AHP AND DEA HYBRID MODEL FOR PERFORMANCE MEASURES AGGREGATION AND RANKING OF DECISION MAKING UNITS

BY

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I dedicate this work in memory of my father for his sincere love and ever-present support of my personal endeavors towards learning

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The completion of this thesis is a major milestone in my life. I still do not believe that I have finally reached this stage. It took enormous self-motivation, discipline, and encouragement from my advisor, family and friends to overcome the frustrations and roadblocks to reach this stage.

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ABSTRACT

Full Name : Majdi A. Al-Basarah

Thesis Title : AHP and DEA Hybrid Model for Performance Measures Aggregation and Ranking of Decision Making Units

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Performance measurement techniques/systems normally assume homogeneity among decision making units (DMUs) where the units under evaluation share the same characteristics. However, in practice, the units are not homogenous and naturally fall into groups based on the nature of the business processes or organizational structures. This implies that simple efficiency indicators cannot be applied to assess the performance of such units and sub-units.

Another issue faced with this type of problems is with the aggregation of the performance measures. Normally, the efficiency evaluation of the unit depends on the efficiency values of its sub-units which require the assessment of the sub-units in order to evaluate the overall efficiency of the unit. However, since the units might not have the same number of sub-units and don't share the same characteristics; simple summation cannot be applied to aggregate the performance measures.

In this thesis, an AHP and DEA hybrid model has been developed for calculating and aggregating performance measures in an organization with several units and sub-units considering their individual characteristics. In addition, the ranks of such units and sub-units were determined. The model was compared with other models and its advantage in limiting the effect of zero weights problem is demonstrated.

ملخص الرسالة

الاسم الكامل: مجدي عبد رب الرسول البصاره

عنوان الرسالة: نموذج هجين من تقنية التحليل الهرمي و تقنية التحليل التطويقي للبيانات لقياس الأداء وتحديد رتبة وحدات العمل

التخصص: هندسة النظم الصناعية

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عادة ما تفترض أساليب قياس الأداء أن تكون وحدات العمل (DMUs) الخاضعة لعملية التقييم متجانسة فيما بينها وأنها تشترك في نفس نوعية المدخلات والمخرجات في أداء عملها. لكن تواجهنا مشكلة في الواقع العملي وهي أن وحدات العمل غير متجانسة فيما بينها بل تصنف في مجموعات استنادا إلى طبيعة عملها أو الهياكل التنظيمية التي تكون مندرجة تحتها. هذا يعني أننا لا نستطيع تطبيق المؤشرات البسيطة أو الاعتيادية لقياس وتقييم كفاءتها وأداءها.

وهناك مشكلة أخرى تواجهنا أيضا، الا وهي طريقة حساب الأداء الكلي للوحدات. حيث أنه في العادة يتم تقييم كفاءة الوحدة باحتساب كفاءة الوحدات الفرعية التابعة لها. لكن المشكلة تكمن في أن الوحدات قد لا تمتلك نفس عدد الوحدات الفرعية وأنها لا تشترك في نفس الخصائص وبالتالي قد يتأثر الأداء الكلي بحسب عدد الوحدات الفرعية.

طورت هذه الأطروحة نموذج هجين من تقنية التحليل التطويقي للبيانات وتقنية التحليل الهرمي لقياس الأداء وتحديد رتبة وحدات العمل في منظومة مكونة من عدة وحدات ووحدات فرعية وذلك لمعالجة المشاكل التي تطرأ في قياس الأداء والكفاءة لهذا النوع من المنظومات. وتم مقارنة نتائج النموذج الجديد مع نماذج طورت سلفا وقد بينت الدراسة مقدرة هذا النموذج على معالجة المشاكل التي تنجم عادة من تطبيق تقنية التحليل التطويقي للبيانات.

CHAPTER 1

INTRODUCTION

1.1. Introduction

High level of competition in industry increased the demand for measures that reflect the true performance of companies. At the strategic level, companies and organizations need to aggregate and rank performance from lower operational levels to higher ones especially in the case of multiple units consisting of multiple sub-units. This chapter is organized as follows: Section 1.2 provides the problem definition and the motivation for this research. In section 1.3, the objectives of this thesis are stated. Finally, the thesis organization is presented in section 1.4.

1.2. Performance Measurement and Ranking

In order to improve the operational performance and reduce manufacturing costs, effective methods for measuring the efficiency and ranking the performance of the manufacturing units are required. Various industries have developed and used conceptual models as well as measurement systems in order to quantify, compare and manage their performance. Occasionally, companies set their targets depending on external benchmarks available through industry trade associations or through consulting organizations (Jain, Triantis and Liu, 2011). The challenge faced in industry is that there is little guidance available on setting performance improvement targets. In addition, targets based on external benchmarks need to be adjusted to the unique configurations and circumstances of the unit that is being evaluated.

Normally, performance measurement techniques/systems assume homogeneity among decision making units (DMUs) where the units under evaluation share the same characteristics. However, in practice, the units are not homogenous and naturally fall into groupings based on the nature of the business processes or organizational structures. Putting this into consideration, the common set of performance indicators is not adequate to measure the efficiency of these units because indicators that are valid for one unit might not be valid for other units. In addition, the performance indicators might not have the same level of influence on the units' performance. So what we need is a dynamic performance measurement system that can accommodate this requirement.

Another requirement that need to be addressed is the aggregation of the performance measures. Normally, the efficiency evaluation of the unit depends on the efficiency values of its sub-units which require the assessment of the sub-units in order to evaluate the overall efficiency of the unit. However, since the units might not have the same number of sub-units and don't share the same characteristics; we cannot apply simple summation to aggregate the performance measures. We need a mechanism to consistently aggregate efficiency measures across sub-units to obtain a comprehensive measure of efficiency for the units.

This thesis intends to develop models to address the above two problems. The first is to calculate efficiency measures and aggregate them in an organization with several units and sub-units. The second is to rank the units and sub-units considering their individual characteristics. The approach for developing the above model is based on integrating DEA and AHP.

Data Envelopment Analysis (DEA) is a proven technique for performance measurement and benchmarking. Many applications of DEA in the literature show a great ability of the technique in measuring the overall performance of the decision making units (DMU) and identifying the best performers that are used as a benchmark for the underperforming units. In addition, several ranking methods have been employed to improve the discrimination power of DEA and the analytic hierarchy process (AHP) is one of these methods that can be applied for ranking units.

1.3. Research Objectives

The main objectives of this thesis are to develop a model for ranking decision making units and propose a model for aggregating performance measures in an organization with several units and sub-units. The approach for developing the above model is based on integrating DEA and AHP. The specific objectives are:

- Critical review of past research in the field of performance measurement.
- Develop a new model for aggregating performance measures in an organization with multi units in a hierarchical structure.

- Develop a new hybrid DEA and AHP model for ranking decision making units.
- Apply the developed models using data from the literature.
- Set the path forward for further research and development in this field

1.4. Thesis Organization

The rest of this thesis is organized as follows. In chapter 2, a literature review in the field of performance measurement using DEA is presented. The chapter consists of several sections covering the origins of performance measurement systems, applications of DEA, ranking methods and aggregation methods. In chapter 3, the problem definition and model development is covered. The developed model is tested and verified with numerical example. In chapter 4, the model is compared with other models proposed by different authors and general findings are highlighted. Finally, in chapter 5, the thesis is concluded and further research is proposed.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

The purpose of this chapter is to present the literature in the area of performance measurement with emphasis on performance measures ranking and aggregation using DEA. Section 2.2 studies the origins of the performance measurement concept, evolvement, applications and challenges in its implementation. Section 2.3 addresses the DEA method and its application in performance measurement. Extensions to DEA in order to enable full ranking of decision making units are thoroughly covered in section 2.4. Finally, section 2.5 presents techniques for aggregating performance measures using DEA.

2.2. Performance Measurement

Performance measurement is a discipline that assists in establishing, monitoring and achieving individual and organizational goals (Brudan 2010). The first performance measurement concept was developed during the early 1900s by DuPont and General Motors and it was based on financial ratios and budgetary control procedures (Neely & Bourne 2000). Initially, performance measures based on the financials aspect were widely adopted, but soon expanded to cover other aspects.

The trend of integrating several different aspects into performance measures has been fuelled by the increased competition, the need to increase efficiency and effectiveness of operations, and the greater customers' expectations. Throughout the 1980s and early 1990s, numerous authors suggested measurement frameworks that might be appropriate such as:

- The performance pyramid (Lynch and Cross, 1991)
- The results-determinants framework (Fitzgerald et al., 1991)
- The performance measurement matrix (Keegan et al., 1989), and
- The balanced scorecard (Kaplan and Norton, 1992).

These have been followed with a rich stream of research on the design and deployment of balanced and integrated performance measurement systems. Neely (2005) has identified 1,352 papers published in 546 different journals during the period from 1981 to 2005. In fact, it was observed in his research that the four lead authors whose works were cited more than 100 times have somewhat different disciplinary backgrounds, namely:

- Kaplan: accounting
- Neely: operations management
- Banker: accounting/operations research and information systems
- Charnes: mathematics/operations research

However, in spite of the different disciplinary backgrounds of these authors, they are seeking solutions to a common challenge which is how to ensure performance measurement systems relate to an organization's strategy.

Neely (2005) observed that the balanced scorecard framework by Kaplan and Norton (1992) is dominating the field of performance measurement systems with 30% to 60% of firms adopting the balanced scorecard. Neely and Bourne (2000) concluded that despite the popularity of the balanced scorecards, it is claimed that 70 percent of the implementations failed. The failure of implementation is attributed to two main reasons: poor design of the measurement system and difficulty of implementation. Neely and Bourne (2000) also identified three obstacles that might lead to failure of implementation of the performance measurement systems:

1) Political challenges: relate to the fact that many people feel threatened by measures, especially when there is a culture of blame within the organization. In such environments, even if the implementation succeeds, the focus will be on how to deliver good numbers instead of delivering real performance measures.
2) Infrastructural challenges: a major issue in many organizations but it is underestimated. It is not uncommon to see the data needed to calculate particular performance measures scattered on multiple systems. The amount of time, effort and resources required to re-engineer these information systems is enormous. Normally, management gets frustrated

by the fact that the implementation of the performance measurement system needs such long time to be ready.

3) Loss of focus: this is caused by the infrastructural challenges. Too often the organization's priorities shift and attention is no longer is devoted to the implementation of the performance measurement system.

A recent research by Waal and Counet (2009) identified 31 problem categories that can be encountered during the implementation and use of performance measurement systems. The research was based on a survey which was sent to a panel of performance management experts. The research showed that the failure rate of systems implementations has decreased in the past decade from 70 to 56 percent.

Nudurupati et al. (2011) researched the role of the Management Information Systems (MIS) and change management towards the successful implementation of the performance management systems. They studied and described issues faced in practice when implementing performance measurement systems in organizations throughout its lifecycle, which led to better understanding and explanation of the challenges.

2.3. Data Envelopment Analysis

Data Envelopment Analysis is a well-established methodology to evaluate the relative efficiencies of a homogeneous set of production processes based on mathematical programming models. The production processes are called Decision Making Units (DMUs) and are assumed to perform the same function by transforming multiple inputs into multiple outputs. The efficiency measure of a specific DMU is obtained by the ratio of the weighted outputs to the weighted inputs and is benchmarked against the ratio of the best DMU in the group.

The DEA model determines the weights for each input/output that give the highest possible relative efficiency score for each DMU and keeps the efficiency scores of all other DMUs less than or equal to unity when evaluated with similar weights. If the DMU being assessed does not obtain the maximum efficiency score (100%), then its peers are more productive even when all the weights are set to maximize the score of the focus unit. This means that no inefficient unit can complain that its score would have been better if a different set of weights were used.

The evaluation of efficiency performance of production processes has traditionally been carried out through the use of a production frontier Farrell (1957). Farrell proposed an activity analysis approach that could combine the measurements of the multiple inputs into a satisfactory measure of efficiency. Unfortunately, he confined his numerical examples and discussion to single output situations, although he was able to formulate a multiple output case.

Twenty years after Farrell's seminal work, and building on those ideas, Charnes et al. (1978) responded to the need for satisfactory procedures to assess the relative efficiencies of multi-input and multi-output production units. They introduced a powerful model based on linear programming which has been referred to as the Charnes, Cooper and Rhods (CCR) model. The CCR model was generic and superior to Farell's approach in the case of a single output and the change of origin approach proposed in the multiple output case in Farrel and Fieldhouse 1962. (Førsund and Sarafoglou 2002)

Since the advent of DEA in 1978, there has been an impressive growth both in theoretical developments and applications of the ideas to practical situations. We shall limit our discussion to the general DEA model and extensions to handle practical situations in manufacturing. The more comprehensive DEA expositions can be found in the recent publications by Cooper et al. (2006) and Cook and Seiford (2009).

Based on the benefit/cost theory, the original DEA model proposed by Charnes, Cooper and Rhods can be represented as a fractional programming problem. For a set of n DMUs ($j=1,\ldots,n$), each DMU_j is consuming m inputs x_{ij} ($i=1,\ldots,m$) to produce t outputs y_{rj} ($r=1,\ldots,t$). The relative efficiency of a DMU_{jo}, for an input oriented assessment, can be obtained from the following DEA ratio model, where u_r is the output weight, v_i is the input weight and ε is a small positive number:

$$maximize\ h_o = \frac{\sum_{r=1}^{t} u_r y_{rjo}}{\sum_{i=1}^{m} v_i x_{ijo}}$$

$$subject\ to$$

$$\frac{\sum_{r=1}^{t} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \qquad j = 1, \ldots, n$$

$u_r \geq \varepsilon \quad for \quad r = 1, \ldots, t \qquad and \qquad v_i \geq \varepsilon \quad for \quad i = 1, \ldots, m$

The fractional model can be converted into a linear form through simple transformation as explained in Charnes et al. (1978). This can be achieved by maximizing the numerator of the objective function and setting the denominator as a constraint restricted with equality to 1. The linear form of the model will be as follows:

$$maximize\ h_o = \sum_{r=1}^{t} u_r y_{rjo}$$

$$subject\ to$$

$$\sum_{i=1}^{m} v_i x_{ijo} = 1$$

$$\sum_{r=1}^{t} u_r y_{rjo} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$$

$$u_r \geq \varepsilon \quad for \quad r = 1, \ldots, t \qquad and \qquad v_i \geq \varepsilon \quad for \quad i = 1, \ldots, m$$

Many extensions to the original DEA model were derived by the need for handling specific business requirements. These included varying business processes leading to differences in selection of input and output measures. When the data for the inputs and outputs are selected, it is important that more attention be paid to the analysis since the values assigned to the inputs and outputs could be overlapping. Also, resources used as input might be shared between different DMUs.

Shammari (1999) performed an effectiveness analysis with DEA on 55 manufacturing companies in Jordan. The DEA model was modified to eliminate the inefficient units by imposing realistic limits on input and output factors. The feasible direction for efficiency improvement was found by establishing a certain range for every slack variable within which it is allowed to vary.

Leachman et al. (2005) studied the automobile industry to evaluate a firm’s performance relative to its rivals. They developed a performance metric based on traditional measures of total expenditures as input and production volume and quality as output. The study showed how manufacturing performance can be measured objectively with a composite performance index.

Düzakın and Düzakın (2007) used DEA with balance sheet level data to analyze the performance and ranking of 500 industrial enterprises in Turkey. They applied the “Slack-based measure of super-efficiency” (super-SBM) DEA model using the DEA Solver Pro 4.1 software package.

Jha et. al. (2007) modified the standard DEA model incorporating the concept of Assurance Region (AR) type I constrains and ordering of weights for performance measurement and benchmarking of the hydropower plants in Nepal. They proposed a way to simplify the DEA model by redefining the actual input/output data set to include categorical inputs in the analysis.

In some application areas, it has been recognized that the DMU may perform different types of functions in which the performance needs to be measured considering the efficiency of its subcomponents. Also, the subcomponents might share common resources where the DEA model needs to be modified to provide splitting of those resources. A modified DEA model was developed by Cook and Green (2004) to measure multicomponent efficiency and to identify the core business components in multi-plant firms. The new model was developed to identify the most appropriate product grouping for each plant (DMU).

In the standard DEA model, DMUs efficiency is improved by either increasing their output levels or decreasing their input levels. However, both undesirable inputs and outputs might exist in manufacturing. For example, undesirable outputs such as scrap and pollutants should be reduced to improve the efficiency. Fare et al. (1989) developed a non-linear DEA model to handle the case where the desirable outputs are increased and the undesirable outputs are decreased for a paper mill production system.

Scheel (2001) compared several approaches for incorporating undesirable outputs in DEA models. Also, he proposed a new concept which takes into account that changes to the output level will involve changes to both desirable and undesirable outputs. The new “non-separating” measures approach is compared to the traditional measures which consider desirable and undesirable outputs separately.

Seiford and Zhu (2002) revised the standard DEA to consider both desirable and undesirable outputs while preserving the linearity and convexity in the Banker, Charnes and Cooper (BCC) model. They used the classification invariance property to show that the standard DEA model can be applied to improve the performance by increasing the desirable outputs and decreasing the undesirable outputs.

The DEA is built on the assumption that the DMUs form a relatively homogeneous set of units evaluated relative to other members of the set. However, there are cases where the DMUs are not similar wherein the units can be grouped into different categories based on different characteristics of the units. Banker et al. (1986) examined the grouping of DMUs based on categorical variables. Such variables allow for a comparison of any DMU with those in its own category and in those categories below it. However, in many situations where there is a grouping phenomenon present, categorical variables do not provide an appropriate structure for analysis.

Cook et al. (1998) presented a model for evaluating group and individual DMUs efficiency in a hierarchy for a set of power plants. The hierarchical efficiency was viewed as a multi-stage process. In stage 1, performance measures for power units within each plant are computed relative to their peers. In stage 2, the plants at level 2 are treated as DMUs and the efficiency scores are computed there.

Cook and Green (2005) extended the previous work with a concept to measure efficiency of the hierarchical structure by considering all levels simultaneously. The new model has been applied to 40 power generation units organized under 8 plants. The developed model considered the plants to be the DMUs and the power units to be subcomponents of the DMUs. Also, the model handled splitting plant level (DMU) outputs across the power units (components) within each plant.

2.4. Ranking of Decision Making Units

Another area of research interest in DEA methodology is concerned with the ranking of DMUs. Tsou and Huang (2010) highlighted that the main issue is that basic procedures of DEA methodology can only group the DMUs into two sets: those that are efficient and define the Pareto frontier, and those that are inefficient. Several ranking methods in the DEA context have been employed to improve the discrimination power of DEA. Related articles appearing in the international journals from 2000 to 2013 are gathered and classified to help researchers and decision makers in applying the approaches effectively. Adler et al. (2002) gives an extensive review of ranking methods in DEA model. These methods can be classified into six main groups. It is possible that somewhat these groups have overlapping with the others as each of the existing methods can be viewed from different aspects

The first group involves the evaluation of a cross-efficiency matrix, in which the units are self and peer evaluated. The second group is generally known as the super-efficiency method. The super-efficiency method ranks DMUs through the exclusion of the unit under evaluation and analyzing the changes of frontier. The third group utilizes statistical techniques, which are generally applied after the DEA dichotomic classification. The forth requires the collection of additional, preferential information from relevant decision-makers and combines multiple-criteria decision methodologies with the DEA approach. The fifth method is concerned with the multipliers (weights) of inputs and outputs and ranking DMU based on weights selection. The last group covers other techniques that received less attention in literature.

2.4.1. Cross-Efficiency Evaluation Technique

The cross-efficiency method was first proposed by Sexton et al. (1986). The main idea of this method is to use DEA in a peer-evaluation instead of a self-evaluation which is calculated by the classic DEA models. A peer-evaluation means that each DMU is evaluated according to the optimal weighting scheme of other DMUs. The mean of these efficiencies is the “cross-evaluation”. Then the efficiency score will be the mean of the efficiencies of a DMU calculated with the weighting schemes, which is considering the points of view of other DMUs.

There is a problem in cross-efficiency where scores obtained from the original DEA are generally not unique, and depending on which of the alternate optimal solutions to the DEA linear programs is used, it may be possible to improve a DMU’s (cross efficiency) performance rating, but generally only by worsening the ratings of others. Doyle and Green (1994) proposed the use of secondary goals to deal with the non-uniqueness issue by presenting aggressive and benevolent model formulations. Liang et. al. (2008) extended the model of Doyle and Green (1994) by introducing various secondary objective functions. Each new secondary objective function represents an efficiency evaluation criterion. With these new models, the efficiency scores are maximized to obtain a better picture of cross-efficiency stability with respect to multiple DEA weights. Wu et. al. (2009) proposed a new model considering the principle of rank priority as secondary objective functions, which means pursuing the best ranking order is more important than maximizing the individual score. Contreras (2012) extended the model considering that efficiency scores induce a weak order of alternatives. The proposed procedure introduces an incentive to break level-pegging ties between alternatives.

Liang et. al. (2008b) also generalized the DEA cross-efficiency concept to game cross-efficiency by viewing each DMU as a player that seeks to maximize its own efficiency under the condition that the cross-efficiency of each of the other DMUs does not deteriorate. An algorithm was presented to derive the best game cross-efficiency scores. It was shown that the optimal game cross-efficiency scores constituted a Nash equilibrium point.

Wu et. al. (2009a) proposed a model to eliminate the average assumption in determining the ultimate cross efficiency and improve the cross efficiency evaluation method from a cooperative game perspective. In the game, each DMU will be a player, the characteristic function value of each coalition is defined, and the solution of Shapley value is computed to determine the ultimate cross efficiency of each DMU.

Wang and Chin (2010) proposed a neutral DEA model for cross-efficiency evaluation. Unlike the aggressive and benevolent formulations, in cross-efficiency evaluation, the neutral DEA model determines one set of input and output weights for each DMU from its own point of view without being aggressive or benevolent to the other DMUs.

Wu et al. (2011) described the main suffering of cross efficiency when the ultimate average cross efficiency is utilized for ranking units. For removing this shortcoming they eliminated the assumption of average and utilize the Shannon entropy in order to obtain the weights for ultimate cross efficiency scores.

Wang et al. (2011) provided a cross efficiency evaluation based on ideal and anti-ideal units for ranking. As the authors mentioned a DMU could choose a unique set of input and output weights to make its distance from ideal DMU as small as possible, or the distance from anti ideal DMU as large as possible, or the both.

Ramon et al. (2011) selected the profiles of weights used in cross-efficiency assessment to prevent unrealistic weighting. They have discussed about the zero weights as they excluded variables from the evaluation.

Rodder and Reucher (2011) presented a consensual peer based DEA model for ranking units. As the authors said this method is generalized twofold. The first is an optimal efficiency improving input allocation, the second aim is the choice of a peer-DMU that corresponding price is acceptable for the other units. Orkju and Bal (2011) extended the model by providing a goal programming technique to be used in the second stage of the cross evaluation.

Jahanshahloo et al. (2011) provided a method for selecting symmetric weights to be used in DEA cross efficacy.

Wang and Chin (2011) proposed the use of ordered weighted averaging (OWA) operator weights for cross-efficiency aggregation instead of average cross-efficiency score.

Wu et al. (2012) proposed a weight balanced DEA model to reduce large differences in weights data and reduce number of zero weights for inputs and outputs.

Zerafat Angiz et al. (2013) introduced a cross efficiency matrix based on this idea that ranking order is much more significant than individual efficiency score.

Alcaraz et. al. (2013) developed a procedure to carry out the cross-efficiency evaluation without the need to make any specific choice of DEA weights. The proposed procedure takes into consideration all the possible choices of weights that all the DMUs can make, and yields for each unit a range for its possible rankings instead of a single ranking.

2.4.2. Super-Efficiency Evaluation Technique

The main idea of this method, as introduced by Andersen and Petersen (1993), is to compare the DMU being evaluated with a linear combination of other DMUs of the sample while excluding the observations of the DMU being evaluated. This only affects the efficiency scores of the extreme efficient DMUs. In this case, these DMUs can obtain an efficiency score greater than one. This approach provides a ranking of efficient DMUs similar to the ranking of inefficient DMUs.

Although this idea is useful for further discriminating efficient units it has been shown in literature that it may be infeasible and non-stable. Thrall (1996) mentioned the infeasibility of super efficiency CCR model. Mehrabian et al. (1999) presented a complete ranking for efficiency units in DEA context which does not have the difficulties of A.P. model.

Tone (2002) proposed a super-efficiency model based on slack based measure of efficiency (super SBMT model). The model returns optimal objective value greater than or equal to one where the efficient DMUs will always score higher than one. All inefficient DMUs will have the score of one; hence, the model can be used to rank efficient DMUs only. Jablonsky (2004) modified the model by proposing goal programming to measure the super-efficiency (super SBMG model).

Jahanshahllo et al. (2004) added some ratio constraints to the multiplier form of A.P. model and introduced a new method for ranking DMUs. Jahanshahloo et al. (2004a) presented a method for ranking efficient units on basis of the idea of one leave out and L_1 norm. The proposed model is proved to be always feasible and stable.

Chen and Sherman (2004) presented a non-radial super efficiency method and discussed the advantage of it. They verified that this model in invariant to units of input/ output measurement.

Wang et. al. (2007a) proposed the concept of optimistic and pessimistic efficiency and super-efficiency. The optimistic model looks for a set of weights of inputs and outputs that is most favorable to DMU to maximize its efficiency. In the contrary the pessimistic model looks for a set of weights that is most unfavorable to the evaluated DMU and minimizes its efficiency under the constraints that the efficiency of all other units is greater or equal to one.

Li et al. (2007) presented a new method for ranking which does not have difficulties of earlier methods. The presented model is always feasible and stable.

Khodabakhshi (2007) addressed super-efficiency on improved outputs. He mentioned that as A.P. model may be infeasible under variable returns to scale technology, using the presented model gives a complete ranking when getting an input combination for improving outputs.

Sadjadi et al. (2011) presented a robust super efficiency DEA for ranking efficient units. They noted that as in most of the times, exact data do not exist and the stochastic super efficiency model presented in their paper incorporates the robust counterpart of super-efficiency DEA.

