deviation of education level	0	1.35	0.4708	0.33426
T_1	Capability of information access	Estimated value from 1 to 10	2	10	7.1633	1.49703
T_2	Capability of swift adjustment	Estimated value from 1 to 10	1	10	6.9082	1.65652
T_3	Capability of evaluation	Estimated value from 1 to 10	2	10	7.2806	1.42703
T_4	Capability of communication	Estimated value from 1 to 10	2	10	7.26523	1.54353
T_5	Capability of empowerment	Estimated value from 1 to 10	2	10	6.7938	1.60038
T_6	Capability of innovation	Estimated value from 1 to 10	0	10	6.5765	1.89866

The result of descriptive analysis has been shown in Table 1. As a special occasion in this statistics, seven individually-owned firms are considered to be only one in their size of TMT. We use least square method to estimate the coefficients and perform T-test and F-test. Detailed regression results and analysis for T_1 (Capability of information access) is illustrated as an example, and all the rest T_i (i=2~6) are calculated in the same way. We found that female members were seldom in their TMT, and this discouraged the diversity in gender.

TABLE 2
MODEL SUMMARY ONLY ON CAPABILITY OF INFORMATION ACCESS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.910[a]	.829	.827	.20087
2	.960[b]	.922	.920	.13632
3	.980[c]	.961	.960	.09705
4	.988[d]	.977	.976	.07484
5	.991[e]	.981	.980	.06756

a. Predictors (Constant), Education level
b. Predictors (Constant), Education level, Gender
c. Predictors (Constant), Education level, Gender, Difference in education level
d. Predictors (Constant), Education level, Gender, Difference in education level, Size of TMT
e. Predictors (Constant), Education level, Gender, Difference in education level, Size of TMT, Difference in age

As shown in Table 2, there are five times of regression with an additional variable each time. Age was excluded from the result by SPSS, which implies age and capability of information access are irrelevant. Adjusted R square is 98%, which indicates a very good fit of distribution. This situation can be observed on Fig.2.

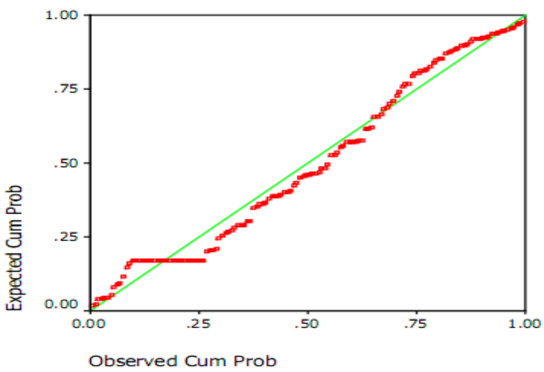

Figure 2. Normal P-P plot of regression standardized residual

Fig.2 shows very good fit between expected and observed cumulative probabilities, thus standard residual are normally distributed, which meets the precondition of multiple linear regression.

Hence, we could present capability of information access (T_1) as follows:

$$T_1 = 5.5154 - 0.919C_2 + 0.773C_3 + 0.009C_4 - 0.012C_5 + 0.38C_6 \tag{6}$$

In all, (6) is rigorously tested and another five rounds of regressions lead to equations on T_2 to T_6.

$$\begin{cases} T_1 = 5.154 \quad -0.919C_2+0.773C_3+0.009C_4-0.012C_5+0.38C_6 \\ T_2 = 6.726+0.005\,C_1-0.951C_2+0.299C_3+0.01C_4-0.049C_5+0.612C_6 \\ T_3 = 5.155+0.005C_1 \quad +0.472C_3+0.02C_4-0.016C_5+0.401C_6 \\ T_4 = 4.935+0.012\,C_1-0.148C_2+0.472C_3+0.002C_4-0.031C_5+0.816C_6 \\ T_5 = 5.205+0.012\,C_1-0.482C_2+0.381C_3-0.014C_4+0.025C_5+0.84C_6 \\ T_6 = 6.214+0.009\,C_1-0.796C_2+0.176C_3-0.021C_4 \quad +1.008C_6 \end{cases} \tag{7}$$

A series of findings could be discussed based on standardized coefficients in Table 3. To begin with, the negative or zero relationship between every dimension of TMT efficiency and gender suggests an increase of female leaders in TMT. Secondly, the positive or zero relationship between every dimension of TMT efficiency and age corresponds with the general opinion that capabilities would increase with age. Adjustment in the structure of TMT gender and age is decided by firms without any special barriers in most cases. Thirdly, there is a positive relationship between TMT education level and every dimension of TMT efficiency; furthermore, the coefficients are relatively larger, which means education has both large and beneficial impacts on TMT efficiency. Finally, difference in education level has positive relationship with all dimensions of TMT efficiency, thus TMT is advised to have members with different levels of education to complement each other in different capabilities.

