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An ANP-SWOT approach for ESCOs industry strategies in Chinese building sectors

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ABSTRACT

China consumes more energy and emits more carbon dioxide than any other country. The building sector accounts for nearly 1/3 of the total national energy consumption in China; thus, it is critical to find a solution for improving buildings' energy efficiency. Under the market-oriented mechanism, constrained by the energy performance contracting (EPC) mode, energy service companies (ESCOs) play an important role in improving energy efficiency for high-energy-consumption industries, including the building sector. The aim of this study is to determine the strategy for boosting the building ESCO industry. By conducting a strength, weakness, opportunity, and threat (SWOT) analysis, this paper presented the status of the building ESCO industry in China and proposed alternative strategies. By utilizing a conventional multi-criteria decision-making method, namely, the Analytic Network Process (ANP), this study provides a quantitative basis to analytically determine the ranking of the factors in SWOT analysis and select the best strategy to promote the development of the building ESCO industry. The results showed that the ANP-SWOT is a viable and highly capable methodology that provides invaluable insights for strategic management decisions in the building ESCO industry, and a set of strategies for promoting ESCO development in the building sector were proposed based on this approach.

1. Introduction

Due to urbanization and industrialization, China has been the biggest contributor to emissions since 2007 [1]. Industry, transportation and buildings are the three main fields of energy consumption in China, and consumption in the building sector in China has occupied more than 33% of the national energy consumption [2]. Currently, the total building area in China is near 40 billion m^2, and by 2020, the total building area will reach 70 billion m^2 [2]. Meanwhile, more than 90% of existing buildings are high energy consumption, thus making China's existing building energy consumption per unit area approximately 2 times that of developed countries in same environmental conditions [3]. Building Energy Efficiency Retrofit (BEER) provides excellent opportunities to reduce energy consumption in buildings and encourages the implementations of other sustainability practices, such as environmental protection, rational resource use, and occupants' healthcare [4]. Building Energy Efficiency Retrofit (BEER) is a process to reduce buildings' operational energy use by applying certain approaches of the building envelope and mechanical systems improvements while keeping the buildings' indoor environment and comfort [5]. Thus, China should accelerate the energy efficiency improvements of existing buildings.

The Energy Service Companies (ESCOs) industry, a recently emergent industry, provides a market mechanism called energy performance contracting (EPC) to deliver energy efficiency projects. EPC is a financing package that includes energy savings guarantees, associated designs and installation services for energy efficiency retrofit projects [6–9]. EPC was introduced to China in 1996 in partnership with the World Bank and the Global Environment Fund. The program aims to introduce EPC, improve energy efficiency, reduce greenhouse gas emissions, and protect the environment in China. In 1998, three pilot ESCOs were created: the Beijing ESCO, the Liaoning ESCO, and the Shandong ESCO [8]. In 2004, The Energy Management Company Association (EMCA) was created to facilitate the operation of EPC and development of the ESCOs industry in China. From then on, the number of ESCOs experienced a rapid growth period. The numbers of ESCOs, investments and production have increased over all these years (Figs. 1 and 2). There has surely been a significant average annual growth rate of 34.91% in the number of ESCOs from 2004 to 2013. In this millennium, the Chinese government has established a series of policies to

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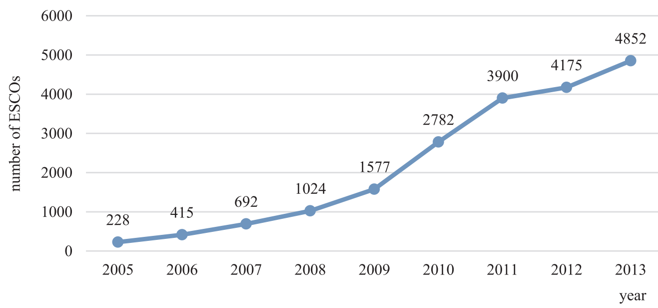

Fig. 1. Numbers of ESCOs in China.

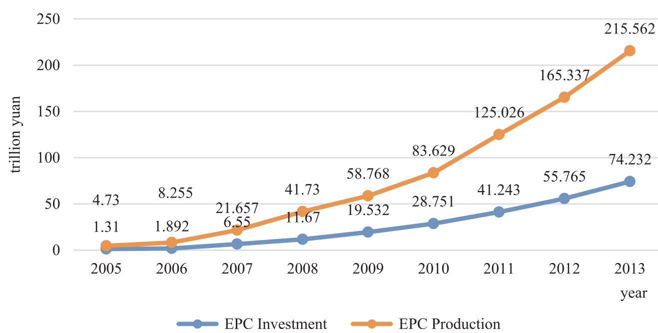

Fig. 2. EPC investments and production.

support the application of EPC and the development of ESCOs. Obviously, the government's attention brings huge developmental opportunities for ESCOs.

However, such a number cannot represent a healthy energy service market since there are some inevitable obstacles leading to a difficult situation for ESCOs, especially in building sector [10]. Most of the ESCOs in China remain small. According to the EMCA, the financial capacity of Chinese ESCOs is limited: 60% of the ESCOs have less than 10 million RMB of registration capital; 20% have more than 50 million RMB of registration capital; and approximately 50% of ESCOs have less than 100 employees [11]. Moreover, in China, it is difficult for small companies with little capital to obtain loans or other financial support, thereby making it difficult for ESCOs to obtain financing [12–14]. Furthermore, financial matters make many Chinese ESCOs incapable of developing technical skills. Thus, they just sell the product that they make instead of creating energy efficiency solutions for their clients [15,16]. Such low-end services provided by these ESCOs further reduce the market recognition, thus causing their existential crises [17,18]. In the building sector, the characteristics of ESCOs are more evident [19] and, compared to other sectors in the ESCO industry, the building ESCO industry is lagging behind. From the perspective of numbers, building energy service projects account for 18% of the total (Fig. 3). In terms of investments, building energy service projects account for only 7% (Fig. 4). These findings indicate that the building energy service projects (BESP in Figs. 3 and 4) are often small ones that need fewer investments than industrial projects.