Gholam Abri et. al (2011) proposed a model for ranking efficient units. They used Representation theory and represented the DMU under assessment as a convex combination of extreme efficient units

Ashrafi et al. (2011) introduced an enhanced Russell measure of super efficiency for ranking efficient units in DEA.

Chen et al. (2011) proposed a modified super efficiency method for ranking units based on simultaneous input-output projection.

Rezai Balf et al. (2012) provided a model for ranking units based on Tchebycheff norm. They proved that this model is always feasible and stable and it seems to have superiority over other models.

Chen et al. (2013) developed NerloveLuenberger (NL) measure of super-efficiency for overcoming the infeasibility problem that occurs in variable returns to scale super efficiency DEA model a directional distance function.

2.4.3. Statistical Techniques

In DEA technique, the frontier is taken into consideration rather than central tendency in regression analysis. DEA considers an envelope encompasses through all the observations as tight as possible and does not try to fit regression planes in center of data. Friedman et al. (1997) proposed the use of canonical correlation analysis for ranking units. This method is somehow an extension of regression analysis. The aim in canonical correlation analysis is to find a single vector common weight for the inputs and outputs of all units.

One of the limitations in DEA is that it does not allow stochastic variations in input and output data (measurement errors, data errors, etc.) while the efficiency measurement may be sensitive to such variations. Cooper et. al. (2004) proposed a model in which DMUs with stochastic data have been assessed and have thus defined the stochastic efficient DMUs. Behzadia et. al. (2009) extended this model by considering the inefficiency score of efficient DMUs. A DMU with greater distance from the inefficient stochastic frontier has a better ranking score. Razavyan and Tohidi (2008) proposed a method for ranking efficient DMUs with stochastic data. Khodabakhshi (2011) extended the model introduced in Khodabakhshi (2007) allowing deterministic inputs and outputs to be stochastic.

Jahanshahloo et. al. (2005) used Monte Carlo method to develop a method which is able to rank all efficient DMUs. The concept is based on the solely domination region by the DMU under consideration. Jahanshahloo et. al. (2008) extended the model to address the ranking of interval data by using the Monte Carlo method.

Adler and Yazhemsky (2010) applied Monte Carlo simulation to generalize and compare two discrimination improving methods; principal component analysis applied to data envelopment analysis (PCA–DEA) and variable reduction based on partial covariance (VR). The comparison of the two methodologies carried out in the study identifies PCA–DEA as a more powerful discrimination tool than VR.

2.4.4. Multi-Criteria Decision Making Analysis Techniques

Integration of MCDM and DEA was first introduced by Golany (1988) when he combined interactive multiple-objective linear programming and DEA. Golany (1988), Kornbluth (1991), Thanassoulis and Dyson (1992), Golany and Roll (1994), Zhu (1996b) and Halme et al. (1999) each incorporated preferential information into the DEA models through, for example, a selection of preferred input/output targets or hypothetical DMUs.

Li and Reeves (1999) suggested utilizing multiple objectives linear program (MOLP), such as minimax and minisum efficiency in addition to the standard DEA objective function in order to increase discrimination between DMUs. This approach has an advantage where it does not require additional preferential information but it does not guarantee complete ranking.

Strassert and Prato (2002) presented the Balancing and Ranking Method which uses a three-step procedure for deriving an overall complete or partial final order of options

Bal et. al. (2010) proposed two new models (GPDEA-CCR and GPDEA-BCC) based on weighted goal programming (GP) to improve the discriminating power of DEA and also yield more reasonable input and output weights. Örkcü and Bal (2011) proposed goal programming models that could be used in the second stage of the cross-efficiency evaluation.

Wang and Jiang (2012) presented an alternative mixed integer linear programming models in order to identify the most efficient units in DEA technique. The models can make full use of input/output information with no need to specify any assurance regions for input and output weights to avoid zero weights.

Hosseinzadeh Lotfi et. al. (2013) provided an improved three-stage method for ranking alternatives in multiple criteria decision analysis.

2.4.4.1. The Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is a multi-criteria decision making method that was first introduced by Saaty (1980). It allows decision makers to model a complex problem in a hierarchical structure which consists of the goal, objectives (criteria), sub-objectives, and alternatives. The first (topmost) level defines the main goal of the decision problem and the last (lowest) level usually describes the decision alternatives. The levels in between can contain secondary goals, criteria and sub-criteria of the decision problem. The decision maker should determine the weight of all criteria in order to do pairwise comparison between them.

Ho (2008) reviewed the literature of the applications of AHP from 1997 to 2006 focusing on the integration of AHP with other techniques such as data envelopment analysis (DEA).

Sinuany-Stern et al. (2000) combined AHP and DEA model based on a two-stage process for complete ranking of DMUs. However, this method suffered from some problems. The most significant problem is that AHP/DEA ranking is incompatible with efficient/inefficient ranking in DEA in the case of multiple inputs and outputs, and it may illogically rank an efficient DMU under inefficient DMUs. Alirezaee and Rafiee Sani (2011) proposed a new AHP/DEA methodology for ranking DMUs to eliminate the problems of AHP/DEA method.

Jablonsky (2007) used an original AHP/DEA approach with interval pairwise comparisons for ranking of DMUs. Jablonsky (2011) developed two original models for ranking of efficient units in data envelopment analysis. The models are based on multiple criteria decision making techniques: Goal Programming and Analytic Hierarchy Process (AHP).

Alem et. al. (2013) proposed the use of fuzzy analytical hierarchy process (FAHP) for ranking of decision-making units in the fuzzy environment. In this approach, the fuzzy efficiency score, input, and output of a DMU are considered as triangular fuzzy number.

Wang et. al. (2013) used cross-weight evaluation technique for priority determination in the AHP. The model derives true weights for perfectly consistent pairwise comparison matrices and logical weights for inconsistent pairwise comparison matrices

2.4.5. DMU Inputs/Outputs Multipliers Optimization Techniques

The DEA model solves *n* linear problems to evaluate *n* DMUs, and for each DMU evaluates a set of weights (multipliers). In the multipliers optimization method, we attempt to perform complete ranking of DMUs using common set of weights. A separate set of papers reflected preferential information through limitations on the values of the weights (assurance regions or cone-ratio models), which can increase the discrimination among units by reducing the number of efficient DMUs. Such papers include Thompson et al. (1986), Dyson and Thanassoulis (1988), Charnes et al. (1990, 1989), Cook and Kress (1990a,b), Thompson et al. (1990), Wong and Beasley (1990), Cook and Johnston (1992) and Green and Doyle (1995). However, this concept does not guarantee the complete ranking of DMUs.

Adler and Glony (2001) utilized the principal component analysis (PCA) to improve the discrimination power by reducing the number of inputs/outputs. However, this technique cannot ensure complete ranking but reducing the set of efficient units.

Liu and Peng (2008) proposed a method for determining the common set of weights for ranking units. Wang et al. (2009) proposed a model for ranking decision making units by imposing a minimum weight restriction in DEA. Wang et al. (2011) presented two nonlinear regression models for deriving common set of weights for fully ranking units.

Jahanshahloo et al (2011) used the gradient line to rank extreme efficient units and given a note on some of the DEA models for complete ranking using common set of weights. They proved that by solving only one problem it is possible to determine the common set of weighs. Hatefi and Torabi (2012) proposed a common weight multi criteria decision analysis (MCDA)-data envelopment analysis (DEA) for constructing composite indicators (CIs) and obtain common weights to improve the discriminating power of the model.

Ramon et al. (2012) aimed at deriving a common set of weights for ranking units. The approach is based upon minimization of the deviations of the common weights from the nonzero weighs obtained from DEA. Furthermore, several norms are used for measuring such differences.

2.4.6. Other Techniques

There exist some other ranking methods not much developed in the literature. Jahanshahloo et al. (2007) presented a new model for ranking DMUs based on alteration in reference set. The idea is based on the fact that efficient units can be the target unit (benchmark) for inefficient units. Lu and Lo (2009) provided an interactive benchmark model for ranking units. The idea is based upon considering a fixed unit as a benchmark and calculating the efficiency of other units, pair by pair, to this unit.

Hosseinzadeh Lotfi et al. (2011) proposed one DEA ranking model based on applying artificial units called aggregate units.

Tsou and Huang (2010) proposed two novel methods named performance baseline and performance correspondence matrices to evaluate and rank the DMUs based on the technique of singular value decomposition (SVD). They applied the methods on three case studies and demonstrated the effectiveness and robustness of the methods for correspondence analysis between a specific DMU and individual input or output variable.

Alirezaee and Afsharian (2007) introduced a new method for complete ranking of DMUs, which does not make any changes in original models. The basic idea in this method is to compare the DMUs by first; efficiency score; second, Balance index, which are obtained from basic definitions of models. Wu et. al. (2010) showed that the previous model is not stable and then amend the model by introducing the Maximal Balance Index to fix the problem. Guo and Wu (2013) presented an extended DEA model considering undesirable outputs using restrictions to realize a unique ranking of DMUs through the new ‘‘Maximal Balance Index’’ based on the optimal shadow prices.

Bao and Lee (2010) proposed the Expanded Feasible Region Method for re-ranking efficient DMUs.

Wen and Li (2009) and Wen et. al. (2010) proposed a new model with fuzzy inputs and outputs based on credibility measure, and developed a method for ranking all the DMUs. They have designed a hybrid algorithm combined with fuzzy simulation and genetic algorithm to compute and solve the fuzzy model.

Zerafat Angiz et. al. (2010) proposed a method for ranking efficient decision-making units in data envelopment analysis using fuzzy concept. They developed a multi-objective linear model that has the ability to handle the infeasibility situation sometimes faced by previously introduced models.

2.5. Aggregation of Performance Measures in DEA

Conventional applications of data envelopment analysis (DEA) presume the existence of a set of similar decision making units, wherein each DMU is evaluated relative to other members of the set. However, the DMUs usually fall into groupings, giving rise to the problem of how to assess performance of the DMUs and how to view the groups themselves as DMUs. In addition, the efficiency evaluation of the DMU depends on the efficiency values of its subunits which require the assessment of the subunits in order to evaluate the overall efficiency of the DMU. Castelli et. al (2008) surveyed the models that consider internal structures of DMUs. They described the commonalities and differences between these models and show how they relate to the basic formulation.

Cook et. al. (1998) introduced the concept of hierarchical DEA, where efficiency can be viewed at various levels. They provided a means for adjusting the ratings of DMUs at one level to account for the ratings received by the groups (into which these DMUs fall) at a higher level. Cook and Green (2005) extended the previous work with a concept to measure efficiency of the hierarchical structure by considering all levels simultaneously.

Castelli et. al. (2004) proposed DEA models for DMUs evaluation with one-level and two-level hierarchical structures of the DMUs. Each unit is composed of consecutive stages of parallel subunits all with constant returns to scale.

Dia and Ben Abdelaziz (2011) developed a hierarchical DEA model incorporating the cross-efficiency and superiority index techniques for the measurement of competitiveness of heterogeneous companies in an economy. They proposed a tree structure with three levels (company, sector and economy) to homogenize and aggregate the DMUs by grouping them and taking into consideration both basic and specific characteristics of the companies.

Deville et. al. (2013) developed a model to measure performance at the different levels of the hierarchy and showed how these measures determine overall organizational performance.

2.6. Conclusion

Data Envelopment Analysis (DEA) is a proven technique for performance measurement and benchmarking. Many applications of DEA in the literature show a great ability of the technique in measuring the overall performance of the decision making units (DMU) and identifying the best performers that are used as a benchmark for the underperforming units. Several ranking methods have been employed to improve the discrimination power of DEA and the analytic hierarchy process (AHP) is one of these methods that can be applied for ranking units. In next chapter, we will propose a new technique based on integrating DEA and AHP to provide a solution to the problem being addressed in this thesis.

CHAPTER 3

PROBLEM DEFINITION AND MODELING

3.1. Introduction

In this chapter, a model is developed to measure the efficiency of heterogeneous units in an organization with several units and sub units. The model will have the capability of measuring the aggregated efficiency on higher levels of the organization in addition to ranking the efficiency of the units at each level. In section 3.2, the problem is described. Section 3.3 explains the steps for developing the model. Finally, a numerical example is provided in section 3.4 to demonstrate the applicability of the proposed model.

3.2. Statement of the Problem

Consider an organization providing a wide variety of products/services. The organization consists of units and each unit is split into multiple sub units. The grouping of the units and sub units is based on the nature of the products/services being provided. It is assumed that the sub-units under a specific unit consume similar type of inputs to produce specific products/services. For example, sub units producing aluminum bars are grouped under aluminum production unit. The sub-units producing steel bars and sheets are grouped under the steel production unit.

The conceptual hierarchical structure of the model is presented in figure 1 where the organization consists of *(k)* units *(U)* and each unit consists of *(n)* sub-units *(SU)*.

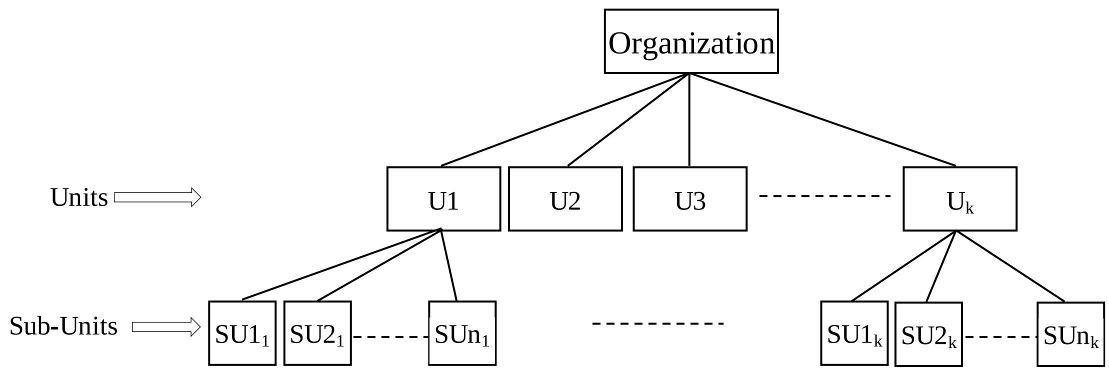

Figure 1 Hierarchical Structure of the Problem

The performance evaluation in the organization is done in multiple steps. First, the sub-units performance is measured against all sub-units within the same group (unit). Then, the results are aggregated to measure the unit's performance within the organization. The unit's performance will depend on the performance of its sub-units in addition to some measures that are applicable to the unit itself (i.e. profitably and customer satisfaction). Finally, the unit overall performance is calculated and compared with other units in the organization.

Considering the above problem, we need to develop a DEA-AHP hybrid model for measuring the performance of the sub-units and the aggregated performance of the units in the organization. Also, we need to rank the sub-units in their respective units and rank the units in the organization.

3.3. Model Development

The performance is defined as the relative efficiency ratio of DEA which is the weighted sum of the outputs over the weighted sum of the inputs, and takes its values between 0 and 1. The formulation of the model is done in multiple steps. First, one DEA model will be developed for each unit to assess the performance of its sub-units. Then, one DEA model will be developed to assess the performance of the units in the organization. The average performance score of the sub-units within each unit will be used as an output measure for the assessment of the units aggregated performance. Finally, AHP-DEA hybrid models will be developed for ranking the units and sub-units. The following diagram illustrates the steps of model development:

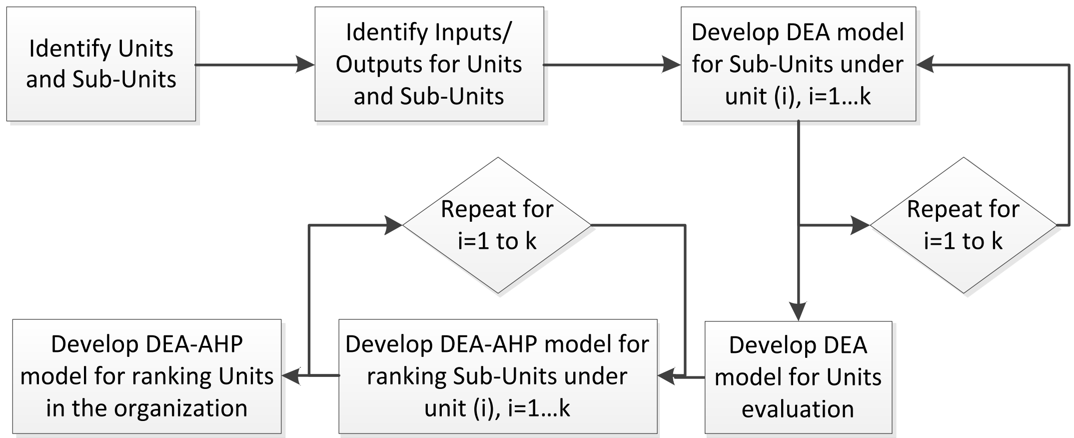

Figure 2 Model Development Steps

I. Define Units and Sub-Units and Identify Input / Output Measures

The model is developed to measure the efficiency of heterogeneous DMUs within an organization. The DMUs are homogenized by splitting them into groups based on their specific characteristics. This will result in a three level tree structure: Organization, Units and Sub-Units. For each group of DMUs, a fixed set of Input and output measures that better indicate the DMUs performance are identified. The units will be treated as DMUs and hence will have their own input and output measures. The performance of the units will be evaluated against these measures in addition to the aggregated performance of the sub-units within the units.

II. Develop DEA Models for the Units and Sub-Units Evaluation

Consider the situation in which there are K units, with n sub-units (SU_n) within unit k (U_k). The performance of a sub-unit (SU_i) is characterized by a production process of m different inputs (x_{ij}; $j = 1,\dots,m$) to produce t different outputs (y_{ik}; $k = 1,\dots,t$). Let (μ_k, v_j) be an optimal vector of output and input weights respectively for the DMU under evaluation. The performance level of sub-unit i (SU_i) is obtained by solving the standard CCR DEA model in order to maximize the relative efficiency score of the DMU:

$$\max P_i^{\,U} = \frac{\sum_{k=1}^{t} \mu_{ik} y_{ik}}{\sum_{j=1}^{m} v_{ij} x_{ij}} \qquad \text{Equation (1)}$$

Subject to

$$\frac{\sum_{k=1}^{t} \mu_{ik} y_{ik}}{\sum_{j=1}^{m} v_{ij} x_{ij}} \le 1 , \qquad i = 1, \dots n$$

$$\mu_{ik}, v_{ij} \ge \varepsilon \qquad for \quad k = 1\ to\ t \quad and \quad j = 1\ to\ m$$

Where:

n	number of DMUs
t	number of outputs
m	number of inputs
x_{ij}	value of input j for DMU*i*
y_{ik}	value of output k for DMU*i*
P_i^U	performance of Sub-Unit *i* under Unit *U*
P_i^O	performance of Unit *i* in the organization *O*

μ_{ik} weight (multiplier) of output *k.(decision variable)*

v_{ij} weight (multiplier) of input *j. (decision variable)*

ε small positive real value

The fractional program is transformed to a linear program as follows:

$$\max P_i^U = \sum_{k=1}^{t} \mu_{ik} y_{ik} \qquad \text{Equation (2)}$$

Subject to

$$\sum_{j=1}^{m} v_{ij} x_{ij} = 1$$

$$\sum_{k=1}^{t} \mu_{ik} y_{ik} - \sum_{j=1}^{m} v_{ij} x_{ij} \leq 0 , \qquad i = 1, \dots n$$

$$\mu_{ik}, v_{ij} \geq \varepsilon \qquad for \quad k = 1 \; to \; t \quad and \quad j = 1 \; to \; m$$

The DMU is efficient if and only if $P_i^U = 1$ otherwise it is inefficient.

After calculating the performance of sub-units within a unit, we get a vector of performances of sub-units. The mean of the sub-units performance is obtained and is used as an output measure in the unit performance evaluation. The aggregated performance of a unit within the organization is calculated in the same way that the sub-unit performance is calculated within a unit.

$$\max P_i^O = \sum_{k=1}^{t} \mu_{ik} y_{ik} \qquad \text{Equation (3)}$$

Subject to

$$\sum_{j=1}^{m} v_{ij} x_{ij} = 1$$

$$\sum_{k=1}^{t} \mu_{ik} y_{ik} - \sum_{j=1}^{m} v_{ij} x_{ij} \leq 0 \,, \qquad i = 1, \dots n$$

$$\mu_{ik}, v_{ij} \geq \varepsilon \qquad for \quad k = 1\ to\ t \quad and \quad j = 1\ to\ m$$

III. Develop DEA-AHP Hybrid Model for Ranking Units and Sub-Units

The execution of the DEA models will produce two groups of DMUs, efficient units and inefficient units. The efficient units will form the efficient frontier and will have a score of one. The inefficient units will have a score less than one and it is possible that some inefficient units have the same score of inefficiency.

In this section, a DEA-AHP hybrid model is developed for full ranking of efficient and inefficient units. The AHP organizes the decision problem in a hierarchical structure containing several levels. The first (topmost) level defines the main goal of the decision problem and the last (lowest) level usually describes the decision alternatives (DMUs in DEA). The level in between contains the evaluation criteria of the decision problem. The following graph illustrates the proposed AHP-DEA model hierarchy:

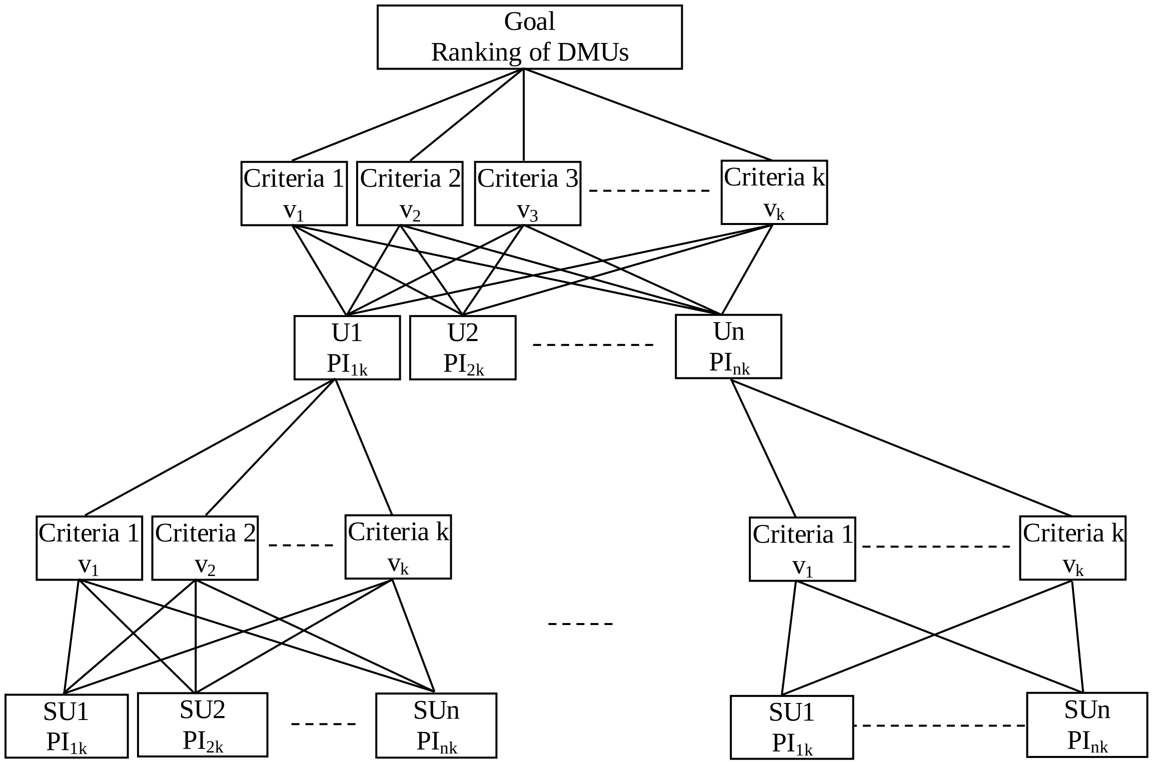

Figure 3 Integrated AHP/DEA Model for Ranking Units and Sub-Units

The construction of the model is done in four steps:

Step 1. Define the problem, structure a hierarchy, determine the criteria and identify the alternatives

The first level of the AHP model defines the main goal of the decision problem which, in our case, will be to rank the decision making units. The lowest level of the hierarchy describes the decision alternatives (DMUs in our case). The level in between contains the evaluation criteria of the decision problem. The evaluation criteria for the AHP model (criteria *k*) is normally determined by decision maker. However, in our model we will derive it from the inputs and outputs of the DEA model using all possible ratios Output/Input. This will generate *m*t* evaluation criteria.

Table 1 Sample Evaluation Criteria Table for DMUs with two inputs and two outputs

DMU	Criteria 1	Criteria 2	Criteria 3	Criteria 4
DMU 1	$\frac{y_{11}}{x_{11}}$	$\frac{y_{11}}{x_{12}}$	$\frac{y_{12}}{x_{11}}$	$\frac{y_{12}}{x_{12}}$
DMU 2	$\frac{y_{21}}{x_{21}}$	$\frac{y_{21}}{x_{22}}$	$\frac{y_{22}}{x_{21}}$	$\frac{y_{22}}{x_{22}}$
DMU 3	$\frac{y_{31}}{x_{31}}$	$\frac{y_{31}}{x_{32}}$	$\frac{y_{32}}{x_{31}}$	$\frac{y_{32}}{x_{32}}$

Step 2. Make pairwise comparisons to obtain weights of the criteria (rate the relative importance between each pair of criteria)

The weights of the criteria v_k, $k=1,2,\ldots m.t$, are normally derived by pairwise comparisons in AHP which is performed by decision makers. In our model, we will use Jablonsky (2011) approach to derive the weights of the criteria v_k from the average weights of inputs and outputs obtained from the DEA models. Using all possible ratios (Output Weight)/(Input Weight) we will generate $m*t$ weights of evaluation criteria.

$$v_k = \frac{output\ weight\ (\mu_i)}{input\ weight\ (v_j)} \qquad \text{Equation (4)}$$

$$where \quad k = 1,..,m*t \quad , \quad i = 1,..,t \quad , \quad j = 1,..,m$$

Step 3. Make pairwise comparisons to obtain the preference index of the alternatives (Rate the relative importance between each pair of DMUs with respect to each evaluation criteria)

Preference indices (PI_i) of the DMUs on the last level of the hierarchy are derived using pairwise comparisons. The pairwise comparison matrices will be constructed based on the data obtained in the evaluation criteria table (criteria *k*) in step 1. This approach is the first one based on my research that uses systematic and objective method for obtaining the priority of the alternatives (DMUs). Joblonsky (2011) used a subjective approach to assign the evaluated DMUs into five elements of evaluation scale. Also, he suggested that pairwise comparisons can be used to calculate the preference index (PI_i). However, it is subjective and depends on the decision makers' judgment.

