

Nhu-Mai Thi Nong

**Article**

## An application of Delphi and DEA to performance efficiency assessment of retail stores in fashion industry

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## Original article

An application of delphi and dea to performance efficiency assessment of retail stores in fashion industry<sup>\*</sup>Nhu-Mai Thi Nong<sup>\*</sup>

University of Finance – Marketing, Vietnam

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## ABSTRACT

Efficiency management is increasing its importance in the improvement of the chain sustainability. As such, this study aims to assess the performance efficiency of retail stores in fashion industry. The integrated approach of Delphi and DEA techniques was employed to address the performance efficiency assessment problem. The Delphi method was used to define the input and output variables, whereas the DEA was applied to evaluate the performance efficiency. The proposed approach was then applied into a fashion company in Hochiminh city of Vietnam to assess its retail chain performance. The results showed that labour, operational costs, size of store, number of customers, and sales revenue are considered as input and output variables in the retailing performance efficiency evaluation. Besides, it is also concluded in the study that most of efficiency retail stores are located in the dynamic districts and the efficient stores can be at any size. The proposed approach verifies its usefulness in the retailing sector. Therefore, it can be applied to the performance efficiency of retail stores in all industries. In terms of theoretical contribution, the input and output variables proposed in this study may devote to the literature in the concept and assessment of the performance efficiency. Moreover, comprehensive and multi-variable assessment of retailing sector may bring lots of benefits not only to the decision-making units but also the authorities or association with constraint funds.

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## 1. Introduction

Vietnam has long been a developing country with fast growth speed in the retail sector. Statistics reveal that the number of trade centres and supermarkets surged from 95 trade centres and 567 supermarkets in 2010–250 and 1163 respectively in 2020. Upon its integration into the global economy, Vietnam has attracted lots of foreign direct investment (FDI) and franchising activities, especially in the retail sector. According to the Ministry of Planning and Investment of Vietnam, the overall amount of freshly registered FDI in the retail, wholesale, and engine repair sectors in the first quarter of 2021 was 22.1 million USD with 42 projects, which accounted for 0.3% of the country's entire capital. FDI projects in the retailing constitute to a large extent a chain of convenience stores, supermarkets, and foreign retail businesses.

Managing chain stores, especially their performance efficiency is a primary task because the chain stores compose of a huge amount of distribution activities and resources (Bruce, Daly, & Towers, 2004). The overall profitability of any chain company is subject to the performance efficiency of each individual store (Barros & Alves, 2003). Therefore, it is of importance for a chain company to measure its retail stores' performance efficiency. If there are any differences among them, the causes should be figured out for the purpose of improving the efficiency of that store in particular and of the whole company in general.

A range of methods have been applied recently for the efficiency assessment such as Data Envelopment Analysis (DEA), Analytical Hierarchy Process (AHP), Order Preference Similarity to the Ideal Solution (TOPSIS), stochastic frontier ... (Alves & Portela, 2015b; Barros, 2005a, 2006a; Lukic, Kljenak, & Anđelić, 2020). Out of these methods, DEA is the most popular one as it is a non-parametric productive efficiency evaluation method handling with a variety of performance metrics, which include numerous inputs and numerous output. However, to the author's knowledge, these metrics are

<sup>\*</sup> Production and hosting by The Korean Association of Shipping and Logistics, Inc.

<sup>\*</sup> Corresponding author.

E-mail address: [ntnmai@ufm.edu.vn](mailto:ntnmai@ufm.edu.vn).

merely defined through the literature. There is a lack of research on defining them under the management judgements and on proposing a comprehensive retail store performance efficiency measurement process. For that reason, in this study, an attempt to propose a process to evaluate performance efficiency has been made to support the evaluation of retail store. The author proposed a process of Delphi and DEA methods to define the input and output criteria and evaluate the retail store performance efficiency, respectively. This approach was proposed because to the extent of the author's knowledge there is no evidence of combining Delphi and DEA methods in the field of retail store performance efficiency assessment. Additionally, this approach provides a structured method for assessing retail store performance and ensures the conformance between the individual store efficiency results and the business strategy of the whole chain. The suggested process was then applied into an empirical case of assessing retail stores' performance efficiency of a company to demonstrate its effectiveness and feasibility.

The empirical case was conducted in a fashion company. The outbreak of the Covid-19 pandemic in the world has seriously impacted the fashion market. Remarkably, the pandemic has hit a succession of great fashion brands in the globe, making them on the verge of bankruptcy. Nonetheless, the fashion industry in Vietnam is estimated to have the third highest growth rate of more than 37% in 2020 compared to 2019, only after the food and health care ones. As a consequence, a stream of brands rushing to freshly markets from the end of 2020 come about fiercely, and Vietnam is a precedence terminus with efficient pandemic control and prevention, together with the positive economic growth. Additionally, over the years the fashion industry has been characterized as having an uncertain business environment and erratic consumers (Su, 2013). Proposing an easy-to-use, simple, effective, and speedy performance efficiency assessment process is of significance and urgency. For these reasons, it can be noted that studying the retail store performance efficiency evaluation problem for a fashion company is practically and theoretically significant in the context of acrimonious competition.