Therefore, there is an urgent need to study the building ESCO industry to design strategies to improve it. To achieve this goal, first of all, it is essential to get a clear understanding of the effect factors for the building ESCO industry. In this paper, SWOT analysis is utilized to examine the strengths, weaknesses, opportunities and threats for ESCOs in the Chinese building sector when implementing development strategies. The remainder of the paper is divided to the following sections: Section 2 provides a description of the SWOT analysis method; Section 3 presents a thorough SWOT analysis of ESCOs in Chinese building sector; Section 4 includes 8 critical strategies that can be used to tackle these problems in China; Section 5 gives a ranking analysis of critical strategies to assess which is more important and several related

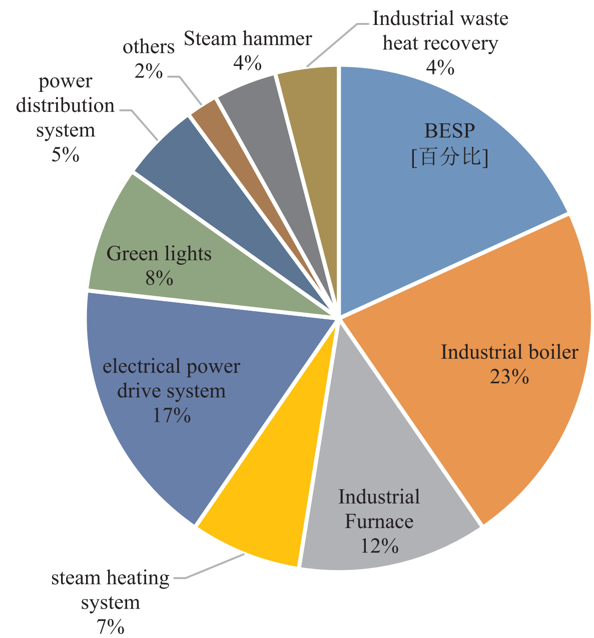

Fig. 3. Building energy service projects.

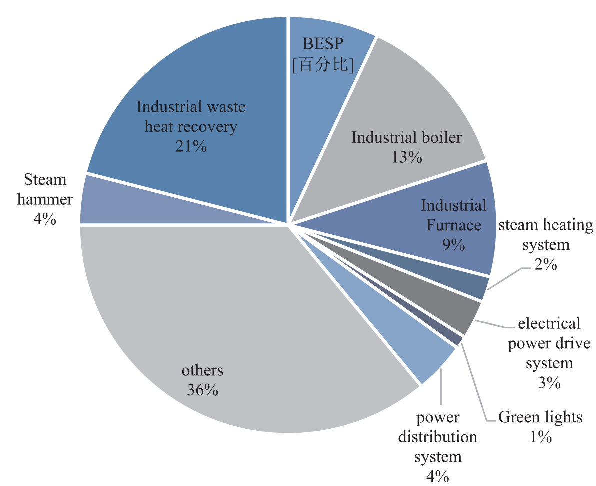

Fig. 4. Building energy service investments.

suggestions are made. Then, the main conclusions are discussed in the last section.

2. Literature review

Many approaches and techniques can be used to analyze strategic cases in the strategic management process [20–22]. Among them, Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, which evaluates the opportunities, threats, strengths and weaknesses of an organization, is the most common [23]. “S” and “W” are internal factors, while “O” and “T” are external factors [24]. After identifying the SWOT factors, every organization should use its strategies to protect or improve strengths and eliminate weaknesses, the usage of opportunities and collation with threats [25]. Since the SWOT method was created, it has been used widely for a single enterprise and in other scopes. Yuan (2013) adopted SWOT analysis in that study to strategically analyze CWM (construction waste management) in Shenzhen [26]. Nikolaou and Evangelinos used SWOT analysis in environmental management in the Greek mining and mineral industry [27]. Srivastava et al. performed SWOT analysis to formulate strategic action plans for municipal solid waste management. In this way, it can mobilize and utilize the community resources on the one hand and the municipal corporation's resources on the other hand [28]. All these SWOT-related studies show that the SWOT analysis method is an excellent tool to resolve the issue from a strategic perspective. Since the ESCO industry has encountered so many obstacles, strategic measures need to be made to boost the industry. SWOT analysis is an appropriate approach for analyzing ESCOs' development in the Chinese building sector. However, SWOT analysis has its weaknesses in the measurement and evaluation steps for that purpose [23,29] since the magnitudes of the factors are not quantified to determine the effect of each factor [30]. As a result, individual factors are usually described very briefly and generally [23].

The quantitative SWOT methodology was first presented by Kurttila et al. [31] and named A-WOT since it was used in the Analytic Hierarchy Process (AHP) method. After that, an increasing number of researchers adopted AHP in SWOT analysis [32–34]. Although the AHP method does provide an analytical means to determine the relative importance of the factors, it ignores the interdependence between factors. If an organization has the ability to show its strengths, it can make full use of its opportunities; otherwise, it will lose its opportunity before any benefit can be gained or are used by rivals [35]. There exists a similar relationship between threats and strengths. The ability to overcome or resist the effects of threats depends on one's strengths. A strong organization can use its strengths to either eliminate or minimize the effects of these threats. The relationship between weaknesses and strengths allows organizations with more strengths to have fewer weaknesses, and thus, they are able to cope with the situation caused by these weaknesses. Due to the characteristics of ANP, some researchers adopt the Analytic Network Process (ANP) method to replace the AHP method in SWOT analysis [36,37]. ANP is a developed method of AHP that was presented by Saaty [38–41]. Unlike the AHP (Analytic Hierarchy Structure) method, ANP has a network and cluster structure. The hierarchy formation in AHP is a linear top-down structure, and the network is a nonlinear structure that extends in all directions. ANP is always used to model the complex problems in the real world [42,43]. A complex problem can be divided into several sub-problems based on the hierarchical level, where each level denotes a set of criteria or attributes related to each sub-problem. The top level of the hierarchy is the main goal of the decision problem. The lower levels denote the factors of the respective upper levels. The ANP method is able to consider the mutual and interdependent relationships among factors and sub-factors and rank alternatives, criteria and sub-criteria by considering the mentioned relationships. A system with feedback can be represented by a network. The elements of a cluster may influence some or all the elements of any other cluster [38,44,45].