In the new approach, we consider the evaluation criteria values to be the actual weight of the DMU with respect to the criteria. For example, if a DMU has values for input 1 and output 1 as 50 and 48 respectively, then, criteria 1 (ratio of output 1 over input 1) will have the value of 0.96 and this will represent the DMU preference with respect to that criteria. In AHP, the preference assignment scale is from 1 to 9 and we can scale the obtained preference value to this range. Based on this information we can construct the pairwise comparison table without intervention from the decision maker. This approach is more logical than Jablonsky (2011) method because it is fully dependent on the DEA model to construct the AHP model and obtain the ranking of the DMUs.

When the DEA model is constructed, the input and output measures are selected based on their importance as indicators of the DMU efficiency. Also, the scale for each measure is decided to reflect the weight of that measure in the evaluation of the DMU overall performance. Putting into consideration that the decision makers are involved during the construction of the DEA model, we can rely on the DEA model data to construct the AHP model because it represent the decision maker preference.

Table 2 Sample Pairwise Comparison Table for Criteria A

	DMU 1	DMU 2	DMU 3	Mc (geometric mean)	PI
DMU 1	1	$\frac{\text{DMU 1(Criteria A)}}{\text{DMU 2(Criteria A)}}$	$\frac{\text{DMU 1(Criteria A)}}{\text{DMU 3(Criteria A)}}$	Mc_1	PI_1
DMU 2	$\frac{\text{DMU 2(Criteria A)}}{\text{DMU 1(Criteria A)}}$	1	$\frac{\text{DMU 2(Criteria A)}}{\text{DMU 3(Criteria A)}}$	Mc_2	PI_2
DMU 3	$\frac{\text{DMU 3(Criteria A)}}{\text{DMU 1(Criteria A)}}$	$\frac{\text{DMU 3(Criteria A)}}{\text{DMU 2(Criteria A)}}$	1	Mc_3	PI_3

Where:

$$Mc_1 = (1 * \frac{\text{DMU 1(Criteria A)}}{\text{DMU 2(Criteria A)}} * \frac{\text{DMU 1(Criteria A)}}{\text{DMU 3(Criteria A)}})^{(1/3)}$$ Equation (5)

$$PI_i = \frac{Mc_i}{Mc1+Mc2+Mc3}$$ Equation (6)

Step 4. Synthesize the results to determine the best alternative and obtain the final results

The final score (rank) for each DMU will be the summation of weighted Preference indices (PI_i).

$$Rank(DMUi) = \sum_{k=1}^{m*t} v_k PI_k$$ Equation (7)

3.4. Model Illustration and Results

The model is illustrated using a simulated example of evaluating the competitiveness of 81 companies in an economy where the companies have been grouped into 6 sectors. This simulation is based on a confidential competitiveness analysis of Tunisian firms obtained from Dia and Ben Abdelaziz (2011) paper. The solution has been developed using Microsoft Excel 2010 and the Solver package was used to construct the LP programs of the DEA models.

I. Define Units and Sub-Units and Identify Input and Output Measures

The data is generated for the evaluation of the companies in their respective sectors and for the sectors in the economy. The sectors are evaluated based on two criteria to minimize two inputs and two criteria to maximize two outputs. An additional output measure is added to the original data which represents the aggregated performance measure of the sub-units (companies) within the sector. The companies in sector 1 are evaluated based on three inputs and two outputs. The companies in sector 2 are evaluated based on three inputs and two outputs. The companies in sector 3 are evaluated based on two inputs and four outputs. The companies in sector 4 are evaluated based on four inputs and three outputs. The companies in sector 5 are evaluated based on three inputs and four outputs. The companies in sector 6 are evaluated based on one input and seven outputs. The data is available in **Appendix A**.

II. Execute DEA Models for Units and Sub-Units Evaluation

A. Sub-Units (Companies) Efficiency Evaluation

The DEA model for the sub-units (companies) evaluation is run for each DMU (company) under sector 1 to obtain the optimal weights of the input & output measures; hence, calculate the overall efficiency score of the DMU. The results of the model execution gave companies 4, 6, 7 and 10 an efficiency score of 1. Companies 1, 2, 3, 5, 8 and 9 are inefficient and received efficiency scores 0.847, 0.972, 0.734, 0.829, 0.660 and 0.536 respectively. The average efficiency score of the companies in sector 1 is 0.858 and this will be used as an output measure for Sector 1 evaluation. The results of the sub-units efficiency evaluation for each sector are available in **Appendix B**.

B. Units (Sectors) Efficiency Evaluation

After completing the evaluation of the companies in all sectors, we get the average efficiency of the companies in their respective sectors. The results will be used as an additional output measure when constructing the DEA model for the sectors efficiency evaluation.

Sector	Inputs		Outputs		
	in1	in2	out1	out2	out3
S1	23	24	25	26	85.78
S2	21	23	24	20	78.29
S3	26	21	25	28	95.91
S4	21	20	29	22	91.00
S5	21	26	27	26	88.57
S6	22	23	24	20	89.57

The results of DEA model execution identified sectors 3, 4 and 5 as efficient and received an efficiency score of 1. Sectors 1, 2 and 6 are inefficient and received efficiency scores 0.97, 0.87 and 0.94 respectively. The results of the sectors efficiency evaluation are available in **Appendix B**.

Sector ID	Effeciency Score
S1	0.97
S2	0.87
S3	1.00
S4	1.00
S5	1.00
S6	0.94

III. Execute DEA-AHP Hybrid Model for Ranking Units and Sub-Units

The ranking of sectors and companies follows the steps explained in section 3.3. Here, we will follow the steps to rank the companies in Sector 1 and the results for the reaming sectors can be found in **Appendix C**.

- **Ranking Companies in Sector 1**

The DEA model for sector 1 evaluation consists of three inputs and two outputs. Hence, we will have 3x2=6 evaluation criteria for the AHP model.

Step 1. Define the problem, structure a hierarchy, determine the criteria and identify the alternatives

From the inputs and outputs of the DEA model, the evaluation criteria matrix is constructed as shown below:

DMU	The evaluation criteria					
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6
	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3
E01	0.090	1.125	0.0017	7.000	87.500	0.130
E02	0.067	1.000	0.0021	6.333	95.000	0.198
E03	0.067	0.381	0.0016	6.250	35.714	0.147
E04	0.090	1.500	0.0021	9.000	150.000	0.214
E05	0.039	1.400	0.0012	4.444	160.000	0.133
E06	0.143	1.111	0.0019	7.143	55.556	0.096
E07	0.080	2.667	0.0016	7.000	233.333	0.140
E08	0.063	0.500	0.0014	6.250	50.000	0.136
E09	0.046	0.813	0.0011	3.929	68.750	0.096
E10	0.106	0.944	0.0019	11.250	100.000	0.200

Step 2. Obtain weights of the criteria

The weights of the criteria are derived from the average weights obtained from the DEA results.

	The weights of the criteria					
v_k	Criteria 1 μ1/v1	Criteria 2 μ1/v2	Criteria 3 μ1/v3	Criteria 4 μ2/v1	Criteria 5 μ2/v2	Criteria 6 μ2/v3
	21.613	1.786	415.511	0.218	0.018	4.198

Step 3. Make pairwise comparisons to obtain the preference index of the alternatives

Using the evaluation criteria matrix from step 1, pairwise comparisons for each criterion is conducted. The results of the pairwise comparisons are available in **Appendix C**. After completing the pairwise comparisons, the preference indices for each company are obtained. The results are shown in the table below.

DMU	Criteria 1 PI_1	Criteria 2 PI_2	Criteria 3 PI_3	Criteria 4 PI_4	Criteria 5 PI_5	Criteria 6 PI_6
E01	0.1139	0.0983	0.1007	0.1020	0.0845	0.0869
E02	0.0844	0.0874	0.1259	0.0923	0.0917	0.1327
E03	0.0844	0.0333	0.0948	0.0911	0.0345	0.0986
E04	0.1139	0.1311	0.1295	0.1312	0.1448	0.1437
E05	0.0492	0.1224	0.0705	0.0648	0.1545	0.0894
E06	0.1808	0.0971	0.1162	0.1041	0.0536	0.0645
E07	0.1012	0.2331	0.0967	0.1020	0.2253	0.0939
E08	0.0791	0.0437	0.0824	0.0911	0.0483	0.0914
E09	0.0588	0.0710	0.0689	0.0573	0.0664	0.0647
E10	0.1344	0.0826	0.1142	0.1640	0.0965	0.1341

Step 4. Synthesize the results to determine the best alternative and obtain the final results

The final score (rank) for each DMU is calculated as the summation of weighted Preference indices (PI_i).

$$Rank(DMUi) = \sum_{k=1}^{m*t} v_k PI_k$$

The following table shows the final results for ranking companies in sector 1.

DMU	Score (Overall Priority)	Rank
E1	44.88	5
E2	54.88	2
E3	41.71	7
E4	57.15	1
E5	30.98	9
E6	52.67	3
E7	43.21	6
E8	36.44	8
E9	30.32	10
E10	51.09	4

After completing the ranking of all companies and sectors, we get the following results:

Table 3 Results of Ranking Companies and Sectors

RANK	Sectors Ranking	Companies Ranking					
		Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6
1	Sector 3	E04	E13	E11	E17	E03	E03
2	Sector 4	E02	E12	E10	E15	E01	E06
3	Sector 1	E06	E11	E09	E10	E07	E10
4	Sector 5	E10	E06	E14	E11	E04	E01
5	Sector 6	E01	E04	E15	E05	E06	E14
6	Sector 2	E07	E10	E04	E02	E05	E05
7		E03	E02	E13	E16	E02	E17
8		E08	E01	E05	E04	E09	E12
9		E05	E07	E08	E03	E08	E02
10		E09	E03	E02	E09		E08
11			E08	E07	E01		E07
12			E09	E06	E06		E15
13			E05	E12	E07		E04
14				E03	E14		E09
15				E01	E12		E11
16					E08		E13
17					E13		E16
18							

3.5. Conclusion

In this chapter, a model has been developed for measuring the efficiency and ranking of heterogeneous decision making units organized in a hierarchical structure. Also, the model presented a technique to measure the aggregated efficiency of decision making units at the upper levels of the hierarchical structure. The illustrated example and obtained results demonstrate the applicability of the proposed model for solving the problem described in this chapter.

CHAPTER 4

MODEL DISCUSSION AND COMPARISON

4.1. Introduction

In this chapter, the proposed model is compared with two other models. The first one is the cross-efficiency model that was developed by Dia and Ben Abdelaziz (2011). The second one is a DEA-AHP model that was developed by Jablonsky (2011). In section 4.2, a brief description of Dia and Ben Abdelaziz (2011) model is provided. In section 4.3, Jablonsky (2011) model is covered and, finally, in section 4.4 the models are compared and the results are discussed.

4.2. Dia & Ben Abdelaziz (2011) Model

Dia and Ben Abdelaziz proposed an approach to measure the competitiveness of heterogeneous companies in an economy where they used a tree structure with three levels (company, sector and economy) to homogenize the data and to better identify the competitiveness indicators of companies in an economy. They applied the cross-efficiency evaluation technique to, first, evaluate the performance of sectors in the economy, and second, to evaluate the performance of companies in their respective sectors.

After calculating the mutual performances of sectors in the economy and companies in their respective sectors, the mutual performances are aggregated using the superiority index method to indices of competitiveness of sectors in the economy and indices of competitiveness of companies in their respective sectors. Then, the index of competitiveness of the company in its sector is combined with that of its sector in the economy to obtain its index of competitiveness in the economy.

4.3. Jablonsky (2011) Model

Jablonsky (2011) presented two original models for ranking of efficient units based on multiple criteria decision making techniques. The first model uses goal programming methodology and minimizes either the sum of undesirable deviations or maximal undesirable deviation from the efficient frontier. The second approach is analytic hierarchy process model for ranking of efficient units. The AHP model is constructed using the DEA model data where the evaluation criteria is created from all possible ratios of the DEA output/input ratios. The DMUs are the decision alternatives of the AHP model. The DEA/AHP model is solved in five steps explained in the paper.

4.4. Results and Discussion

The data from Dia and Ben Abdelaziz (2011) is used to compare the three models. Jablonsky (2011) model has been adjusted to fit the problem data. **Appendix F** references some communication with the author to clarify a missing step in his paper. The following table presents the results of ranking the companies in sector 2 using the standard DEA model, Dia & Ben Abdelaziz (2011) model, Jablonsky (2011) model and the proposed model.

Table 4 Results of Ranking Companies in Sector 2

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
E1	0.681	9	0.330	9	28.628	9	0.753	8
E2	0.833	7	0.552	7	54.205	7	0.890	6
E3	0.627	10	0.255	10	28.542	10	0.688	10
E4	0.900	5	0.679	4	55.227	6	0.942	4
E5	0.560	12	0.166	12	13.478	13	0.504	12
E6	0.906	4	0.543	8	64.433	4	0.908	5
E7	0.800	8	0.635	5	28.801	8	0.721	9
E8	0.573	11	0.225	11	28.798	11	0.607	11
E9	0.456	13	0.000	13	8.251	12	0.497	13
E10	0.840	6	0.579	6	32.968	5	0.862	7
E11	1		1	1	66.569	3	1.015	3
E12	1		0.944	2	112.686	1	1.101	2
E13	1		0.893	3	105.512	2	1.126	1

The above table shows that the three models lead to similar results to that of the standard DEA model. However, the results of ranking the companies in sector 3 show clear differences between the three models as clearly presented in table 3 below. For example, company 1 received the first rank by Dia and Ben Abdelaziz model while it is ranked as the last company by Jablonsky model and the proposed model. By analyzing the data and decision variables used to calculate the efficiency ratio of company 1, we find that input 1 has been assigned a very small weight by the linear program. Also, outputs 1, 3 and 4 has been assigned zero weight which resulted in giving efficiency score of 100% to company 1 while it is inefficient. This issue is known in DEA models because they allow total flexibility in allocating weights to the input and output measures of the DMU under consideration.

From these results, we observe that Dia and Ben Abdelaziz model is impacted by the weights assigned by the DEA model. On the other hand, Jablonsky model and the proposed model seem to limit the effect of this problem on the final ranks of the companies because they derive the weights of the criteria from the average weights of inputs and outputs obtained from the DEA models. Also, this issue can be eliminated in the proposed model by deriving the weights of the criteria using standard pairwise comparisons in AHP.

Table 5 shows the results of ranking the companies under sector 3. It is observed from the results that Jablonsky model and the proposed model produce similar results with few differences. The difference in results is due to the difference in calculating the preference index of the DMU where Jablonsky applies a scale of evaluation and assigns scores based on predefined ranges that are set by the decision maker. On the other hand, the proposed model applies standard AHP pairwise comparisons using the data derived from the DEA model and calculates the preference index of the DMU accordingly.

Table 5 Results of Ranking Companies in Sector 3

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
E01	1		1	1	5.650	15	0.16	15
E02	0.99	11	0.4322	10	19.559	12	0.55	10
E03	1		0.5388	6	19.881	11	0.37	14
E04	1		0.5108	8	39.043	5	1.05	6
E05	0.813	14	0.0091	14	28.111	8	0.87	8

E06	0.94	12	0.2885	11	19.185	13	0.39	12
E07	0.888	13	0.2171	12	19.035	14	0.46	11
E08	1		0.7108	3	31.344	7	0.86	9
E09	1		0.6015	4	73.689	1	2.78	3
E10	1		0.1894	13	72.970	2	2.83	2
E11	1		0.4331	9	72.357	3	3.03	1
E12	1		0.9149	2	20.264	9	0.39	13
E13	1		0.5214	7	20.254	10	0.91	7
E14	1		0.5944	5	40.161	4	1.56	4
E15	0.752	15	0	15	38.147	6	1.41	5

The sectors ranking using Jablonsky (2011) and the proposed model produced same results and they are completely different from Dia and Ben Abdelaziz model as clearly presented in table 6 below. The results of ranking the remaining sectors are available in **Appendix E**.

Table 6 Results of Ranking Sectors in the Organization

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
S1	0.97	4	0.578	4	0.98358	3	2.833	3
S2	0.85	6	0.2016	5	0.33758	6	2.469	6
S3	1		0.9627	2	1.8611	1	3.311	1
S4	1		1	1	1.56393	2	3.151	2
S5	1		0.8172	3	0.72046	4	2.757	4
S6	0.817	5	0	6	0.38654	5	2.491	5

4.5. Conclusion

It is observed in this chapter that the total flexibility in allocating weights to the input and output measures in DEA leads to rating inefficient DMUs as efficient. From these results, it is observed that Dia and Ben Abdelaziz model is impacted by the weights assignment in DEA. On the other hand, Jablonsky model and the proposed model seem to limit the effect of this problem on the final ranks of the companies because they derive the weights of the criteria from the average weights of inputs and outputs obtained from the DEA models. Hence, no zero weights will appear in the evaluation criteria.

CHAPTER 5

CONCLUSION

In this thesis, a model is proposed that allows the performance evaluation and ranking of decision making units in an organization with several units and sub units forming a hierarchical structure. The application of DEA principles to hierarchical structures is an important area of research because many organizational structures tend to exhibit such a profile. The approach for developing the above model is based on the integration of DEA and AHP.

The developed model is an extension of the DEA-AHP model developed by Jablonsky (2011). It extended the model to evaluate the efficiency of heterogeneous DMUs that are homogenized by fitting them into a hierarchical structure. In addition, this model is the first one based on my research that uses systematic and objective method for obtaining the priority of the alternatives (DMUs) without intervention from the decision maker. This approach is more logical than Jablonsky (2011) method because it is fully dependent on the DEA model to construct the AHP model and obtain the ranking of the DMUs.

The numerical example and the results demonstrate the applicability of the proposed model for performance measurement and ranking of heterogeneous DMUs. The model developed here has been applied to a two level hierarchical structure of

DMUs; however, it can be applied to multilevel structures where, at each level, several comparison criteria (inputs / outputs) can be defined.

The work done in this thesis can be further extended to investigate several issues in DEA models. The following points outline some areas of further research:

- DEA models allow total flexibility in allocating weights to the input and output measures of the DMU under consideration. This can lead to artificially high efficiency scores which do not reflect the actual performance of the DMU. An area of extension would be to handle the issue of zero weights or very high weights in the DEA model.
- The proposed model assumes that the sub-units performance contribute to the unit's performance at higher levels. It would be interesting to study the effect of the case where the units' performance at higher levels contributes to the sub-units performance at lower levels.
- Sometime the DMUs might have shared resources consumed to produce the outputs. Another area of research would be extend the model to handle the case where the sub-units have shared input resources.

Appendix A: Data for Testing the Model

Table 7 Input & Output Measures of the Sectors

Sector ID	Inputs		Outputs	
	in1	in2	out1	out2
S1	23	24	25	26
S2	21	23	24	20
S3	26	21	25	28
S4	21	20	29	22
S5	21	26	27	26
S6	22	23	24	20

Table 8 Input & Output Measures of Companies in sector 1 (S1)

Company ID	Inputs			Outputs	
	in1	in2	in3	out1	out2
E1	10	0.8	540	0.9	70
E2	15	1	480	1	95
E3	12	2.1	510	0.8	75
E4	10	0.6	420	0.9	90
E5	18	0.5	600	0.7	80
E6	7	0.9	520	1	50
E7	10	0.3	500	0.8	70
E8	12	1.5	550	0.75	75
E9	14	0.8	570	0.65	55
E10	8	0.9	450	0.85	90

Table 9 Input & Output Measures of Companies in sector 2 (S2)

Company ID	Inputs			Outputs	
	in1	in2	in3	out1	out2
E1	35	2.8	1890	3.15	245
E2	52.5	3.5	1680	3.5	332.5
E3	42	7.35	1785	2.8	262.5
E4	35	2.1	1470	3.15	315
E5	63	1.75	2100	2.45	280
E6	24.5	3.15	1820	3.5	175
E7	35	1.05	1750	2.8	245
E8	42	1.75	1925	2.625	262.5
E9	49	6.3	1995	2.275	192.5
E10	28	3.15	1575	2.975	315
E11	21	1.05	1575	3.325	350
E12	24.5	1.05	1470	3.5	350
E13	28	1.05	1400	3.5	332.5

Table 10 Input & Output Measures of Companies in sector 3 (S3)

Company ID	Inputs		Outputs			
	in1	in2	out1	out2	out3	out4
E1	1204.65	4.54	1707	330	0.14	0.59
E2	349.53	4.97	776	107	0.17	0.72
E3	504.88	2.98	860	115	0.15	0.66
E4	179.62	3.44	492	52	0.17	0.72
E5	196.75	3.66	265	50	0.17	0.59
E6	457.72	4.73	881	105	0.15	0.68
E7	338.63	5.28	722	91	0.15	0.54
E8	207.75	1.8	337	51	0.14	0.7
E9	71.72	3.16	227	11	0.2	0.74
E10	82.84	5.94	225	10	0.2	1.02
E11	56.18	7.35	33	2	0.14	0.77
E12	467.69	2.56	724	156	0.13	0.68
E13	209.13	2.7	364	70	0.17	0.7
E14	105.86	1.72	190	11	0.15	0.63
E15	129.41	4.55	293	17	0.17	0.72

Table 11 Input & Output Measures of Companies in sector 4 (S4)

Company ID	Inputs				Outputs		
	in1	in2	in3	in4	out1	out2	out3
E1	67.55	82.83	44.37	60.85	26.04	85	23.95
E2	85.78	123.98	55.13	108.46	43.51	173.93	6.45
E3	80.33	104.65	53.3	79.06	27.28	132.49	42.67
E4	205.92	183.49	144.16	59.66	14.09	196.29	16.15
E5	51.28	117.51	32.07	84.5	46.2	144.99	0
E6	82.09	104.94	46.51	127.28	44.87	108.53	0
E7	123.02	82.44	87.35	98.8	43.33	125.84	404.69
E8	71.77	88.16	69.19	123.14	44.83	74.54	6.14
E9	61.95	99.77	33	86.37	45.43	79.6	1252.62
E10	25.83	105.8	9.51	227.2	19.4	120.09	0
E11	27.87	107.6	14	146.43	25.47	131.79	0
E12	72.6	132.73	44.67	173.48	5.55	135.65	24.13
E13	84.83	104.28	159.12	171.11	11.53	110.22	49.09
E14	202.21	187.74	149.39	93.65	44.97	184.77	0
E15	66.65	104.18	257.09	13.65	139.74	115.96	0
E16	51.62	11.23	49.22	33.52	40.49	14.89	3166.71
E17	36.05	193.32	59.52	8.23	46.88	190.77	822.92

Table 12 Input & Output Measures of Companies in sector 5 (S5)

Company ID	Inputs			Outputs			
	in1	in2	in3	out1	out2	out3	out4
E1	22	50	40	20	43	75	75
E2	60	100	100	100	60	25	30
E3	24	17	29	25	50	50	60
E4	37	23	40	40	13	25	30
E5	40	30	60	30	50	50	40
E6	80	25	90	55	85	10	20
E7	70	75	18	30	29	7	50
E8	50	55	55	11	29	10	40
E9	100	80	100	90	100	5	25

Table 13 Input & Output Measures of Companies in sector 6 (S6)

Company ID	Inputs	Outputs						
	in1	out1	out2	out3	out4	out5	out6	out7
E1	48	58	31	51	26	43	18	13
E2	48	62	67	43	23	26	23	8
E3	78	100	77	100	100	57	23	100
E4	68	75	63	70	42	40	19	8
E5	44	47	62	49	35	25	23	16
E6	52	60	100	68	34	28	75	24
E7	52	59	72	52	21	20	34	13
E8	52	51	51	44	33	23	48	16
E9	72	63	38	67	21	18	100	11
E10	84	86	88	53	53	100	42	0
E11	100	73	78	89	88	56	42	16
E12	42	26	53	51	21	19	52	2
E13	56	23	33	37	18	26	26	11
E14	92	99	62	74	57	98	45	5
E15	56	34	37	30	24	50	47	0
E16	46	18	24	25	10	21	8	0
E17	72	54	87	43	29	73	38	13

Appendix B: DEA Models Results

1. Evaluation of companies under Sector 1

Company ID	Inputs			Outputs	
	in1	in2	in3	out1	out2
E01	10	0.8	540	0.9	70
E02	15	1	480	1	95
E03	12	2.1	510	0.8	75
E04	10	0.6	420	0.9	90
E05	18	0.5	600	0.7	80
E06	7	0.9	520	1	50
E07	10	0.3	500	0.8	70
E08	12	1.5	550	0.75	75
E09	14	0.8	570	0.65	55
E10	8	0.9	450	0.85	90

	v1	*v2*	*v3*	*μ1*	*μ2*
weights	0.0644	0.4448	0.0000	0.6902	0.0032

Objective Function	Weighted Inputs	Weighted Outputs	Ratio
E01	1.000	0.847	0.847

Company ID	weighted inputs			weighted outputs	
	in1		in2	out1	out2
E01	0.6442	0.3558	-	0.6212	0.2255
E02	0.9663	0.4448	-	0.6902	0.3060
E03	0.7730	0.9340	-	0.5521	0.2416
E04	0.6442	0.2669	-	0.6212	0.2899
E05	1.1595	0.2224	-	0.4831	0.2577
E06	0.4509	0.4003	-	0.6902	0.1610
E07	0.6442	0.1334	-	0.5521	0.2255
E08	0.7730	0.6672	-	0.5176	0.2416
E09	0.9018	0.3558	-	0.4486	0.1771
E10	0.5153	0.4003	-	0.5867	0.2899

