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Abstract

Purpose – The purpose of this paper is to propose a franchising decision support system (FDSS) for future development planning by center positioning strategy formulation under a franchising business model.

Design/methodology/approach – The system makes use of data collected from the franchising business and external environment analysis for decision making in center positioning problems. The fuzzy logic approach is integrated into the system for analyzing the geographical market dynamics including profitability and competitiveness in the district concerned. To demonstrate the application of the proposed FDSS, a case study is conducted in a Hong Kong-based franchising private education center, i.e. Dr I-Kids Education Center.

Findings – The tailor made FDSS helps to facilitate the business operations of the franchising education center and develops a district positioning model for the centers located in the 18 districts of Hong Kong. The findings provide a solid foundation for marketing strategy and expansion direction formulation.

Originality/value – Due to the globalization of business, managing a growing franchising business model becomes challenging to the franchisor. In order to fully leverage the merits of the franchising system, an intelligent decision support model, focusing on making strategic development plans, is needed so as to expand the scale of business efficiently.

Keywords Artificial intelligence, Fuzzy logic, Decision support, Franchising model

Paper type Research paper

1. Introduction

In a highly competitive environment, the franchising business model becomes an efficient choice for companies to expand their business scale and market share at a rapid rate. In order to join the franchising business, interested parties (i.e. franchisee) pay a monthly franchise fee to the product owners or service providers, known as franchisors, so as to operate the same type of business at their own cost (Combs *et al.*, 2004; Watson and Johnson, 2010). In such practice, the franchisees can lower the startup and operation risk by taking advice from the franchisor, such as marketing strategy formulation, resources allocation, promotion and advertising activities (Barthelemy, 2008; Sigue and Chintagunta, 2009).

Although the franchising system is desirable and common for expanding a business network, the franchisor always finds it challenging in managing the increasing number of franchisees and maintaining the quality of every individual franchisee in a fast

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company expansion. Moreover, instead of formulating effective operational marketing strategies for each franchisee in operating the business, support to the franchisor for decision making in strategic planning is neglected (Aliouche and Schlentrich, 2011). The lack of decision support (DS) in making strategic development directions makes the franchisor have difficulty in planning and managing the choice of center positioning in a particular district (Gillis and Combs, 2009).

A center positioning strategy is one of the important decisions that should be made by the franchisor to analysis the current market situation and identify the location of setting up a franchising shop (Combs *et al.*, 2011). If the franchisor fails to identify the existing competitiveness and potential profitability in a particular district, the franchisor is unable to make a proper decision on where the franchising shop should be located (Vrontis and Pavlou, 2008). The franchisee may set up a new franchising shop in a district with severe competition, in which a number of shops with similar types of products or services already exist. As a result, the franchisor may suffer losses as the franchisees leave the business due to failure in making a reasonable profit (Bordonaba-Juste *et al.*, 2011). In order to assist the franchisor in formulating a center positioning strategy, a franchising decision support system (FDSS) is proposed to make use of data collected from the franchising business and external environment analysis in decision making. An artificial intelligent (AI) approach, fuzzy logic, is adopted to analyze the competitiveness and profitability of the district. With the FDSS, the franchisor can benefit from the support in continual operations and further development of the business.

This paper is divided into six sections. In Section 2, a literature review is conducted on the existing franchising business model, DS on center positioning strategy and the application of AI techniques. Section 3 shows the architecture of the FDSS. A case study is conducted in Section 4 to demonstrate the application of FDSS in a private franchising education center, i.e. Dr I-Kids Education center. The results and discussion are presented in Section 5 and the conclusions are drawn in Section 6.

2. Literature review

From the franchisors' perspective, franchisees are considered as one of the most important customers, as well as the business partners, within the company. Building and handling customer relationships are the main foci in the business world. Using customer information wisely to build relationships is widely adopted by successful companies (Xu, *et al.*, 2002). It is also suggested that AI would increase the business opportunities and, thus, transform the way to handle customer relationships (Ngai, 2005). In order to design a better solution for a franchising company, past literature on the existing franchising business, DS on center positioning strategy and the application of AI techniques are reviewed.

2.1 Existing franchising business model

Starting from the last century, franchising arrangements have taken up a significant part of the economy. According to the statistics of Coughlan *et al.* (2006), the sales made by franchising companies exceeded $529 billion early in 1985, which took up one third of all US retail sales. Under a franchising business model, a contractual agreement is usually signed between the franchisor and franchisee in managing the relationship between both parties (Cochet and Garg, 2008; Davies *et al.*, 2011). In doing so, the franchisees are eligible to join the business established by the franchisor and enjoy the support provided by the franchisor (Paswan and Wittmann, 2009). By examining the franchisee's personality and performance, the franchisor is able to control and offer customized strategies to the franchisee in daily operations (Salaogi, 2009; Weaven *et al.*, 2009). Providing appropriate resources such as marketing needs and knowledge, the financial performance of franchisees can be improved (Grewal *et al.*, 2011; Cadez and Guilding, 2012). Bordonaba-Juste and Polo-Redondo (2008) examined the structure between the franchisor and franchisee on their commitment and satisfaction from a marketing perspective. According to Yan and Wang (2012), enabling information sharing between the franchisor and franchisee can benefit high-tech franchising firms in demand forecasts when franchising so as to enhance franchise performance. Lam *et al.* (2014) proposed a customer relationship mining system to formulate customized marketing strategies by investigating customer behavior patterns and forecasting sales demand. The findings provided effective promotion advice to franchisees for attracting customers and in better preparation in resources allocation. However, most past related literature focused on providing operational assistance and marketing advice to franchisees so as to increase the profit. The attention paid to solving difficulties faced by the franchisor is relatively limited.

2.2 DS on center positioning strategy in franchising business model

In a franchising business model, DS on strategy formulation is crucial and gives a direction for the franchisor to manage the operations of the business. The decision support system (DSS), also named as the business intelligence system, enables managers to get answers to such unexpected and generally nonrecurring kinds of problems by recording, summarizing and analyzing data (Eom, 1999; Sugumaran and Bose, 1999; O'leary and O'leary, 2010). Huang and Hsueh (2010) studied customer behavior in the refurbishment industry so as to make key decisions on marketing policy. Altinay and Okumus (2010) investigated different decision making models in order to improve franchise partner selection. The result of the study suggested the factors that are important when selecting a franchise partner. However, it is also essential for franchisor to determine the geographic location, or namely, center positioning of the franchisees, in order to increase the profit and market share.

The center positioning strategy, which is one of the major initiatives offered by the franchisor, is an important strategic decision that should be made when expanding the network of a franchising business model (Rondan-Cataluna *et al.*, 2012; Wirtz, 2011). According to Karamychev and van Reeven (2009), firm's location strategies contribute significantly to the expansion of the stores in the retail chain. If an unfavorable decision is made, the franchisees may face complex situations as is how to react to the strategic plan provided by the franchisor (Croonen and Brand, 2009). De Jonghe and Vennet (2008) suggested that competition is one of the important key factors to drive the success of franchise values. Bordonaba-Juste *et al.* (2010) examined the impact of franchise network size and the competitive strategies adopted at each stage of the life cycle. To define the promising center position of a new outlet, Ehrmann and Meiseberg (2010) determined the location decision by considering the inner strength perspective and direct economic effects in a competitive environment. The results showed that the location decision relied on both perspectives when designing the strategic plan for growth.

2.3 Application of AI techniques in decision making

With the advantages of supporting the decision makers and improving decision-making, the DSS has been widely adopted by industries over the past two decades. Liu *et al.* (2011) proposed an integrated DS system to make global co-ordination decisions among raw material suppliers, component specialists, systems manufacturers and systems integrators. An architecture for database management is presented to support the decision making across multiple business functions and multiple geographical locations. However, the proposed system focused to facilitate information sharing among different parties. The consideration for future development planning by center positioning strategy formulation under a franchising business model is neglected. To locate a now franchises in an existing network, Kolli and Evans (1999) developed a multiple objective integer programming model based on the number of customers attracted from competing stores and existing franchises, the number of customers that visit the franchisor's outlets, the number of customers attracted from the existing franchises, and the number of customers lost from each of the existing franchises. Suarez-Vega *et al.* (2012) developed a multi-objective competitive location model with Geographical Information Systems to determine a franchise retail site selection. Although using integer programming approach can obtain exact solution, it is still not suitable to handle a big pool of decision variables otherwise too many alternatives. Given that if the case company expands her business in mainland China, then, size of the variables will be boost up obviously.