Because of the existing interdependency and dependency among all components of SWOT analysis, it can be inferred that there is a necessity to apply the ANP method for the ranking of strategies, factors and sub-factors. Many researchers developed different techniques to quantify the SWOT analysis, such as applying the ANP method to calculate each of SWOT factors, sub-factors and alternatives. Yüksel and Dağdeviren used the ANP method for SWOT analysis to identify the factors and strategies of a textile firm [36]. Sevkli et al. applied the fuzzy ANP method for the strategic planning of the airline industry in Turkey. In this study, SWOT analysis is performed with the help of the ANP method, which considered the dependency among SWOT factors [37]. An external environment analysis was performed by an expert team familiar with the building ESCO industry. In this way, those SWOT sub-factors, the SWOT matrix and alternative strategies were developed.

3. SWOT analysis of ESCOs in Chinese building sector

To perform an in-depth SWOT analysis, 8 experts from government, industry, and academia in the field of energy efficiency were invited to an in-depth interview in 2015, and each interview lasted for 30–50 min. The main research questions developed for the in-depth interview in this study mainly includes four questions that are described and explained as follows:

Q1: What are the strengths of ESCOs in the Chinese building sector?

The first question examines the major strengths of the internal conditions of ESCOs in the Chinese building sector. During the in-depth interview, the questions asked to the participants might be phrased in another way, such as:

- ◆ What are the advantages when introducing ESCOs to conduct BEER?
- ◆ Why are ESCOs competitive in BEER?

Q2: What are the weaknesses of ESCOs in the Chinese building sector?

The second question examines the major weaknesses of the internal conditions of ESCOs in the Chinese building sector. The questions that the participants answered were explained like:

- ◆ What are the disadvantages when introducing ESCOs to conduct BEER?
- ◆ In which aspects do ESCOs need to improve?

Q3: What are the opportunities for ESCOs in the Chinese building sector?

The third question examines the major opportunities of the external conditions of ESCOs in the Chinese building sector. Questions with similar meanings were asked, such as:

- ◆ What chances can be taken to develop ESCOs in the Chinese building sector?
- ◆ What benefits can Chinese ESCOs utilize to improve in the building sector?

Q4: What are the threats of ESCOs in the Chinese building sector?

The third question examines the major opportunities of the external conditions of ESCOs in the Chinese building sector. The questions asked in the in-depth interview include:

- ◆ What difficulties should be overcome in the process of developing ESCOs in the Chinese building sector?
- ◆ What obstacles will ESCOs in the Chinese building sector face in its development process?

At last, according to the identified SWOTs, strategies for developing ESCOs in the Chinese building sector were proposed to cope with the weaknesses and threats.

The SWOT analysis of ESCOs in the building sector can further boost the understanding about both the external and internal conditions that the Chinese building sector would face when promoting the ESCO business model. The internal conditions consist of the strengths and the weaknesses, and the external conditions are related to the opportunities and the threats. Based on the results of in-depth interviews and a literature review, the SWOTs are shown as Table 1.

3.1. Strengths

3.1.1. S1: Providing professional building energy services

According to the '*General technical rules for energy performance contracting*' (GB/T 24915 - 2010), ESCOs are specialized companies providing energy condition diagnosis, energy saving project design, financing, transformation (construction, equipment installation, and commissioning), operation management and so on. Therefore, ESCOs could provide the whole process of BEER services, such as energy audits, feasibility research, design, financing, the procurement of equipment and materials, construction, personnel training, energy conservation measurement and verification, the running of the modified

Table 1
Results of SWOT analysis of ESCOs in Chinese building sector.

Internal factors	External factors
Strengths: ● S1: Providing professional building energy services ● S2: Taking the risks of clients	**Opportunities:** ● O1: Good policy opportunities ● O2: Huge building energy conservation potential ● O3: Lessons from developed countries
Weaknesses: ● W1: Hard to measure and verify building energy conservation ● W2: Long duration of service ● W3: Lack of advanced technology ● W4: Lack of qualified talents ● W5: Financing difficulty	**Threats:** ● T1: Lack of recognition about EPC and ESCOs ● T2: Lack of appropriate policies and laws ● T3: Restriction of ownership and use rights ● T4: Low energy price

system, maintenance and management. As the companies that adopt energy performance contracting (EPC) in BEER, ESCOs in the Chinese building sector have significant professional strengths compared with other companies.

3.1.2. S2: Taking the risks of clients

There are many ways to structure an EPC model. Two of the most common EPC models are the guaranteed savings contract and the shared savings contract [4,46]. In the guaranteed savings contract, the ESCO guarantees that the energy savings will be sufficient to cover debt service payments. In the shared savings contract, the ESCO designs, finances and implements the project, verifies the energy savings, and shares an agreed upon percentage of the actual energy savings over a fixed period with the customer. In both the guaranteed savings contract and the shared savings contract, most of the risks are transferred to the ESCO. If property owners intend to conduct BEER, they should purchase materials and equipment, and maybe hire some professionals or skilled workers if necessary. In other words, they assume the technical and economic risks themselves. ESCOs provide funds and technologies in the entire process of BEER. Meanwhile, the interests of ESCOs rely on the energy conservation efficiency that they installed. If BEER fails to achieve the goal of energy conservation, ESCOs should bear the losses. The entire process service is offered by ESCOs, and clients do not have to invest in the BEER, thereby avoiding the technical, economic and other possible risks of executing BEER.

3.2. Weaknesses

3.2.1. W1: Hard to measure and verify building energy conservation

Measurement and verification is the first and foremost weakness recognized by the interviewees. The measurement and verification of energy conservation is the basis of all ESCO services, even though it is difficult to do it well [46]. Currently, there is no general technical specification of building energy conservation measurement and verification in China. Various elements will influence the amount of energy conservation, including the climate, users' energy conservation awareness, management and maintenance capabilities. It is hard for both ESCOs and clients to reach a consensus on the amount of building energy conservation and energy conservation benefit sharing. Thus, how to accurately calculate the amount of energy conservation is a complex problem.