Constraints		
-0.1534	<=	0
-0.4149	<=	0
-0.9133	<=	0
0.0000	<=	0
-0.6411	<=	0
0.0000	<=	0
0.0000	<=	0
-0.6810	<=	0
-0.6319	<=	0
-0.0391	<=	0

Solve the linear program for each company to get its efficiency score. Final scores will be as follows:

Company ID	Effeciency Score
E01	0.847
E02	0.972
E03	0.734
E04	1.000
E05	0.829
E06	1.000
E07	1.000
E08	0.660
E09	0.536
E10	1.000
Average Score	0.858

2. Evaluation of companies under Sector 2

Company ID	Inputs			Outputs	
	in1	in2	in3	out1	out2
E01	35	2.8	1890	3.15	245
E02	52.5	3.5	1680	3.5	332.5
E03	42	7.35	1785	2.8	262.5
E04	35	2.1	1470	3.15	315
E05	63	1.75	2100	2.45	280
E06	24.5	3.15	1820	3.5	175
E07	35	1.05	1750	2.8	245
E08	42	1.75	1925	2.625	262.5
E09	49	6.3	1995	2.275	192.5
E10	28	3.15	1575	2.975	315
E11	21	1.05	1575	3.325	350
E12	24.5	1.05	1470	3.5	350
E13	28	1.05	1400	3.5	332.5

	v1	*v2*	*v3*	*µ1*	*µ2*
weights	0.0077	0.0000	0.0004	0.2162	0.0000

Objective Function	Weighted Inputs	Weighted Outputs	Ratio
E1	1.000	0.681	0.681

Company ID	weighted inputs			weighted outputs		Constraints		
	in1	in2	in3	out1	out2			
E01	0.2703	-	0.7297	0.6811	-	-0.3189	<=	0
E02	0.4054	-	0.6486	0.7568	-	-0.2973	<=	0
E03	0.3243	-	0.6892	0.6054	-	-0.4081	<=	0
E04	0.2703	-	0.5676	0.6811	-	-0.1568	<=	0
E05	0.4865	-	0.8108	0.5297	-	-0.7676	<=	0
E06	0.1892	-	0.7027	0.7568	-	-0.1351	<=	0
E07	0.2703	-	0.6757	0.6054	-	-0.3405	<=	0
E08	0.3243	-	0.7432	0.5676	-	-0.5000	<=	0
E09	0.3784	-	0.7703	0.4919	-	-0.6568	<=	0
E10	0.2162	-	0.6081	0.6432	-	-0.1811	<=	0
E11	0.1622	-	0.6081	0.7189	-	-0.0514	<=	0
E12	0.1892	-	0.5676	0.7568	-	0.0000	<=	0
E13	0.2162	-	0.5405	0.7568	-	0.0000	<=	0

Solve the linear program for each company to get its efficiency score. Final scores will be as follows:

Company ID	Effeciency Score
E01	0.681
E02	0.833
E03	0.627
E04	0.900
E05	0.560
E06	0.906
E07	0.800
E08	0.573
E09	0.456
E10	0.840
E11	1.000
E12	1.000
E13	1.000
Average Score	0.783

3. Evaluation of companies under Sector 3

Company ID	Inputs		Outputs			
	in1	in2	out1	out2	out3	out4
E01	1204.65	4.54	1707	330	0.14	0.59
E02	349.53	4.97	776	107	0.17	0.72
E03	504.88	2.98	860	115	0.15	0.66
E04	179.62	3.44	492	52	0.17	0.72
E05	196.75	3.66	265	50	0.17	0.59
E06	457.72	4.73	881	105	0.15	0.68
E07	338.63	5.28	722	91	0.15	0.54
E08	207.75	1.8	337	51	0.14	0.7
E09	71.72	3.16	227	11	0.2	0.74
E10	82.84	5.94	225	10	0.2	1.02
E11	56.18	7.35	33	2	0.14	0.77
E12	467.69	2.56	724	156	0.13	0.68
E13	209.13	2.7	364	70	0.17	0.7
E14	105.86	1.72	190	11	0.15	0.63
E15	129.41	4.55	293	17	0.17	0.72

	v1	*v2*	*μ1*	*μ2*	*μ3*	*μ4*
weights	0.0004	0.1060	0.0000	0.0030	0.0000	0.0000

Objective Function	Weighted Inputs	Weighted Outputs	Ratio
E1	1.000	1.000	1.000

Company ID	weighted inputs		weighted outputs				Constraints		
	in1	in2	out1	out2	out3	out4			
E01	0.5190	0.4810	-	1.0000	-	-	0.0000	<=	0
E02	0.1506	0.5266	-	0.3242	-	-	-0.3529	<=	0
E03	0.2175	0.3158	-	0.3485	-	-	-0.1848	<=	0
E04	0.0774	0.3645	-	0.1576	-	-	-0.2843	<=	0
E05	0.0848	0.3878	-	0.1515	-	-	-0.3210	<=	0
E06	0.1972	0.5012	-	0.3182	-	-	-0.3802	<=	0
E07	0.1459	0.5595	-	0.2758	-	-	-0.4296	<=	0
E08	0.0895	0.1907	-	0.1545	-	-	-0.1257	<=	0
E09	0.0309	0.3348	-	0.0333	-	-	-0.3324	<=	0
E10	0.0357	0.6294	-	0.0303	-	-	-0.6348	<=	0
E11	0.0242	0.7788	-	0.0061	-	-	-0.7969	<=	0
E12	0.2015	0.2712	-	0.4727	-	-	0.0000	<=	0
E13	0.0901	0.2861	-	0.2121	-	-	-0.1641	<=	0
E14	0.0456	0.1822	-	0.0333	-	-	-0.1945	<=	0
E15	0.0557	0.4821	-	0.0515	-	-	-0.4863	<=	0

Solve the linear program for each company to get its efficiency score. Final scores will be as follows:

Company ID	Effeciency Score
E01	1.000
E02	0.990
E03	1.000
E04	1.000
E05	0.815
E06	0.939
E07	0.888
E08	1.000
E09	1.000
E10	1.000
E11	1.000
E12	1.000
E13	1.000
E14	1.000
E15	0.751
Average Score	0.959

4. Evaluation of companies under Sector 4

Company ID	Inputs				Outputs		
	in1	in2	in3	in4	out1	out2	out3
E01	67.55	82.83	44.37	60.85	26.04	85	23.95
E02	85.78	123.98	55.13	108.46	43.51	173.93	6.45
E03	80.33	104.65	53.3	79.06	27.28	132.49	42.67
E04	205.92	183.49	144.16	59.66	14.09	196.29	16.15
E05	51.28	117.51	32.07	84.5	46.2	144.99	0
E06	82.09	104.94	46.51	127.28	44.87	108.53	0
E07	123.02	82.44	87.35	98.8	43.33	125.84	404.69
E08	71.77	88.16	69.19	123.14	44.83	74.54	6.14
E09	61.95	99.77	33	86.37	45.43	79.6	1252.62
E10	25.83	105.8	9.51	227.2	19.4	120.09	0
E11	27.87	107.6	14	146.43	25.47	131.79	0
E12	72.6	132.73	44.67	173.48	5.55	135.65	24.13
E13	84.83	104.28	159.12	171.11	11.53	110.22	49.09
E14	202.21	187.74	149.39	93.65	44.97	184.77	0
E15	66.65	104.18	257.09	13.65	139.74	115.96	0
E16	51.62	11.23	49.22	33.52	40.49	14.89	3166.71
E17	36.05	193.32	59.52	8.23	46.88	190.77	822.92

	v1	*v2*	*v3*	*v4*	*μ1*	*μ2*	*μ3*
weights	0.0000	0.0077	0.0027	0.0040	0.0048	0.0076	0.0000

Objective Function	Weighted Inputs	Weighted Outputs	Ratio
E1	1.000	0.773	0.773

Company ID	weighted inputs				weighted outputs			Constraints		
	in1	in2	in3	in4	out1	out2	out3			
E01	-	0.6366	0.1205	0.2429	0.1245	0.6487	-	-0.2267	<=	0
E02	-	0.9528	0.1497	0.4330	0.2081	1.3275	-	0.0000	<=	0
E03	-	0.8042	0.1448	0.3156	0.1305	1.0112	-	-0.1230	<=	0
E04	-	1.4101	0.3915	0.2382	0.0674	1.4981	-	-0.4743	<=	0
E05	-	0.9031	0.0871	0.3374	0.2210	1.1066	-	0.0000	<=	0
E06	-	0.8065	0.1263	0.5082	0.2146	0.8283	-	-0.3980	<=	0
E07	-	0.6336	0.2372	0.3945	0.2072	0.9604	-	-0.0976	<=	0
E08	-	0.6775	0.1879	0.4916	0.2144	0.5689	-	-0.5738	<=	0
E09	-	0.7667	0.0896	0.3448	0.2173	0.6075	-	-0.3764	<=	0
E10	-	0.8131	0.0258	0.9071	0.0928	0.9165	-	-0.7367	<=	0
E11	-	0.8269	0.0380	0.5846	0.1218	1.0058	-	-0.3219	<=	0
E12	-	1.0200	0.1213	0.6926	0.0265	1.0353	-	-0.7721	<=	0
E13	-	0.8014	0.4321	0.6832	0.0551	0.8412	-	-1.0203	<=	0
E14	-	1.4428	0.4057	0.3739	0.2151	1.4102	-	-0.5972	<=	0
E15	-	0.8006	0.6982	0.0545	0.6683	0.8850	-	0.0000	<=	0
E16	-	0.0863	0.1337	0.1338	0.1936	0.1136	-	-0.0465	<=	0
E17	-	1.4857	0.1616	0.0329	0.2242	1.4560	-	0.0000	<=	0

Solve the linear program for each company to get its efficiency score. Final scores will be as follows:

Company ID	Effeciency Score
E01	0.773
E02	1.000
E03	0.940
E04	0.935
E05	1.000
E06	0.829
E07	1.000
E08	0.687
E09	1.000
E10	1.000
E11	1.000
E12	0.763
E13	0.743
E14	0.800
E15	1.000
E16	1.000
E17	1.000
Average Score	0.910

5. Evaluation of companies under Sector 5

Company ID	Inputs			Outputs			
	in1	in2	in3	out1	out2	out3	out4
E1	22	50	40	20	43	75	75
E2	60	100	100	100	60	25	30
E3	24	17	29	25	50	50	60
E4	37	23	40	40	13	25	30
E5	40	30	60	30	50	50	40
E6	80	25	90	55	85	10	20
E7	70	75	18	30	29	7	50
E8	50	55	55	11	29	10	40
E9	100	80	100	90	100	5	25

	v1	*v2*	*v3*	*µ1*	*µ2*	*µ3*	*µ4*
weights	0.0278	0.0077	0.0000	0.0000	0.0000	0.0000	0.0133

Objective Function	Weighted Inputs	Weighted Outputs	Ratio
E1	1.000	1.000	1.000

Company ID	weighted inputs			weighted outputs				Constraints		
	in1	in2	in3	out1	out2	out3	out4			
E1	0.6126	0.3874	-	-	-	-	1.0000	0.0000	<=	0
E2	1.6707	0.7748	-	-	-	-	0.4000	-2.0455	<=	0
E3	0.6683	0.1317	-	-	-	-	0.8000	0.0000	<=	0
E4	1.0303	0.1782	-	-	-	-	0.4000	-0.8085	<=	0
E5	1.1138	0.2324	-	-	-	-	0.5333	-0.8129	<=	0
E6	2.2276	0.1937	-	-	-	-	0.2667	-2.1546	<=	0
E7	1.9492	0.5811	-	-	-	-	0.6667	-1.8636	<=	0
E8	1.3923	0.4262	-	-	-	-	0.5333	-1.2851	<=	0
E9	2.7845	0.6199	-	-	-	-	0.3333	-3.0710	<=	0

Solve the linear program for each company to get its efficiency score. Final scores will be as follows:

Company ID	Effeciency Score
E1	1.000
E2	1.000
E3	1.000
E4	1.000
E5	0.694
E6	1.000
E7	1.000
E8	0.348
E9	0.929
Average Score	0.886

6. Evaluation of companies under Sector 6

Company ID	Inputs in1	Outputs out1	out2	out3	out4	out5	out6	out7
E01	48	58	31	51	26	43	18	13
E02	48	62	67	43	23	26	23	8
E03	78	100	77	100	100	57	23	100
E04	68	75	63	70	42	40	19	8
E05	44	47	62	49	35	25	23	16
E06	52	60	100	68	34	28	75	24
E07	52	59	72	52	21	20	34	13
E08	52	51	51	44	33	23	48	16
E09	72	63	38	67	21	18	100	11
E10	84	86	88	53	53	100	42	0
E11	100	73	78	89	88	56	42	16
E12	42	26	53	51	21	19	52	2
E13	56	23	33	37	18	26	26	11
E14	92	99	62	74	57	98	45	5
E15	56	34	37	30	24	50	47	0
E16	46	18	24	25	10	21	8	0
E17	72	54	87	43	29	73	38	13

	v1	*μ1*	*μ2*	*μ3*	*μ4*	*μ5*	*μ6*	*μ7*
weights	0.0208	0.0000	0.0000	0.0088	0.0000	0.0129	0.0000	0.0000

Objective Function	Weighted Inputs	Weighted Outputs	Ratio
E1	1.000	1.000	1.000

Company ID	weighted in in1	weighted outputs out1	out2	out3	out4	out5	out6	out7	Constraints		
E01	1.0000	-	-	0.4474	-	0.5526	-	-	0.0000	<=	0
E02	1.0000	-	-	0.3773	-	0.3341	-	-	-0.2886	<=	0
E03	1.6250	-	-	0.8773	-	0.7325	-	-	-0.0152	<=	0
E04	1.4167	-	-	0.6141	-	0.5140	-	-	-0.2885	<=	0
E05	0.9167	-	-	0.4299	-	0.3213	-	-	-0.1655	<=	0
E06	1.0833	-	-	0.5966	-	0.3598	-	-	-0.1269	<=	0
E07	1.0833	-	-	0.4562	-	0.2570	-	-	-0.3701	<=	0
E08	1.0833	-	-	0.3860	-	0.2956	-	-	-0.4017	<=	0
E09	1.5000	-	-	0.5878	-	0.2313	-	-	-0.6809	<=	0
E10	1.7500	-	-	0.4650	-	1.2850	-	-	0.0000	<=	0
E11	2.0833	-	-	0.7808	-	0.7196	-	-	-0.5829	<=	0
E12	0.8750	-	-	0.4474	-	0.2442	-	-	-0.1834	<=	0
E13	1.1667	-	-	0.3246	-	0.3341	-	-	-0.5079	<=	0
E14	1.9167	-	-	0.6492	-	1.2593	-	-	-0.0081	<=	0
E15	1.1667	-	-	0.2632	-	0.6425	-	-	-0.2610	<=	0
E16	0.9583	-	-	0.2193	-	0.2699	-	-	-0.4691	<=	0
E17	1.5000	-	-	0.3773	-	0.9381	-	-	-0.1847	<=	0

Solve the linear program for each company to get its efficiency score. Final scores will be as follows:

Company ID	Effeciency Score
E01	1.000
E02	1.000
E03	1.000
E04	0.859
E05	0.904
E06	1.000
E07	0.913
E08	0.823
E09	0.963
E10	1.000
E11	0.783
E12	0.929
E13	0.591
E14	1.000
E15	0.959
E16	0.514
E17	0.989
Average Score	0.896

7. Evaluation of the sectors in the organization

Sector ID	Inputs		Outputs		
	in1	in2	out1	out2	out3
S1	23	24	25	26	85.78
S2	21	23	24	20	78.29
S3	26	21	25	28	95.91
S4	21	20	29	22	91.00
S5	21	26	27	26	88.57
S6	22	23	24	20	89.57

	v1	*v2*	*µ1*	*µ2*	*µ3*
weights	0.0476	0.0000	0.0000	0.0058	0.0096

Objective Function	Weighted Inputs	Weighted Outputs	Ratio
S2	1.000	0.867	0.867

Sector ID	weighted inputs		weighted outputs			Constraints		
	in1	in2	out1	out2	out3			
S1	1.0952	-	-	0.1515	0.8218	-0.1220	<=	0
S2	1.0000	-	-	0.1165	0.7500	-0.1335	<=	0
S3	1.2381	-	-	0.1631	0.9189	-0.1561	<=	0
S4	1.0000	-	-	0.1282	0.8718	0.0000	<=	0
S5	1.0000	-	-	0.1515	0.8485	0.0000	<=	0
S6	1.0476	-	-	0.1165	0.8581	-0.0730	<=	0

Solve the linear program for each sector to get its efficiency score. Final scores will be as follows:

Sector ID	Effeciency Score
S1	0.97
S2	0.87
S3	1.00
S4	1.00
S5	1.00
S6	0.94
Average Score	0.96

Appendix C: DEA-AHP Models Results

1. Ranking of companies under Sector 1

The evaluation criteria						
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6
DMU	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3
E01	0.090	1.125	0.0017	7.000	87.500	0.130
E02	0.067	1.000	0.0021	6.333	95.000	0.198
E03	0.067	0.381	0.0016	6.250	35.714	0.147
E04	0.090	1.500	0.0021	9.000	150.000	0.214
E05	0.039	1.400	0.0012	4.444	160.000	0.133
E06	0.143	1.111	0.0019	7.143	55.556	0.096
E07	0.080	2.667	0.0016	7.000	233.333	0.140
E08	0.063	0.500	0.0014	6.250	50.000	0.136
E09	0.046	0.813	0.0011	3.929	68.750	0.096
E10	0.106	0.944	0.0019	11.250	100.000	0.200

Weights of inputs and outputs of all DMUs					
DMU	*v1*	*v2*	*v3*	*μ1*	*μ2*
E01	0.0644	0.4448	0.0000	0.6902	0.0032
E02	0.0000	0.0000	0.0021	0.9722	0.0000
E03	0.0195	0.0000	0.0015	0.9176	0.0000
E04	0.0000	0.0000	0.0024	0.0000	0.0111
E05	0.0000	0.9286	0.0009	0.0000	0.0104
E06	0.0212	0.0000	0.0016	1.0000	0.0000
E07	0.0714	0.9524	0.0000	0.0000	0.0143
E08	0.0340	0.0000	0.0011	0.7152	0.0016
E09	0.0000	0.5405	0.0010	0.8250	0.0000
E10	0.0263	0.0000	0.0018	0.0000	0.0111
Average weights	0.0237	0.2866	0.0012	0.5120	0.0052

The weights of the criteria						
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6
M	21.613	1.786	415.511	0.218	0.018	4.198
Normalized	0.4681	0.0387	9.0000	0.0047	0.0004	0.0909

Pairwise Comparisons

DMU	Criteria 1 (O1/I1)											Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	Mc	Pi
E01	1.000	1.350	1.350	1.000	2.314	0.630	1.125	1.440	1.938	0.847	1.215993	0.1139
E02	0.741	1.000	1.000	0.741	1.714	0.467	0.833	1.067	1.436	0.627	0.9007356	0.0844
E03	0.741	1.000	1.000	0.741	1.714	0.467	0.833	1.067	1.436	0.627	0.9007356	0.0844
E04	1.000	1.350	1.350	1.000	2.314	0.630	1.125	1.440	1.938	0.847	1.215993	0.1139
E05	0.432	0.583	0.583	0.432	1.000	0.272	0.486	0.622	0.838	0.366	0.5254291	0.0492
E06	1.587	2.143	2.143	1.587	3.673	1.000	1.786	2.286	3.077	1.345	1.9301477	0.1808
E07	0.889	1.200	1.200	0.889	2.057	0.560	1.000	1.280	1.723	0.753	1.0808827	0.1012
E08	0.694	0.938	0.938	0.694	1.607	0.438	0.781	1.000	1.346	0.588	0.8444396	0.0791
E09	0.516	0.696	0.696	0.516	1.194	0.325	0.580	0.743	1.000	0.437	0.627298	0.0588
E10	1.181	1.594	1.594	1.181	2.732	0.744	1.328	1.700	2.288	1.000	1.4355473	0.1344

DMU	Criteria 2 (O1/I2)											Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	Mc	Pi
E01	1.000	1.125	2.953	0.750	0.804	1.013	0.422	2.250	1.385	1.191	1.1224285	0.0983
E02	0.889	1.000	2.625	0.667	0.714	0.900	0.375	2.000	1.231	1.059	0.9977142	0.0874
E03	0.339	0.381	1.000	0.254	0.272	0.343	0.143	0.762	0.469	0.403	0.3800816	0.0333
E04	1.333	1.500	3.938	1.000	1.071	1.350	0.563	3.000	1.846	1.588	1.4965713	0.1311
E05	1.244	1.400	3.675	0.933	1.000	1.260	0.525	2.800	1.723	1.482	1.3967999	0.1224
E06	0.988	1.111	2.917	0.741	0.794	1.000	0.417	2.222	1.368	1.176	1.1085713	0.0971
E07	2.370	2.667	7.000	1.778	1.905	2.400	1.000	5.333	3.282	2.824	2.6605712	0.2331
E08	0.444	0.500	1.313	0.333	0.357	0.450	0.188	1.000	0.615	0.529	0.4988571	0.0437
E09	0.722	0.813	2.133	0.542	0.580	0.731	0.305	1.625	1.000	0.860	0.8106428	0.0710
E10	0.840	0.944	2.479	0.630	0.675	0.850	0.354	1.889	1.162	1.000	0.9422856	0.0826

DMU	Criteria 3 (O1/I3)											Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	Mc	Pi
E01	1.000	0.800	1.063	0.778	1.429	0.867	1.042	1.222	1.462	0.882	1.0299971	0.1007
E02	1.250	1.000	1.328	0.972	1.786	1.083	1.302	1.528	1.827	1.103	1.2874964	0.1259
E03	0.941	0.753	1.000	0.732	1.345	0.816	0.980	1.150	1.376	0.830	0.969409	0.0948
E04	1.286	1.029	1.366	1.000	1.837	1.114	1.339	1.571	1.879	1.134	1.324282	0.1295
E05	0.700	0.560	0.744	0.544	1.000	0.607	0.729	0.856	1.023	0.618	0.720998	0.0705
E06	1.154	0.923	1.226	0.897	1.648	1.000	1.202	1.410	1.686	1.018	1.1884582	0.1162
E07	0.960	0.768	1.020	0.747	1.371	0.832	1.000	1.173	1.403	0.847	0.9887972	0.0967
E08	0.818	0.655	0.869	0.636	1.169	0.709	0.852	1.000	1.196	0.722	0.8427249	0.0824
E09	0.684	0.547	0.727	0.532	0.977	0.593	0.713	0.836	1.000	0.604	0.7047349	0.0689
E10	1.133	0.907	1.204	0.881	1.619	0.982	1.181	1.385	1.656	1.000	1.1673301	0.1142

DMU	Criteria 4 (O2/I1)											Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	Mc	Pi
E01	1.000	1.105	1.120	0.778	1.575	0.980	1.000	1.120	1.782	0.622	1.0631812	0.1020
E02	0.905	1.000	1.013	0.704	1.425	0.887	0.905	1.013	1.612	0.563	0.9619258	0.0923
E03	0.893	0.987	1.000	0.694	1.406	0.875	0.893	1.000	1.591	0.556	0.9492689	0.0911
E04	1.286	1.421	1.440	1.000	2.025	1.260	1.286	1.440	2.291	0.800	1.3669472	0.1312
E05	0.635	0.702	0.711	0.494	1.000	0.622	0.635	0.711	1.131	0.395	0.6750357	0.0648
E06	1.020	1.128	1.143	0.794	1.607	1.000	1.020	1.143	1.818	0.635	1.0848788	0.1041
E07	1.000	1.105	1.120	0.778	1.575	0.980	1.000	1.120	1.782	0.622	1.0631812	0.1020
E08	0.893	0.987	1.000	0.694	1.406	0.875	0.893	1.000	1.591	0.556	0.9492689	0.0911
E09	0.561	0.620	0.629	0.437	0.884	0.550	0.561	0.629	1.000	0.349	0.5966833	0.0573
E10	1.607	1.776	1.800	1.250	2.531	1.575	1.607	1.800	2.864	1.000	1.708684	0.1640

DMU	Criteria 5 (O2/I2)											Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	Mc	Pi
E01	1.000	0.921	2.450	0.583	0.547	1.575	0.375	1.750	1.273	0.875	0.9813747	0.0845
E02	1.086	1.000	2.660	0.633	0.594	1.710	0.407	1.900	1.382	0.950	1.0654926	0.0917
E03	0.408	0.376	1.000	0.238	0.223	0.643	0.153	0.714	0.519	0.357	0.4005611	0.0345
E04	1.714	1.579	4.200	1.000	0.938	2.700	0.643	3.000	2.182	1.500	1.6823567	0.1448
E05	1.829	1.684	4.480	1.067	1.000	2.880	0.686	3.200	2.327	1.600	1.7945138	0.1545
E06	0.635	0.585	1.556	0.370	0.347	1.000	0.238	1.111	0.808	0.556	0.6230951	0.0536
E07	2.667	2.456	6.533	1.556	1.458	4.200	1.000	4.667	3.394	2.333	2.6169993	0.2253
E08	0.571	0.526	1.400	0.333	0.313	0.900	0.214	1.000	0.727	0.500	0.5607856	0.0483
E09	0.786	0.724	1.925	0.458	0.430	1.238	0.295	1.375	1.000	0.688	0.7710801	0.0664
E10	1.143	1.053	2.800	0.667	0.625	1.800	0.429	2.000	1.455	1.000	1.1215711	0.0965