The rest of this research is organized as follows: Section 2 highlights literature review on previous studies. Research design and methodology are presented in Section 3. In Section 4, an empirical case applies the proposed process into the retail stores' performance efficiency of a fashion company. Conclusion is then withdrawn in Section 5.

## 2. Literature review

### 2.1. Methods to measure efficiency

The goal of an enterprise in managing its performance efficiency is how to maximize the output within a given number of resources or how to employ minimum inputs for a given amount of output (Karakitsiou, Dimitriadis, & Kavakiotis, 2016). It means that multiple inputs and multiple outputs will be considered in efficiency measurement. Barros (2006a) utilized a stochastic frontier model to generate the efficiency scores for a Portuguese hypermarket chain. Nevertheless, this method does not permit the application of multiple inputs and multiple outputs. Lukic et al. (2020) employed AHP and TOPSIS methods to evaluate the efficiency of food retailers in Serbia, in which the AHP method was used to define the weights of evaluation criteria whilst the TOPSIS was applied to measure the efficient food retailer. However, the limitation of this approach is that it merely ranks the retail stores basing on their final performance without considering constant returns to scale (CRS), variable returns to scale (VRS), or which unit will be a peer for inefficient one.

These limitations may be overcome by using DEA method. It has been proved over time to be a good approach for measuring the performance of retail stores (Barros, 2005a). The earliest study that applied DEA into the performance assessment of retail stores was

introduced by Norman and Stocker (1991). Later, Duman, Tozanli, Kongar, and Gupta (2017) also used DEA into analyzing 24 outlets of a fast food restaurant chain in the United States. Keh and Chu (2003) measured the operation efficiency of a chain of grocery stores in the United States. There have been lots of other researches on retailers' efficiency in Portuguese, Spain, Europe, Korea, China, Turkey ... (Alves & Portela, 2015b; Barros, 2005a; Camanho, Portela, & Vaz, 2009; de Jorge Moreno, 2010; Donthu & Yoo, 1998; Gandhi & Shankar, 2014; Ko, Chang, Bae, & Kim, 2017; Malhotra, Malhotra, & Lafond, 2010). The greatest advantage of DEA in performance efficiency evaluation is that a retail store is put in comparison with the best performing stores, from then improving the operation efficiency of the whole chain. In case the researchers wish to rank the stores after evaluating their efficiency, DEA may be combined with TOPSIS. In 2017, Duman, Tozanli, Kongar, and Gupta proposed an integrated approach combining fuzzy AHP, DEA, and TOPSIS methods for the evaluation of food store retail performance. In the first step, the authors employed the AHP method to derive the weights of qualitative and quantitative KPIs. Then, DEA was applied to measure the performance efficiency of food retail stores by using quantitative KPIs. In the final phase, TOPSIS was utilized to rank the stores basing on their performances. The proposed methodology provided a comprehensive approach for the retail store evaluation. However, in the authors' language, the qualitative and quantitative inputs and outputs used in the research were not enough for decision making, which then affected the final results.

In addition to the efficiency measurement, lots of authors extended their studies to factors affecting efficiency by combining DEA with the Tobit regression method. Barros (2006b) employed DEA to evaluate the efficiency of 22 supermarkets in Portugal and then explored the efficiency drivers using a Tobit regression method. The results revealed that larger retail stores are more efficient than small ones, and national retail groups are more efficient than regional ones. Additionally, factors affecting the efficiency of supermarkets' performance include market share, location, and number of retail stores, location, and regulation. Later on, many other researchers also integrated DEA with the Tobit regression method to evaluate the retailers' efficiency and define the efficiency drivers (Grime & Wright, 2014; Uyar, Bayyurt, Dilber, & Karaca, 2013; Yu & Ramanathan, 2008) or combine DEA and the Tobit regression with Malmquist indices to compare among groups of retail stores (Yu & Ramanathan, 2009).

To conclude, there have been numerous researches on the application of diversified methods to the performance efficiency measurement, in which DEA is the most popular one for the evaluators because of its effectiveness in the performance measurement (see Table 1). However, to the best of the author's knowledge, there are yet no articles involving the application of Delphi and DEA methods in assessing the performance efficiency of the retail industry, especially in the fashion one and in Vietnam. Thus, this research provides a novel technique to measure retail stores performance using Delphi and DEA approaches. The Delphi approach is used to arrive at a group of managers' opinion on the input and output criteria. It is common to use managerial judgement in the creation of suitable variables (Norman & Stoker, 1991). For the DEA method, it is especially well suited to be used in the efficiency evaluation field, which is proven through numerous literatures above.