Artificial intelligence (AI) has the ability to learn from experience and to handle uncertain, fuzzy, and complex information in a competitive and quality demanding environment. Kuo *et al.* (2002) considered the selection of franchise convenience store location by integrating analytical hierarchy process (AHP) and neural network. Hsu and Chen (2008) adopted AHP to design a durable goods chain store franchisee selection model considering consumer purchasing power, individuals passing by and parking convenience. Faradillah *et al.* (2011) applied AHP in the web site design for tea beverages outlet franchise selection. Li *et al.* (2009) solved high-dimensional site selection problems using ant colony optimization techniques to minimize the total costs. Furthermore, Zhang and Rushton (2008) optimized the size and locations of a typical franchise competitive service system by genetic algorithm (GA). Yu *et al.* (2007) applied GA to optimize the distribution of franchise shopping centers in order to shorten the car-based shopping trips in urban area. From the past literature, it is found that the consumer preference and cost are one of the major considerations to solve the franchise location selection problem using AI. However, the above AI techniques used are difficult to deal with variables that are vague and fuzzy such as franchise store density or distance.

Fuzzy logic is one of the AI tools for executing problem reasoning with uncertainty and vagueness. It is able to mimic human thinking and decision-making mechanisms (Leung *et al.*, 2004). With fuzzy logic, the precise value of a variable is replaced by a linguistic description, the meaning of which is represented by a fuzzy set. Fuzzy logic is widely adopted in various industries as it is permissible to incorporate human knowledge to a system (Munoz *et al.*, 2008; Wang and Wang, 2008; Shih *et al.*, 2009, Tseng *et al.*, 2011). According to Petrovic *et al.* (2007), fuzzy logic can be used to solve problems related to decision making, with the aim of optimizing one or more objectives. Moreover, fuzzy logic enables the qualitative and inexact nature of human reasoning. Anagnostopoulos *et al.* (2008) adopted fuzzy logic in modeling a decision maker's preference in location site selection. Batanovic *et al.* (2009) studied the potential location coverage problems in an uncertain environment by considering fuzzy sets in service distance and traveling times. By integrating real-time location tracking technology, Ocalir *et al.* (2010) proposed a fuzzy logic model for decision makers to determine taxicab stand location decision making. On the other hand, Liu *et al.* (2011) presented a multi-objective fuzzy logic approach to determine an optimal distribution center location by taking cost and profit earning into consideration. This paper provided an insight to decision makers on the use of past numeric data and multiple objective functions for analysis and optimization.

In summary, the above studies concluded that providing DS to the franchisor in making strategic development plans is crucial for further expansion. Effective formulation of a center positioning strategy using minimum resources could bring additional profit to the business against severe competition. However, literature related to the design of a DSS for making center positioning strategy is limited (Power and Sharda, 2007; Arnott and Pervan, 2008). Most of them focused on formulating mathematical optimization model to minimize the cost. The considerations on data analysis in current franchising business, social and external competition environment are neglected. Hence, the franchising business is unable to plan for future development due to the lack of measure in existing geographical market dynamics such as profitability and competitiveness in the district concerned. To provide a solid foundation for marketing strategy and expansion direction formulation, a DSS with new functionality in both district and center positioning based on profitability and competition is valuable for the franchising business. The proposed DSS should be able to identify the strategies for both existing market and potential market so as to expand its scale practically. To conclude, this paper attempts to apply a Data Analysis with Dual-Fuzzy Approach (DADA) for developing a FDSS in the franchising business model. DADA is designed to analyze the market dynamics of different districts with a dual-fuzzy approach to position the center district profitability and competition. Compared to mathematical programming approach, DADA provides flexibility in defining constraints and solution optimization, which is believed to be a promising tool in assessing the profitability and competitiveness. Although an exact solution can be obtained using mathematical programming approach, the basic requirement confines that the objective function and every constraint must be linear and they should be designed in an ideal case (Williams, 2013). In practical situations, business and industrial problems are often nonlinear in nature, while assumptions must be defined ideally in order to find the exact solution. In addition, factors such as uncertainty are not taken into consideration using mathematical programming approach (Azaron *et al.*, 2008). These increase the complexity and computational time to obtain a feasible solution in real life situation. In most cases, AI techniques are adopted to compensate the limitations of mathematical modeling for obtaining nearly optimal solution within a short period of time. Meanwhile, the DADA approach is able to deal with factors in uncertainty which are commonly faced in making center positioning decision.

3. Architecture of FDSS

In order to support the franchising business model, a FDSS is designed to determine future development plans and center positioning strategies for the franchisor. By adopting this system, the franchisor can examine the performance of all franchisees while the collected data are converted into useful knowledge for decision making. Hence, a constructive marketing strategy is provided according to the individual condition of the franchisee. The FDSS comprises three modules, which are Data Collection and Storage (DCSM), DADA, and DS. Figure 1 shows the architecture of FDSS.

3.1 DCSM

In this module, franchisees, who are geographically distributed, are connected together in order to share the same information. With the internet, data, information and

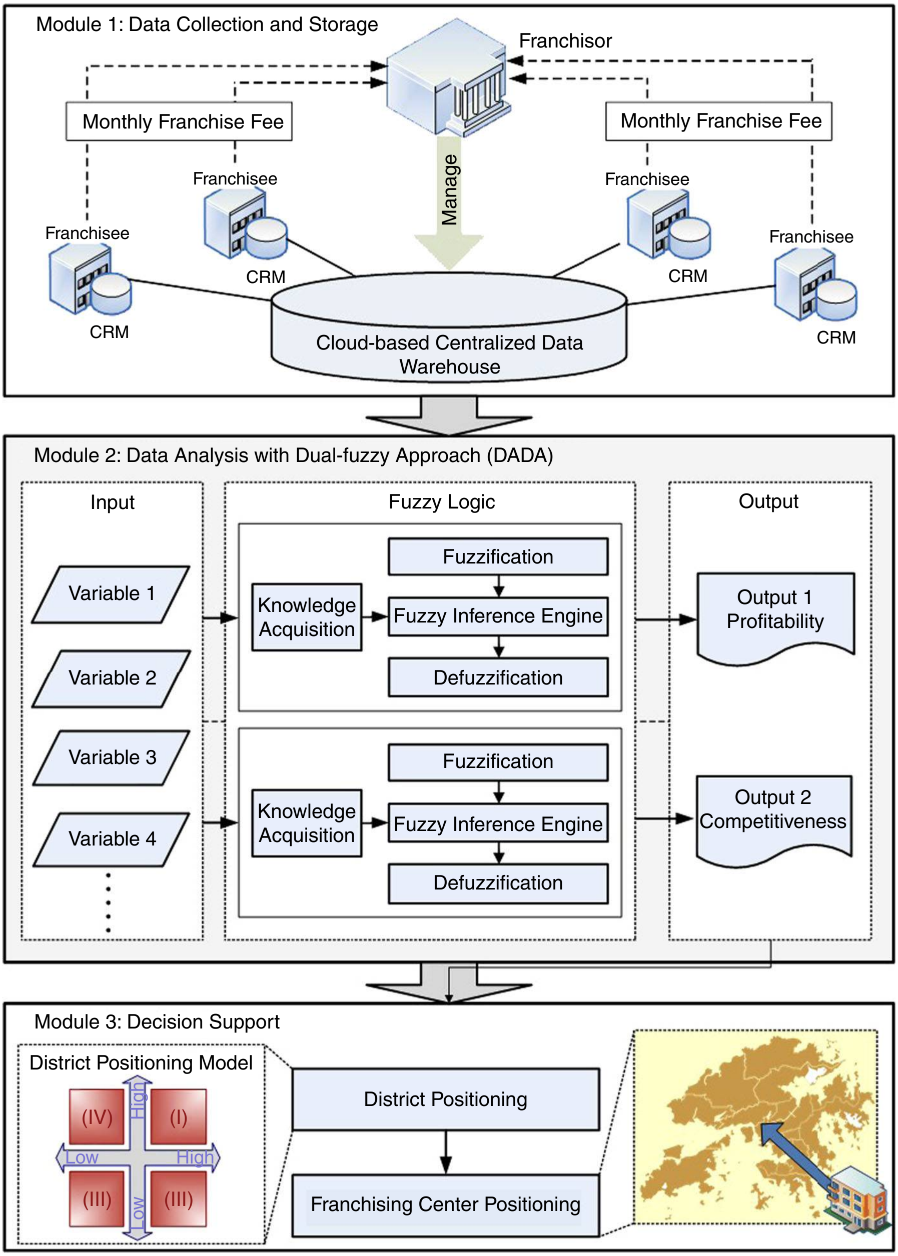

Figure 1.
Architecture of franchising decision support system (FDSS)

knowledge can be distributed easily in the economy (Chou and Lin, 2002). The franchisees are linked to a centralized database that is equipped by the internet, cloud technology and a web portal. Authorized users can easily access the system for obtaining and delivering the most updated information. Collected data is divided, summarized, catergorized into subsets before they are stored in the centralized data warehouse. Besides, all bi-directional data flow is translated by the XML translator. This allows the integration of the franchisor' existing data models, solutions and applications such that data can be transfered through XML effectively. The direct connection speeds up the information sharing and collaboration between various franchisees and the franchisor.