3.2.2. W2: Long duration of service

BEER is a complicated problem related to whole building life cycle. In most cases, the retrofit is implemented in the building's use process, and all the ESCOs' work should not affect the daily lives and work of the clients. Therefore, from the earliest negotiation until the BEER effect appears, a BEER project may last for 2 years or up to 5 years. From the input-output ratio perspective, the implementation of the BEER (especially the basis of energy conservation such as the curtain wall, heat preservation, and air conditioning system) always require huge investments. The average investment recovery period is longer than a decade, and this will increase the risk for ESCOs.

3.2.3. W3: Lack of core competitiveness

Building energy conservation projects, in essence, are performed by ESCOs for high energy-consuming buildings and utilize advanced energy conservation technologies. The core competitiveness of an ESCO relies on whether or not it has advanced energy conservation technologies, research and development capabilities and integration capabilities. However, in China, a low market access threshold leads to good and bad ESCOs being intermingled. The majority of building ESCOs are small and lack comprehensive BEER technologies, market development capabilities, business planning capabilities, financial management capacities, risk prevention capacities, late management capabilities, etc., thereby reducing the total level of the building energy services in the market.

3.2.4. W4: Lack of qualified professionals

From the viewpoint of management, ESCOs in China have high operational risk because of an immature market environment that may consume anticipated profits. To resolve the issue, qualified management talents who are able to diagnose risk according to the specific project situation and propose countermeasures is an urgent need. However, in China, there are no specialist agencies providing training services building energy conservation management. Most of the so called 'specialist agencies' focus on charging training fees without providing professional training. People can get of 'Energy Manager' or 'Energy Auditor' certificates in only two or three days of study in those agencies, while few of them can be familiar with EPC in that time.

3.2.5. W5: Financing difficulty

EPC projects usually have a long development cycle and weak short-term profitability. Therefore, building ESCOs cannot run without financing. However, the reality is cruel in that financing difficulties are the fatal weaknesses for building ESCOs' survival. Building ESCOs lack a guaranty channel, and the majority of ESCOs in China (especially building ESCOs) are generally under development, small and weak [6]. Their credit ratings in the process of examining and verifying bank loans are low, which leads to the consequence that banks increase the guaranty requirements of building ESCOs. In addition, banks set up a low credit limit for building ESCOs, and the venture's investors are cautious about building ESCOs. Such constraints force ESCOs into a vicious circle since ESCOs have no credit and strength and find it hard to get financing, and thus, they have no ability to perform BEER projects as a result.

3.3. Opportunities

3.3.1. O1: Good policy opportunities

Since 2000, the Chinese central government has established a series of policies to support the application of EPC and the development of ESCOs. These policies include '*the scheme of comprehensive energy-saving emission reduction work*', the '*building energy-saving and green building development plan*', and the '*low carbon development program for energy conservation and emission reduction*' among others. These policies involve financing supports, financial incentives, tax supports, technology supports, market cultivating, etc. at the national level. Local governments have also issued policies to support EPC and local ESCOs. The current policies are far from perfect for EPC and ESCOs. Nonetheless, governments' policy supports still stimulate EPC and ESCOs' development, and there is no doubt that policy supports will be increasingly stronger in the future.

3.3.2. O2: Huge building energy conservation potential

In 2002, China's urbanization rate was 39.09%. It climbed to 52.57% in 2012 at an average annual growth of 1.35%, which means that there were a tremendous number of buildings constructed every year. In addition, it is predicted that the urbanization rate in China reach 68.38% in 2030 [39]. As is mentioned above, the total building area in China has an annual growth rate of 2 billion m^2, and more than 90% of existing buildings today are high energy consumption [3]. In addition, China's existing building energy consumption per unit area is approximately 2 times that of developed countries with the same environment conditions. Therefore, the degree of BEER performed by building ESCOs also has huge promotional space. In general, there is huge building energy conservation potential now and in the future.

3.3.3. O3: Lessons from developed countries

The initial European ESCO concept started more than 100 years ago and moved to North America in the 1970s [47]. The development of ESCOs in western developed countries is far more advanced than in China. During long term development, ESCOs in these advanced countries faced or are facing some barriers, such as low energy prices, conflicts with other government outcomes and policies, short repayment requirements, high transaction costs and so on [47,48]. In the foreseeable future, China might face the same barriers. Thus, many lessons about preventing or coping with barriers of ESCOs in their developmental process are quite worth being learned.

3.4. Threats

3.4.1. T1: Lack of recognition about EPC and ESCOs

For many public institutions, enterprises, financial institutions and occupants, EPC is still a completely new concept. Most people in China do not accept it because they hold the wrong view of it. According to the feedback of one interviewee from industry, “after propaganda and explanation, when these owners were asked whether they are willing to perform BEER in the EPC mechanism, less than half of them desired to carry out BEER in the EPC mechanism for solving the funding problem. About half of them lack confidence about EPC because they have not adopted EPC to perform BEER before, and they will consider whether to adopt it if there are several successful BEER cases. Only a few of them did not tend to adopt it because of the uncertainty of the BEER effect and the immature development of EPC in China”.

3.4.2. T2: Lack of sufficient support from government

Although Chinese governments have issued a series of policies to support EPC and ESCOs (such as tax reductions and exemptions, specifications of payable tax categories, government subsidy increases, etc.), there are still some unscientific policies restricting their development. The laws and regulations of energy conservation services are also imperfect. Currently, there are no specific laws and regulations on EPC. Interviewees from both government and industry reflected the same problem. It is difficult for BEER projects to apply for governmental financial subsidies because of the small scale of this type of project.

3.4.3. T3: Restriction of ownership and use right

The ownership and use rights of buildings and facilities are separated from beneficiaries. The building energy conservation service market is building-targeted. However, the facilities inside the building belong to the owners, while their operations and management are the property management office's responsibilities. If the owners are not willing to bear the costs of BEER, then the property companies (even though they are familiar with energy the consumption of buildings) can do nothing to address the high energy consumption because they have no autonomy in adopting BEER. For those property companies that manage buildings in the way of general contracting, they do have the autonomy to implement BEER. In other words, the separation of ownership, the right to the use and the benefitted body in buildings and facilities hinder the exploitation of the building energy efficiency service market.