### 2.2. Input-output measures

Efficiency has always been a crucial issue in retailing. Efficiency can be evaluated through output expansion or input reduction. Generally, outputs are related to monetary units such as sales and profits (see Table 1), in which sales can be in aggregated (Alves & Portela, 2015b; Duman et al., 2017; Gafner et al., 2021; Keh & Chu,

**Table 1**  
List of studies on retail store performance efficiency.

| Ordinal No. | Studies                          | Methods                                              | Input                                                                                                                                                                                                         | Output                                                                                                                                                                                               |
|-------------|----------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | Norman and Stocker (1991)        | DEA                                                  | Age of store<br>Location<br>Population<br>Competition                                                                                                                                                         | Revenue                                                                                                                                                                                              |
| 2           | Duman et al. (2017)              | DEA                                                  | Store size, Store manager experience, Store location, Promotion expenses.                                                                                                                                     | Sales, Customer satisfaction                                                                                                                                                                         |
| 3           | Keh and Chu (2003)               | DEA                                                  | Labour (floor staff, management wages and benefits), Capital (occupancy, utilities, maintenance, and general expenses)                                                                                        | Distribution services (accessibility, assortment, assurance of product delivery, availability of information, ambience), Sales revenue                                                               |
| 4           | Barros (2006a)                   | Stochastic frontier                                  | Price of capital, Price of labour                                                                                                                                                                             | Sales, Earnings                                                                                                                                                                                      |
| 5           | Barros (2006b)                   | DEA – Tobit regression                               | Labour, Capital                                                                                                                                                                                               | Sales, Operational results, Value added                                                                                                                                                              |
| 6           | Yu and Ramathanan (2008)         | DEA – Tobit regression                               | Total assets, Shareholders funds, Number of employees                                                                                                                                                         | Turnover, Profit before taxation                                                                                                                                                                     |
| 7           | Yu and Ramathanan (2009)         | DEA – Malmquist productivity index -Tobit regression | Number of employees, Selling floor space                                                                                                                                                                      | Sales revenue, Profit volume                                                                                                                                                                         |
| 8           | Camanho et al. (2009)            | DEA                                                  | Stock, Operational costs                                                                                                                                                                                      | Sales                                                                                                                                                                                                |
| 9           | Malhotra et al. (2010)           | DEA                                                  | Staff costs, Product spoiled, Area, Population<br>Days of sales outstanding (Average collection period), Total debt/equity ratio                                                                              | Return on assets, Quick ratio, Operating profit margin, Inventory turnover ratio, Asset turnover ratio                                                                                               |
| 10          | Donthu and Yoo (1998)            | DEA                                                  | Employees, Fixed assets, Cost of labour, Stock                                                                                                                                                                | Sales revenue, Operational results                                                                                                                                                                   |
| 11          | Uyar et al. (2013)               | DEA – Tobit regression                               | Area, Population, Inventory, Employee, Salaries, Other costs                                                                                                                                                  | Sales revenue, Profit                                                                                                                                                                                |
| 12          | Grime and Wright (2014)          | DEA – Tobit regression                               | Cost of labour, Capital employed                                                                                                                                                                              | Sales, Profit                                                                                                                                                                                        |
| 13          | Barros (2005a)                   | DEA                                                  | Area of the store, Age, FTE (Full time equivalent personnel), Average value of the stock                                                                                                                      | Sales of textile, Sales of non-textile, Sales of hair products, Sales of bijou, Sales of shoes, Sales of handbags, Sales of party bags, Sales of evening bags, Sales of wallet, Sales of travel bags |
| 14          | Karakitsiou et al. (2016)        | DEA                                                  | Salary costs, Branch's area<br>Products spoiled,                                                                                                                                                              | Sales                                                                                                                                                                                                |
| 15          | Ko et al. (2017)                 | DEA                                                  | Store size, Number of items, Number of employees, Rental cost                                                                                                                                                 | Sales revenue, Number of customers                                                                                                                                                                   |
| 16          | Gafner, Joske, and Klumpp (2021) | FAHP – DEA - TOPSIS                                  | Store territory (Sq. mile), Population density (Population/Sq. mile), Weekly expenses (\$/week), Total hours worked by in-store personnel (Hours/week), Total hours worked by delivery personnel (Hours/week) | Total number of carry-out orders (number of orders/week), Total number of delivery orders (number of orders/ week), Sales, % delivery on time (%), % out to door time (%)                            |
| 17          | de Jorge Moreno (2010)           | DEA                                                  | Initial allocation quantity, Replenishment quantity                                                                                                                                                           | Sales quantity, Inventory quantity                                                                                                                                                                   |
| 18          | Lukic et al. (2020)              | AHP-TOPSIS                                           | Purchase value of goods sold<br>Operating costs                                                                                                                                                               | Gross margin, Net profit                                                                                                                                                                             |
| 19          | Barros (2005b)                   | DEA                                                  | Personnel expenses, Rent costs, Advertising expenses                                                                                                                                                          | Sales, Profits                                                                                                                                                                                       |
| 20          | Gandhi and Shankar (2014)        | DEA                                                  | Area, Personnel costs, Fixed material costs, Variable material costs                                                                                                                                          | Number of orders processed, orders delivered too late, stores supplied, incorrectly picked units, inventory difference, average stock                                                                |

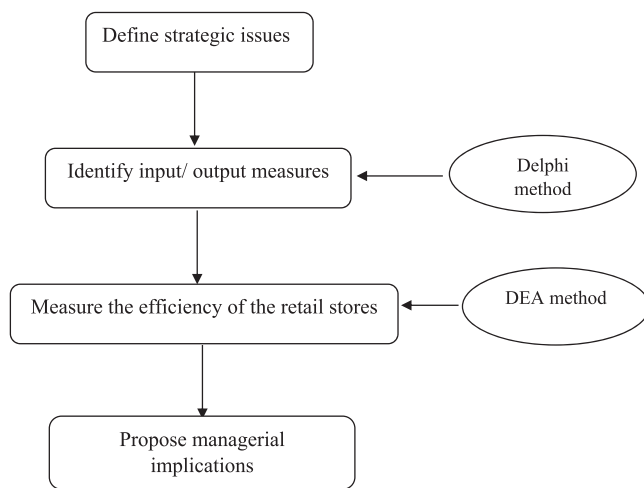


Fig. 1. Research framework.