3.2 DADA

Based on different demographic conditions, franchisees encounter different business opportunities (profitability) and challenges (competition). In this module, DADA is designed to analyze the market dynamics of different districts with a dual-fuzzy approach to position the center district profitability and competition. Useful data is extracted from the centralized database and processed by the fuzzy logic principle. These input data may exist in dissimilar formats, e.g. bivalent data, linguistic data, crisp numberic data and statistical data. An intermediate process is required to translate the incompatible data for direct data assimilation. On the other hand, knowledge extracted from the related domains should be transformed into the IF-THEN rules, which is part of the fuzzy system. Knowledge acquistion can be conducted in several approaches, such as data mining of the historical data and interview of the domain experts. By interviewing the domain experts, implicit knowledge is transformed into explict through a set of special processes. DADA provides external analysis on the profitability and competition of a particular business in different districts with the processes of fuzzification, fuzzy interference and defuzzification.

Fuzzification operates by converting the input data into fuzzy data sets. Two important factors, including the universe of discourse and membership function, are specified for determining the basic features of a fuzzy set. The membership function is represented by the fuzzy set Z which is shown in as the following equation:

$$Z = \sum_{i=1}^{n} \frac{\mu_A(X_i)}{X_i} \tag{1}$$

Equation (1) shows the mathematical expression of the fuzzy set Z of X, where X is the whole fuzzy data set and equals to $X = \{x_1, x_2, x_3, \ldots, x_n\}$, x is the element of the subset $Z, \mu_A(X_i)$ is the membership function of element X_i.

Figure 2 shows an example of the composition of a fuzzy set by the predicate function. The universe of discourse represents the numerical input range, which is the same as the range of the x-axis in the graphical representation of the fuzzy set. Bascially, the input ranges are determined by the analysis and results of the previous stage. The universe of discourse is usually divided into a few regions for different predicates. In Figure 2, the fuzzy set is composed of small (S), relatively small (RS), average (A), relativly large (RL) and large (L). Different predicate functions are vary in shape and height since they have different membership functions. Shape such as triangles and trapezoids are the most common forms.

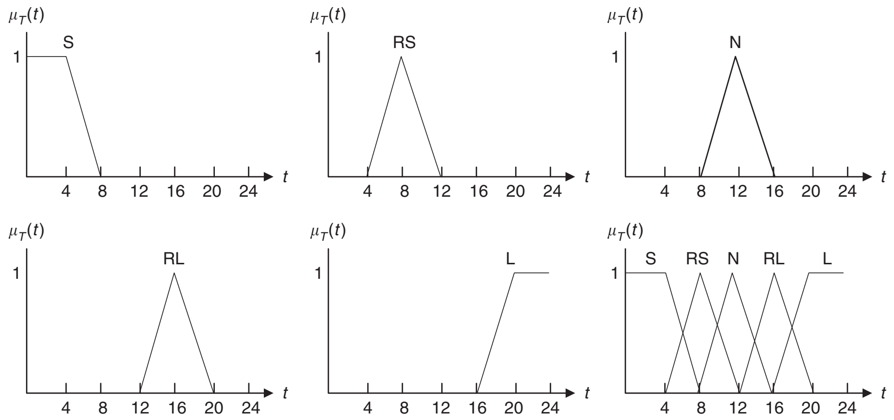

Figure 2.
Example of the composition of fuzzy set by the predicate function

After the fuzzification process, the input fuzzy set is converted into the output set by the fuzzy interference engine. A number of inter-related fuzzy rules, which are based on the required criteria, are composed. The rules are usually comprised of two parts (i.e. IF-part/ antecedent and THEN-part/consequence). The fuzzy rules are better than the traditional rule-based mechanism as it allows the use of uncertain, imprecious and ambiguous terms. Example of fuzzy rules are shown below.

"IF the average family income IS *middle* AND density of school IS *very spare* AND the density of targetd student IS *spare THEN* the district profitability IS *low.*"

Selected rules are fired and selected for further analysis. All fired rules are aggregated to be the result of the fuzzy logistics approach, such as risp or linguistic values, which represents the membership function of the aggregated fuzzy control action, are obtained from the defuzzification process. There are different defuzzification methods, among which, the center of area is one of the most common techniques due to its simplicity. Equation (2) shows the calculation of defuzzification of the fuzzy rules:

$$P = \frac{\sum_{j=1}^{N} w_j \overline{C_j A_j}}{\sum_{j=1}^{N} w_j \overline{A_j}} \quad (2)$$

where P denotes the profitability, w donates the weight, C and A denote the center of gravity and the individual implication result, respectively.

3.3 DS

In order to let the franchising company expand their business by operating more franchising shops in different districts, the franchisor should have a clear understanding on the district condition in choosing a suitable location. This module provides DS for the franchisor through a district positioning model and a franchising center positioning model. Figure 3 shows the district positioning model with a standard scale of district profitability and competition. The profitability and competition index of each district are calculated according to the defined scale. The two scales are assigned as the X and Y axis of the center positioning model with four quadrants, as shown in Table I.

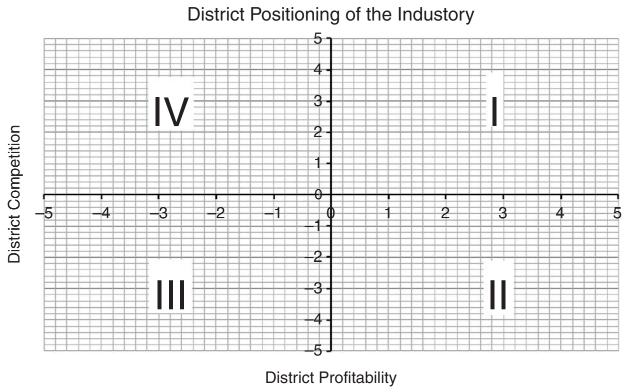

Figure 3. District positioning model

Table I. Four quadrants in the district positioning model

Quadrant	I	II	III	IV
Profitability	High	Low	Low	High
Competition	High	High	Low	Low

The four quadrants represent different levels of profitability and competition in the industry. The analysis can serve the following two main purposes:

(1) According to the variance of different center positions, different centers can have better understanding on their district opportunities, threats and risks, and hence, tailor-made strategy can be designed, as shown in Table II. Different strategies should be applied to centers of different quadrants.

(2) The results of the districts can be further developed as DS for the company expansion plans. The analysis is helpful for the franchisee in choosing a suitable location for the new center.

4. Case study

In order to validate the feasibility and performance of FDSS, the system was applied to the private education industry in Hong Kong. Dr I-Kids Education Center, which is a private education center, was established in Hong Kong in 2004. It provides a good learning environment by offering a wide range of tutorial courses for students in kindergarten, primary and secondary school so as to fulfill their needs in learning. These tutorial courses include English Phonics, Chinese and English writing,

Table II. Market dynamics of the four quadrants

Quadrant	Opportunity	Threat	Risk
I	High	High	Medium
II	Low	High	High
III	Low	Low	Medium
IV	High	Low	Low

Cambridge English, Mathematics and Oral Presentation. Based on a good reputation in the private education industry, Dr I-Kids Education Center has further expanded its business and started to adopt a franchising system since 2007. After paying a monthly franchisee fee, franchisees are eligible to make use of the resources and teaching materials provided by Dr I-Kids Education Center to run the business. Up to now, there are over 20 centers distributed in the districts of Hong Kong.

According to the statistics from the Education Bureau of the Hong Kong Special Administrative Region Government, the enrollment number of school-aged students to primary school will increase continuously from 57,500 in 2014/2015 to 67,500 in 2018/2019. On the other hand, the number of private tutorial centers has increased significantly from less than 300 centers to over 2,000 centers from 2003 to 2013. It is anticipated that the number of the tutorial centers will keep on increasing at a rapid rate due to the increasing number of school-aged students in the coming four years. The competition in the private education industry is expected to be fierce, and thus, effective planning on business expansion and future development is crucial for private tutorial centers to survive.