3.4.4. T4: Low energy price

The monopolization of the energy department contributes to unreasonable price mechanisms for energy. In terms of power consumption, that of civil buildings is much less than that of industry and the amount of energy conservation by performing BEER is less than that in industry. Conversely, the energy prices for residential buildings are much lower than it in industry. For example, the electricity price is 0.6 ¥RMB/degree in residential buildings and up to 1.8 ¥RMB/degree in an industrial building. Moreover, in a residential building, owners are not single but are composed of many different individuals or families. For each building or community, the amount that energy consumption decreased may be quite considerable, but for each owner, the average charge by energy conservation is not high enough to be adopted.

3.5. Strategies for developing ESCOs in Chinese building sector

According to the feedback of interviewees and the SWOT analysis above, it is evident that the negative influence brought by the serious weaknesses and grave threats are stronger than the effect of strengths and opportunities. Thus, strategies for developing ESCOs in the Chinese building sector for specifically coping with the weaknesses and threats must be established, which are shown in Table 2.

The strategy identified as SO involves making good use of opportunities by using the existing strengths of the system. The WO strategy

Table 2
Strategies for developing ESCOs in the Chinese building sector.

	Internal factors	
External Factors	**Strengths:** S1: Providing professional building energy services S2: Taking on the risks of clients	**Weaknesses:** W1: Hard to measure and verify building energy conservation W2: Long duration of service W3: Lack of advanced technology W4: Lack of qualified talents W5: Financing difficulties
Opportunities: O1: Good policy opportunities O2: Huge building energy conservation potential O3: Lessons from developed countries	**SO Strategy:** SO1: Strengthening economic incentives SO2: Establishing building EPC credit system	**WO Strategy:** WO1: Promoting technological innovation
Threats: T1: Lack of recognition about EPC and ESCOs T2: Lack of appropriate policies and laws T3: Restriction of ownership and use rights T4: Low energy prices	**ST Strategy:** ST1: Expanding information dissemination channel ST2: Promoting model innovation	**WT Strategy:** WT1: Conducting standardizations WT2: Adjusting energy prices

seeks to gain benefits from the opportunities presented by the external environmental factors by taking into account the weaknesses. Similarly, ST is the strategy associated with using strengths to remove or reduce the effects of threats. The fourth and last strategy is WT, in which the system tries to reduce the effects of its threats by taking its weaknesses into account. In this study, the aim of the SWOT analysis is to determine the priorities of the developed strategies and to determine the best strategy.

3.5.1. SO1: Strengthening economic incentives

Due to the small size and low profits of most building ESCOs, governments in China should subsidize ESCOs with a certain size and financial strength, and economic incentive policies aimed at BEER also need to be introduced. Any occupants, enterprises, public sectors, etc. conducting BEER in the EPC mechanism and building ESCOs should be rewarded in order to increase the enthusiasm regarding EPC in society. In addition, since building ESCOs in China have little overall strength and lack comprehensive BEER technologies, governments' financial incentives should also cover technological research and development of building ESCOs in order to encourage them improve their core competitiveness and keep advancing technologically. Additionally, establishing a specialized EPC guarantee fund through local financial expenditures and reducing ESCOs' loan interest rates are also effective methods to address their weak financial strength.

3.5.2. WT1: Carrying out standardizations

Energy consumption quota standards and technical standards for government agencies, markets, hotels, hospitals, schools, resident buildings, etc. should be revised over a short time interval. In addition, the provisions of the Energy Saving Law are too general and vague. Thus, a specialized EPC legal system in all aspects such as institutional goals, system contents, Procedural rules, legal liability, etc. should be established. This legal system will explicitly stipulate building ESCOs' qualification certification, build detailed EPC market rules, establish trade standards, and clarify the corresponding legal responsibility in order to truly achieve the standardization and industrialization of EPC.

3.5.3. ST1: Expanding information dissemination channel

The information dissemination channel of EPC includes two major aspects: knowledge diffusion of EPC and ESCOs, and establishing EPC talent training. In terms of knowledge diffusion, central and local governments must take responsibility to vigorously promote the knowledge. Governments can organize public institutions, enterprises, financial institutions, residents, etc. for establishing focused learning and building an information platform. Thus, public supervision of the energy service market can be strengthened, and the social cognition of EPC and ESCOs can be improved. In terms of talent training, the scope of talent training should be extended into vocational schools, universities and other education institutions. The training should be systematic and cover all building EPC related topics, including technical expertise, energy audits, financing negotiations, marketing plans, legal consulting, etc.

3.5.4. SO2: Establishing building EPC credit system

Due to the different characteristics of building EPC, the traditional financing mode is unable to meet the financing requirements of building ESCOs. Therefore, financial institutions should change their ways of asset identification and design new and feasible financial products and financial modes, such as approving building ESCOs to achieve pledge loans through their own building energy conservation technology patents. Moreover, industrial associations or related government regulators should conduct general evaluations on building ESCOs' credit to provide the basis of a credit rating for financial institutions to implement different loan strategies and provide references for clients to select appropriate ESCOs.

3.5.5. WO1: Promoting technological innovation

Currently, many building ESCOs in China generally face the risk of being phased out by the market. In this case, building ESCOs should improve their capabilities of technological research and development rather than focusing on immediate interests. They should invest a certain amount of capital and hire scientific research staff for the technological innovation of BEER. The improvement of technical strength can reduce the costs, decrease the duration of the investment recovery period and enhance core competitiveness. In addition, the development of energy conservation measurement and verification technology can provide more accurate judgments of investment returns and reduce project risks.

3.5.6. ST2: Promoting model innovation

The separation of ownership and use rights of buildings and facilities restrain BEER projects. A new property management model should be innovated. In the new model, the profit method of property companies includes payments for labor remuneration and shares of building energy conservation costs, even after the expiration of their service contract. In addition, buildings in a certain area should be 'packed' by a joint organization, which can be property management companies or owner associations. In this way, ESCOs' profits and retrofit efficiency will significantly increase.