2003, etc.) or disaggregated by product type to understand the importance of each product in the store's performance (Barros, 2005a), and profit can be before taxation (Yu & Ramanathan, 2008) or net (Lukic et al., 2020). Many other research also considered different measures in non-monetary units including customer satisfaction (Duman et al., 2017), distribution services (Keh & Chu, 2003), value added, operational results (Barros, 2006b; Donthu & Yoo, 1998), return on assets, quick ratio, inventory turnover ratio, asset turnover ratio (Malhotra et al., 2010), number of customers (Ko et al., 2017), percentage of delivery on time, percentage out to door time, inventory quantity, number of carry-out orders, number of delivery orders (Gafner et al., 2021), orders delivered too late, store supplied, incorrectly picked units, and average stock (Gandhi & Shankar, 2014) as outputs for the efficient measurement.

When defining the set of inputs to include in the DEA method to evaluate the performance efficiency of the retail stores, it is common to divide the inputs into two groups: controllable and non-controllable. Controllable inputs refer to those metrics that may be controlled by firms to get competitive advantage and are often used in efficiency evaluation. As in the literature, controllable inputs cover from labour (Thomas et al., 1998; Moreno, 2010; Keh & Chu, 2003; Yu & Ramanathan, 2008; Yu & Ramanathan, 2009; Donthu & Yoo, 1998; Uyar et al., 2013; Ko et al., 2017; Alves & Portela, 2015b), personnel cost (Camanho et al., 2009; Moreno, 2010; Barros, 2006a; Barros, 2006b; Donthu & Yoo, 1998; Uyar et al., 2013; Grime & Wright, 2014; Alves & Portela, 2015b; Gandhi & Shankar, 2014), size of the store (Thomas et al., 1998; Camanho et al., 2009; Yu & Ramanathan, 2009; Uyar et al., 2013; Barros, 2005a; Karakitsiou et al., 2016; Ko et al., 2017; Gafner et al., 2021; Gandhi & Shankar, 2014), rent cost (Alves & Portela, 2015b; Ko et al., 2017; Uyar et al., 2013), operational costs (Camanho et al., 2009; Lukic et al., 2020; Uyar et al., 2013), experience (Duman et al., 2017), location related costs (Uyar et al., 2013), advertising expenses (Alves & Portela, 2015b; Duman et al., 2017; Uyar et al., 2013), fixed material costs (Gandhi & Shankar, 2014; Uyar et al., 2013), variable material costs (Gandhi & Shankar, 2014; Uyar et al., 2013), purchase value of goods sold (Lukic et al., 2020), average value of the stock (Barros, 2005a; Camanho et al., 2009; Donthu & Yoo, 1998), product spoiled (Camanho et al., 2009; Karakitsiou et al., 2016), total hours worked by in-store personnel (Hours/week), total hours worked by delivery personnel (Gafner et al., 2021), inventory (Uyar et al., 2013), capital employed (Barros, 2006a, 2006b; Grime & Wright, 2014; Keh & Chu, 2003), age of store (Norman & Stocker, 1991), total assets (Yu & Ramanathan, 2008) to shareholders' funds (Yu & Ramanathan, 2008). In contrast, non-controllable metrics are referred to location (Duman et al., 2017; Norman & Stocker, 1991),

population, and competition (Norman & Stocker, 1991). Nonetheless, according to the literature, these non-controllable inputs were not popularly used in efficiency measurement.

To conclude, a series of inputs and outputs can be considered to measure the performance efficiency of the retail chain mentioned labour, size of the store, costs ranging from rent cost, operational costs, location related costs, advertising expenses, fixed material costs, variable material costs to purchase value of goods sold, population for the inputs and profits and sales for the outputs. Nevertheless, the input and output metrics for DEA should be customized to suit well the retail company's objective and situation (Duman et al., 2017); for example, in fashion retailing, Barros (2005a) paid their attention to size of the store, age of the store, full time equivalent personnel, and average value of the stock for the inputs and detailed sales volume of each category of the store's product such as sales of textile, sales of non-textile, sales of hair products, sales of bijou, sales of shoes, sales of handbags, sales of party bags, sales of evening bags, sales of wallet, and sales of travel bags for the outputs.

### 3. Research design and methodology

#### 3.1. Research design

As stated in the previous parts, to measure the efficiency of retail stores, Delphi and DEA methods are proposed to be used in this research. The flowchart for the proposed approach is depicted in Fig. 1.

Step 1: Define strategic issues related to efficiency evaluation.