In order to expand its business to more districts in Hong Kong, Dr I-Kids Education Center has decided to adopt the franchising business model to attract franchisees to join their business. However, a franchising business model is still new to Dr I-Kids Education Center, and is more complicated than the traditional business model. Problems exist between the franchises and headquarters such as the monitoring and providing managerial support to the franchises. The center lacks a systematic and effective communication system among their stakeholders and franchisees. With continuous expansion of the franchising business, it becomes challenging for Dr I-Kids Education Center to handle the massive amount of data from different franchisees with the existing system. Therefore, the proposed FDSS is implemented in the Dr I-Kids Education Center so as to facilitate the operation within different tuition centers, enhance the efficiency in monitoring the franchisees, and provide a DS for improvement of the performance of individual centers and the company expansion project. Figure 4 shows the implementation flow of FDSS in Dr I-Kids Education Center.

Prior to designing and implementing FDSS to the Dr I-Kids Education Center, two sources of data, i.e. Census and Statistics Department (C&SD) of Hong Kong Government, and the internal Customer Relationship System of Dr i-Kids Education

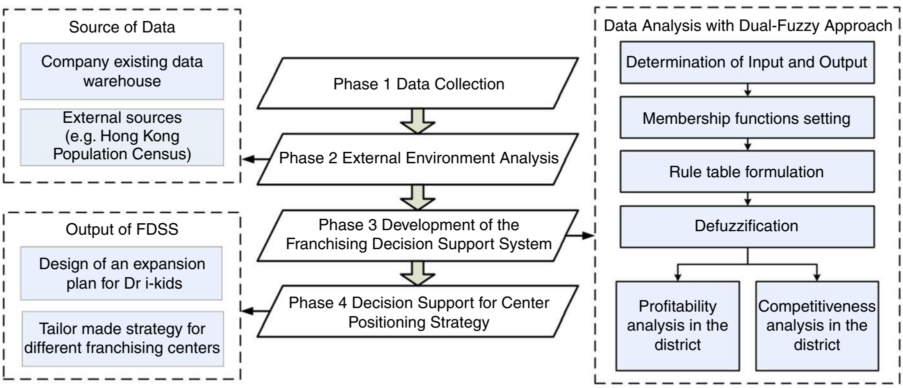

Figure 4.
Implementation flow of FDSS in Dr I-Kids education center

Center, are collected for the case study. First, data were collected by company visits and interviews with the top management and company staff. The collected data consists of five major dimensions, which includes the company workflow, franchisees and stakeholder relationship, company challenge and corresponding expectation, course and student information. After that, external analysis is carried out for the Hong Kong 18 districts with respect to the education industry to determinate the district profitability and competition. Useful data from the data warehouse of Dr I-Kids Education Center and other external sources (e.g. C&SD of Hong Kong Government) are extracted for supporting the data mining process.

Dr i-Kids Education Center obtains the ISO 9001:2008 standards which helps the company to ensure that they meet the needs of customers and other stakeholders while meeting statutory and regulatory requirements related to a product/service. The business has created systems for communicating with customers about product information, inquiries, contracts, orders, feedback and complaints. The business regularly reviews performance through internal audits and meetings. The business determines whether the quality system is working and what improvements can be made. It has a documented procedure for internal audits and so as to the data obtained. The business also deals with past problems and potential problems. It keeps every record of these activities and the resulting decisions, and thus there are essential data for support the proposed approach.

On the other hand, the C&SD compiles a wide range of economic and labor statistics through conducting establishment surveys. The statistics are a prime component of Hong Kong's information infrastructure, and play a key role in furthering the economic and social development of Hong Kong. The survey data are used for industry analysis, compilation of national accounts and balance of payments. Such information is useful to both the government and the private sector in formulating policies and making decisions. Timeliness is of paramount importance to the usefulness of statistics. Being a renowned trade and financial center in the world, Hong Kong is expected to produce accurate and timely statistics. Furthermore, in data dissemination, C&SD complies with the Special Data Dissemination Standard (SDDS) of the International Monetary Fund. Under the SDDS, C&SD undertakes to pre-announce the schedule for issuing regular press releases of statistics in the ensuring year in September of each year.

4.1 Development of the FDSS

The FDSS, which is equipped with the specific features for a franchising education company, is tailor-designed to provide a comprehensive DSS to Dr I-Kids Education Center. It acts as an effective tool for facilitating the business operation, improving the communication among various stakeholders and developing a comprehensive web based database. The major operation workflows are reengineered for the integration of the computerized system, in which most of the manual procedures are replaced by automatic functions.

After developing the database structure, the system is implemented in the franchising tuition centers in the Dr I-Kids Education Center. Figure 5 shows the user interface of FDSS adopted in the Dr I-Kids Education Center. Feasibility testing, documentation, pilot-run and training, which are the major factors that lead to success in system implementation, are carried out with the cooperation of the IT team, top management and staff in Dr I-Kids Education Center.

Figure 5.
User interface of FDSS in Dr I-Kids education center

4.2 Identification of input and output variables

In order to build up the center positioning model, the fuzzy logic technique is applied for measuring the district profitability and competition. The major component in the FDSS is the dual-fuzzy inference engine, which is shown in Figure 6. The fuzzy rules in the rule block are composed through the interview process of the experts in the education fields. The interviewees include the top management, senior staff and teachers of Dr I-Kids.

Five input variables including District Density of Kindergarten and Primary School (*S*), District Density of Targeted Student (*C*), Average Family Income (*F*), District Density of Tuition Center (*T*) and District Supply of Private Commercial Stock (*P*), and two output variables including District Profitability (*PR*) and District Competition (*CO*) are defined. The five input and two output variables are modeled into different fuzzy sets with five predicates. These inputs data are chosen for the analysis of the district profitability and competition, as these factors represent the market demand for the tuition center. The representation and membership function of each input and output variable are described below and shown in Figures 7(a-e) and 8(a-b), respectively.