3.5.7. WT2: Adjusting energy prices

Low energy prices restrict owners' initiatives to conduct BEER. Although China introduced multistep electricity prices in 2012, the price cannot effectively promote people's energy conservation awareness. However, simply raising energy prices is highly likely to affect the living conditions of people at the bottom of the social ladder. Therefore, governments should distinguish between different building categories and consider average energy consumption by applying general energy conservation technology. Then, the classification in different level of multistep energy price should be adjusted. Finally, the electricity prices at higher levels ought to be enhanced to a certain height. By this means, the owners will be pressured to conduct building energy efficient conservation.

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretations and the experimental conclusions that can be drawn.

4. Application of ANP model for SWOT analysis in the building ESCO industry

4.1. Framework of SWOT-ANP analysis

The problem is converted into a hierarchical structure in order to transform the sub factors and alternative strategies into a state in which they can be measured by the ANP technique. The schematic structure that is established is shown in Fig. 5. The aim of "choosing the best strategy" is placed in the first level of the ANP model and the SWOT factors (Strengths, Weaknesses, Opportunities, Threats) are in the second level. The SWOT sub-factors in the third level include the following: three sub-factors for the Strengths factor, five sub-factors for the Weaknesses factor, three sub-factors for the Opportunities factor, and five sub-factors for the Threats factor. Seven alternative strategies developed for this study are placed in the last level of the model. The ANP is composed of four major steps, including the model's construction, pairwise comparisons and local priority vectors, the super matrix formation and final priorities.

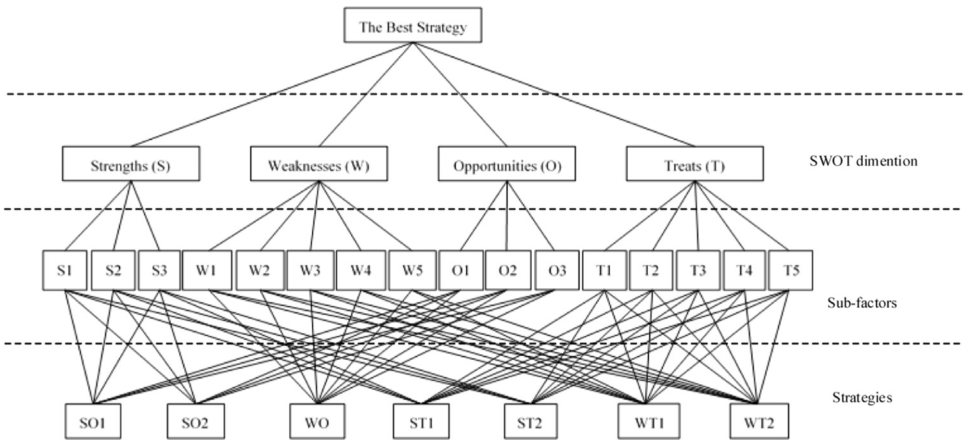

Fig. 5. ANP model for SWOT.

Table 3
pairwise comparison scale.

Definition	Intensity of importance
Equal importance	1
Weak importance	3
Strong importance	5
Very strong importance	7
Extreme importance	9
Intermediate values	2, 4, 6, 8

4.2. Data collection and model calculation

First, the pairwise comparison of each element is needed. A group meeting was conducted in April 2016 to format the pairwise comparison matrix. Six experts took part in this group meeting, including two from the ESCOs, two from EMCA, and two academics. All the experts have more than five years of experience in the area of energy efficiency. It should be noted building ESCO industry is a relatively new and small industry in China. Therefore, most of the experts just cover the specific part of the industry and not the whole from beginning to end. The pairwise comparison matrices were developed based on the ANP structure. Assuming that there is no dependence among the SWOT factors, the pairwise comparisons of the SWOT factors using a 1–9 scale is made with respect to the goal, whereby a score of 1 indicates equal importance between the two elements and 9 represents the extreme importance of one element compared with the other one (as explained in Table 3).

According to the ANP structure developed above, there are three comparison matrices in the control hierarchy. One matrix involves the SWOT dimensions (Table 4), and W_1 is gained. The experts justified the importance of two dimensions, for example “S” and “W”. If their importance were determined to be the same, then 1 is input in the comparison table. One matrix considers the inner dependence between SWOT factors (Tables 5–8) to determine W_2. Then, according to W_1 and W_2, the interdependent priorities of the SWOT factors are calculated as W_3.

Table 4
Pairwise comparisons of the SWOT factors assuming that there is no dependence among them.

SWOT factors	S	W	O	T	Importance degrees of SWOT factors
Strengths (S)	1	1	3	2	0.3452
Weaknesses (W)	1	1	3	2	0.3452
Opportunities (O)	1/3	1/3	1	1/3	0.0994
Threats (T)	1/2	1/2	3	1	0.2101

Table 5
The interdependence matrix of the SWOT factors with respect to “Strengths”.

Strengths	W	O	T	Relative importance weights
Weaknesses (W)	1	5	7	0.7235
Opportunities (O)	1/5	1	3	0.1932
Threats (T)	1/7	1/3	1	0.0833

Table 6
The interdependence matrix of the SWOT factors with respect to “Weaknesses”.

Weaknesses	S	O	T	Relative importance weights
Strengths (S)	1	5	3	0.6333
Opportunities (O)	1/5	1	1/3	0.1062
Threats (T)	1/3	3	1	0.2605

Table 7
The interdependence matrix of the SWOT factors with respect to “Weaknesses”.

Opportunities (O)	S	W	T	Relative importance weights
Strengths (S)	1	3	7	0.6434
Weaknesses (W)	1/3	1	5	0.2828
Threats (T)	1/7	1/5	1	0.0738

Table 8
The interdependence matrix of the SWOT factors with respect to “Threats”.