DMU	Criteria 6 (O2/I3)											Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	Mc	Pi
E01	1.000	0.655	0.881	0.605	0.972	1.348	0.926	0.951	1.343	0.648	0.9005591	0.0869
E02	1.527	1.000	1.346	0.924	1.484	2.058	1.414	1.451	2.051	0.990	1.3749607	0.1327
E03	1.134	0.743	1.000	0.686	1.103	1.529	1.050	1.078	1.524	0.735	1.0216426	0.0986
E04	1.653	1.083	1.457	1.000	1.607	2.229	1.531	1.571	2.221	1.071	1.4886793	0.1437
E05	1.029	0.674	0.907	0.622	1.000	1.387	0.952	0.978	1.382	0.667	0.9262893	0.0894
E06	0.742	0.486	0.654	0.449	0.721	1.000	0.687	0.705	0.997	0.481	0.6679971	0.0645
E07	1.080	0.707	0.952	0.653	1.050	1.456	1.000	1.027	1.451	0.700	0.9726038	0.0939
E08	1.052	0.689	0.927	0.636	1.023	1.418	0.974	1.000	1.413	0.682	0.9473414	0.0914
E09	0.744	0.488	0.656	0.450	0.724	1.004	0.689	0.708	1.000	0.482	0.670341	0.0647
E10	1.543	1.011	1.360	0.933	1.500	2.080	1.429	1.467	2.073	1.000	1.389434	0.1341

Synthesize the results to determine the best alternative.
Obtain the final results

								Score	Rank
wieght	0.468	0.039	9.000	0.005	0.000	0.091			
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6			
E01	0.1139	0.0983	0.1007	0.1020	0.0845	0.0869		0.97	5
E02	0.0844	0.0874	0.1259	0.0923	0.0917	0.1327		1.19	2
E03	0.0844	0.0333	0.0948	0.0911	0.0345	0.0986		0.90	7
E04	0.1139	0.1311	0.1295	0.1312	0.1448	0.1437		1.24	1
E05	0.0492	0.1224	0.0705	0.0648	0.1545	0.0894		0.67	9
E06	0.1808	0.0971	0.1162	0.1041	0.0536	0.0645		1.14	3
E07	0.1012	0.2331	0.0967	0.1020	0.2253	0.0939		0.94	6
E08	0.0791	0.0437	0.0824	0.0911	0.0483	0.0914		0.79	8
E09	0.0588	0.0710	0.0689	0.0573	0.0664	0.0647		0.66	10
E10	0.1344	0.0826	0.1142	0.1640	0.0965	0.1341		1.11	4

2. Ranking of companies under Sector 2

The evaluation criteria						
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6
DMU	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3
E01	0.090	1.125	0.0017	7.000	87.500	0.130
E02	0.067	1.000	0.0021	6.333	95.000	0.198
E03	0.067	0.381	0.0016	6.250	35.714	0.147
E04	0.090	1.500	0.0021	9.000	150.000	0.214
E05	0.039	1.400	0.0012	4.444	160.000	0.133
E06	0.143	1.111	0.0019	7.143	55.556	0.096
E07	0.080	2.667	0.0016	7.000	233.333	0.140
E08	0.063	1.500	0.0014	6.250	150.000	0.136
E09	0.046	0.361	0.0011	3.929	30.556	0.096
E10	0.106	0.944	0.0019	11.250	100.000	0.200
E11	0.158	3.167	0.0021	16.667	333.333	0.222
E12	0.143	3.333	0.0024	14.286	333.333	0.238
E13	0.125	3.333	0.0025	11.875	316.667	0.238

Weights of inputs and outputs of all DMUs					
DMU	$v1$	$v2$	$v3$	$\mu1$	$\mu2$
E01	0.0077	0.0000	0.0004	0.2162	0.0000
E02	0.0000	0.0000	0.0006	0.0119	0.0024
E03	0.0000	0.0000	0.0006	0.2241	0.0000
E04	0.0000	0.0000	0.0007	0.0000	0.0029
E05	0.0000	0.0000	0.0005	0.0000	0.0020
E06	0.0210	0.0000	0.0003	0.2590	0.0000
E07	0.0000	0.9524	0.0000	0.2857	0.0000
E08	0.0000	0.0000	0.0005	0.0000	0.0022
E09	0.0000	0.0000	0.0005	0.2005	0.0000
E10	0.0000	0.0000	0.0006	0.0000	0.0027
E11	0.0136	0.0000	0.0005	0.0000	0.0029
E12	0.0000	0.0000	0.0007	0.0000	0.0029
E13	0.0000	0.0000	0.0007	0.0143	0.0029
Average weights	0.0033	0.0733	0.0005	0.0932	0.0016

The weights of the criteria						
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6
M	28.650	1.272	187.310	0.488	0.022	3.193
Normalized	1.377	0.061	9.000	0.023	0.001	0.153

Pairwise Comparisons

DMU	Criteria 1 (O1/I1)														Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	Mc	Pi
E01	1.000	1.350	1.350	1.000	2.314	0.630	1.125	1.440	1.938	0.847	0.568	0.630	0.720	1.04725	0.0740
E02	0.741	1.000	1.000	0.741	1.714	0.467	0.833	1.067	1.436	0.627	0.421	0.467	0.533	0.775741	0.0548
E03	0.741	1.000	1.000	0.741	1.714	0.467	0.833	1.067	1.436	0.627	0.421	0.467	0.533	0.775741	0.0548
E04	1.000	1.350	1.350	1.000	2.314	0.630	1.125	1.440	1.938	0.847	0.568	0.630	0.720	1.04725	0.0740
E05	0.432	0.583	0.583	0.432	1.000	0.272	0.486	0.622	0.838	0.366	0.246	0.272	0.311	0.452515	0.0320
E06	1.587	2.143	2.143	1.587	3.673	1.000	1.786	2.286	3.077	1.345	0.902	1.000	1.143	1.662301	0.1174
E07	0.889	1.200	1.200	0.889	2.057	0.560	1.000	1.280	1.723	0.753	0.505	0.560	0.640	0.930889	0.0658
E08	0.694	0.938	0.938	0.694	1.607	0.438	0.781	1.000	1.346	0.588	0.395	0.438	0.500	0.727257	0.0514
E09	0.516	0.696	0.696	0.516	1.194	0.325	0.580	0.743	1.000	0.437	0.293	0.325	0.371	0.540248	0.0382
E10	1.181	1.594	1.594	1.181	2.732	0.744	1.328	1.700	2.288	1.000	0.671	0.744	0.850	1.236337	0.0873
E11	1.759	2.375	2.375	1.759	4.071	1.108	1.979	2.533	3.410	1.490	1.000	1.108	1.267	1.842384	0.1302
E12	1.587	2.143	2.143	1.587	3.673	1.000	1.786	2.286	3.077	1.345	0.902	1.000	1.143	1.662301	0.1174
E13	1.389	1.875	1.875	1.389	3.214	0.875	1.563	2.000	2.692	1.176	0.789	0.875	1.000	1.454514	0.1028

DMU	Criteria 2 (O1/I2)														Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10				Mc	Pi
E01	1.000	1.125	2.953	0.750	0.804	1.013	0.422	0.750	3.115	1.191	0.355	0.338	0.338	0.835269	0.0516
E02	0.889	1.000	2.625	0.667	0.714	0.900	0.375	0.667	2.769	1.059	0.316	0.300	0.300	0.742462	0.0458
E03	0.339	0.381	1.000	0.254	0.272	0.343	0.143	0.254	1.055	0.403	0.120	0.114	0.114	0.282843	0.0175
E04	1.333	1.500	3.938	1.000	1.071	1.350	0.563	1.000	4.154	1.588	0.474	0.450	0.450	1.113693	0.0687
E05	1.244	1.400	3.675	0.933	1.000	1.260	0.525	0.933	3.877	1.482	0.442	0.420	0.420	1.039446	0.0642
E06	0.988	1.111	2.917	0.741	0.794	1.000	0.417	0.741	3.077	1.176	0.351	0.333	0.333	0.824957	0.0509
E07	2.370	2.667	7.000	1.778	1.905	2.400	1.000	1.778	7.385	2.824	0.842	0.800	0.800	1.979898	0.1222
E08	1.333	1.500	3.938	1.000	1.071	1.350	0.563	1.000	4.154	1.588	0.474	0.450	0.450	1.113693	0.0687
E09	0.321	0.361	0.948	0.241	0.258	0.325	0.135	0.241	1.000	0.382	0.114	0.108	0.108	0.268111	0.0165
E10	0.840	0.944	2.479	0.630	0.675	0.850	0.354	0.630	2.615	1.000	0.298	0.283	0.283	0.701214	0.0433
E11	2.815	3.167	8.313	2.111	2.262	2.850	1.188	2.111	8.769	3.353	1.000	0.950	0.950	2.351129	0.1451
E12	2.963	3.333	8.750	2.222	2.381	3.000	1.250	2.222	9.231	3.529	1.053	1.000	1.000	2.474872	0.1527
E13	2.963	3.333	8.750	2.222	2.381	3.000	1.250	2.222	9.231	3.529	1.053	1.000	1.000	2.474872	0.1527

DMU	Criteria 3 (O1/I3)														Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10				Mc	Pi
E01	1.000	0.800	1.063	0.778	1.429	0.867	1.042	1.222	1.462	0.882	0.789	0.700	0.667	0.947361	0.0708
E02	1.250	1.000	1.328	0.972	1.786	1.083	1.302	1.528	1.827	1.103	0.987	0.875	0.833	1.184202	0.0885
E03	0.941	0.753	1.000	0.732	1.345	0.816	0.980	1.150	1.376	0.830	0.743	0.659	0.627	0.891634	0.0666
E04	1.286	1.029	1.366	1.000	1.837	1.114	1.339	1.571	1.879	1.134	1.015	0.900	0.857	1.218036	0.0910
E05	0.700	0.560	0.744	0.544	1.000	0.607	0.729	0.856	1.023	0.618	0.553	0.490	0.467	0.663153	0.0496
E06	1.154	0.923	1.226	0.897	1.648	1.000	1.202	1.410	1.686	1.018	0.911	0.808	0.769	1.093109	0.0817
E07	0.960	0.768	1.020	0.747	1.371	0.832	1.000	1.173	1.403	0.847	0.758	0.672	0.640	0.909467	0.0680
E08	0.818	0.655	0.869	0.636	1.169	0.709	0.852	1.000	1.196	0.722	0.646	0.573	0.545	0.775114	0.0579
E09	0.684	0.547	0.727	0.532	0.977	0.593	0.713	0.836	1.000	0.604	0.540	0.479	0.456	0.648195	0.0485
E10	1.133	0.907	1.204	0.881	1.619	0.982	1.181	1.385	1.656	1.000	0.895	0.793	0.756	1.073676	0.0803
E11	1.267	1.013	1.346	0.985	1.810	1.098	1.319	1.548	1.851	1.118	1.000	0.887	0.844	1.199991	0.0897
E12	1.429	1.143	1.518	1.111	2.041	1.238	1.488	1.746	2.088	1.261	1.128	1.000	0.952	1.353374	0.1012
E13	1.500	1.200	1.594	1.167	2.143	1.300	1.563	1.833	2.192	1.324	1.184	1.050	1.000	1.421042	0.1062

DMU	Criteria 4 (O2/I1)														Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10				Mc	Pi
E01	1.000	1.105	1.120	0.778	1.575	0.980	1.000	1.120	1.782	0.622	0.420	0.490	0.589	0.891248	0.0628
E02	0.905	1.000	1.013	0.704	1.425	0.887	0.905	1.013	1.612	0.563	0.380	0.443	0.533	0.806367	0.0568
E03	0.893	0.987	1.000	0.694	1.406	0.875	0.893	1.000	1.591	0.556	0.375	0.438	0.526	0.795757	0.0561
E04	1.286	1.421	1.440	1.000	2.025	1.260	1.286	1.440	2.291	0.800	0.540	0.630	0.758	1.145891	0.0808
E05	0.635	0.702	0.711	0.494	1.000	0.622	0.635	0.711	1.131	0.395	0.267	0.311	0.374	0.565872	0.0399
E06	1.020	1.128	1.143	0.794	1.607	1.000	1.020	1.143	1.818	0.635	0.429	0.500	0.602	0.909437	0.0641
E07	1.000	1.105	1.120	0.778	1.575	0.980	1.000	1.120	1.782	0.622	0.420	0.490	0.589	0.891248	0.0628
E08	0.893	0.987	1.000	0.694	1.406	0.875	0.893	1.000	1.591	0.556	0.375	0.438	0.526	0.795757	0.0561
E09	0.561	0.620	0.629	0.437	0.884	0.550	0.561	0.629	1.000	0.349	0.236	0.275	0.331	0.50019	0.0353
E10	1.607	1.776	1.800	1.250	2.531	1.575	1.607	1.800	2.864	1.000	0.675	0.788	0.947	1.432363	0.1010
E11	2.381	2.632	2.667	1.852	3.750	2.333	2.381	2.667	4.242	1.481	1.000	1.167	1.404	2.12202	0.1496
E12	2.041	2.256	2.286	1.587	3.214	2.000	2.041	2.286	3.636	1.270	0.857	1.000	1.203	1.818874	0.1282
E13	1.696	1.875	1.900	1.319	2.672	1.663	1.696	1.900	3.023	1.056	0.713	0.831	1.000	1.511939	0.1066

DMU	Criteria 5 (O2/I2)														Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10				Mc	Pi
E01	1.000	0.921	2.450	0.583	0.547	1.575	0.375	0.583	2.864	0.875	0.263	0.263	0.276	0.710845	0.0420
E02	1.086	1.000	2.660	0.633	0.594	1.710	0.407	0.633	3.109	0.950	0.285	0.285	0.300	0.771775	0.0457
E03	0.408	0.376	1.000	0.238	0.223	0.643	0.153	0.238	1.169	0.357	0.107	0.107	0.113	0.290141	0.0172
E04	1.714	1.579	4.200	1.000	0.938	2.700	0.643	1.000	4.909	1.500	0.450	0.450	0.474	1.218592	0.0721
E05	1.829	1.684	4.480	1.067	1.000	2.880	0.686	1.067	5.236	1.600	0.480	0.480	0.505	1.299831	0.0769
E06	0.635	0.585	1.556	0.370	0.347	1.000	0.238	0.370	1.818	0.556	0.167	0.167	0.175	0.45133	0.0267
E07	2.667	2.456	6.533	1.556	1.458	4.200	1.000	1.556	7.636	2.333	0.700	0.700	0.737	1.895587	0.1121
E08	1.714	1.579	4.200	1.000	0.938	2.700	0.643	1.000	4.909	1.500	0.450	0.450	0.474	1.218592	0.0721
E09	0.349	0.322	0.856	0.204	0.191	0.550	0.131	0.204	1.000	0.306	0.092	0.092	0.096	0.248232	0.0147
E10	1.143	1.053	2.800	0.667	0.625	1.800	0.429	0.667	3.273	1.000	0.300	0.300	0.316	0.812394	0.0481
E11	3.810	3.509	9.333	2.222	2.083	6.000	1.429	2.222	10.909	3.333	1.000	1.000	1.053	2.707981	0.1602
E12	3.810	3.509	9.333	2.222	2.083	6.000	1.429	2.222	10.909	3.333	1.000	1.000	1.053	2.707981	0.1602
E13	3.619	3.333	8.867	2.111	1.979	5.700	1.357	2.111	10.364	3.167	0.950	0.950	1.000	2.572582	0.1522

DMU	Criteria 6 (O2/I3)														Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10				Mc	Pi
E01	1.000	0.655	0.881	0.605	0.972	1.348	0.926	0.951	1.343	0.648	0.583	0.544	0.546	0.80624	0.0592
E02	1.527	1.000	1.346	0.924	1.484	2.058	1.414	1.451	2.051	0.990	0.891	0.831	0.833	1.230955	0.0904
E03	1.134	0.743	1.000	0.686	1.103	1.529	1.050	1.078	1.524	0.735	0.662	0.618	0.619	0.914641	0.0672
E04	1.653	1.083	1.457	1.000	1.607	2.229	1.531	1.571	2.221	1.071	0.964	0.900	0.902	1.332763	0.0979
E05	1.029	0.674	0.907	0.622	1.000	1.387	0.952	0.978	1.382	0.667	0.600	0.560	0.561	0.829275	0.0609
E06	0.742	0.486	0.654	0.449	0.721	1.000	0.687	0.705	0.997	0.481	0.433	0.404	0.405	0.598035	0.0439
E07	1.080	0.707	0.952	0.653	1.050	1.456	1.000	1.027	1.451	0.700	0.630	0.588	0.589	0.870739	0.0640
E08	1.052	0.689	0.927	0.636	1.023	1.418	0.974	1.000	1.413	0.682	0.614	0.573	0.574	0.848122	0.0623
E09	0.744	0.488	0.656	0.450	0.724	1.004	0.689	0.708	1.000	0.482	0.434	0.405	0.406	0.600133	0.0441
E10	1.543	1.011	1.360	0.933	1.500	2.080	1.429	1.467	2.073	1.000	0.900	0.840	0.842	1.243912	0.0914
E11	1.714	1.123	1.511	1.037	1.667	2.311	1.587	1.630	2.303	1.111	1.000	0.933	0.936	1.382125	0.1015
E12	1.837	1.203	1.619	1.111	1.786	2.476	1.701	1.746	2.468	1.190	1.071	1.000	1.003	1.480848	0.1088
E13	1.832	1.200	1.615	1.108	1.781	2.470	1.696	1.742	2.461	1.188	1.069	0.998	1.000	1.477146	0.1085

Synthesize the results to determine the best alternative.
Obtain the final results

wieght	1.377	0.061	9.000	0.023	0.001	0.153		
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Score	Rank
E01	0.0740	0.0516	0.0708	0.0628	0.0420	0.0592	0.75	8
E02	0.0548	0.0458	0.0885	0.0568	0.0457	0.0904	0.89	7
E03	0.0548	0.0175	0.0666	0.0561	0.0172	0.0672	0.69	10
E04	0.0740	0.0687	0.0910	0.0808	0.0721	0.0979	0.94	5
E05	0.0320	0.0642	0.0496	0.0399	0.0769	0.0609	0.50	13
E06	0.1174	0.0509	0.0817	0.0641	0.0267	0.0439	0.91	4
E07	0.0658	0.1222	0.0680	0.0628	0.1121	0.0640	0.72	9
E08	0.0514	0.0687	0.0579	0.0561	0.0721	0.0623	0.61	11
E09	0.0382	0.0165	0.0485	0.0353	0.0147	0.0441	0.50	12
E10	0.0873	0.0433	0.0803	0.1010	0.0481	0.0914	0.86	6
E11	0.1302	0.1451	0.0897	0.1496	0.1602	0.1015	1.01	3
E12	0.1174	0.1527	0.1012	0.1282	0.1602	0.1088	1.10	2
E13	0.1028	0.1527	0.1062	0.1066	0.1522	0.1085	1.13	1

3. Ranking of companies under Sector 3

The evaluation criteria								
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8
DMU	O1/I1	O1/I2	O2/I1	O2/I2	O3/I1	O3/I2	O4/I1	O4/I2
E01	1.417	375.991	0.2739	72.6872	0.0001	0.031	0.0005	0.13
E02	2.220	156.137	0.3061	21.5292	0.0005	0.034	0.0021	0.14
E03	1.703	288.591	0.2278	38.5906	0.0003	0.050	0.0013	0.22
E04	2.739	143.023	0.2895	15.1163	0.0009	0.049	0.0040	0.21
E05	1.347	72.404	0.2541	13.6612	0.0009	0.046	0.0030	0.16
E06	1.925	186.258	0.2294	22.1987	0.0003	0.032	0.0015	0.14
E07	2.132	136.742	0.2687	17.2348	0.0004	0.028	0.0016	0.10
E08	1.622	187.222	0.2455	28.3333	0.0007	0.078	0.0034	0.39
E09	3.165	71.835	0.1534	3.4810	0.0028	0.063	0.0103	0.23
E10	2.716	37.879	0.1207	1.6835	0.0024	0.034	0.0123	0.17
E11	0.587	4.490	0.0356	0.2721	0.0025	0.019	0.0137	0.10
E12	1.548	282.813	0.3336	60.9375	0.0003	0.051	0.0015	0.27
E13	1.741	134.815	0.3347	25.9259	0.0008	0.063	0.0033	0.26
E14	1.795	110.465	0.1039	6.3953	0.0014	0.087	0.0060	0.37
E15	2.264	64.396	0.1314	3.7363	0.0013	0.037	0.0056	0.16

Weights of inputs and outputs of all DMUs						
	$v1$	$v2$	$\mu1$	$\mu2$	$\mu3$	$\mu4$
E01	0.0004	0.1060	0.0000	0.0030	0.0000	0.0000
E02	0.0027	0.0105	0.0004	0.0066	0.0000	0.0000
E03	0.0015	0.0843	0.0010	0.0011	0.0000	0.0000
E04	0.0025	0.1589	0.0020	0.0000	0.0000	0.0000
E05	0.0051	0.0000	0.0000	0.0124	1.1397	0.0000
E06	0.0013	0.0833	0.0011	0.0000	0.0000	0.0000
E07	0.0028	0.0108	0.0004	0.0068	0.0000	0.0000
E08	0.0035	0.1570	0.0009	0.0064	0.0000	0.5185
E09	0.0037	0.2328	0.0020	0.0000	2.6747	0.0000
E10	0.0070	0.0708	0.0000	0.0000	0.0000	0.9804
E11	0.0138	0.0306	0.0000	0.0000	0.0000	1.2987
E12	0.0021	0.0010	0.0000	0.0064	0.0000	0.0000
E13	0.0048	0.0000	0.0000	0.0143	0.0000	0.0000
E14	0.0007	0.5404	0.0000	0.0000	0.0000	1.5873
E15	0.0062	0.0439	0.0026	0.0000	0.0000	0.0000
Average weights	0.0039	0.1020	0.0007	0.0038	0.2543	0.2923

The weights of the criteria								
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8
M	0.179	0.007	0.983	0.037	65.720	2.493	75.550	2.866
Normalized	0.021	0.001	0.117	0.004	7.829	0.297	9.000	0.341

Pairwise Comparisons

DMU	Criteria 1 (O1/I1)																Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Mc	Pi
E01	1.000	0.638	0.832	0.517	1.052	0.736	0.665	0.874	0.448	0.522	2.412	0.915	0.814	0.789	0.626	0.783	0.0490
E02	1.567	1.000	1.303	0.811	1.648	1.153	1.041	1.369	0.701	0.817	3.780	1.434	1.276	1.237	0.981	1.227	0.0768
E03	1.202	0.767	1.000	0.622	1.265	0.885	0.799	1.050	0.538	0.627	2.900	1.100	0.979	0.949	0.752	0.942	0.0589
E04	1.933	1.234	1.608	1.000	2.034	1.423	1.285	1.689	0.865	1.008	4.663	1.769	1.574	1.526	1.210	1.514	0.0947
E05	0.951	0.607	0.791	0.492	1.000	0.700	0.632	0.830	0.426	0.496	2.293	0.870	0.774	0.750	0.595	0.745	0.0466
E06	1.358	0.867	1.130	0.703	1.429	1.000	0.903	1.187	0.608	0.709	3.277	1.243	1.106	1.072	0.850	1.064	0.0666
E07	1.505	0.960	1.252	0.778	1.583	1.108	1.000	1.314	0.674	0.785	3.630	1.377	1.225	1.188	0.942	1.179	0.0737
E08	1.145	0.731	0.952	0.592	1.204	0.843	0.761	1.000	0.513	0.597	2.762	1.048	0.932	0.904	0.716	0.897	0.0561
E09	2.234	1.426	1.858	1.156	2.350	1.644	1.484	1.951	1.000	1.165	5.388	2.045	1.818	1.763	1.398	1.75	0.1094
E10	1.917	1.223	1.595	0.992	2.017	1.411	1.274	1.674	0.858	1.000	4.624	1.755	1.560	1.513	1.200	1.501	0.0939
E11	0.415	0.265	0.345	0.214	0.436	0.305	0.275	0.362	0.186	0.216	1.000	0.379	0.337	0.327	0.259	0.325	0.0203
E12	1.092	0.697	0.909	0.565	1.149	0.804	0.726	0.954	0.489	0.570	2.635	1.000	0.889	0.862	0.684	0.856	0.0535
E13	1.228	0.784	1.022	0.635	1.292	0.904	0.816	1.073	0.550	0.641	2.963	1.124	1.000	0.970	0.769	0.962	0.0602
E14	1.267	0.808	1.054	0.655	1.333	0.932	0.842	1.106	0.567	0.661	3.056	1.159	1.031	1.000	0.793	0.992	0.0621
E15	1.598	1.020	1.329	0.827	1.681	1.176	1.062	1.396	0.715	0.834	3.854	1.463	1.301	1.261	1.000	1.252	0.0783

DMU	Criteria 2 (O1/I2)																Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Mc	Pi
E01	1.000	2.408	1.303	2.629	5.193	2.019	2.750	2.008	5.234	9.926	83.743	1.329	2.789	3.404	5.839	3.513	0.1669
E02	0.415	1.000	0.541	1.092	2.156	0.838	1.142	0.834	2.174	4.122	34.776	0.552	1.158	1.413	2.425	1.459	0.0693
E03	0.768	1.848	1.000	2.018	3.986	1.549	2.110	1.541	4.017	7.619	64.277	1.020	2.141	2.613	4.482	2.696	0.1281
E04	0.380	0.916	0.496	1.000	1.975	0.768	1.046	0.764	1.991	3.776	31.855	0.506	1.061	1.295	2.221	1.336	0.0635
E05	0.193	0.464	0.251	0.506	1.000	0.389	0.529	0.387	1.008	1.911	16.126	0.256	0.537	0.655	1.124	0.676	0.0321
E06	0.495	1.193	0.645	1.302	2.572	1.000	1.362	0.995	2.593	4.917	41.485	0.659	1.382	1.686	2.892	1.74	0.0827
E07	0.364	0.876	0.474	0.956	1.889	0.734	1.000	0.730	1.904	3.610	30.456	0.484	1.014	1.238	2.123	1.278	0.0607
E08	0.498	1.199	0.649	1.309	2.586	1.005	1.369	1.000	2.606	4.943	41.699	0.662	1.389	1.695	2.907	1.749	0.0831
E09	0.191	0.460	0.249	0.502	0.992	0.386	0.525	0.384	1.000	1.896	16.000	0.254	0.533	0.650	1.116	0.671	0.0319
E10	0.101	0.243	0.131	0.265	0.523	0.203	0.277	0.202	0.527	1.000	8.437	0.134	0.281	0.343	0.588	0.354	0.0168
E11	0.012	0.029	0.016	0.031	0.062	0.024	0.033	0.024	0.063	0.119	1.000	0.016	0.033	0.041	0.070	0.042	0.0020
E12	0.752	1.811	0.980	1.977	3.906	1.518	2.068	1.511	3.937	7.466	62.990	1.000	2.098	2.560	4.392	2.642	0.1255
E13	0.359	0.863	0.467	0.943	1.862	0.724	0.986	0.720	1.877	3.559	30.027	0.477	1.000	1.220	2.094	1.26	0.0598
E14	0.294	0.707	0.383	0.772	1.526	0.593	0.808	0.590	1.538	2.916	24.604	0.391	0.819	1.000	1.715	1.032	0.0490
E15	0.171	0.412	0.223	0.450	0.889	0.346	0.471	0.344	0.896	1.700	14.343	0.228	0.478	0.583	1.000	0.602	0.0286