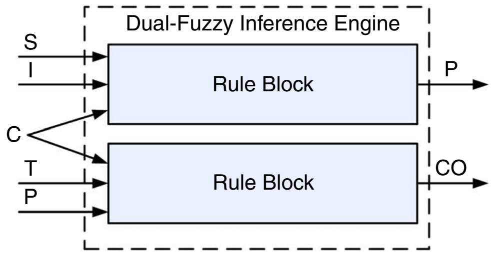

Figure 6.
Structure of the dual-fuzzy inference engine

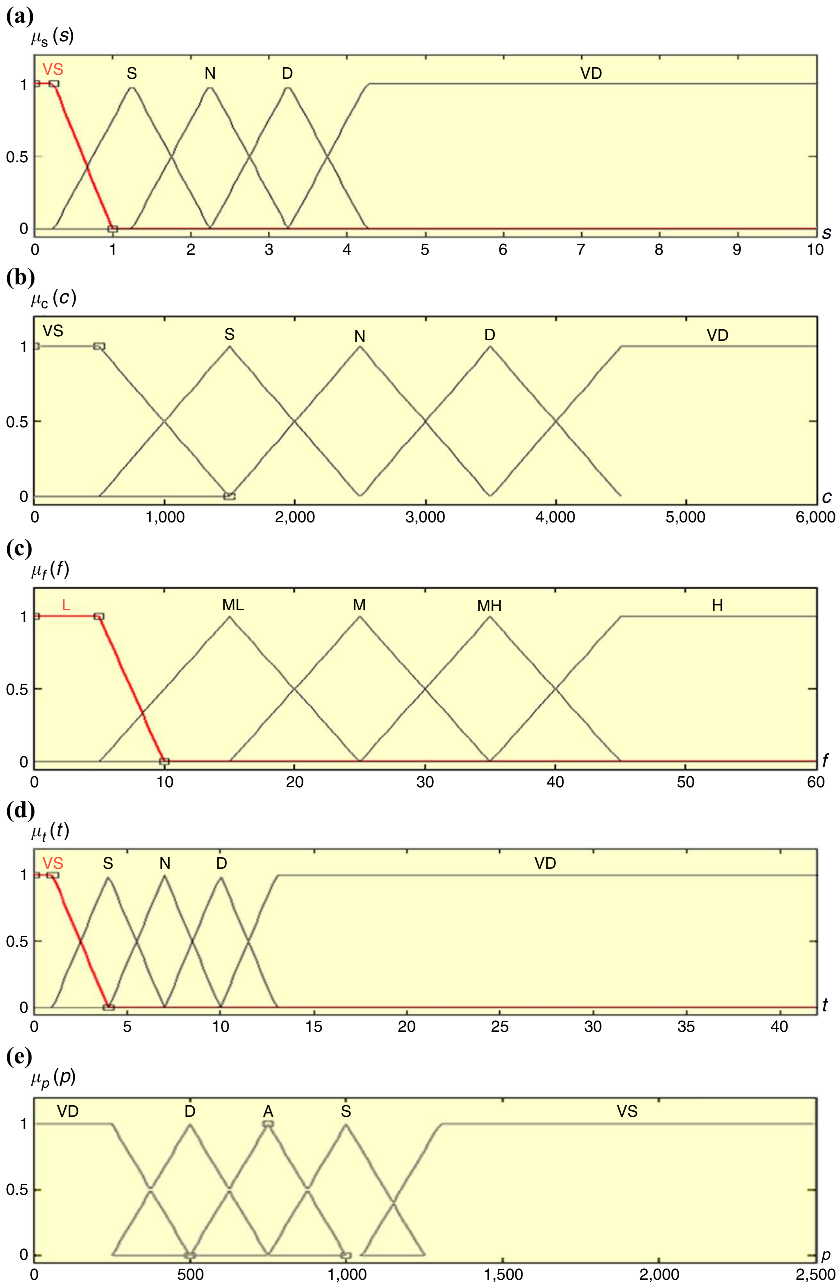

Figure 7.
The fuzzy set of (a) $\mu_s(s_i)$; (b) $\mu_c(c_i)$; (c) $\mu_f(f_i)$; (d) $\mu_t(t_i)$; (e) $\mu_p(p_i)$

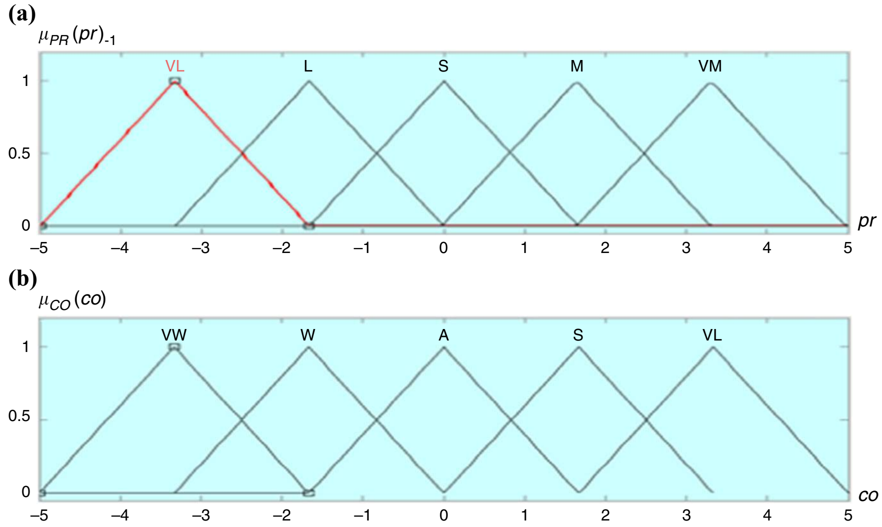

Figure 8.
The fuzzy set of (a) $\mu_{pr} pr_i$; (b) $\mu_{co}(co_i)$

Input variable 1. District Density of Kindergarten and Primary School (S):

$$S = \sum_{i=1}^{n} \frac{\mu_s(s_i)}{s_i}$$

where S is the fuzzy set, S_i is an element in the data set and $\mu_s S_i$ is the membership function (Figure 7(a)). S is divided into five predicates: S = {VS, S, N, D, VD}, where VS is very sparse, S is sparse, N is normal, D is dense and VD is very dense.

Input variable 2. District Density of Targeted Student (C):

$$C = \sum_{i=1}^{n} \frac{\mu_c(c_i)}{c_i}$$

where C is the fuzzy set, c_i is an element in the data set and $\mu_c c_i$ is the membership function (Figure 7(b)). C is divided into five predicates: C = {VS, S, N, D, VD}, where S is very sparse, S is sparse, N is normal, D is dense and VD is very dense.

Input variable 3. Average Family Income (F):

$$F = \sum_{i=1}^{n} \frac{\mu_f(f_i)}{f_i}$$

where F is the fuzzy set, f_i is an element in the data set and $\mu_f f_i$ is the membership function (Figure 7(c)). F is divided into five predicates: F = {L, ML, M, MH, H}, where L is low, ML is mid low, M is middle, MH is mid high and H is high.

Input variable 4. District Density of Tuition Center (T):

$$T = \sum_{i=1}^{n} \frac{\mu_t(t_i)}{t_i}$$

where T is the fuzzy set, t_i is an element in the data set and $\mu_t t_i$ is the membership function (Figure 7(d)). T is divided into five predicates: $T = \{VS, S, N, D, VD\}$, where VS is very sparse, S is sparse, N is normal, D is dense and VD is very dense.

Input variable 5. District Supply of Private Commercial Stock (P):

$$P = \sum_{i=1}^{n} \frac{\mu_p(p_i)}{p_i}$$

where P is the fuzzy set, p_i is an element in the data set and $\mu_p p_i$ is the membership function (Figure 7(e)). P is divided into five predicates: $P = \{VD, D, A, S, VS\}$, where VD is very deficient, D is deficient, A is average, S is sufficient and VS is very sufficient.

Output variable 1. District Profitability:

$$PR = \sum_{i=1}^{n} \frac{\mu_p(pr_i)}{pr_i}$$

where PR is the fuzzy set, pr_i is an element in the data set and $\mu_{pr} pr_i$ is the membership function (Figure 8(a)). PR is divided into five predicates: $PR = \{VL, L, S, H, VH\}$, where VL is very low, L is low, S is satisfaction, H is high and VH is very high.

Output variable 2. District Competition:

$$CO = \sum_{i=1}^{n} \frac{\mu_{co}(co_i)}{co_i}$$

where CO is the fuzzy set, co_i is an element in the data set and $\mu_{co} co_i$ is the membership function (Figure 8(b)). CO is divided into five predicates: $CO = \{VI, I, A, W, VW\}$, where VI is very intense, I is intense, A is average, W is weak and VW is very weak.

In order to illustrate the application of FDSS, the Eastern District of Hong Kong is used to determine its profitability and competition. Table III shows the data collected in the Eastern District. Descriptions of the input and output variables can be found in Sections 4.3 and 4.4.

4.3 District profitability

To determine the profitability of each district, three input and one output variables are selected. Input variables include District Density of Kindergarten and Primary School (*S*); Density of Targeted Student (*C*); Average Family Income (*F*), while output variable refers to district profitability.

	Variable	District (Eastern)
Input 1	District Density of Kindergarten and Primary School (S)	3.66 school/km^2
Input 2	District Density of Targeted Students (C)	3,270 people/km^2
Input 3	Average Family Income (F)	HK$ 32.6 k
Input 4	District Density of Tuition Center (T)	12.93 school/km^2
Input 5	Supply of Private Commercial Stock (P)	759.8 PCS/district area

Table III. Input data for district profitability and competition fuzzy system

The data from the 18 districts are evaluated in different fuzzy sets so as to determine the membership values. According to the analytical result, the universe of discourse for s in fuzzy set S is 0-10 school/km^2; c in fuzzy set C is 0-6,000 people/km^2; f in fuzzy set F is 0-60,000 Hong Kong dollars. Take the Eastern District as an example. The membership values of the three inputs then calculated. Figure 9(a-c) shows the membership values of the three input variables.

Table IV shows the indicator of the profitability fuzzy system which can pinpoint the position of the associated three dimensions, while Table V shows examples of the