TABLE 3.
STANDARD COEFFICIENTS ANALYSIS

	Gender	Age	Edu. level	Size of TMT	Diff. in age	Diff. in Edu.
Capability of info access	-0.276	0	0.997	0.142	-0.072	0.223
Capability of swift adjust.	-0.409	0.103	0.552	-0.229	-0.424	0.514
Capability of communication	0	0.107	0.918	0.47	0.146	0.354
Capability of evaluation	-0.148	0.182	0.731	0.036	0.225	0.573
Capability of empowerment	-0.146	0.159	0.495	-0.212	0.15	0.496
Capability of innovation	-0.3	0.143	0.286	-0.409	0	0.742

All these empirical findings from regression results have been applied in our knowledge-based TMT multiple-objective configuration optimization model.

IV. KNOWLEDGE-BASED MULTIPLE-OBJECTIVE OPTIMIZATION MODEL

As discussed in the review section, the previous literature has developed much knowledge on TMT configuration and its relationship with organizational performance, yet less research has been done to integrate the existing knowledge and apply them into practice. Based on the TMT performance evaluation model, knowledge-based multiple-objective optimization model would be proposed to provide practical guidance for TMT configuration.

A. Multiple-Objective Optimization Model

When firms decide multiple objectives and their level of importance and performances, the values of $T-efficiency_i$ and w_i could be assigned. Based on (7), we could calculate surface level variables C_1 to C_6 using (8) as quantitative reference.

$$\begin{cases} C_1 = \alpha_{10} + \alpha_{11}T\_efficiency_1 + \alpha_{12}T\_efficiency_2 + ... + \alpha_{1n}T\_efficiency_n + \gamma_1 \\ C_2 = \alpha_{20} + \alpha_{21}T\_efficiency_1 + \alpha_{22}T\_efficiency_2 + ... + \alpha_{2n}T\_efficiency_n + \gamma_2 \\ .... \\ C_m = \alpha_{m0} + \alpha_{m1}T\_efficiency_1 + \alpha_{m2}T\_efficiency_2 + ... + \alpha_{mn}T\_efficiency_n + \gamma_m \end{cases} \quad (8)$$

Combined with cumulative knowledge on best practices of TMT configurations at similar size firms in the same industry, the detailed qualifications on age, gender and other characteristics of TMT members could be zoomed into a small range. Candidates will be selected based on the qualifications. Once the characteristics of each candidate are recorded into the data pool, a large number of configurations could be formed using combination of different candidates and each configuration has an overall $T-efficiency$. Calculate $T-efficiency$ for each configuration and choose the configuration with the highest $T-efficiency$. Equation (9) is the multiple-objective optimization model for TMT configuration.

$$Max \quad (T\_efficiency) = Max(\sum_{i=1}^{n} w_i T\_efficiency_i)$$

$$\text{when } w_1 + w_2 + ... w_n = 1 \quad (9)$$

B. Knowledge-Based Multiple-Objective Optimization Method

The TMT configuration optimization process demands a lot of time and resources from senior managers. In addition, many areas of knowledge are required to facilitate the TMT configuration optimization process such as environmental analysis, strategy management, human resource management and knowledge on the relationship between TMT characteristics and organizational performance. Therefore, it is necessary to organize and store those areas of knowledge into knowledge database in a systematic and dynamic manner. A knowledge management system based on the knowledge database is responsible to acquire, present, store, search, reason, apply and maintain knowledge, which provides guidance to senior managers on TMT configuration at different stages of the optimization process.

Based on the knowledge management system and our multiple-objective optimization model, a knowledge-based TMT multiple-objective optimization process is developed and shown in Fig.3. For each step, how to integrate the idea of knowledge management system is subsequently elaborated.