Step 2: Identify input/ output measures by applying Delphi method.

Step 3: Utilize DEA approach to measure the efficiency of the retail stores.

Step 4: Propose managerial implications to improve the efficiency of the whole chain and each store.

#### 3.2. Research methodology

##### 3.2.1. Delphi

Delphi method, originally introduced in the 1950s by Olaf Helmer and Norman Dalkey of the Rand Corporation, is a forecasting process which is based on the results of numerous rounds of questionnaires delivered to a panel of experts. The application of the Delphi method is to collect a consensus of expert opinions for the complicated problems (Huang, Li, & Yu, 2019). The Delphi process is illustrated as follows:

Firstly, the moderator chooses a panel of experts with relevant knowledge and experience for the project.

Secondly, each expert is delivered a series of questions with instructions to give responses anonymously on the topic.

Thirdly, the moderator aggregates the responses by removing irrelevant materials and looking for common answers and feeds back to the group.

Fourthly, the experts are then given the chance to revise their responses based on the feedback. The experts' responses are returned to the moderator for the next aggregate.

The controlled feedback process continues until a common consensus among experts is reached.

##### 3.2.2. DEA

The DEA method was developed by Charnes, Cooper, and Rhodes (1978) as a method to define the efficiency with numerous inputs and outputs, however it originated more than 20 years before. In 1957, Farrell proposed the idea of applying the Production Possibility Frontier (PPF) as a criterion for evaluating (relative) efficiency between units (Decision Making Units – DMU) within an industry; whereby units that reach the frontier will be considered (more) efficient and units that do not reach the PPF curve will be considered less efficient (than others).

For efficient DMUs, since they lie on the frontier, their technical efficiency score (TE) is equal to 1. For less efficient DMUs (within the limit line), their effective score will be less than 1.

There are two different models of DEA mentioning Constant returns to scale (CRS) and variable Returns to Scale (VRS). In terms of CRS, a growth in inputs results in a proportional growth in outputs whereas with VRS a growth in inputs does not conduce a proportional change in outputs.

Efficiency is calculated from the obtained outputs corresponding to the given inputs. The DEA method applies a non-parametric linear optimization problem to construct a PPF curve based on given data about a certain group of units and computes the efficiency scores for those units.

According to Coelli, Rao, O'Donnell, and Battese (2005), performance efficiency can be measured using the CRS Input - oriented DEA model. In the input-oriented cases, a measure of efficiency in allocating resources in the direction of minimizing production costs can be used to determine the optimal quantity of resources (inputs) for which a household can minimize production costs without reducing outputs whilst with output-oriented case, the inefficient retailers are proposed to push up their outputs for a given set of inputs.

Concerning the multiple input and multiple output case, assume a situation with  $n$  decision making units (DMUs), each of which produces  $q$  products using  $m$  different input variables. In this study, to estimate the efficiency of each DMU, a set of linear equations must be established and solved for each DMU. This problem will be done by using the CRS Input-Oriented DEA model because it is of difficulty for the retailers to directly control their outputs in the competitive markets (Grime & Wright, 2014). In addition, it is unclear to define whether VRS exists in the retail stores or not. The CRS Input-Oriented DEA model is of the following form:

$$\begin{aligned} &\text{Min}_{\lambda, x_i^*} w_i' x_i^*, \\ &\text{Subject to:} \end{aligned}$$

$$\sum_i^N = 1 \lambda_i X_{ji} - X_{ji}^* \leq 0, \quad \forall j$$

$$\sum_i^N = \lambda_i y_{ki} - y_{ki} \leq 0, \quad \forall k$$

$$\lambda_i \geq 0, \quad \forall i$$

where:  $w_i$  = the input price vector of the  $i^{\text{th}}$  DMU,

$x_i^*$  = the cost minimization - oriented vector of input quantities for the  $i^{\text{th}}$  DMU, given the  $w_i$  input price and  $y_k$  output levels,

$i = 1$  to  $n$  (DMUs),

$k = 1$  to  $q$  (outputs),

$j = 1$  to  $m$  (input variables),

$y_{ki}$  = quantity of output  $k$  produced by the  $i^{\text{th}}$  DMU,

$x_{ji}$  = quantity of input  $j$  used by the  $i^{\text{th}}$  DMU,

$\lambda_i$  = dual variables.

The estimation of performance efficiency can be performed by various computer programs. However, for convenience, the author used DEAP1 version 2.1 for estimating the performance efficiency in the study.

## 4. Empirical study

### 4.1. Company background

ACB fashion company was established in an effort to realize the desire to bring elegant fashion solutions, the value of Vietnamese people to Vietnamese people through the exploitation of preeminent fashion technologies and the essence in the industry from international cooperation with corporate strategic partners. The company has more than 1000 retail stores throughout 63 cities and provinces of Vietnam with four different brands. In this study, those retail stores for one Men's fashion brand of the company in Hochiminh city – one of the most active fashion centres in Vietnam are measured their efficiency. This resulted in a total of 16 stores participating in the efficiency evaluation.