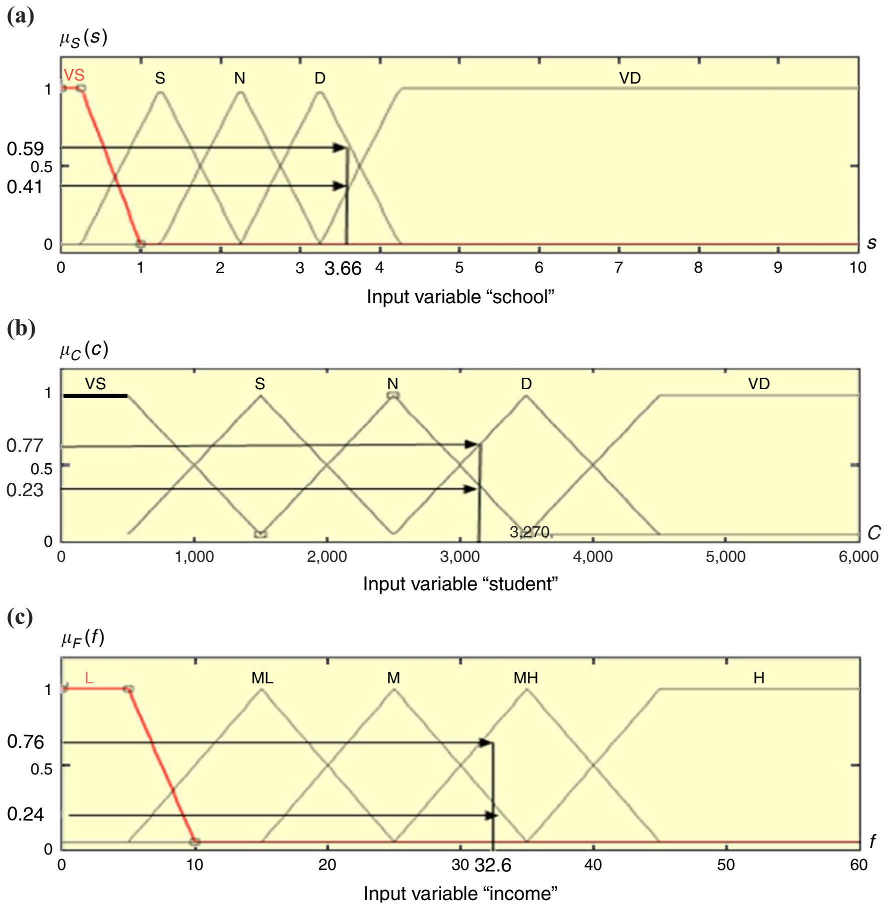

Figure 9.
The fuzzy set of
(a) $\mu_s(3.66)$;
(b) $\mu_c(3{,}270)$;
(c) $\mu_f(32.6)$

Table IV.
Rules table structure of the profitability fuzzy model

Average Family Income (f)	
District Density of Target Student (c)	District Density of School (s)
	District Profitability (pr)

fuzzy rules composed. Each rule is assigned with a number starting from one and counts from left to right, top to bottom.

Among all rules in the rule block, there are eight successful fired rules for the case of Eastern District. Example of fired rules and the composition result of the successful rules are shown in Table VI.

In order to determine the output fuzzy set, the eight results are then put into the implication process. The result of the rules can be express by the following mathematical equation:

$$\mu(x,y) = \gamma\left[\mu_A(x), \mu_B(y)\right] = \mu_A(x) \wedge \mu_B(y)$$

Density of School (*s*)	Mid high Average Family Income (*F*)				
Density of Targeted Student (*c*)	VS	S	N	D	VD
VS	VL	VL	L	S	S
S	L	L	S	S	H
N	H	H	H	H	VH
D	H	VH	VH	VH	VH
VD	VH	VH	VH	VH	VH

Table V. Fuzzy profitability rule table with high average family income

Rule no.	IF-THEN Rule	Composition Result
Rule 14	IF Average Family Income IS *Mid High* AND District Density of School IS *Dense* AND District Density of Target Student IS *Normal* THEN District Profitability IS *High*	(0.76^0.45^0.23) = 0.23
Rule 15	IF Average Family Income IS *Mid High* AND District Density of School IS *Very Dense* AND District Density of Target Student IS *Normal* THEN District Profitability IS *Very High*	(0.76^0.41^0.23) = 0.23
Rule 19	IF Average Family Income IS *Mid High* AND District Density of School IS *Dense* AND District Density of Target Student IS *Dense* THEN District Profitability IS *Very High*	(0.76^0.59^0.77) = 0.59
Rule 20	IF Average Family Income IS *Mid High* AND District Density of School IS *Very Dense* AND District Density of Target Student IS *Dense* THEN District Profitability IS *Very High*	(0.76^0.41^0.77) = 0.41
Rule 39	IF Average Family Income IS *Middle* AND District Density of School IS *Dense* AND District Density of Target Student IS *Normal* THEN District Profitability IS *High*	(0.24^0.59^0.23) = 0.23
Rule 40	IF Average Family Income IS *Middle* AND District Density of School IS *Very Dense* AND District Density of Target Student IS *Normal* THEN District Profitability IS *Very High*	(0.24^0.41^0.23) = 0.23
Rule 44	IF Average Family Income IS *Middle* AND District Density of School IS *Dense* AND District Density of Target Student IS *Dense* THEN District Profitability IS *Very High*	(0.24^0.59^0.77) = 0.24
Rule 45	IF Average Family Income IS *Middle* AND District Density of School IS *Very Dense* AND District Density of Target Student IS *Dense* THEN District Profitability IS *Very High*	(0.24^0.41^0.77) = 0.24

Table VI. Rule tables for successful sample rules of profitability fuzzy set where the implicator operator is denoted by γ, the input membership function is $\mu_A(x)$, the output membership function is $\mu_B(Y)$ and the intersection function is represented by the symbol ^.

Under the aggregation process, the eight results are fused by the aggregation operator for generating the final fuzzy set, with the results shown in Figure 10.

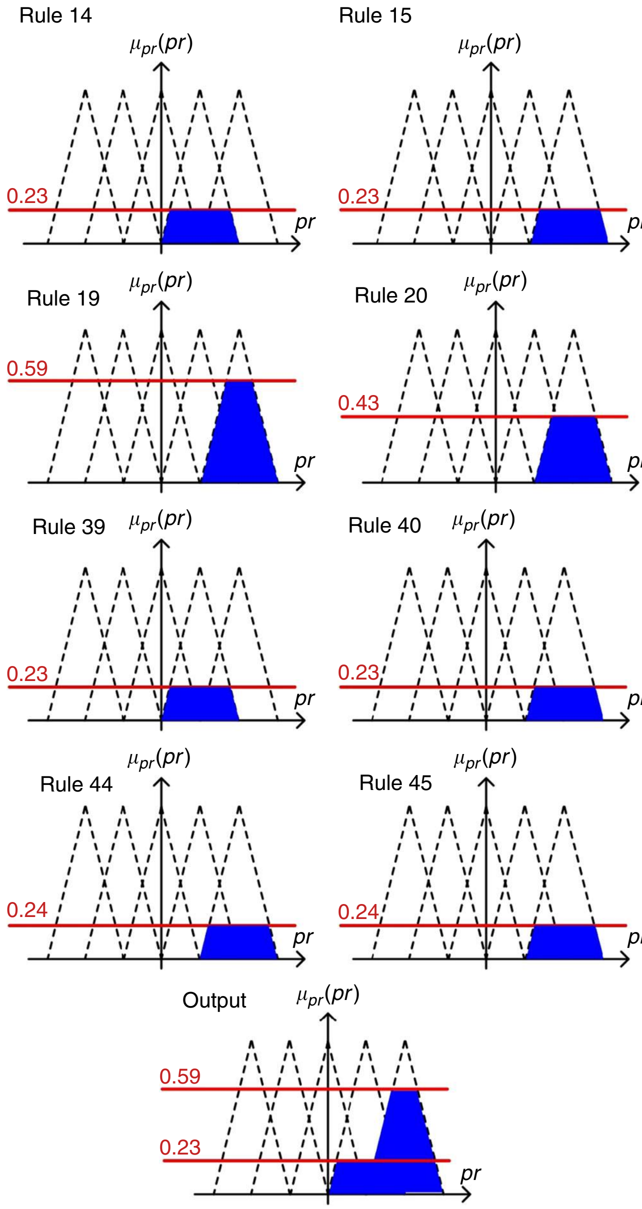

Figure 10.
Implication results of the profitability fuzzy set in the Eastern District

The defuzzification process is required to determine the crisp value of the system. The defuzzification can be calculated by the mathematical equation:

$$Y = \frac{\sum_{j=1}^{N} w_j \overline{C_j A_j}}{\sum_{j=1}^{N} w_j \overline{A_j}}$$

where w, C and A represent the weight, center of gravity and area for each individual implication result. The results are illustrated in Table VII.

As the Siu Sai Wan Center is located in the Eastern District of the Hong Kong Island, the related data is input in the fuzzy set to determine the district grading in terms of profitability. The profitability of the Eastern District is 2.990, which is considered as very high in productivity.

4.4 District competition

For the district competition, three input and one output variables are defined. The input variables include: District Density of Tuition Center (T); District Density of Targeted Student (C); District Supply of Private Commercial Stock (P).

The data from the 18 districts are evaluated in different fuzzy sets so as to determine the membership values. According to the analytical result, the universe of discourse for t in fuzzy set S is 0-42 school/km^2; c in fuzzy set C is 0-6,000 ppl/km^2; f in fuzzy set F is 0-2,500 $\times 10^3$m^2 area, which is the area of the private commercial stock/district area. The rules table used to determine the competition is illustrated in Table VIII.