Threats	S	W	O	Relative importance weights
Strengths (S)	1	3	5	0.6555
Weaknesses (W)	1/3	1	1	0.1867
Opportunities (O)	1/5	1	1	0.1578

$$W_1 = \begin{bmatrix} S \\ W \\ O \\ T \end{bmatrix} = \begin{bmatrix} 0.3452 \\ 0.3452 \\ 0.0994 \\ 0.2101 \end{bmatrix} \quad W_2 = \begin{array}{c} \\ S \\ W \\ O \\ T \end{array} \begin{array}{c} \begin{array}{cccc} S & W & O & T \end{array} \\ \begin{bmatrix} 0 & 0.6333 & 0.6434 & 0.6555 \\ 0.7235 & 0 & 0.2828 & 0.1867 \\ 0.1932 & 0.1062 & 0 & 0.1578 \\ 0.0833 & 0.2605 & 0.0738 & 0 \end{bmatrix} \end{array}$$

$$W_3 = W_2 * W_1 = \begin{bmatrix} 0.4237 \\ 0.3207 \\ 0.1379 \\ 0.1277 \end{bmatrix}$$

One matrix is the pairwise comparison matrix, which is utilized to calculate the local priorities of the SWOT sub-factors (Table 9). Based on the three matrices gained, the overall priorities of the SWOT sub-factors are calculated by multiplying the interdependent priorities of the SWOT factors with the obtained local priorities of the SWOT sub-

Table 9
The interdependence matrix of the sub-factors.

	S1	S2	W1	W2	W3	W4	W5	O1	O2	O3	T1	T2	T3	T4
S1	1	3												
S2	1/3	1												
W1			1	1	3	3	3							
W2			1	1	3	3	3							
W3			1/3	1/3	1	1	1							
W4			1/3	1/3	1	1	1							
W5			1/3	1/3	1	1	1							
O1								1	1/3	3				
O2								3	1	5				
O3								1/3	1/5	1				
T1											1	1/5	1/3	1
T2											5	1	3	5
T3											3	1/3	1	3
T4											1	1/5	1/3	1

Table 10
Overall priority of the SWOT sub-factors.

SWOT factors	Priority of the factors	SWOT sub-factors	Priority of the sub-factors	Overall priority of the sub-factors
S	0.4237	S1	0.7500	0.3177
		S2	0.2500	0.1059
W	0.3207	W1	0.3333	0.1069
		W2	0.3333	0.1069
		W3	0.1111	0.0356
		W4	0.1111	0.0356
		W5	0.1111	0.0356
O	0.1379	O1	0.2605	0.0359
		O2	0.6333	0.0873
		O3	0.1062	0.0146
T	0.1277	T1	0.0967	0.0123
		T2	0.5549	0.0709
		T3	0.2516	0.0321
		T4	0.0967	0.0123

factors. The computations are provided in Table 10. We calculate the importance degrees of the alternative strategies with respect to each SWOT sub-factor. Using Expert Choice software, the eigenvectors are computed by analyzing these matrices and the W4 matrix.

$$W_4 = \begin{bmatrix} 0.0506 & 0.2137 & 0.0615 & 0.0776 & 0.1094 & 0.2291 & 0.4046 & 0.2537 & 0.0691 & 0.1429 & 0.1395 & 0.2635 & 0.1271 & 0.0842 \\ 0.1585 & 0.0756 & 0.2252 & 0.1625 & 0.1965 & 0.0932 & 0.1433 & 0.1293 & 0.0427 & 0.1429 & 0.0885 & 0.1298 & 0.1271 & 0.0366 \\ 0.4087 & 0.3444 & 0.1165 & 0.3515 & 0.4487 & 0.0318 & 0.0380 & 0.0486 & 0.1120 & 0.1429 & 0.0520 & 0.0494 & 0.0496 & 0.0842 \\ 0.1106 & 0.0315 & 0.0470 & 0.0289 & 0.0352 & 0.4154 & 0.0614 & 0.0728 & 0.1120 & 0.1429 & 0.4066 & 0.0834 & 0.0496 & 0.1433 \\ 0.1106 & 0.1089 & 0.0988 & 0.2394 & 0.0352 & 0.0318 & 0.0950 & 0.0728 & 0.0427 & 0.1429 & 0.0520 & 0.0494 & 0.3981 & 0.0842 \\ 0.1106 & 0.1089 & 0.4039 & 0.1111 & 0.1270 & 0.1669 & 0.2169 & 0.3499 & 0.1771 & 0.1429 & 0.2096 & 0.3750 & 0.1990 & 0.2261 \\ 0.0506 & 0.1170 & 0.0470 & 0.0289 & 0.0480 & 0.0318 & 0.0408 & 0.0728 & 0.4445 & 0.1429 & 0.0520 & 0.0494 & 0.0496 & 0.3413 \end{bmatrix}$$

Finally, the overall priorities of the alternative strategies that reflected the interrelationships within the SWOT factors are calculated as follows:

$$W_{\text{alternatives}} = W_4 * W_{\text{sub-factors}} = \begin{bmatrix} 0.1228 \\ 0.1405 \\ 0.2552 \\ 0.0936 \\ 0.1150 \\ 0.1884 \\ 0.0944 \end{bmatrix}$$

4.3. Data analysis

According to the results, the most important strength is "providing professional building energy services", while the biggest weaknesses are "hardness to measure and verify building energy conservation" and "long duration of service". The greatest weight of all strategic factors belongs to "providing professional building energy services", "hard to measure and verify building energy conservation" and "long duration of service". The strategy ranking attained from the ANP method is shown in Table 11. The most important, best strategies to be taken are "WO1: Promoting technological innovation", "WT1: Carrying out standardized policies and laws" and "SO2: Establishing building EPC credit system", which account for 60% of the whole.

Table 11
The ranking result of the ANP methods.

Strategy	Ranking result	
	ANP	ANP
SO1	0.1058	5
SO2	0.1696	3
WO1	0.2316	1
ST1	0.0938	6
ST2	0.1217	4
WT1	0.2021	2
WT2	0.0855	7

Based on the results gained, several suggestions are proposed as follows:.