### 4.2. Input – output measures

The selection of input and output variables is of importance in using DEA successfully. Input and output metrics should be selected such that they fit well the company's strategies and goals (Duman et al., 2017). As presented in the research framework (Fig. 1), input and output measures in this study were chosen by applying Delphi method. After three rounds of consideration, 3 inputs and 2 outputs were chosen: labour, operational costs, and size of the store for the inputs, and sales revenue and number of customers for the outputs.

Labour refers to the total number of hours worked including both full-time and part-time employees. This input variable was also used in the study of many researchers such as Thomas et al. (1998), Keh and Chu (2003), Yu and Ramanathan (2008, 2009), Donthu and Yoo (1998), de Jorge Moreno (2010), Uyar et al. (2013), Ko et al. (2017), and Barros (2005b).

Operational costs relate to all expenses needed to run the store covering staff costs, rent costs, advertising costs, utility costs, and communication costs, etc. This was utilized as an input metric in Camanho et al. (2009), Uyar et al. (2013), and Lukic et al. (2020).

Size of the store is the area within the store measured in square metres. The larger the size of the store is, the more the number of items may be exposed to the customers. The store size was considered as an input variable in the previous studies of Thomas et al. (1998), Camanho et al. (2009), Yu and Ramanathan (2009), Uyar et al. (2013), Barros (2005a), Karakitsiou et al. (2016); Ko et al. (2017), Gafner et al. (2021), and Gandhi and Shankar (2014).

Sales revenue is the turnover of the store within a month denoted in Vietnam Dong. This output variable has been used in most of previous studies namely Duman et al. (2017), Keh and Chu (2003), Gafner et al. (2021), Barros (2005b), etc.

Number of customers are those who used to and are currently buying the store's product. This output is of extreme importance for the chain company as sometimes the number of customers is high but the sales revenue is low. This variable was also used in the study of Ko et al. (2017).

**Table 2**  
Descriptive statistics of variable utilized in the study.

| Variables                        | Minimum      | Maximum      | Mean         | Standard deviations |
|----------------------------------|--------------|--------------|--------------|---------------------|
| <b>Outputs</b>                   |              |              |              |                     |
| Sales revenue (VND)              | 2951,000,000 | 5876,000,000 | 4352,500,000 | 881,000,000         |
| Number of customers              | 145          | 205          | 174.13       | 21.18               |
| <b>Inputs</b>                    |              |              |              |                     |
| Labour (number of working hours) | 672          | 864          | 816.00       | 85.87               |
| Size of store                    | 70           | 288          | 140.13       | 74.95               |
| Operational costs (VND)          | 2854,220,000 | 5033,530,000 | 3971,510,000 | 773,220,000         |

**Table 3**

The efficiency results of ACB fashion company's retailers.

| Ordinal No. | Name of retailers         | Scale efficiency | Peers           | Peer count | Input target |                   |               | Compared to original value |                   |               |
|-------------|---------------------------|------------------|-----------------|------------|--------------|-------------------|---------------|----------------------------|-------------------|---------------|
|             |                           |                  |                 |            | Labour       | Operational costs | Size of store | Labour                     | Operational costs | Size of store |
| 1           | Dist. 1 (D1)              | 0.939            | PN – D3         | 0          | 812          | 4260,303,200      | 113           | -52                        | -520,600,572      | -7            |
| 2           | Dist.3 (D3)               | 1                | D3              | 8          | 864          | 4417,452,584      | 70            | 0                          | 0                 | 0             |
| 3           | Dist.4 (D4)               | 0.850            | D3              | 0          | 685          | 3500,622,802      | 55            | -179                       | -618,221,035      | -35           |
| 4           | Dist.5 (D5)               | 1                | D5              | 3          | 864          | 3992,666,320      | 72            | 0                          | 0                 | 0             |
| 5           | Dist.6 (D6)               | 0.973            | D3– D12<br>– D5 | 0          | 636          | 3003,333,484      | 66            | -36                        | -83,305,356       | -2            |
| 6           | Dist.7 (D7)               | 0.915            | PN – D3         | 0          | 790          | 4106,309,847      | 91            | -74                        | -399,656,538      | -9            |
| 7           | Dist.8 (D8)               | 0.884            | D12             | 0          | 552          | 2522,618,905      | 82            | -120                       | -331,604,824      | -98           |
| 8           | Dist.10 (D10)             | 0.899            | D5 –<br>D3– D12 | 0          | 710          | 3341,302,479      | 90            | -154                       | -375,063,977      | -10           |
| 9           | Dist.11 (D11)             | 0.891            | D3– D5<br>– D12 | 0          | 592          | 2796,359,954      | 62            | -272                       | -343,092,664      | -8            |
| 10          | Dist.12 (D12)             | 1                | D12             | 8          | 672          | 3068,858,648      | 100           | 0                          | 0                 | 0             |
| 11          | Binh Thanh (BT)           | 0.941            | D12–<br>D3– PN  | 0          | 813          | 4118,615,908      | 89            | -51                        | -258,817,706      | -135          |
| 12          | Thu Duc (TD)              | 0.937            | TB –<br>D12– PN | 0          | 809          | 4547,271,661      | 187           | -55                        | -366,397,341      | -13           |
| 13          | Go Vap (GV)               | 0.971            | D3– D12         | 0          | 724          | 3488,065,317      | 85            | -140                       | -105,029,332      | -15           |
| 14          | Phu Nhuan (PN)            | 1                | PN              | 4          | 864          | 4941,873,236      | 288           | 0                          | 0                 | 0             |
| 15          | Tan Binh (TB)             | 1                | TB              | 1          | 864          | 5033,531,694      | 180           | 0                          | 0                 | 0             |
| 16          | Hoc Mon (HM)              | 0.985            | D12             | 0          | 647          | 2956,875,227      | 96            | -25                        | -46,343,051       | -184          |
|             | <b>Mean</b>               | <b>0.949</b>     |                 |            |              |                   |               |                            |                   |               |
|             | <b>Median</b>             | <b>0.956</b>     |                 |            |              |                   |               |                            |                   |               |
|             | <b>Standard deviation</b> | <b>0.049</b>     |                 |            |              |                   |               |                            |                   |               |