Take the Eastern District as an example, where there are two successful fired rules. The two rules are shown in Table IX.

In order to determine the output fuzzy set, the two results are then put into the aggregation process. The aggregation result of Rule 40 and 45, as well as the output fuzzy set with the result, are shown in Figure 11.

	Area (A)	Center of gravity (C)	Weight (w)	$A \times C \times w$	$A \times w$
Rule 14	0.678	1.667	1	1.130	0.678
Rule 15	0.678	3.333	1	2.260	0.678
Rule 19	1.386	3.333	1	4.620	1.386
Rule 20	1.086	3.333	1	3.620	1.086
Rule 39	0.678	1.667	1	1.130	0.678
Rule 40	0.678	3.333	1	2.260	0.678
Rule 44	0.704	3.333	1	2.346	0.704
Rule 45	0.704	3.333	1	2.346	0.704
			Sum	19.712	6.592

$$Y = \frac{\sum_{j=1}^{N} w_j \overline{C_j A_j}}{\sum_{j=1}^{N} w_j \overline{A_j}} = \frac{19.712}{6.592} = 2.990$$

Table VII. Data for the defuzzification process for the profitability fuzzy set

Supply of Private Commercial Stock (p)	
District Density of Target Student (c)	District Density of Tuition Center (t)
	District Competition (co)

Table VIII. Rules table of the competition fuzzy system

Through the defuzzification process shown in Table X, the competition index of Eastern District is found to be 3.33, which shows that the competition in the district is very intense.

5. Results and discussion

By repeating the dual-fuzzy approach for all 18 districts in Hong Kong, the result of profitability analysis and competition analysis are discussed in order to provide DS function for the expansion plan of Dr I-Kids Education Center.

Table IX.
Rule tables for successful sample rules of competition fuzzy set

Rule no.	IF-THEN rule	Composition result
Rule 40	IF District Density of Tuition Center IS Very *Dense* AND District Density of Target Student IS *Normal* AND Supply of Private Commercial Stock IS *Average* THEN District Competition IS *Very Intense*	(0.98^0.23^0.96) = 0.23
Rule 45	IF District Density of Tuition Center IS *Very Dense* AND District Density of Target Student IS *Dense* AND Supply of Private Commercial Stock IS *Average* THEN District Profitability IS *Very Intense*	(0.98^0.77^0.96) = 0.77

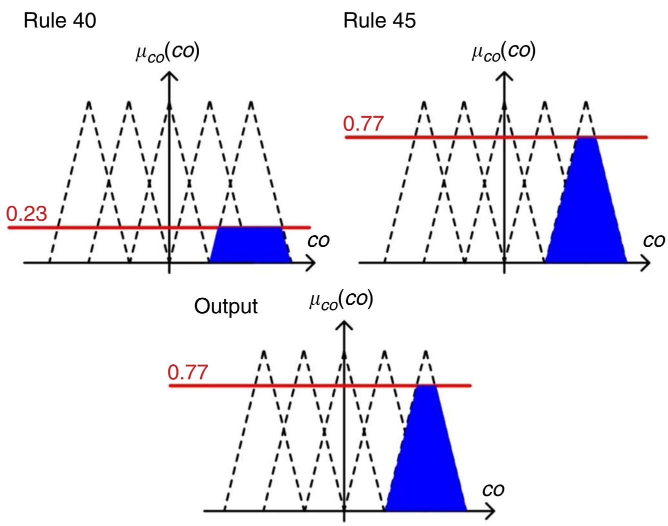

Figure 11.
The implication results of the competition fuzzy set for the Eastern District

Table X.
Data for the defuzzification process for the competition fuzzy set

	Area (A)	Center of gravity (C)	Weight (w)	$A \times C \times w$	$A \times w$
Rule 40	0.679	3.333	1	2.263	0.679
Rule 45	1.579	3.333	1	5.261	1.579
			Sum	7.524	2.258

$$Y = \frac{\sum_{j=1}^{N} w_j \overline{C_j A_j}}{\sum_{j=1}^{N} w_j \overline{A_j}} = \frac{7.524}{2.258} = 3.33$$

5.1 Result of profitability analysis

The result of profitability analysis of the 18 districts in Hong Kong is shown in Table XI. The profitability index is presented in numeric values, where a positive value indicates a high profitability in the district while the negative value shows a low profitability. According to the profitability index, the profitability in the 18 districts is divided into the grading of very high, high, satisfactory, low and very low, showing the level of profitability. To validate the profitability index, the percentage change of profit from the centers in existing market are collected and compared with the profitability index. Table XII shows the comparison result for existing market. Based on the profitability analysis, it is found that Yau Tsim Mong and Kowloon City have the highest Profitability Index, which is equal to 3.33. Compared to the data collected in existing market, it is found that Yau Tsim Mong and Kowloon City also got a significant increase in profit from 2013 to 2014, which shows that the high profitability index represents a higher profit earned by the franchising center. The results are further presented graphically based on the descending order of profitability index of the district, as shown in Figure 12.

District	Profitability index	Grading
Central & Western	1.85	High
Wan Chai	1.05	Satisfactory
Eastern	2.99	Very high
Southern	−2.81	Very low
Yau Tsim Mong	3.33	Very high
Sham Shui Po	3.17	Very high
Kowloon City	3.33	Very high
Wong Tai Sin	2.84	Very high
Kwun Tong	2.93	Very high
Kwai Tsing	0.814	Satisfactory
Tsuen Wan	−3.14	Very low
Tuen Mun	−2.87	Very low
Yuen Long	−3.09	Very low
North	−3.33	Very low
Tai Po	−3.33	Very low
Sha Tin	−2.57	Very low
Sai Kung	−3.33	Very low
Islands	−3.33	Very low

Table XI. Profitability analysis of the 18 districts in Hong Kong

District	Profitability index	Percentage change in profit (from 2013 to 2014) (%)
Yau Tsim Mong	3.33	+11.7
Kowloon City	3.33	+11.1
Sham Shui Po	3.17	+9.8
Eastern	2.99	+6.7
Kwun Tong	2.93	+6.0
Wong Tai Sin	2.84	+4.5
Sha Tin	−2.57	−3.1
Tuen Mun	−2.87	−5.9
Tsuen Wan	−3.14	−9.0
North	−3.33	−10.0
Sai Kung	−3.33	−10.9

Table XII. Comparison of profitability index and percentage change in profit for existing market

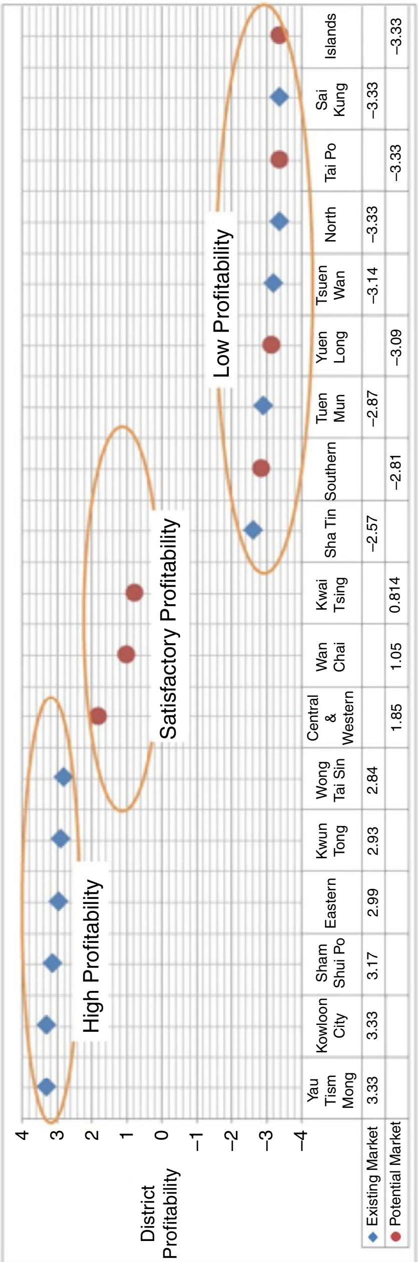

Figure 12.
District profitability of the private education industry in Hong Kong

As shown in Figure 12, it is found that six districts have high profitability, three districts have satisfactory profitability and nine districts have low profitability. All six districts with high profitability belong to the existing market, which indicates that at least one tuition center has already been set up in the district. The franchisor can consider setting up more tuition centers in those districts. However, the franchisor should also take into consideration whether students in the district have the need to join more courses in the private education center. Following the districts with high profitability, three districts including Central and Western, Wan Chai and Kwai Tsing belong to the region with satisfactory profitability. As there is no tuition center of Dr I-Kids Education Center being operated in these districts, the three districts are defined as potential markets. Dr I-Kids Education Center can consider setting up new tuition centers there so as to extent their business in more locations.