DMU	Criteria 3 (O2/I1)																Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Mc	Pi
E01	1.000	0.895	1.203	0.946	1.078	1.194	1.019	1.116	1.786	2.269	7.695	0.821	0.818	2.636	2.085	1.409	0.0828
E02	1.117	1.000	1.344	1.057	1.205	1.334	1.139	1.247	1.996	2.536	8.599	0.918	0.915	2.946	2.330	1.575	0.0925
E03	0.831	0.744	1.000	0.787	0.896	0.993	0.848	0.928	1.485	1.887	6.398	0.683	0.680	2.192	1.734	1.172	0.0688
E04	1.057	0.946	1.271	1.000	1.139	1.262	1.077	1.179	1.888	2.398	8.132	0.868	0.865	2.786	2.204	1.489	0.0875
E05	0.928	0.830	1.116	0.878	1.000	1.108	0.946	1.035	1.657	2.105	7.139	0.762	0.759	2.446	1.935	1.307	0.0768
E06	0.837	0.749	1.007	0.792	0.903	1.000	0.854	0.934	1.496	1.900	6.444	0.688	0.685	2.208	1.746	1.18	0.0693
E07	0.981	0.878	1.180	0.928	1.057	1.171	1.000	1.095	1.752	2.226	7.549	0.806	0.803	2.586	2.046	1.383	0.0812
E08	0.896	0.802	1.078	0.848	0.966	1.070	0.914	1.000	1.601	2.034	6.896	0.736	0.733	2.362	1.869	1.263	0.0742
E09	0.560	0.501	0.673	0.530	0.604	0.669	0.571	0.625	1.000	1.271	4.308	0.460	0.458	1.476	1.168	0.789	0.0464
E10	0.441	0.394	0.530	0.417	0.475	0.526	0.449	0.492	0.787	1.000	3.391	0.362	0.361	1.162	0.919	0.621	0.0365
E11	0.130	0.116	0.156	0.123	0.140	0.155	0.132	0.145	0.232	0.295	1.000	0.107	0.106	0.343	0.271	0.183	0.0108
E12	1.218	1.090	1.464	1.152	1.313	1.454	1.241	1.359	2.175	2.763	9.370	1.000	0.997	3.210	2.539	1.716	0.1008
E13	1.222	1.093	1.470	1.156	1.317	1.459	1.246	1.363	2.182	2.773	9.402	1.003	1.000	3.221	2.548	1.722	0.1012
E14	0.379	0.339	0.456	0.359	0.409	0.453	0.387	0.423	0.677	0.861	2.919	0.312	0.310	1.000	0.791	0.535	0.0314
E15	0.480	0.429	0.577	0.454	0.517	0.573	0.489	0.535	0.857	1.088	3.690	0.394	0.392	1.264	1.000	0.676	0.0397

DMU	Criteria 4 (O2/I2)																Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Mc	Pi
E01	1.000	3.376	1.884	4.809	5.321	3.274	4.217	2.565	20.881	43.176	#####	1.193	2.804	11.366	19.455	6.321	0.2191
E02	0.296	1.000	0.558	1.424	1.576	0.970	1.249	0.760	6.185	12.788	79.120	0.353	0.830	3.366	5.762	1.872	0.0649
E03	0.531	1.792	1.000	2.553	2.825	1.738	2.239	1.362	11.086	22.923	#####	0.633	1.488	6.034	10.329	3.356	0.1163
E04	0.208	0.702	0.392	1.000	1.107	0.681	0.877	0.534	4.342	8.979	55.552	0.248	0.583	2.364	4.046	1.314	0.0456
E05	0.188	0.635	0.354	0.904	1.000	0.615	0.793	0.482	3.924	8.115	50.205	0.224	0.527	2.136	3.656	1.188	0.0412
E06	0.305	1.031	0.575	1.469	1.625	1.000	1.288	0.783	6.377	13.186	81.580	0.364	0.856	3.471	5.941	1.93	0.0669
E07	0.237	0.801	0.447	1.140	1.262	0.776	1.000	0.608	4.951	10.238	63.338	0.283	0.665	2.695	4.613	1.499	0.0519
E08	0.390	1.316	0.734	1.874	2.074	1.276	1.644	1.000	8.139	16.830	#####	0.465	1.093	4.430	7.583	2.464	0.0854
E09	0.048	0.162	0.090	0.230	0.255	0.157	0.202	0.123	1.000	2.068	12.793	0.057	0.134	0.544	0.932	0.303	0.0105
E10	0.023	0.078	0.044	0.111	0.123	0.076	0.098	0.059	0.484	1.000	6.187	0.028	0.065	0.263	0.451	0.146	0.0051
E11	0.004	0.013	0.007	0.018	0.020	0.012	0.016	0.010	0.078	0.162	1.000	0.004	0.010	0.043	0.073	0.024	0.0008
E12	0.838	2.830	1.579	4.031	4.461	2.745	3.536	2.151	17.506	36.197	#####	1.000	2.350	9.528	16.310	5.299	0.1837
E13	0.357	1.204	0.672	1.715	1.898	1.168	1.504	0.915	7.448	15.400	95.278	0.425	1.000	4.054	6.939	2.254	0.0781
E14	0.088	0.297	0.166	0.423	0.468	0.288	0.371	0.226	1.837	3.799	23.503	0.105	0.247	1.000	1.712	0.556	0.0193
E15	0.051	0.174	0.097	0.247	0.273	0.168	0.217	0.132	1.073	2.219	13.731	0.061	0.144	0.584	1.000	0.325	0.0113

DMU	Criteria 5 (O3/I1)																Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Mc	Pi
E01	1.000	0.239	0.391	0.123	0.135	0.355	0.262	0.172	0.042	0.048	0.047	0.418	0.143	0.082	0.088	0.159	0.0074
E02	4.185	1.000	1.637	0.514	0.563	1.484	1.098	0.722	0.174	0.201	0.195	1.750	0.598	0.343	0.370	0.664	0.0310
E03	2.556	0.611	1.000	0.314	0.344	0.907	0.671	0.441	0.107	0.123	0.119	1.069	0.365	0.210	0.226	0.405	0.0190
E04	8.144	1.946	3.186	1.000	1.095	2.888	2.137	1.404	0.339	0.392	0.380	3.405	1.164	0.668	0.720	1.291	0.0604
E05	7.435	1.777	2.908	0.913	1.000	2.637	1.951	1.282	0.310	0.358	0.347	3.108	1.063	0.610	0.658	1.179	0.0551
E06	2.820	0.674	1.103	0.346	0.379	1.000	0.740	0.486	0.118	0.136	0.132	1.179	0.403	0.231	0.249	0.447	0.0209
E07	3.812	0.911	1.491	0.468	0.513	1.352	1.000	0.657	0.159	0.183	0.178	1.594	0.545	0.313	0.337	0.604	0.0283
E08	5.799	1.386	2.268	0.712	0.780	2.056	1.521	1.000	0.242	0.279	0.270	2.424	0.829	0.476	0.513	0.919	0.0430
E09	23.995	5.734	9.386	2.946	3.227	8.509	6.295	4.138	1.000	1.155	1.119	10.032	3.430	1.968	2.123	3.804	0.1779
E10	20.774	4.964	8.126	2.551	2.794	7.367	5.450	3.583	0.866	1.000	0.969	8.686	2.970	1.704	1.838	3.294	0.1541
E11	21.443	5.124	8.388	2.633	2.884	7.604	5.626	3.698	0.894	1.032	1.000	8.965	3.066	1.759	1.897	3.4	0.1590
E12	2.392	0.572	0.936	0.294	0.322	0.848	0.628	0.412	0.100	0.115	0.112	1.000	0.342	0.196	0.212	0.379	0.0177
E13	6.995	1.671	2.736	0.859	0.941	2.481	1.835	1.206	0.292	0.337	0.326	2.924	1.000	0.574	0.619	1.109	0.0519
E14	12.192	2.913	4.769	1.497	1.640	4.324	3.199	2.103	0.508	0.587	0.569	5.098	1.743	1.000	1.079	1.933	0.0904
E15	11.304	2.701	4.422	1.388	1.520	4.009	2.966	1.949	0.471	0.544	0.527	4.726	1.616	0.927	1.000	1.792	0.0838

DMU	Criteria 6 (O3/I2)																Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Mc	Pi
E01	1.000	0.902	0.613	0.624	0.664	0.972	1.085	0.396	0.487	0.916	1.619	0.607	0.490	0.354	0.825	0.711	0.0438
E02	1.109	1.000	0.680	0.692	0.736	1.079	1.204	0.440	0.540	1.016	1.796	0.674	0.543	0.392	0.915	0.789	0.0486
E03	1.632	1.472	1.000	1.019	1.084	1.587	1.772	0.647	0.795	1.495	2.643	0.991	0.799	0.577	1.347	1.161	0.0716
E04	1.603	1.445	0.982	1.000	1.064	1.558	1.740	0.635	0.781	1.468	2.594	0.973	0.785	0.567	1.323	1.139	0.0702
E05	1.506	1.358	0.923	0.940	1.000	1.465	1.635	0.597	0.734	1.380	2.439	0.915	0.738	0.533	1.243	1.071	0.0660
E06	1.028	0.927	0.630	0.642	0.683	1.000	1.116	0.408	0.501	0.942	1.665	0.624	0.504	0.364	0.849	0.731	0.0451
E07	0.921	0.831	0.564	0.575	0.612	0.896	1.000	0.365	0.449	0.844	1.491	0.559	0.451	0.326	0.760	0.655	0.0404
E08	2.522	2.274	1.545	1.574	1.675	2.453	2.738	1.000	1.229	2.310	4.083	1.532	1.235	0.892	2.082	1.793	0.1106
E09	2.052	1.850	1.257	1.281	1.363	1.996	2.228	0.814	1.000	1.880	3.323	1.246	1.005	0.726	1.694	1.459	0.0900
E10	1.092	0.984	0.669	0.681	0.725	1.062	1.185	0.433	0.532	1.000	1.768	0.663	0.535	0.386	0.901	0.776	0.0479
E11	0.618	0.557	0.378	0.385	0.410	0.601	0.670	0.245	0.301	0.566	1.000	0.375	0.303	0.218	0.510	0.439	0.0271
E12	1.647	1.485	1.009	1.028	1.093	1.601	1.788	0.653	0.802	1.508	2.666	1.000	0.807	0.582	1.359	1.171	0.0722
E13	2.042	1.841	1.251	1.274	1.356	1.985	2.216	0.810	0.995	1.870	3.306	1.240	1.000	0.722	1.685	1.452	0.0895
E14	2.828	2.550	1.733	1.765	1.878	2.750	3.070	1.121	1.378	2.590	4.578	1.717	1.385	1.000	2.334	2.011	0.1240
E15	1.212	1.092	0.742	0.756	0.804	1.178	1.315	0.480	0.590	1.110	1.962	0.736	0.593	0.428	1.000	0.862	0.0531

DMU	Criteria 7 (O4/I1)																Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Mc	Pi
E01	1.000	0.238	0.375	0.122	0.163	0.330	0.307	0.145	0.047	0.040	0.036	0.337	0.146	0.082	0.088	0.154	0.0070
E02	4.206	1.000	1.576	0.514	0.687	1.387	1.292	0.611	0.200	0.167	0.150	1.417	0.615	0.346	0.370	0.646	0.0294
E03	2.669	0.635	1.000	0.326	0.436	0.880	0.820	0.388	0.127	0.106	0.095	0.899	0.391	0.220	0.235	0.41	0.0187
E04	8.184	1.946	3.066	1.000	1.337	2.698	2.514	1.190	0.388	0.326	0.292	2.757	1.198	0.674	0.720	1.258	0.0573
E05	6.123	1.456	2.294	0.748	1.000	2.018	1.880	0.890	0.291	0.244	0.219	2.062	0.896	0.504	0.539	0.941	0.0429
E06	3.033	0.721	1.136	0.371	0.495	1.000	0.932	0.441	0.144	0.121	0.108	1.022	0.444	0.250	0.267	0.466	0.0212
E07	3.256	0.774	1.220	0.398	0.532	1.073	1.000	0.473	0.155	0.130	0.116	1.097	0.476	0.268	0.287	0.5	0.0228
E08	6.880	1.636	2.578	0.841	1.124	2.268	2.113	1.000	0.327	0.274	0.246	2.317	1.007	0.566	0.606	1.057	0.0482
E09	21.067	5.009	7.893	2.574	3.441	6.945	6.470	3.062	1.000	0.838	0.753	7.096	3.083	1.734	1.854	3.238	0.1475
E10	25.140	5.977	9.419	3.072	4.106	8.288	7.721	3.654	1.193	1.000	0.898	8.469	3.679	2.069	2.213	3.864	0.1760
E11	27.985	6.654	10.485	3.419	4.571	9.226	8.595	4.068	1.328	1.113	1.000	9.427	4.095	2.303	2.463	4.301	0.1959
E12	2.969	0.706	1.112	0.363	0.485	0.979	0.912	0.432	0.141	0.118	0.106	1.000	0.434	0.244	0.261	0.456	0.0208
E13	6.834	1.625	2.561	0.835	1.116	2.253	2.099	0.993	0.324	0.272	0.244	2.302	1.000	0.562	0.602	1.05	0.0478
E14	12.151	2.889	4.553	1.485	1.985	4.006	3.732	1.766	0.577	0.483	0.434	4.093	1.778	1.000	1.070	1.867	0.0851
E15	11.360	2.701	4.256	1.388	1.855	3.745	3.489	1.651	0.539	0.452	0.406	3.827	1.662	0.935	1.000	1.746	0.0795

DMU	Criteria 8 (O4/I2)																Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Mc	Pi
E01	1.000	0.897	0.587	0.621	0.806	0.904	1.271	0.334	0.555	0.757	1.240	0.489	0.501	0.355	0.821	0.689	0.0424
E02	1.115	1.000	0.654	0.692	0.899	1.008	1.416	0.373	0.619	0.844	1.383	0.545	0.559	0.396	0.915	0.768	0.0473
E03	1.704	1.529	1.000	1.058	1.374	1.541	2.166	0.570	0.946	1.290	2.114	0.834	0.854	0.605	1.400	1.175	0.0723
E04	1.611	1.445	0.945	1.000	1.298	1.456	2.047	0.538	0.894	1.219	1.998	0.788	0.807	0.571	1.323	1.11	0.0684
E05	1.240	1.113	0.728	0.770	1.000	1.121	1.576	0.415	0.688	0.939	1.539	0.607	0.622	0.440	1.019	0.855	0.0526
E06	1.106	0.992	0.649	0.687	0.892	1.000	1.406	0.370	0.614	0.837	1.372	0.541	0.555	0.392	0.909	0.762	0.0470
E07	0.787	0.706	0.462	0.489	0.634	0.711	1.000	0.263	0.437	0.596	0.976	0.385	0.394	0.279	0.646	0.542	0.0334
E08	2.992	2.684	1.756	1.858	2.412	2.705	3.802	1.000	1.661	2.265	3.712	1.464	1.500	1.062	2.458	2.063	0.1270
E09	1.802	1.616	1.057	1.119	1.453	1.629	2.290	0.602	1.000	1.364	2.235	0.882	0.903	0.639	1.480	1.242	0.0765
E10	1.321	1.185	0.775	0.820	1.065	1.194	1.679	0.442	0.733	1.000	1.639	0.646	0.662	0.469	1.085	0.911	0.0561
E11	0.806	0.723	0.473	0.501	0.650	0.729	1.024	0.269	0.447	0.610	1.000	0.394	0.404	0.286	0.662	0.556	0.0342
E12	2.044	1.834	1.199	1.269	1.648	1.848	2.597	0.683	1.134	1.547	2.536	1.000	1.025	0.725	1.679	1.409	0.0868
E13	1.995	1.790	1.171	1.239	1.608	1.803	2.535	0.667	1.107	1.510	2.475	0.976	1.000	0.708	1.638	1.375	0.0847
E14	2.818	2.528	1.654	1.750	2.272	2.548	3.581	0.942	1.564	2.133	3.496	1.379	1.413	1.000	2.315	1.943	0.1196
E15	1.218	1.092	0.714	0.756	0.982	1.101	1.547	0.407	0.676	0.922	1.510	0.596	0.610	0.432	1.000	0.839	0.0517

Synthesize the results to determine the best alternative. Obtain the final results										
wieght	0.021	0.001	0.117	0.004	7.829	0.297	9.000	0.341	Score	Rank
	O1/I1	O1/I2	O2/I1	O2/I2	O3/I1	O3/I2	O4/I1	O4/I2		
E01	0.0490	0.1669	0.0828	0.2191	0.0074	0.0438	0.0070	0.0424	0.16	15
E02	0.0768	0.0693	0.0925	0.0649	0.0310	0.0486	0.0294	0.0473	0.55	10
E03	0.0589	0.1281	0.0688	0.1163	0.0190	0.0716	0.0187	0.0723	0.37	14
E04	0.0947	0.0635	0.0875	0.0456	0.0604	0.0702	0.0573	0.0684	1.05	6
E05	0.0466	0.0321	0.0768	0.0412	0.0551	0.0660	0.0429	0.0526	0.87	8
E06	0.0666	0.0827	0.0693	0.0669	0.0209	0.0451	0.0212	0.0470	0.39	12
E07	0.0737	0.0607	0.0812	0.0519	0.0283	0.0404	0.0228	0.0334	0.46	11
E08	0.0561	0.0831	0.0742	0.0854	0.0430	0.1106	0.0482	0.1270	0.86	9
E09	0.1094	0.0319	0.0464	0.0105	0.1779	0.0900	0.1475	0.0765	2.78	3
E10	0.0939	0.0168	0.0365	0.0051	0.1541	0.0479	0.1760	0.0561	2.83	2
E11	0.0203	0.0020	0.0108	0.0008	0.1590	0.0271	0.1959	0.0342	3.03	1
E12	0.0535	0.1255	0.1008	0.1837	0.0177	0.0722	0.0208	0.0868	0.39	13
E13	0.0602	0.0598	0.1012	0.0781	0.0519	0.0895	0.0478	0.0847	0.91	7
E14	0.0621	0.0490	0.0314	0.0193	0.0904	0.1240	0.0851	0.1196	1.56	4
E15	0.0783	0.0286	0.0397	0.0113	0.0838	0.0531	0.0795	0.0517	1.41	5

4. Ranking of companies under Sector 4

	The evaluation criteria											
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8	Criteria 9	Criteria 10	Criteria 11	Criteria 12
DMU	O1/I1	O1/I2	O1/I3	O1/I4	O2/I1	O2/I2	O2/I3	O2/I4	O3/I1	O3/I2	O3/I3	O3/I4
E01	0.385	0.314	0.587	0.428	1.258	1.026	1.916	1.397	0.355	0.289	0.540	0.394
E02	0.507	0.351	0.789	0.401	2.028	1.403	3.155	1.604	0.075	0.052	0.117	0.059
E03	0.340	0.261	0.512	0.345	1.649	1.266	2.486	1.676	0.531	0.408	0.801	0.540
E04	0.068	0.077	0.098	0.236	0.953	1.070	1.362	3.290	0.078	0.088	0.112	0.271
E05	0.901	0.393	1.441	0.547	2.827	1.234	4.521	1.716	0.000	0.000	0.000	0.000
E06	0.547	0.428	0.965	0.353	1.322	1.034	2.333	0.853	0.000	0.000	0.000	0.000
E07	0.352	0.526	0.496	0.439	1.023	1.526	1.441	1.274	3.290	4.909	4.633	4.096
E08	0.625	0.509	0.648	0.364	1.039	0.846	1.077	0.605	0.086	0.070	0.089	0.050
E09	0.733	0.455	1.377	0.526	1.285	0.798	2.412	0.922	20.220	12.555	37.958	14.503
E10	0.751	0.183	2.040	0.085	4.649	1.135	12.628	0.529	0.000	0.000	0.000	0.000
E11	0.914	0.237	1.819	0.174	4.729	1.225	9.414	0.900	0.000	0.000	0.000	0.000
E12	0.076	0.042	0.124	0.032	1.868	1.022	3.037	0.782	0.332	0.182	0.540	0.139
E13	0.136	0.111	0.072	0.067	1.299	1.057	0.693	0.644	0.579	0.471	0.309	0.287
E14	0.222	0.240	0.301	0.480	0.914	0.984	1.237	1.973	0.000	0.000	0.000	0.000
E15	2.097	1.341	0.544	10.237	1.740	1.113	0.451	8.495	0.000	0.000	0.000	0.000
E16	0.784	3.606	0.823	1.208	0.288	1.326	0.303	0.444	61.347	281.987	64.338	94.472
E17	1.300	0.242	0.788	5.696	5.292	0.987	3.205	23.180	22.827	4.257	13.826	99.990

Weights of inputs and outputs of all DMUs							
	v1	v2	v3	v4	μ1	μ2	μ3
E01	0.0000	0.0077	0.0027	0.0040	0.0048	0.0076	0.0000
E02	0.0009	0.0075	0.0000	0.0000	0.0000	0.0057	0.0000
E03	0.0000	0.0068	0.0003	0.0035	0.0000	0.0071	0.0000
E04	0.0000	0.0045	0.0002	0.0024	0.0000	0.0048	0.0000
E05	0.0040	0.0061	0.0000	0.0010	0.0000	0.0069	0.0000
E06	0.0000	0.0077	0.0042	0.0000	0.0052	0.0055	0.0000
E07	0.0013	0.0101	0.0000	0.0000	0.0000	0.0079	0.0000
E08	0.0058	0.0018	0.0061	0.0000	0.0153	0.0000	0.0000
E09	0.0000	0.0000	0.0227	0.0029	0.0068	0.0043	0.0003
E10	0.0000	0.0078	0.0186	0.0000	0.0000	0.0083	0.0000
E11	0.0044	0.0067	0.0000	0.0011	0.0000	0.0076	0.0000
E12	0.0000	0.0065	0.0032	0.0000	0.0000	0.0056	0.0000
E13	0.0010	0.0087	0.0000	0.0000	0.0000	0.0067	0.0000
E14	0.0000	0.0041	0.0002	0.0021	0.0000	0.0043	0.0000
E15	0.0027	0.0009	0.0028	0.0000	0.0072	0.0000	0.0000
E16	0.019372	0	0	0	0	0	0.000316
E17	0.0028	0.0046	0.0000	0.0006	0.0000	0.0051	0.0000
Average weights	0.0025	0.0054	0.0036	0.0010	0.0023	0.0051	0.0000

The weights of the criteria												
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8	Criteria 9	Criteria 10	Criteria 11	Criteria 12
M	0.928	0.429	0.645	2.229	2.070	0.957	1.438	4.969	0.017	0.008	0.012	0.040
Normalized	1.682	0.778	1.168	4.037	3.749	1.733	2.605	9.000	3.749	1.733	2.605	9.000

Pairwise Comparisons

DMU	Criteria 1 (O1/I1)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.760	1.135	5.634	0.428	0.705	1.094	0.617	0.526	0.513	0.422	5.043	2.836	1.733	0.184	0.491	0.296	0.8586	0.0359
E02	1.316	1.000	1.494	7.413	0.563	0.928	1.440	0.812	0.692	0.675	0.555	6.635	3.732	2.281	0.242	0.647	0.390	1.1297	0.0472
E03	0.881	0.670	1.000	4.963	0.377	0.621	0.964	0.544	0.463	0.452	0.372	4.442	2.499	1.527	0.162	0.433	0.261	0.7564	0.0316
E04	0.177	0.135	0.201	1.000	0.076	0.125	0.194	0.110	0.093	0.091	0.075	0.895	0.503	0.308	0.033	0.087	0.053	0.1524	0.0064
E05	2.337	1.776	2.653	13.167	1.000	1.648	2.558	1.442	1.229	1.200	0.986	11.785	6.628	4.051	0.430	1.149	0.693	2.0066	0.0839
E06	1.418	1.078	1.610	7.988	0.607	1.000	1.552	0.875	0.745	0.728	0.598	7.150	4.021	2.458	0.261	0.697	0.420	1.2174	0.0509
E07	0.914	0.694	1.037	5.148	0.391	0.644	1.000	0.564	0.480	0.469	0.385	4.607	2.591	1.584	0.168	0.449	0.271	0.7845	0.0328
E08	1.620	1.231	1.839	9.129	0.693	1.143	1.773	1.000	0.852	0.832	0.683	8.171	4.596	2.809	0.298	0.796	0.480	1.3912	0.0582
E09	1.902	1.446	2.159	10.717	0.814	1.342	2.082	1.174	1.000	0.976	0.802	9.593	5.395	3.297	0.350	0.935	0.564	1.6333	0.0683
E10	1.948	1.481	2.212	10.977	0.834	1.374	2.132	1.202	1.024	1.000	0.822	9.825	5.526	3.377	0.358	0.958	0.578	1.6728	0.0699
E11	2.371	1.802	2.691	13.356	1.014	1.672	2.595	1.463	1.246	1.217	1.000	11.955	6.724	4.109	0.436	1.165	0.703	2.0354	0.0851
E12	0.198	0.151	0.225	1.117	0.085	0.140	0.217	0.122	0.104	0.102	0.084	1.000	0.562	0.344	0.036	0.097	0.059	0.1703	0.0071
E13	0.353	0.268	0.400	1.986	0.151	0.249	0.386	0.218	0.185	0.181	0.149	1.778	1.000	0.611	0.065	0.173	0.105	0.3027	0.0127
E14	0.577	0.438	0.655	3.250	0.247	0.407	0.631	0.356	0.303	0.296	0.243	2.909	1.636	1.000	0.106	0.284	0.171	0.4953	0.0207
E15	5.439	4.133	6.174	30.641	2.327	3.836	5.953	3.357	2.859	2.792	2.294	27.426	15.426	9.428	1.000	2.673	1.612	4.6697	0.1952
E16	2.035	1.546	2.310	11.464	0.871	1.435	2.227	1.256	1.070	1.044	0.858	10.261	5.771	3.527	0.374	1.000	0.603	1.7470	0.0730
E17	3.373	2.564	3.829	19.005	1.443	2.379	3.692	2.082	1.773	1.731	1.423	17.011	9.568	5.847	0.620	1.658	1.000	2.8963	0.1211