4.3.1. Promoting technological innovation

The core of building energy services is the energy saving amount, which relies on energy-saving technology. Promoting technology innovation can bring more benefits. BEER is a complex of technical chains, including building envelopes, electromechanical equipment systems, indoor environment control devices, control measures for system operations, the operations management of building facilities, etc. When these technologies are intertwined into an organic whole, a significant energy conservation effect can be achieved. However, most ESCOs can only provide a single product or technology that retrofits the easiest part and ignores the complex part. In building EPC projects (especially large-scale public buildings), the effects of building energy conservation are not obvious, and ESCOs' annual returns are low. Therefore, many ESCOs perform BEER projects that focus on replacing equipment in order to increase cash flows. As a result, promoting technological innovation admits no delay.

(1) The government should pay more attention to technology in the building ESCO industry. More investments need to be made in developing advanced technologies. The government can establish a fund to reward the outstanding people who have made brilliant contributions to technology innovation.
(2) It is also essential to learn technology from developed countries and introduce them into China.
(3) For ESCOs, they need to investment more into technology and not just seek profits. Once they possess the irreplaceable technology, they will find their place in the market. Since talent is the heart of a company, it is necessary for ESCOs to hire more technical personnel. In addition, since China's "General technical rules for energy performance contracting" was established since August 2010, the ESCOs need to study it and form their own technological advantages based on it.

4.3.2. Carrying out standardizations

The Chinese government has launched a series of energy conservation policies. During the period of “the twelfth five-year”, almost 20 relative laws and regulations and up to 40 documents and 40 standards relating to energy in building sector have been promulgated. According to Premier Li Keqiang, from 2010 to 2015, 5 trillion yuan was invested for the environmental protection in China with half of that money being allocated to building energy conservation. However, the achievements have been far from satisfactory. In the eleventh five-year period, the energy savings accounted for 19.1%, which was lower that the targeted 20%. Meanwhile, the building energy consumption is on the rise. Thus, there are still not enough scientific policies to provide safeguards for the industry.

(1) The government needs to identify EPC as one of the most important measures in the formation of legislation to encourage energy users, energy companies and other parties to actively involve themselves in EPC projects. Moreover, the government should exempt ESCOs from the enterprise income tax or let the ESCOs use the investments of energy-saving equipment as income tax deductions.
(2) Governments and other stakeholders should jointly develop rules that are specifically applicable to EPC projects. It is advisable to strengthen the energy monitoring and verification of existing buildings in China, determine the form of building energy consumption norms, and create a mandatory implementation of standards. In this, the government can punish the high energy consumption buildings while rewarding the low ones.
(3) To improve the existing subsidy system, it is necessary to broaden the subsidy system in different fields so that the construction industry can get more subsidies to promote the development of the ESCO industry in the building sector. In particular, governments at all levels should arrange certain funds in the budget by using subsidies, incentives, etc. to support the excellent EPC projects and promote efficient energy-saving products and new mechanisms.

4.3.3. Establishing building EPC credit system

In view of China's energy-saving service companies, they are mostly small and medium enterprises and have low credit, which makes it hard for them to get financing. Moreover, since there is a lack of standards for the measurement and verification of energy conservation, it always causes conflicts when sharing profits between clients and ESCOs. Thus, it is essential to establish a sound, standardized, orderly and effective credit system to guarantee the reasonable profits and set rules for all stakeholders [49]. The establishment of the credit system mainly depends on the constraints of the formal policy system and the laws and regulations to regulate the credit of stakeholders.

(1) It is important to establish an effective mechanism to punish dishonesty. The establishment of a standardized enterprise credit system requires the joint efforts of the government, enterprises and the whole of society. During the "12th Five-Year Plan" period, EMCA plans to establish the "Energy Conservation Service Company Integrity Assessment Expert Group" that aims to gradually establish a sound energy-saving service company integrity assessment mechanism, establish a vibrant, distinctive and orderly energy-service market, and provide strong support for the integrity of the ESCO system.
(2) Credit information sharing is the key to the credit system's construction. Therefore, it is necessary to gather the unified enterprise credit conditions into an information platform for consumers to access. A credit supervision system is a necessary condition and guarantee for the credit system's construction. To safeguard the legitimate rights and interests of both sides of credit transactions, regulate the behaviors of credit agencies and maintain the normal order of the credit market, it is necessary to establish a regulatory system and gradually transfer authority to a combination of government regulations and industry self-regulations.
(3) The successful implementation of a credit system relies on the construction of punitive mechanisms for dishonesty. If there is no risk of punishment or the punishments are insufficient, then the main economic body will lack trustworthy incentives, which is the root cause of credit problems. Therefore, it is necessary to promptly investigate and address false information and violations of corporate business secrets and personal privacy in order to maintain an environment of equal competition in the credit market.

5. Conclusions and suggestions

Building ESCOs plays an important role in reducing carbon emissions in the building sector. Implementing strategies to boost the building ESCO industry has become an urgent issue. This paper utilized SWOT analysis to determine the strategic alternatives through internal and external environmental analysis. After analyzing the building ESCO industry in China, a SWOT matrix was developed that contained two strengths, five weaknesses, three opportunities and four threats. Based on the combination of SWOT matrix analysis, this paper presented series of strategies for the building ESCO industry's development, including the strength–opportunity (SO) strategy, the weakness–opportunity (WO) strategy, the strength–threat (ST) strategy and the weakness–threat (WT) strategy. The specific content of the corresponding strategies includes strengthening economic incentives, establishing a building EPC credit system, promoting technological innovation, expanding the information dissemination channel, promoting model innovation, conducting standardized policies and laws and adjusting energy prices.

ANP was adopted to determine the importance ranking of these seven strategies. The empirical result showed that “WO1: Promoting technological innovation”, “WT1: Carrying out standardized policies and laws” and “SO2: Establishing building EPC credit system” are the best strategies. Based on the results, this research recommended three main actions, including promoting technological innovation, conducting standardizations, and establishing a building EPC credit system. There are some research limitations that need to be improved in future research. In this study, the data input was discussed by the expert group. More experts should be involved to improve the accuracy of the results in further research.

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