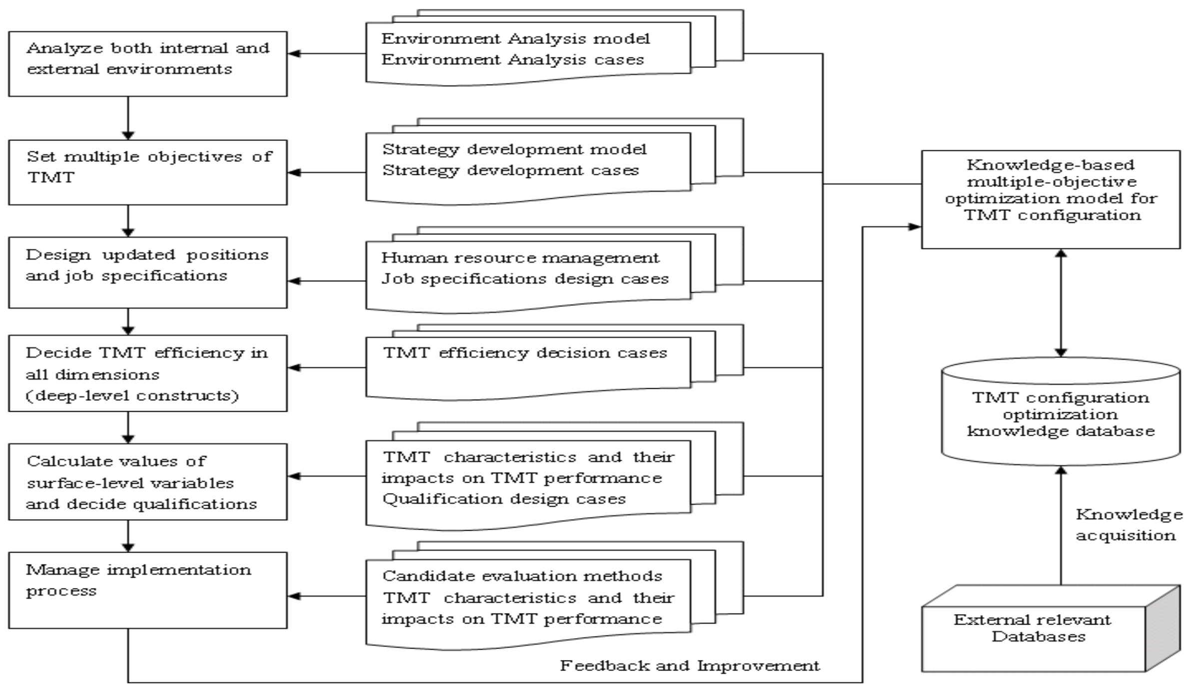

Figure 3. Knowledge-based TMT multiple-objective optimization process

Step 1 Analyze both internal and external environments

Environmental analysis pertains to some environmental factors, and several important questions are asked for each environmental factor in order to make a comprehensive analysis.

Step2 Set multiple-objectives of TMT

The multiple objectives of TMT configuration are usually set according to firm's strategies. These areas are organized into the knowledge management system, and if the firm's strategies are not listed in the knowledge database, new areas or strategies should be integrated into the knowledge database. Furthermore, the system should store and offer multiple objectives design cases for reference.

Step 3 Design updated positions and job specifications

Based on the multiple objectives set in the last step, firms could update the current jobs and their specifications. The knowledge-based TMT configuration optimization model offers current TMT jobs and their specifications, knowledge on human resource management and cases of job specification design. Firms could increase or delete positions and change job specifications according to the knowledge provided by the knowledge management system.

Step 4 Decide TMT efficiency in all dimensions

To quantify the expected performance of multiple objectives, this step is to define $T-efficiency_i$ in all dimensions and the weights w_i using Delphi method. TMT configuration optimization cases with similar size and objectives can help decision making on the values of $T-efficiency_i$ and w_i. The deliverable is a table of precise value on $T-efficiency_i$ and w_i.

Step 5 Decide qualifications

The knowledge-based multiple-objective TMT configuration optimization model would use the expected values of $T-efficiency_i$ and (8) to calculate the values of surface-level variables, combined with TMT configuration principles(relationship between TMT characteristics and $T-efficiency$) and cases, the qualifications are decided within a small range.

Step 6 Manage implementation process

First of all, firms select candidates from both internal human resources and outside labor markets according to the well-designed qualifications. Meanwhile, candidate evaluation methods would be provided by the knowledge management system to facilitate the selection process. Secondly, the qualified candidates would form different TMT configurations and the optimization model would calculate $T-efficiency$ for each configuration and choose the best TMT. Finally, firms may modify some requirements, maintain some current TMT members and hire some new ones.

Step 7 Feedback and improvement

The last step of a cycle is the feedback stage, where the knowledge-based multiple-objective optimization model for TMT configuration would record the weaknesses of qualified candidates in the selection process and generate training programs accordingly. In addition, the system also equips itself with self-learning function. Firms periodically write down the new TMT efficiency into the system so that the system could constantly learn the relationship between TMT configuration and TMT efficiency and update knowledge in the database.

V. EXPERIMENT AND TEST

We further created an information system based on our knowledge-based multiple-objective optimization model for TMT configuration. The pilot experiment on a Chinese firm A was launched to test the model.