5.2 Result of competition analysis

Similar to the profitability analysis, the results of the competition analysis in Hong Kong is summarized in Table XIII. The competition index of each district is presented using numeric values. A positive value of the competition index shows intense competition in the district. On the other hand, a negative value of the competition index shows weak competition. Based on Table XIII, the results are further presented graphically in descending order of competition index of the district, as shown in Figure 13.

As shown in Figure 13, six districts have intense competition while the rest of the districts have average competition. Among the six districts with intense competition, four districts belong to the existing market and the other two districts belong to the potential market. Since intense competition may make the business difficult to survive, it is suggested that the franchisor of Dr I-Kids Education Center does not set up new tuition centers in those districts. On the other hand,

District	Competition index	Grading
Central and Western	2.41	Intense
Wan Chai	3.33	Very intense
Eastern	3.33	Very intense
Southern	0	Average
Yau Tsim Mong	2.5	Intense
Sham Shui Po	1.51	Intense
Kowloon City	2.62	Very intense
Wong Tai Sin	0.7	Average
Kwun Tong	1.36	Intense
Kwai Tsing	0.541	Average
Tsuen Wan	0.7	Average
Tuen Mun	−0.426	Average
Yuen Long	−0.13	Average
North	0	Average
Tai Po	0	Average
Sha Tin	0.3	Average
Sai Kung	2.41	Weak
Islands	−1	Average

Table XIII. Competition analysis of the 18 districts in Hong Kong

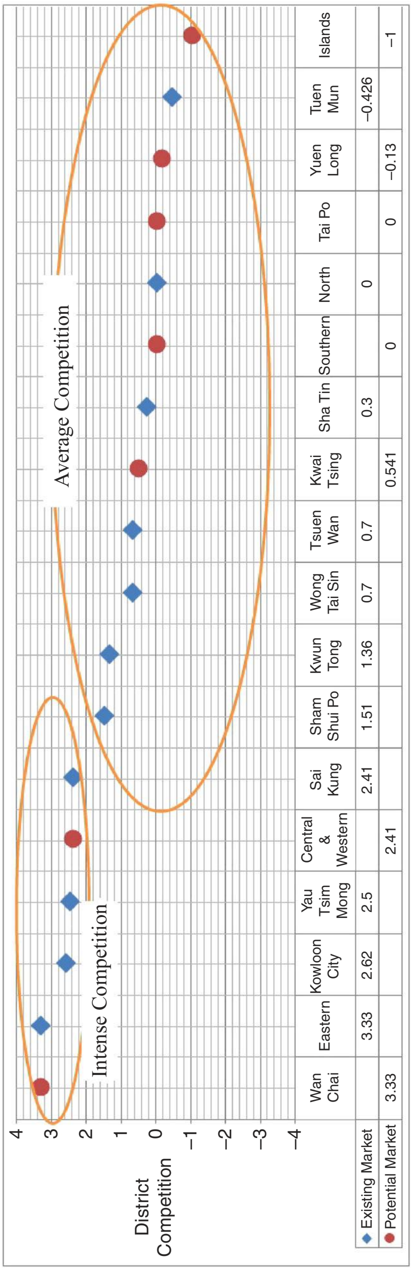

Figure 13.
District competition of the private education industry in Hong Kong

Dr I-Kids Education Center can consider setting up new tuition centers in potential markets which has average competition, such as Kwai Tsing, Southern, Tai Po, Yuen Long and Island.

5.3 Discussion of district positioning model and franchising center positioning strategy

According to the result of the profitability analysis and the competition analysis, it can be noticed that a district with average competition may not have high profitability. Hence, the two analyses should be considered at the same time in order to determine DS on the expansion plan for the franchising business. Therefore, the profitability index and competition index of the 18 districts in Hong Kong are then presented in the form of a matrix, which consists of four quadrants. Districts in the four quadrants demonstrate different characteristics in regard to market demand and competition. The district positioning model is shown in Figure 14.

As shown in Figure 14, quadrants I and IV show a high profitability in the district. To reduce competition, the franchisor should decide to set up new tuition centers in these districts so as to maintain the number of students enrolled and ensure profitability. However, it is found that no district falls into quadrant IV. Meanwhile, nine districts are found in quadrant I. Among them, six districts are located in the existing market while the remaining three districts belong to the potential market. As the franchisees should be able to have a high profitability if the tuition centers are set in these regions, the franchisor should pay attention to the districts in quadrant I.

(i) Strategy for existing market. As mentioned, the existing market refers to districts that have at least one tuition center being set up. In quadrant I, five districts in the existing market fall into the shaded region, namely Yau Tsim Mong, Sham Shui Po, Kowloon City, Wong Tai Sin and Kwun Tong. All the suggested districts are located in the Kowloon Peninsula of Hong Kong, and may serve a group of students with similar characteristics. The franchisor may consider expanding business by setting up more tuition centers to fulfill the needs in the district.

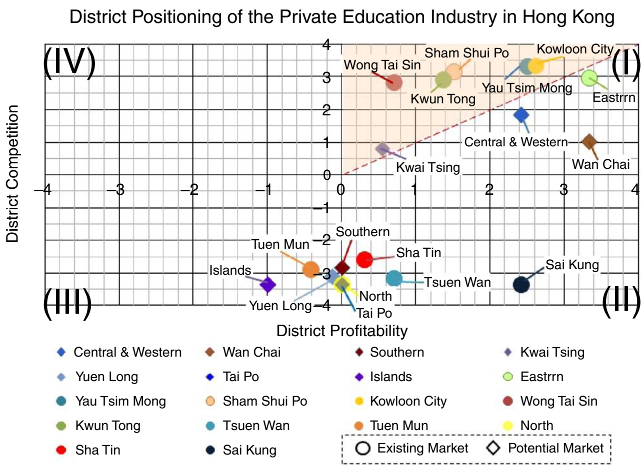

Figure 14. District positioning model for franchising center positioning strategy

(ii) Strategy for potential market. For the potential market, currently, there is no franchising tuition center in the district. To expand the business to a new market, the franchisor should pay attention to districts in the potential market which fall into quadrant I of the district positioning model. Although the districts Eastern, Central and Western and Wan Chai fall into quadrant I, it is found that the competition becomes intense in these districts, with lower levels of profitability. It means that the franchisees may face a harsh operation environment in these districts while the profitability is limited. In this sense, the franchisor could consider the districts in the shaded region of quadrant I in Figure 14. The districts in this quadrant will have lower competition but increasing profitability. Among the six districts in the shaded region of quadrant I, only one district, i.e. Kwai Tsing, belongs to the potential market. The franchisor should take into account of this new market which is considered as a high opportunity so as to explore the business in other location in Hong Kong. Although there is intense competition in the region, the market demand is also high. The new center should differentiate itself from competitors to gain more profit. Aggressive promotion strategies and excellent customer service should be provided for the franchisees to gain competitiveness over others.

6. Conclusions

In order to expand the business at a rapid rate using minimum resources, the franchising business model is considered as one of the possible solutions. By attracting interested parties to be franchisees, the franchisees can operate the business using the same brand name and the resources provided. The franchisor does not have to operate the business directly but needs to provide DS and guidance to franchisees. In such a sense, the franchisor is expected to have good strategic planning for future development.

In this paper, an intelligent FDSS is proposed to support the strategic planning of center positioning strategy formulation in a franchising business model. Fuzzy logic is integrated into the system to determine the profitability and competitiveness of different geographic locations. Through the illustration of FDSS in a Hong Kong-based private franchising education center, the result demonstrates how to develop a comprehensive center positioning strategy for DS. The FDSS provides a practical franchising model to expand the scale of business efficiently by analyzing the district profitability and competitiveness. To apply the proposed FDSS, two sources of data, i.e. C&SD Department of Hong Kong Government, and, the internal Customer Relationship System of Dr i-Kids, are collected in the case study. The C&SD of Hong Kong aims to provide statistics covering various social and economic aspects of Hong Kong. The statistics can be obtained regularly from the C&SD Department to facilitate planning and decision making for franchising industry. On the other hand, Dr i-Kids has developed an internal Customer Relationship System which records all data including in-take, transaction and ordering information of students and franchisees. Such data can be used to formulate strategy for both existing and potential market. Furthermore, the sources of relevant data should be fine-tuned and collected in order to suit the needs of different industries. Further research can be considered to enhance the adaptability and extend the functionality of FDSS by integrating various AI techniques, such as GA.

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