#### 4.3. Data in the DEA method

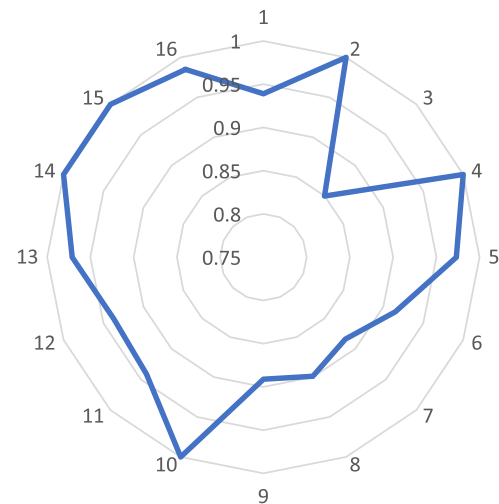
In this study, data of 16 retail stores were taken in the year of 2021. Table 2 reports the summary statistics of the stores analyzed. The standard deviations are rather low relative to the mean, denoting a week diversity in those stores. This motivated the author to use the CRS model for the efficiency evaluation.

#### 4.4. Efficiency scores

Table 3 shows the results of performance efficiency evaluation computed for 16 retail stores of ACB company in the year 2021. Performance efficiency is reached by the stores allocating their resources without waste, which constitutes the best-performance production frontier. The units that move towards this frontier experience improvement, whereas those move away from it experience deterioration.

As seen in Table 3, half of the stores have efficiency scores higher than the median, indicating that the sample has a normal distribution. It is also verified that the stores that achieve performance efficiency are Dist.3, Dist.5, Dist.12, Phu Nhuan, and Tan Binh stores (see Fig. 2). These stores are located in dynamic districts of Ho Chi Minh city. This finding is also in line with the research results of Norman and Stocker (1991) and Duman et al. (2017). Besides, these stores have different acreage which means that the efficient stores can be at any sizes. However, on the whole, stores with modest area tend to be more efficient than larger ones because their rent costs will be less, especially in those places with high rent cost as in Ho Chi Minh city, Vietnam. Specifically, if the store size is classified into 2 groups: under and over 100 square metre, the mean efficiency score of the under-100-square-metre stores outperforms that of the over-100-square-metre stores. This is totally a new finding of this study.

The supplemental element of DEA approach is to constitute benchmarking graphs to make comparison for units. The circles of the graph stand for units and the lines illustrate the relations among the units. The arrows show the direction of inter-relations which are led from the peer (model) units to the units following the peers. The

**Fig. 2.** Efficiency scores.

graph visualizes which units may serve as the peers for the inefficient units to make them optimal.

It can be seen in the benchmarking graph (Fig. 3) that Dist.3, Dist.5, Dist.12, Phu Nhuan, and Tan Binh stores may serve as models for inefficient stores. Special attention should be paid to Dist.3 and Dist.12 stores as they are peers for more than half of less efficiency stores. Dist.5, Phu Nhuan, and Tan Binh stores are also peers for three, four, and one stores, respectively. Benchmarking graph helps retailing companies define the best units to set variables of improvement and progress measurement. Take the case of Thu Duc store, by studying its peer - Phu Nhuan store, ACB fashion company may find that the inefficient points of Thu Duc store lay at its large size and its labour. The company, therefore, should resize Thu Duc store acreage and reduce the number of labourers or the number of working hours. This may result in low operational costs.