Firm A is a stationery firm founded at Ningbo, China in 1996, and experienced steady growth with annual sales from 44 to 73 million US dollars until 2004. In the past few years, the profits began to shrink due to lack of new product development and less competitive quality in its existing products.

Firm A started to form collaboration with a US stationery firm in order to benefit from foreign investments, brand name and advanced technologies. Meanwhile, Firm A decided to change strategies towards reinforcing its new products development with new features, design styles and package, as well as quality improvement for high-end markets. With those strategies in mind, the board of directors started to change TMT.

We first input the results of environmental analysis and multiple objectives into the system. The system searched for the best practices under similar conditions and found five matching cases. The best case (85.12% match) in Table4 is used for reference.

TABLE 4.
BEST PRACTICE CASE UNDER SIMILAR SITUATION

Position	Specification	Age	Gender	Education Level	Working experience	Professional knowledge
General manager	Strategies	53	M	Bachelor	Sales	Strategy management
High-end marketing director	High-end market	45	M	Bachelor	High-end market sales	Sales and marketing
Low-end marketing director	Low-end market	38	M	Bachelor	Low-end market sales	Sales and marketing
R&D manager	New Product Development	35	F	Master	R&D	R&D technology
Manufacturing director	Manufacturing	56	M	Bachelor	Manufacture	Operational management
HR director	HR management	48	F	Bachelor	HR, administration	HR management

Certain modifications were discussed and implemented to make the final decisions on TMT members and their job specifications. Because of the strategic changes, the capabilities in all dimensions and their importance are examined and the outcome is Table 5.

TABLE 5.
TMT EFFICIENCY EVALUATION SYSTEM

Dimension of TMT efficiency	Expected value	weight	$T-efficiency$
Capability of information access	9.17	8.63	8.51
Capability of swift adjustment	8.44	7.86	
Capability of evaluation	8.63	9.37	
Capability of communication	9.28	8.49	
Capability of empowerment	7.91	7.52	
Capability of innovation	7.58	7.29	

The data in Table 5 is used to calculate five surface-level variables using multiple linear regressions based on (8). Combined with other principles of TMT configuration and best practices stored in the KMS, other characteristics can also be reasoned [5]. System reasoning could result in an example like Table 6.

TABLE 6.
SYSTEM REASONING BASED ON ACCUMULATED KNOWLEDGE

Position	Qualification	
General Manager	Professional knowledge	Strategy management, advanced management theories, industrial knowledge
	Career experience	Over 7 years experience in general management responsibility, over 3 years general manager experience in similar firms
	Leadership	> 9.34
	Strategic planning	> 9.12
Marketing director	Professional knowledge	Industry knowledge, consumer behavior, distribution channels, marketing strategies, new product plan
	Sensitivity to changes in market	> 9.22
	Business analysis	> 8.94
	Negotiation	> 9.45
R&D Director	Professional knowledge	Industry technologies
	Career experience	Over 5 years R&D experience, over 2 years experience of R&D management
	Communication	> 8.76
Manufacturing Director	Professional knowledge	Operational management
	Career experience	3-5 years operational management experience
HR Director	Professional knowledge	Human resource management, public policies and labor legislation
	Career experience	Over 8 years HR management experience in large firms or over 2 years experience as HR Director
	Communication	>9.36
	Coordination	>8.72

Based on the qualifications, Firm A selected qualified candidates from both internal management team and external labor markets. Ten candidates passed both written exams designed by the information system and interviews. After that, the system calculated TMT efficiency of each TMT configuration based on the combination of the ten candidates, and chose the team with highest efficiency. Under the leadership of the new TMT, Firm A started to regain its momentum in the last year with 10.2% more sales and twelve new products that launched overseas. The empirical case, to certain extent, demonstrated the practical value of our Knowledge-based multiple-objective optimization model for TMT configuration.

VI. CONCLUSIONS

This paper extends the theoretical discussion of the relationship between TMT characteristics and TMT performance into an applicable solution system for practical use. The first contribution pertains to developing a multiple objective evaluation system to represent TMT efficiency. Based on the literature of relationship between TMT characteristics and TMT efficiency, multiple-objective optimization model for TMT configuration was also established. We thirdly contributed to the extant literature by combining knowledge management system research with the optimization model and introduced a knowledge-based optimization model for TMT configuration. Finally, the information system based on our model is tested in Firm A and achieved significant improvements in financial performance.

However, this paper suffers from certain limitations since the research on TMT optimized configuration is still in a nascent stage. For example, our multiple-objective evaluation system for measuring TMT efficiency should be more precise with different layers. Moreover, our study only considered static characteristics (5 surface-level variables) and future research could integrate dynamic characteristics into our optimization model with research advancement in TMT process mechanism.

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