DMU	Criteria 2 (O1/I2)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.896	1.206	4.094	0.800	0.735	0.598	0.618	0.690	1.714	1.328	7.518	2.843	1.312	0.234	0.087	1.296	1.0069	0.0338
E02	1.116	1.000	1.346	4.570	0.893	0.821	0.668	0.690	0.771	1.914	1.483	8.393	3.174	1.465	0.262	0.097	1.447	1.1240	0.0377
E03	0.829	0.743	1.000	3.395	0.663	0.610	0.496	0.513	0.572	1.422	1.101	6.234	2.358	1.088	0.194	0.072	1.075	0.8349	0.0280
E04	0.244	0.219	0.295	1.000	0.195	0.180	0.146	0.151	0.169	0.419	0.324	1.836	0.694	0.321	0.057	0.021	0.317	0.2459	0.0082
E05	1.251	1.120	1.508	5.120	1.000	0.920	0.748	0.773	0.863	2.144	1.661	9.402	3.556	1.641	0.293	0.109	1.621	1.2592	0.0422
E06	1.360	1.218	1.640	5.568	1.088	1.000	0.814	0.841	0.939	2.332	1.806	10.226	3.867	1.785	0.319	0.119	1.763	1.3694	0.0459
E07	1.672	1.498	2.016	6.845	1.337	1.229	1.000	1.034	1.154	2.866	2.220	12.570	4.754	2.194	0.392	0.146	2.167	1.6834	0.0564
E08	1.617	1.449	1.951	6.622	1.293	1.189	0.967	1.000	1.117	2.773	2.148	12.161	4.599	2.123	0.379	0.141	2.097	1.6286	0.0546
E09	1.448	1.297	1.747	5.930	1.158	1.065	0.866	0.895	1.000	2.483	1.924	10.890	4.118	1.901	0.339	0.126	1.878	1.4584	0.0489
E10	0.583	0.522	0.703	2.388	0.466	0.429	0.349	0.361	0.403	1.000	0.775	4.385	1.658	0.766	0.137	0.051	0.756	0.5873	0.0197
E11	0.753	0.674	0.908	3.083	0.602	0.554	0.450	0.465	0.520	1.291	1.000	5.661	2.141	0.988	0.176	0.066	0.976	0.7581	0.0254
E12	0.133	0.119	0.160	0.545	0.106	0.098	0.080	0.082	0.092	0.228	0.177	1.000	0.378	0.175	0.031	0.012	0.172	0.1339	0.0045
E13	0.352	0.315	0.424	1.440	0.281	0.259	0.210	0.217	0.243	0.603	0.467	2.644	1.000	0.462	0.082	0.031	0.456	0.3541	0.0119
E14	0.762	0.683	0.919	3.119	0.609	0.560	0.456	0.471	0.526	1.306	1.012	5.729	2.166	1.000	0.179	0.066	0.988	0.7672	0.0257
E15	4.267	3.822	5.146	17.468	3.412	3.137	2.552	2.638	2.946	7.315	5.667	32.078	12.131	5.600	1.000	0.372	5.531	4.2960	0.1440
E16	####	10.274	13.831	46.954	9.171	8.432	6.860	7.090	7.918	19.663	15.232	86.227	32.609	15.052	2.688	1.000	14.868	11.5477	0.3871
E17	0.771	0.691	0.930	3.158	0.617	0.567	0.461	0.477	0.533	1.322	1.024	5.799	2.193	1.012	0.181	0.067	1.000	0.7767	0.0260

DMU	Criteria 3 (O1/I3)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.744	1.147	6.005	0.407	0.608	1.183	0.906	0.426	0.288	0.323	4.724	8.099	1.950	1.080	0.713	0.745	1.0503	0.0437
E02	1.345	1.000	1.542	8.075	0.548	0.818	1.591	1.218	0.573	0.387	0.434	6.352	10.892	2.622	1.452	0.959	1.002	1.4124	0.0588
E03	0.872	0.649	1.000	5.237	0.355	0.531	1.032	0.790	0.372	0.251	0.281	4.119	7.063	1.700	0.942	0.622	0.650	0.9160	0.0381
E04	0.167	0.124	0.191	1.000	0.068	0.101	0.197	0.151	0.071	0.048	0.054	0.787	1.349	0.325	0.180	0.119	0.124	0.1749	0.0073
E05	2.455	1.825	2.815	14.739	1.000	1.493	2.904	2.223	1.046	0.706	0.792	11.595	19.881	4.786	2.650	1.751	1.829	2.5781	0.1073
E06	1.644	1.222	1.885	9.871	0.670	1.000	1.945	1.489	0.701	0.473	0.530	7.765	13.314	3.205	1.775	1.173	1.225	1.7265	0.0719
E07	0.845	0.629	0.969	5.075	0.344	0.514	1.000	0.766	0.360	0.243	0.273	3.993	6.846	1.648	0.913	0.603	0.630	0.8877	0.0370
E08	1.104	0.821	1.266	6.629	0.450	0.672	1.306	1.000	0.471	0.318	0.356	5.215	8.942	2.152	1.192	0.788	0.823	1.1595	0.0483
E09	2.346	1.744	2.690	14.085	0.956	1.427	2.775	2.125	1.000	0.675	0.757	11.080	18.999	4.573	2.533	1.673	1.748	2.4637	0.1026
E10	3.476	2.585	3.986	20.872	1.416	2.115	4.112	3.148	1.482	1.000	1.121	16.419	28.152	6.777	3.753	2.480	2.590	3.6508	0.1520
E11	3.100	2.305	3.555	18.614	1.263	1.886	3.668	2.808	1.322	0.892	1.000	14.643	25.107	6.044	3.347	2.212	2.310	3.2558	0.1355
E12	0.212	0.157	0.243	1.271	0.086	0.129	0.250	0.192	0.090	0.061	0.068	1.000	1.715	0.413	0.229	0.151	0.158	0.2224	0.0093
E13	0.123	0.092	0.142	0.741	0.050	0.075	0.146	0.112	0.053	0.036	0.040	0.583	1.000	0.241	0.133	0.088	0.092	0.1297	0.0054
E14	0.513	0.381	0.588	3.080	0.209	0.312	0.607	0.465	0.219	0.148	0.165	2.423	4.154	1.000	0.554	0.366	0.382	0.5387	0.0224
E15	0.926	0.689	1.062	5.561	0.377	0.563	1.096	0.839	0.395	0.266	0.299	4.375	7.501	1.806	1.000	0.661	0.690	0.9727	0.0405
E16	1.402	1.042	1.607	8.417	0.571	0.853	1.658	1.270	0.598	0.403	0.452	6.621	11.353	2.733	1.513	1.000	1.044	1.4722	0.0613
E17	1.342	0.998	1.539	8.059	0.547	0.816	1.588	1.216	0.572	0.386	0.433	6.339	10.870	2.617	1.449	0.957	1.000	1.4096	0.0587

DMU	Criteria 4 (O1/I4)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	1.067	1.240	1.812	0.783	1.214	0.976	1.175	0.814	5.012	2.460	13.376	6.351	0.891	0.042	0.354	0.075	1.0477	0.0198
E02	0.937	1.000	1.163	1.699	0.734	1.138	0.915	1.102	0.763	4.698	2.306	12.539	5.953	0.835	0.039	0.332	0.070	0.9821	0.0186
E03	0.806	0.860	1.000	1.461	0.631	0.979	0.787	0.948	0.656	4.041	1.984	10.786	5.121	0.719	0.034	0.286	0.061	0.8448	0.0160
E04	0.552	0.589	0.684	1.000	0.432	0.670	0.539	0.649	0.449	2.766	1.358	7.382	3.505	0.492	0.023	0.196	0.041	0.5782	0.0109
E05	1.278	1.363	1.585	2.315	1.000	1.551	1.247	1.502	1.039	6.403	3.143	17.090	8.114	1.139	0.053	0.453	0.096	1.3385	0.0253
E06	0.824	0.879	1.022	1.493	0.645	1.000	0.804	0.968	0.670	4.129	2.027	11.019	5.232	0.734	0.034	0.292	0.062	0.8631	0.0163
E07	1.025	1.093	1.271	1.857	0.802	1.244	1.000	1.205	0.834	5.136	2.521	13.708	6.508	0.913	0.043	0.363	0.077	1.0737	0.0203
E08	0.851	0.908	1.055	1.541	0.666	1.033	0.830	1.000	0.692	4.264	2.093	11.380	5.403	0.758	0.036	0.301	0.064	0.8913	0.0168
E09	1.229	1.311	1.524	2.227	0.962	1.492	1.199	1.445	1.000	6.160	3.024	16.441	7.806	1.095	0.051	0.435	0.092	1.2877	0.0243
E10	0.200	0.213	0.247	0.362	0.156	0.242	0.195	0.235	0.162	1.000	0.491	2.669	1.267	0.178	0.008	0.071	0.015	0.2090	0.0039
E11	0.406	0.434	0.504	0.736	0.318	0.493	0.397	0.478	0.331	2.037	1.000	5.437	2.581	0.362	0.017	0.144	0.031	0.4258	0.0080
E12	0.075	0.080	0.093	0.135	0.059	0.091	0.073	0.088	0.061	0.375	0.184	1.000	0.475	0.067	0.003	0.026	0.006	0.0783	0.0015
E13	0.157	0.168	0.195	0.285	0.123	0.191	0.154	0.185	0.128	0.789	0.387	2.106	1.000	0.140	0.007	0.056	0.012	0.1650	0.0031
E14	1.122	1.197	1.392	2.033	0.878	1.362	1.095	1.319	0.913	5.624	2.761	15.010	7.126	1.000	0.047	0.398	0.084	1.1756	0.0222
E15	####	25.519	29.669	43.347	18.724	29.040	####	28.120	19.463	119.893	58.856	319.996	####	21.319	1.000	8.475	1.797	25.0631	0.4735
E16	2.823	3.011	3.501	5.115	2.209	3.426	2.754	3.318	2.296	14.147	6.945	37.757	17.926	2.516	0.118	1.000	0.212	2.9573	0.0559
E17	####	14.199	16.508	24.119	10.418	16.158	####	15.647	10.829	66.711	32.748	178.051	84.534	11.862	0.556	4.716	1.000	13.9455	0.2635

DMU	Criteria 5 (O2/I1)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.621	0.763	1.320	0.445	0.952	1.230	1.212	0.979	0.271	0.266	0.673	0.968	1.377	0.723	4.362	0.238	0.7914	0.0368
E02	1.611	1.000	1.229	2.127	0.717	1.534	1.982	1.952	1.578	0.436	0.429	1.085	1.561	2.219	1.165	7.029	0.383	1.2753	0.0593
E03	1.311	0.813	1.000	1.730	0.583	1.248	1.612	1.588	1.284	0.355	0.349	0.883	1.269	1.805	0.948	5.718	0.312	1.0374	0.0483
E04	0.758	0.470	0.578	1.000	0.337	0.721	0.932	0.918	0.742	0.205	0.202	0.510	0.734	1.043	0.548	3.305	0.180	0.5995	0.0279
E05	2.247	1.394	1.714	2.966	1.000	2.139	2.764	2.722	2.200	0.608	0.598	1.513	2.176	3.094	1.625	9.802	0.534	1.7783	0.0828
E06	1.051	0.652	0.802	1.387	0.468	1.000	1.292	1.273	1.029	0.284	0.280	0.708	1.018	1.447	0.760	4.583	0.250	0.8315	0.0387
E07	0.813	0.504	0.620	1.073	0.362	0.774	1.000	0.985	0.796	0.220	0.216	0.547	0.787	1.119	0.588	3.546	0.193	0.6434	0.0299
E08	0.825	0.512	0.630	1.090	0.367	0.786	1.015	1.000	0.808	0.223	0.220	0.556	0.799	1.137	0.597	3.601	0.196	0.6532	0.0304
E09	1.021	0.634	0.779	1.348	0.454	0.972	1.256	1.237	1.000	0.276	0.272	0.688	0.989	1.406	0.739	4.454	0.243	0.8082	0.0376
E10	3.695	2.293	2.819	4.877	1.644	3.517	4.545	4.476	3.618	1.000	0.983	2.488	3.578	5.088	2.672	16.118	0.879	2.9242	0.1361
E11	3.758	2.332	2.867	4.961	1.672	3.577	4.623	4.553	3.680	1.017	1.000	2.531	3.639	5.175	2.718	16.393	0.894	2.9742	0.1384
E12	1.485	0.921	1.133	1.960	0.661	1.413	1.827	1.799	1.454	0.402	0.395	1.000	1.438	2.045	1.074	6.477	0.353	1.1752	0.0547
E13	1.033	0.641	0.788	1.363	0.460	0.983	1.270	1.251	1.011	0.279	0.275	0.695	1.000	1.422	0.747	4.504	0.246	0.8172	0.0380
E14	0.726	0.451	0.554	0.959	0.323	0.691	0.893	0.880	0.711	0.197	0.193	0.489	0.703	1.000	0.525	3.168	0.173	0.5747	0.0267
E15	1.383	0.858	1.055	1.825	0.615	1.316	1.701	1.675	1.354	0.374	0.368	0.931	1.339	1.904	1.000	6.032	0.329	1.0943	0.0509
E16	0.229	0.142	0.175	0.303	0.102	0.218	0.282	0.278	0.224	0.062	0.061	0.154	0.222	0.316	0.166	1.000	0.055	0.1814	0.0084
E17	4.205	2.610	3.208	5.551	1.872	4.003	5.173	5.095	4.118	1.138	1.119	2.832	4.073	5.791	3.042	18.345	1.000	3.3283	0.1549

DMU	Criteria 6 (O2/I2)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.731	0.811	0.959	0.832	0.992	0.672	1.214	1.286	0.904	0.838	1.004	0.971	1.043	0.922	0.774	1.040	0.9281	0.0539
E02	1.367	1.000	1.108	1.311	1.137	1.356	0.919	1.659	1.758	1.236	1.145	1.373	1.327	1.425	1.260	1.058	1.422	1.2688	0.0736
E03	1.234	0.902	1.000	1.183	1.026	1.224	0.829	1.497	1.587	1.115	1.034	1.239	1.198	1.286	1.137	0.955	1.283	1.1451	0.0665
E04	1.042	0.763	0.845	1.000	0.867	1.034	0.701	1.265	1.341	0.942	0.873	1.047	1.012	1.087	0.961	0.807	1.084	0.9675	0.0562
E05	1.202	0.880	0.975	1.153	1.000	1.193	0.808	1.459	1.547	1.087	1.007	1.207	1.167	1.254	1.109	0.931	1.250	1.1159	0.0648
E06	1.008	0.737	0.817	0.967	0.838	1.000	0.678	1.223	1.296	0.911	0.844	1.012	0.978	1.051	0.929	0.780	1.048	0.9354	0.0543
E07	1.487	1.088	1.206	1.427	1.237	1.476	1.000	1.805	1.913	1.345	1.246	1.494	1.444	1.551	1.371	1.151	1.547	1.3806	0.0801
E08	0.824	0.603	0.668	0.790	0.685	0.818	0.554	1.000	1.060	0.745	0.690	0.827	0.800	0.859	0.760	0.638	0.857	0.7647	0.0444
E09	0.777	0.569	0.630	0.746	0.647	0.771	0.523	0.944	1.000	0.703	0.651	0.781	0.755	0.811	0.717	0.602	0.808	0.7216	0.0419
E10	1.106	0.809	0.897	1.061	0.920	1.098	0.744	1.342	1.423	1.000	0.927	1.111	1.074	1.153	1.020	0.856	1.150	1.0266	0.0596
E11	1.194	0.873	0.967	1.145	0.993	1.184	0.802	1.449	1.535	1.079	1.000	1.198	1.159	1.245	1.100	0.924	1.241	1.1078	0.0643
E12	0.996	0.728	0.807	0.955	0.828	0.988	0.670	1.209	1.281	0.900	0.834	1.000	0.967	1.038	0.918	0.771	1.036	0.9243	0.0536
E13	1.030	0.753	0.835	0.988	0.857	1.022	0.692	1.250	1.325	0.931	0.863	1.034	1.000	1.074	0.950	0.797	1.071	0.9560	0.0555
E14	0.959	0.702	0.777	0.920	0.798	0.952	0.645	1.164	1.234	0.867	0.804	0.963	0.931	1.000	0.884	0.742	0.997	0.8901	0.0517
E15	1.085	0.793	0.879	1.040	0.902	1.076	0.729	1.316	1.395	0.981	0.909	1.089	1.053	1.131	1.000	0.839	1.128	1.0067	0.0584
E16	1.292	0.945	1.047	1.239	1.075	1.282	0.869	1.568	1.662	1.168	1.083	1.297	1.254	1.347	1.191	1.000	1.344	1.1992	0.0696
E17	0.962	0.703	0.779	0.922	0.800	0.954	0.646	1.167	1.237	0.869	0.806	0.966	0.934	1.003	0.887	0.744	1.000	0.8925	0.0518

DMU	Criteria 7 (O2/I3)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.607	0.771	1.407	0.424	0.821	1.330	1.778	0.794	0.152	0.204	0.631	2.766	1.549	4.247	6.333	0.598	0.9682	0.0371
E02	1.647	1.000	1.269	2.317	0.698	1.352	2.190	2.928	1.308	0.250	0.335	1.039	4.555	2.551	6.995	10.429	0.984	1.5944	0.0611
E03	1.298	0.788	1.000	1.826	0.550	1.065	1.725	2.307	1.031	0.197	0.264	0.819	3.589	2.010	5.511	8.217	0.776	1.2562	0.0481
E04	0.711	0.432	0.548	1.000	0.301	0.584	0.945	1.264	0.564	0.108	0.145	0.448	1.966	1.101	3.019	4.501	0.425	0.6881	0.0264
E05	2.360	1.433	1.819	3.320	1.000	1.937	3.138	4.197	1.874	0.358	0.480	1.489	6.527	3.655	10.023	14.945	1.411	2.2848	0.0875
E06	1.218	0.740	0.939	1.714	0.516	1.000	1.620	2.166	0.967	0.185	0.248	0.768	3.369	1.887	5.173	7.713	0.728	1.1793	0.0452
E07	0.752	0.457	0.580	1.058	0.319	0.617	1.000	1.337	0.597	0.114	0.153	0.474	2.080	1.165	3.194	4.762	0.449	0.7281	0.0279
E08	0.562	0.341	0.433	0.791	0.238	0.462	0.748	1.000	0.447	0.085	0.114	0.355	1.555	0.871	2.388	3.561	0.336	0.5445	0.0209
E09	1.259	0.765	0.970	1.772	0.534	1.034	1.674	2.239	1.000	0.191	0.256	0.794	3.482	1.950	5.348	7.973	0.753	1.2190	0.0467
E10	6.592	4.003	5.080	9.274	2.793	5.412	8.765	11.721	5.235	1.000	1.341	4.158	18.230	10.210	27.996	41.742	3.940	6.3818	0.2444
E11	4.914	2.984	3.787	6.914	2.082	4.034	6.534	8.738	3.903	0.745	1.000	3.100	13.590	7.611	20.870	31.117	2.937	4.7574	0.1822
E12	1.585	0.963	1.222	2.230	0.672	1.301	2.108	2.819	1.259	0.240	0.323	1.000	4.384	2.455	6.733	10.038	0.947	1.5347	0.0588
E13	0.362	0.220	0.279	0.509	0.153	0.297	0.481	0.643	0.287	0.055	0.074	0.228	1.000	0.560	1.536	2.290	0.216	0.3501	0.0134
E14	0.646	0.392	0.498	0.908	0.274	0.530	0.859	1.148	0.513	0.098	0.131	0.407	1.786	1.000	2.742	4.088	0.386	0.6251	0.0239
E15	0.235	0.143	0.181	0.331	0.100	0.193	0.313	0.419	0.187	0.036	0.048	0.149	0.651	0.365	1.000	1.491	0.141	0.2279	0.0087
E16	0.158	0.096	0.122	0.222	0.067	0.130	0.210	0.281	0.125	0.024	0.032	0.100	0.437	0.245	0.671	1.000	0.094	0.1529	0.0059
E17	1.673	1.016	1.289	2.354	0.709	1.374	2.225	2.975	1.329	0.254	0.340	1.055	4.627	2.591	7.106	10.595	1.000	1.6198	0.0620

DMU	Criteria 8 (O2/I4)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.871	0.834	0.425	0.814	1.638	1.097	2.308	1.516	2.643	1.552	1.786	2.169	0.708	0.164	3.145	0.060	0.9657	0.0278
E02	1.148	1.000	0.957	0.487	0.935	1.881	1.259	2.649	1.740	3.034	1.782	2.051	2.490	0.813	0.189	3.610	0.069	1.1087	0.0319
E03	1.200	1.045	1.000	0.509	0.977	1.965	1.316	2.768	1.818	3.171	1.862	2.143	2.602	0.849	0.197	3.773	0.072	1.1586	0.0333
E04	2.355	2.052	1.963	1.000	1.917	3.859	2.583	5.435	3.570	6.225	3.656	4.208	5.108	1.668	0.387	7.407	0.142	2.2747	0.0654
E05	1.228	1.070	1.024	0.522	1.000	2.012	1.347	2.835	1.862	3.246	1.906	2.194	2.664	0.870	0.202	3.863	0.074	1.1863	0.0341
E06	0.610	0.532	0.509	0.259	0.497	1.000	0.669	1.409	0.925	1.613	0.947	1.090	1.324	0.432	0.100	1.920	0.037	0.5895	0.0170
E07	0.912	0.794	0.760	0.387	0.742	1.494	1.000	2.104	1.382	2.410	1.415	1.629	1.977	0.646	0.150	2.867	0.055	0.8806	0.0253
E08	0.433	0.377	0.361	0.184	0.353	0.710	0.475	1.000	0.657	1.145	0.673	0.774	0.940	0.307	0.071	1.363	0.026	0.4185	0.0120
E09	0.660	0.575	0.550	0.280	0.537	1.081	0.724	1.523	1.000	1.744	1.024	1.179	1.431	0.467	0.108	2.075	0.040	0.6372	0.0183
E10	0.378	0.330	0.315	0.161	0.308	0.620	0.415	0.873	0.574	1.000	0.587	0.676	0.821	0.268	0.062	1.190	0.023	0.3654	0.0105
E11	0.644	0.561	0.537	0.274	0.525	1.056	0.707	1.487	0.977	1.703	1.000	1.151	1.397	0.456	0.106	2.026	0.039	0.6222	0.0179
E12	0.560	0.488	0.467	0.238	0.456	0.917	0.614	1.292	0.848	1.479	0.869	1.000	1.214	0.396	0.092	1.760	0.034	0.5406	0.0156
E13	0.461	0.402	0.384	0.196	0.375	0.755	0.506	1.064	0.699	1.219	0.716	0.824	1.000	0.326	0.076	1.450	0.028	0.4453	0.0128
E14	1.412	1.230	1.177	0.600	1.150	2.314	1.549	3.259	2.141	3.733	2.192	2.523	3.063	1.000	0.232	4.442	0.085	1.3640	0.0392
E15	6.082	5.297	5.069	2.582	4.951	9.963	6.670	14.034	9.218	16.072	9.439	10.864	13.188	4.306	1.000	19.124	0.366	5.8732	0.1689
E16	0.318	0.277	0.265	0.135	0.259	0.521	0.349	0.734	0.482	0.840	0.494	0.568	0.690	0.225	0.052	1.000	0.019	0.3071	0.0088
E17	####	14.455	13.832	7.045	13.509	27.184	####	38.293	25.151	43.854	25.755	29.644	35.985	11.749	2.729	52.182	1.000	16.0255	0.4610

DMU	Criteria 9 (O3/I1)																	Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	4.715	0.667	4.521	####	####	0.108	4.144	0.018	#####	#####	1.067	0.613	########	######	0.006	0.016	427.4260	0.0032
E02	0.212	1.000	0.142	0.959	####	####	0.023	0.879	0.004	#####	#####	0.226	0.130	########	######	0.001	0.003	90.6472	0.0007
E03	1.498	7.064	1.000	6.773	####	####	0.161	6.209	0.026	#####	#####	1.598	0.918	########	######	0.009	0.023	640.3621	0.0048
E04	0.221	1.043	0.148	1.000	####	####	0.024	0.917	0.004	#####	#####	0.236	0.136	########	######	0.001	0.003	94.5485	0.0007
E05	0.000	0.000	0.000	0.000	1.000	1.601	0.000	0.000	0.000	0.504	0.543	0.000	0.000	3.94	1.300	0.000	0.000	0.0000	0.0000
E06	0.000	0.000	0.000	0.000	0.625	1.000	0.000	0.000	0.000	0.315	0.340	0.000	0.000	2.46	0.812	0.000	0.000	0.0000	0.0000
E07	9.278	43.749	6.193	41.944	####	####	1.000	38.452	0.163	#####	#####	9.898	5.685	########	######	0.054	0.144	######	0.0300
E08	0.241	1.138	0.161	1.091	####	####	0.026	1.000	0.004	#####	#####	0.257	0.148	########	######	0.001	0.004	103.1350	0.0008
E09	####	####	38.066	####	####	####	6.147	####	1.000	#####	#####	60.836	34.941	########	######	0.330	0.886	######	0.1843
E10	0.000	0.000	0.000	0.000	1.985	3.178	0.000	0.000	0.000	1.000	1.079	0.000	0.000	7.83	2.580	0.000	0.000	0.0000	0.0000
E11	0.000	0.000	0.000	0.000	1.840	2.945	0.000	0.000	0.000	0.927	1.000	0.000	0.000	7.26	2.391	0.000	0.000	0.0000	0.0000
E12	0.937	4.420	0.626	4.238	####	####	0.101	3.885	0.016	#####	#####	1.000	0.574	########	######	0.005	0.015	400.6835	0.0030
E13	1.632	7.696	1.089	7.379	####	####	0.176	6.764	0.029	#####	#####	1.741	1.000	########	######	0.009	0.025	697.6286	0.0053
E14	0.000	0.000	0.000	0.000	0.254	0.406	0.000	0.000	0.000	0.128	0.138	0.000	0.000	1.00	0.330	0.000	0.000	0.0000	0.0000
E15	0.000	0.000	0.000	0.000	0.769	1.232	0.000	0.000	0.000	0.388	0.418	0.000	0.000	3.03	1.000	0.000	0.000	0.0000	0.0000
E16	####	####	####	####	####	####	####	####	3.034	#####	#####	184.574	####	########	######	1.000	2.687	######	0.5591
E17	####	####	42.974	####	####	####	6.939	####	1.129	#####	#####	68.680	39.447	########	######	0.372	1.000	######	0.2081