Another beneficial function of input-oriented DEA technique is to propose the input target for the inefficient stores while still keeping

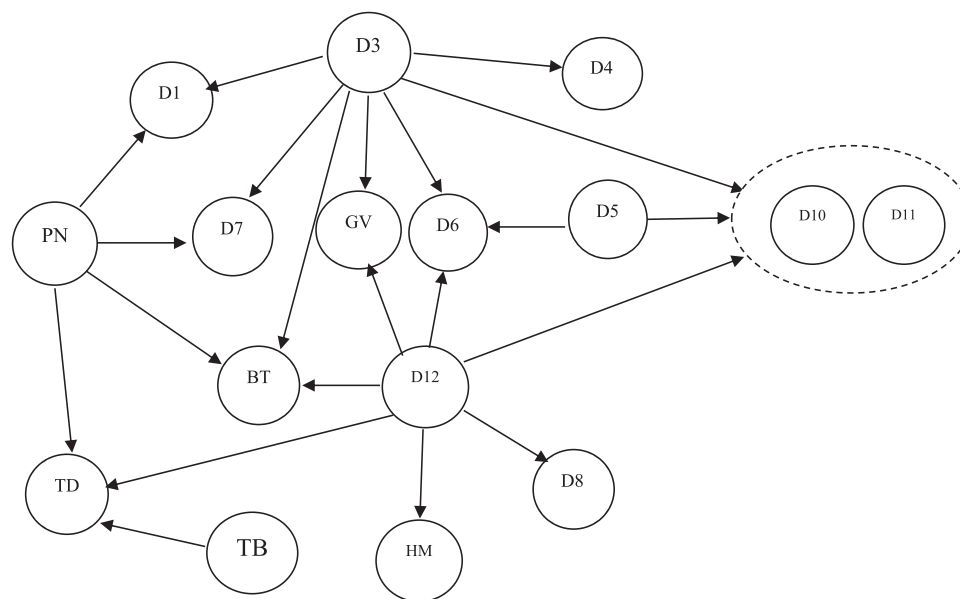


Fig. 3. Benchmarking graph.

the output unchanged. For labour, Dist.11 store should reduce the most working hours (–272), following by Dist.4 (–179), Dist.10 (–154), Go Vap (–140), Dist.8 (–120), Dist.7 (–74), Thu Duc (–55), Dist.1 (–52), Binh Thanh (–51), Dist.6 (–36), and Hoc Mon (–25). In terms of operational costs, Dist.4 store should cut down VND 618,221,035 – the highest cut-down cost in the group of inefficient stores. The least operational cost cut (VND 46,343,051) belongs to Hoc Mon – the best performance store in the inefficient group, followed by Dist.6 (VND 83,305,356), Go Vap (VND 105,029,332), etc. In regard to size of the store, it is quite difficult for retail stores to reduce their size only some square metres. Nevertheless, the proposed considerable size cut by DEA technique should be taken into consideration. For instance, Hoc Mon should reduce its store size by 184 square metres; Binh Thanh needs to narrow its area by 135 square metres; or 98 square metres should be cut down for Dist.8 store. Through the above figures, the author is convinced that large-size store is not beneficial if its location is far away from the downtown as Hoc Mon, Binh Thanh, and Dist.8 stores are suburban. The efficiency at that time may be from the stores's operation and labour. High qualified and skillful sales forces may be a good driver for high sales revenue and low operational costs. One qualified and skillful sales man may substitute for many ordinary ones. This finding is compatible with the research result of [Ko et al. \(2017\)](#).

## 5. Conclusion

The study presented an example of applying Delphi and DEA methods into the performance efficiency evaluation of retail stores in fashion industry. The example verifies the usefulness of Delphi and DEA application in the retailing sector. Additionally, it can be noted that labour, operational costs, size of store, number of customers, and sales revenue are considered as input and output variables in the retailing performance efficiency evaluation. Besides, it is also concluded in the study that most of efficient retail stores are located in the dynamic districts and the efficient stores can be at any sizes; however, in general the modest-sized stores have a tendency to be more efficient than the larger ones.

The contribution of this study is the suggestion of a hybrid Delphi and DEA techniques to deal with numerous inputs and outputs and

assess the efficiency of retail stores. Further, the input and output variables proposed in this study may devote to the literature in the concept and assessment of the performance efficiency. Moreover, comprehensive and multi-variable assessment of retailing sector may bring lots of benefits not only to the decision-making units but also the authorities or association with constraint funds. The store managers may adopt an efficient and systematic policy to enable the less efficient stores to reach the efficient frontier. It is convinced that the performance efficiency analysis could be one of the motives to enhance the quality of business, to avoid the waste of public funds due to limited resources and to perfect the retailing management. In addition, based on the efficiency analysis results, some measures to ensure and improve the competitiveness of retail stores are also implied as followed:

Firstly, the store location, the utmost concern for store managers, should not be far away from downtown or dynamic centres where always gather potential customers.

Secondly, labour measured under the number of working hours is another important efficiency driver which store managers should pay much attention to. Labour should be balanced with the store location and the store size: less labour would be given to small-sized stores and stores in downtown or dynamic centres need more labour. Additionally, store managers also need to have special focus on the qualified labourers – the factor improving the sales revenue of stores.

Thirdly, store managers should consider the store size with its rent cost to save the operational costs – the other efficiency driver of the stores.

In a similar vein, the study findings also carry crucial information on the efficiency of retail stores functioning in regards to other stores with similar sphere of activity.

The suggested methodology could be applied to the performance efficiency of retail stores in all industries. Nonetheless, the study results only pertain to the context of Vietnam. As such, future studies could be extended to other countries with superior conditions. The next limitation refers to the data set, which is relatively small in this study, with only 16 stores in the year 2021. It is not feasible to analyze in details with the given data set. Thus, it is suggested to upgrade the size of the data set to cross-national or time-series basis.

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