DMU	Criteria 10 (O3/I2)																	Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	5.558	0.709	3.285	####	####	0.059	4.152	0.023	#####	#####	1.590	0.614	#######	######	0.001	0.068	501.2550	0.0009
E02	0.180	1.000	0.128	0.591	####	####	0.011	0.747	0.004	#####	#####	0.286	0.111	#######	######	0.000	0.012	90.1880	0.0002
E03	1.410	7.837	1.000	4.633	####	####	0.083	5.854	0.032	#####	#####	2.243	0.866	#######	######	0.001	0.096	706.8452	0.0013
E04	0.304	1.692	0.216	1.000	####	####	0.018	1.264	0.007	#####	#####	0.484	0.187	#######	######	0.000	0.021	152.5812	0.0003
E05	0.000	0.000	0.000	0.000	1.000	0.893	0.000	0.000	0.000	0.900	0.916	0.000	0.000	1.598	0.887	0.000	0.000	0.0000	0.0000
E06	0.000	0.000	0.000	0.000	1.120	1.000	0.000	0.000	0.000	1.008	1.025	0.000	0.000	1.789	0.993	0.000	0.000	0.0000	0.0000
E07	####	94.357	12.039	55.773	####	####	1.000	70.484	0.391	#####	#####	27.002	10.428	#######	######	0.017	1.153	######	0.0161
E08	0.241	1.339	0.171	0.791	####	####	0.014	1.000	0.006	#####	#####	0.383	0.148	#######	######	0.000	0.016	120.7363	0.0002
E09	####	####	30.792	####	####	####	2.558	####	1.000	#####	#####	69.061	26.670	#######	######	0.045	2.949	######	0.0411
E10	0.000	0.000	0.000	0.000	1.111	0.992	0.000	0.000	0.000	1.000	1.017	0.000	0.000	1.774	0.985	0.000	0.000	0.0000	0.0000
E11	0.000	0.000	0.000	0.000	1.092	0.975	0.000	0.000	0.000	0.983	1.000	0.000	0.000	1.745	0.968	0.000	0.000	0.0000	0.0000
E12	0.629	3.494	0.446	2.066	####	####	0.037	2.610	0.014	#####	#####	1.000	0.386	#######	######	0.001	0.043	315.1586	0.0006
E13	1.628	9.049	1.155	5.348	####	####	0.096	6.759	0.037	#####	#####	2.589	1.000	#######	######	0.002	0.111	816.0803	0.0015
E14	0.000	0.000	0.000	0.000	0.626	0.559	0.000	0.000	0.000	0.564	0.573	0.000	0.000	1.000	0.555	0.000	0.000	0.0000	0.0000
E15	0.000	0.000	0.000	0.000	1.128	1.007	0.000	0.000	0.000	1.016	1.033	0.000	0.000	1.802	1.000	0.000	0.000	0.0000	0.0000
E16	####	####	####	####	####	####	####	####	22.460	#####	#####	#####	####	#######	######	1.000	66.244	######	0.9237
E17	####	81.823	10.440	48.364	####	####	0.867	61.120	0.339	#####	#####	23.415	9.043	#######	######	0.015	1.000	######	0.0139

DMU	Criteria 11 (O3/I3)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	4.614	0.674	4.818	####	####	0.117	6.083	0.014	#####	#####	0.999	1.750	#######	######	0.008	0.039	522.8678	0.0044
E02	0.217	1.000	0.146	1.044	####	####	0.025	1.318	0.003	#####	#####	0.217	0.379	#######	######	0.002	0.008	113.3307	0.0009
E03	1.483	6.843	1.000	7.146	####	####	0.173	9.021	0.021	#####	#####	1.482	2.595	#######	######	0.012	0.058	775.4811	0.0065
E04	0.208	0.958	0.140	1.000	####	####	0.024	1.262	0.003	#####	#####	0.207	0.363	#######	######	0.002	0.008	108.5184	0.0009
E05	0.000	0.000	0.000	0.000	1.000	1.450	0.000	0.000	0.000	0.297	0.437	0.000	0.000	4.658	8.017	0.000	0.000	0.0000	0.0000
E06	0.000	0.000	0.000	0.000	0.690	1.000	0.000	0.000	0.000	0.204	0.301	0.000	0.000	3.212	5.528	0.000	0.000	0.0000	0.0000
E07	8.583	39.599	5.787	41.355	####	####	1.000	52.208	0.122	#####	#####	8.577	15.017	#######	######	0.072	0.335	######	0.0376
E08	0.164	0.758	0.111	0.792	####	####	0.019	1.000	0.002	#####	#####	0.164	0.288	#######	######	0.001	0.006	85.9609	0.0007
E09	####	####	47.414	####	####	####	8.193	####	1.000	#####	#####	70.269	####	#######	######	0.590	2.745	######	0.3079
E10	0.000	0.000	0.000	0.000	3.372	4.891	0.000	0.000	0.000	1.000	1.472	0.000	0.000	15.709	27.034	0.000	0.000	0.0000	0.0000
E11	0.000	0.000	0.000	0.000	2.291	3.322	0.000	0.000	0.000	0.679	1.000	0.000	0.000	10.671	18.364	0.000	0.000	0.0000	0.0000
E12	1.001	4.617	0.675	4.822	####	####	0.117	6.087	0.014	#####	#####	1.000	1.751	#######	######	0.008	0.039	523.2596	0.0044
E13	0.572	2.637	0.385	2.754	####	####	0.067	3.477	0.008	#####	#####	0.571	1.000	#######	######	0.005	0.022	298.8437	0.0025
E14	0.000	0.000	0.000	0.000	0.215	0.311	0.000	0.000	0.000	0.064	0.094	0.000	0.000	1.000	1.721	0.000	0.000	0.0000	0.0000
E15	0.000	0.000	0.000	0.000	0.125	0.181	0.000	0.000	0.000	0.037	0.054	0.000	0.000	0.581	1.000	0.000	0.000	0.0000	0.0000
E16	####	####	80.366	####	####	####	####	####	1.695	#####	#####	119.104	####	#######	######	1.000	4.653	######	0.5220
E17	####	####	17.270	####	####	####	2.984	####	0.364	#####	#####	25.595	44.815	#######	######	0.215	1.000	######	0.1122

DMU	Criteria 12 (O3/I4)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	6.618	0.729	1.454	####	####	0.096	7.894	0.027	#####	#####	2.830	1.372	#######	######	0.004	0.004	521.5613	0.0018
E02	0.151	1.000	0.110	0.220	####	####	0.015	1.193	0.004	#####	#####	0.428	0.207	#######	######	0.001	0.001	78.8044	0.0003
E03	1.371	9.076	1.000	1.994	####	####	0.132	10.824	0.037	#####	#####	3.880	1.881	#######	######	0.006	0.005	715.1979	0.0025
E04	0.688	4.552	0.502	1.000	####	####	0.066	5.429	0.019	#####	#####	1.946	0.944	#######	######	0.003	0.003	358.7151	0.0013
E05	0.000	0.000	0.000	0.000	1.000	1.506	0.000	0.000	0.000	2.689	1.733	0.000	0.000	1.108	0.162	0.000	0.000	0.0000	0.0000
E06	0.000	0.000	0.000	0.000	0.664	1.000	0.000	0.000	0.000	1.785	1.150	0.000	0.000	0.736	0.107	0.000	0.000	0.0000	0.0000
E07	####	68.877	7.589	15.131	####	####	1.000	82.148	0.282	#####	#####	29.448	14.277	#######	######	0.043	0.041	######	0.0191
E08	0.127	0.838	0.092	0.184	####	####	0.012	1.000	0.003	#####	#####	0.358	0.174	#######	######	0.001	0.000	66.0739	0.0002
E09	####	####	26.871	53.576	####	####	3.541	####	1.000	#####	#####	104.267	50.552	#######	######	0.154	0.145	######	0.0675
E10	0.000	0.000	0.000	0.000	0.372	0.560	0.000	0.000	0.000	1.000	0.644	0.000	0.000	0.412	0.060	0.000	0.000	0.0000	0.0000
E11	0.000	0.000	0.000	0.000	0.577	0.869	0.000	0.000	0.000	1.552	1.000	0.000	0.000	0.640	0.093	0.000	0.000	0.0000	0.0000
E12	0.353	2.339	0.258	0.514	####	####	0.034	2.790	0.010	#####	#####	1.000	0.485	#######	######	0.001	0.001	184.3182	0.0006
E13	0.729	4.824	0.532	1.060	####	####	0.070	5.754	0.020	#####	#####	2.063	1.000	#######	######	0.003	0.003	380.1702	0.0013
E14	0.000	0.000	0.000	0.000	0.902	1.359	0.000	0.000	0.000	2.426	1.564	0.000	0.000	1.000	0.146	0.000	0.000	0.0000	0.0000
E15	0.000	0.000	0.000	0.000	6.190	9.325	0.000	0.000	0.000	16.645	10.727	0.000	0.000	6.861	1.000	0.000	0.000	0.0000	0.0000
E16	####	####	####	####	####	####	####	####	6.514	#####	#####	679.198	####	#######	######	1.000	0.945	######	0.4398
E17	####	####	####	####	####	####	####	####	6.894	#####	#####	718.869	####	#######	######	1.058	1.000	######	0.4655

Synthesize the results to determine the best alternative.
Obtain the final results

wieght	1.682	0.778	1.168	4.037	3.749	1.733	2.605	9.000	3.749	1.733	2.605	9.000		Score	Rank
	O1/I1	O1/I2	O1/I3	O1/I4	O2/I1	O2/I2	O2/I3	O2/I4	O3/I1	O3/I2	O3/I3	O3/I4			
E01	0.0359	0.0338	0.0437	0.0198	0.0368	0.0539	0.0371	0.0278	0.0032	0.0009	0.0044	0.0018		0.837	11
E02	0.0472	0.0377	0.0588	0.0186	0.0593	0.0736	0.0611	0.0319	0.0007	0.0002	0.0009	0.0003		1.056	6
E03	0.0316	0.0280	0.0381	0.0160	0.0483	0.0665	0.0481	0.0333	0.0048	0.0013	0.0065	0.0025		0.965	9
E04	0.0064	0.0082	0.0073	0.0109	0.0279	0.0562	0.0264	0.0654	0.0007	0.0003	0.0009	0.0013		0.946	8
E05	0.0839	0.0422	0.1073	0.0253	0.0828	0.0648	0.0875	0.0341	0.0000	0.0000	0.0000	0.0000		1.359	5
E06	0.0509	0.0459	0.0719	0.0163	0.0387	0.0543	0.0452	0.0170	0.0000	0.0000	0.0000	0.0000		0.781	12
E07	0.0328	0.0564	0.0370	0.0203	0.0299	0.0801	0.0279	0.0253	0.0300	0.0161	0.0376	0.0191		1.186	13
E08	0.0582	0.0546	0.0483	0.0168	0.0304	0.0444	0.0209	0.0120	0.0008	0.0002	0.0007	0.0002		0.625	16
E09	0.0683	0.0489	0.1026	0.0243	0.0376	0.0419	0.0467	0.0183	0.1843	0.0411	0.3079	0.0675		3.043	10
E10	0.0699	0.0197	0.1520	0.0039	0.1361	0.0596	0.2444	0.0105	0.0000	0.0000	0.0000	0.0000		1.671	3
E11	0.0851	0.0254	0.1355	0.0080	0.1384	0.0643	0.1822	0.0179	0.0000	0.0000	0.0000	0.0000		1.620	4
E12	0.0071	0.0045	0.0093	0.0015	0.0547	0.0536	0.0588	0.0156	0.0030	0.0006	0.0044	0.0006		0.653	15
E13	0.0127	0.0119	0.0054	0.0031	0.0380	0.0555	0.0134	0.0128	0.0053	0.0015	0.0025	0.0013		0.479	17
E14	0.0207	0.0257	0.0224	0.0222	0.0267	0.0517	0.0239	0.0392	0.0000	0.0000	0.0000	0.0000		0.776	14
E15	0.1952	0.1440	0.0405	0.4735	0.0509	0.0584	0.0087	0.1689	0.0000	0.0000	0.0000	0.0000		4.235	2
E16	0.0730	0.3871	0.0613	0.0559	0.0084	0.0696	0.0059	0.0088	0.5591	0.9237	0.5220	0.4398		9.983	7
E17	0.1211	0.0260	0.0587	0.2635	0.1549	0.0518	0.0620	0.4610	0.2081	0.0139	0.1122	0.4655		11.623	1

5. Ranking of companies under Sector 5

The evaluation criteria												
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8	Criteria 9	Criteria 10	Criteria 11	Criteria 12
DMU	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3	O3/I1	O3/I2	O3/I3	O4/I1	O4/I2	O4/I3
E1	0.909	0.400	0.500	1.955	0.860	1.075	3.409	1.500	1.875	3.409	1.500	1.875
E2	1.667	1.000	1.000	1.000	0.600	0.600	0.417	0.250	0.250	0.500	0.300	0.300
E3	1.042	1.471	0.862	2.083	2.941	1.724	2.083	2.941	1.724	2.500	3.529	2.069
E4	1.081	1.739	1.000	0.351	0.565	0.325	0.676	1.087	0.625	0.811	1.304	0.750
E5	0.750	1.000	0.500	1.250	1.667	0.833	1.250	1.667	0.833	1.000	1.333	0.667
E6	0.688	2.200	0.611	1.063	3.400	0.944	0.125	0.400	0.111	0.250	0.800	0.222
E7	0.429	0.400	1.667	0.414	0.387	1.611	0.100	0.093	0.389	0.714	0.667	2.778
E8	0.220	0.200	0.200	0.580	0.527	0.527	0.200	0.182	0.182	0.800	0.727	0.727
E9	0.900	1.125	0.900	1.000	1.250	1.000	0.050	0.063	0.050	0.250	0.313	0.250

Weights of inputs and outputs of all DMUs							
	v1	*v2*	*v3*	*µ1*	*µ2*	*µ3*	*µ4*
E1	0.0278	0.0077	0.0000	0.0000	0.0000	0.0000	0.0133
E2	0.0167	0.0000	0.0000	0.0100	0.0000	0.0000	0.0000
E3	0.0417	0.0000	0.0000	0.0000	0.0171	0.0000	0.0024
E4	0.0189	0.0131	0.0000	0.0241	0.0000	0.0000	0.0012
E5	0.0155	0.0126	0.0000	0.0213	0.0011	0.0000	0.0000
E6	0.0030	0.0303	0.0000	0.0000	0.0118	0.0000	0.0000
E7	0.0046	0.0000	0.0375	0.0000	0.0000	0.0000	0.0200
E8	0.0020	0.0000	0.0163	0.0000	0.0000	0.0000	0.0087
E9	0.0009	0.0013	0.0080	0.0094	0.0009	0.0000	0.0000
Average weights	0.0146	0.0072	0.0069	0.0072	0.0034	0.0000	0.0051

The weights of the criteria												
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8	Criteria 9	Criteria 10	Criteria 11	Criteria 12
M	0.493	0.994	1.045	0.235	0.474	0.498	0.000	0.000	0.000	0.348	0.702	0.738
Normalized	4.249	8.564	9.000	2.026	4.082	4.290	0.000	0.000	0.000	3.001	6.049	6.357

Pairwise Comparisons

DMU	Criteria 1 (O1/I1)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	0.545	0.873	0.841	1.212	1.322	2.121	4.132	1.010	1.1076	0.1183
E2	1.833	1.000	1.600	1.542	2.222	2.424	3.889	7.576	1.852	1.5267	0.1631
E3	1.146	0.625	1.000	0.964	1.389	1.515	2.431	4.735	1.157	1.1904	0.1271
E4	1.189	0.649	1.038	1.000	1.441	1.572	2.523	4.914	1.201	1.2140	0.1297
E5	0.825	0.450	0.720	0.694	1.000	1.091	1.750	3.409	0.833	1.0003	0.1068
E6	0.756	0.413	0.660	0.636	0.917	1.000	1.604	3.125	0.764	0.9553	0.1020
E7	0.471	0.257	0.411	0.396	0.571	0.623	1.000	1.948	0.476	0.7438	0.0795
E8	0.242	0.132	0.211	0.204	0.293	0.320	0.513	1.000	0.244	0.5226	0.0558
E9	0.990	0.540	0.864	0.833	1.200	1.309	2.100	4.091	1.000	1.1017	0.1177

DMU	Criteria 2 (O1/I2)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	0.400	0.272	0.230	0.400	0.182	1.000	2.000	0.356	0.6763	0.0699
E2	2.500	1.000	0.680	0.575	1.000	0.455	2.500	5.000	0.889	1.0985	0.1135
E3	3.676	1.471	1.000	0.846	1.471	0.668	3.676	7.353	1.307	1.3473	0.1393
E4	4.348	1.739	1.183	1.000	1.739	0.791	4.348	8.696	1.546	1.4724	0.1522
E5	2.500	1.000	0.680	0.575	1.000	0.455	2.500	5.000	0.889	1.0985	0.1135
E6	5.500	2.200	1.496	1.265	2.200	1.000	5.500	11.000	1.956	1.6675	0.1724
E7	1.000	0.400	0.272	0.230	0.400	0.182	1.000	2.000	0.356	0.6763	0.0699
E8	0.500	0.200	0.136	0.115	0.200	0.091	0.500	1.000	0.178	0.4685	0.0484
E9	2.813	1.125	0.765	0.647	1.125	0.511	2.813	5.625	1.000	1.1692	0.1209

DMU	Criteria 3 (O1/I3)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	0.500	0.580	0.500	1.000	0.818	0.300	2.500	0.556	0.8379	0.0892
E2	2.000	1.000	1.160	1.000	2.000	1.636	0.600	5.000	1.111	1.2093	0.1288
E3	1.724	0.862	1.000	0.862	1.724	1.411	0.517	4.310	0.958	1.1179	0.1191
E4	2.000	1.000	1.160	1.000	2.000	1.636	0.600	5.000	1.111	1.2093	0.1288
E5	1.000	0.500	0.580	0.500	1.000	0.818	0.300	2.500	0.556	0.8379	0.0892
E6	1.222	0.611	0.709	0.611	1.222	1.000	0.367	3.056	0.679	0.9318	0.0992
E7	3.333	1.667	1.933	1.667	3.333	2.727	1.000	8.333	1.852	1.5849	0.1688
E8	0.400	0.200	0.232	0.200	0.400	0.327	0.120	1.000	0.222	0.5158	0.0549
E9	1.800	0.900	1.044	0.900	1.800	1.473	0.540	4.500	1.000	1.1437	0.1218

DMU	Criteria 4 (O2/I1)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	1.955	0.938	5.563	1.564	1.840	4.718	3.370	1.955	1.4932	0.1583
E2	0.512	1.000	0.480	2.846	0.800	0.941	2.414	1.724	1.000	1.0472	0.1110
E3	1.066	2.083	1.000	5.929	1.667	1.961	5.029	3.592	2.083	1.5445	0.1637
E4	0.180	0.351	0.169	1.000	0.281	0.331	0.848	0.606	0.351	0.6019	0.0638
E5	0.640	1.250	0.600	3.558	1.000	1.176	3.017	2.155	1.250	1.1785	0.1249
E6	0.544	1.063	0.510	3.024	0.850	1.000	2.565	1.832	1.063	1.0814	0.1146
E7	0.212	0.414	0.199	1.179	0.331	0.390	1.000	0.714	0.414	0.6568	0.0696
E8	0.297	0.580	0.278	1.651	0.464	0.546	1.400	1.000	0.580	0.7848	0.0832
E9	0.512	1.000	0.480	2.846	0.800	0.941	2.414	1.724	1.000	1.0472	0.1110

DMU	Criteria 5 (O2/I2)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	1.433	0.292	1.522	0.516	0.253	2.224	1.631	0.688	0.9117	0.0936
E2	0.698	1.000	0.204	1.062	0.360	0.176	1.552	1.138	0.480	0.7535	0.0774
E3	3.420	4.902	1.000	5.204	1.765	0.865	7.606	5.578	2.353	1.7481	0.1795
E4	0.657	0.942	0.192	1.000	0.339	0.166	1.462	1.072	0.452	0.7300	0.0750
E5	1.938	2.778	0.567	2.949	1.000	0.490	4.310	3.161	1.333	1.2941	0.1329
E6	3.953	5.667	1.156	6.015	2.040	1.000	8.793	6.448	2.720	1.8876	0.1939
E7	0.450	0.644	0.131	0.684	0.232	0.114	1.000	0.733	0.309	0.5971	0.0613
E8	0.613	0.879	0.179	0.933	0.316	0.155	1.364	1.000	0.422	0.7037	0.0723
E9	1.453	2.083	0.425	2.212	0.750	0.368	3.233	2.371	1.000	1.1113	0.1141

DMU	Criteria 6 (O2/I3)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	1.792	0.624	3.308	1.290	1.138	0.667	2.039	1.075	1.1296	0.1213
E2	0.558	1.000	0.348	1.846	0.720	0.635	0.372	1.138	0.600	0.8295	0.0891
E3	1.604	2.874	1.000	5.305	2.069	1.826	1.070	3.270	1.724	1.4505	0.1558
E4	0.302	0.542	0.189	1.000	0.390	0.344	0.202	0.616	0.325	0.5996	0.0644
E5	0.775	1.389	0.483	2.564	1.000	0.882	0.517	1.580	0.833	0.9871	0.1060
E6	0.879	1.574	0.548	2.906	1.133	1.000	0.586	1.791	0.944	1.0547	0.1133
E7	1.499	2.685	0.934	4.957	1.933	1.706	1.000	3.056	1.611	1.3994	0.1503
E8	0.490	0.879	0.306	1.622	0.633	0.558	0.327	1.000	0.527	0.7747	0.0832
E9	0.930	1.667	0.580	3.077	1.200	1.059	0.621	1.897	1.000	1.0871	0.1167

DMU	Criteria 7 (O3/I1)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	8.182	1.636	5.045	2.727	27.273	34.091	17.045	68.182	3.0773	0.2653
E2	0.122	1.000	0.200	0.617	0.333	3.333	4.167	2.083	8.333	1.0114	0.0872
E3	0.611	5.000	1.000	3.083	1.667	16.667	20.833	10.417	41.667	2.3711	0.2044
E4	0.198	1.622	0.324	1.000	0.541	5.405	6.757	3.378	13.514	1.3063	0.1126
E5	0.367	3.000	0.600	1.850	1.000	10.000	12.500	6.250	25.000	1.8092	0.1560
E6	0.037	0.300	0.060	0.185	0.100	1.000	1.250	0.625	2.500	0.5347	0.0461
E7	0.029	0.240	0.048	0.148	0.080	0.800	1.000	0.500	2.000	0.4751	0.0410
E8	0.059	0.480	0.096	0.296	0.160	1.600	2.000	1.000	4.000	0.6857	0.0591
E9	0.015	0.120	0.024	0.074	0.040	0.400	0.500	0.250	1.000	0.3292	0.0284

DMU	Criteria 8 (O3/I2)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	6.000	0.510	1.380	0.900	3.750	16.071	8.250	24.000	1.8790	0.1679
E2	0.167	1.000	0.085	0.230	0.150	0.625	2.679	1.375	4.000	0.7277	0.0650
E3	1.961	11.765	1.000	2.706	1.765	7.353	31.513	16.176	47.059	2.6837	0.2398
E4	0.725	4.348	0.370	1.000	0.652	2.717	11.646	5.978	17.391	1.5844	0.1416
E5	1.111	6.667	0.567	1.533	1.000	4.167	17.857	9.167	26.667	1.9867	0.1775
E6	0.267	1.600	0.136	0.368	0.240	1.000	4.286	2.200	6.400	0.9333	0.0834
E7	0.062	0.373	0.032	0.086	0.056	0.233	1.000	0.513	1.493	0.4319	0.0386
E8	0.121	0.727	0.062	0.167	0.109	0.455	1.948	1.000	2.909	0.6148	0.0549
E9	0.042	0.250	0.021	0.058	0.038	0.156	0.670	0.344	1.000	0.3493	0.0312

DMU	Criteria 9 (O3/I3)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	7.500	1.088	3.000	2.250	16.875	4.821	10.313	37.500	2.3280	0.2171
E2	0.133	1.000	0.145	0.400	0.300	2.250	0.643	1.375	5.000	0.8011	0.0747
E3	0.920	6.897	1.000	2.759	2.069	15.517	4.433	9.483	34.483	2.2268	0.2076
E4	0.333	2.500	0.363	1.000	0.750	5.625	1.607	3.438	12.500	1.3013	0.1213
E5	0.444	3.333	0.483	1.333	1.000	7.500	2.143	4.583	16.667	1.5154	0.1413
E6	0.059	0.444	0.064	0.178	0.133	1.000	0.286	0.611	2.222	0.5215	0.0486
E7	0.207	1.556	0.226	0.622	0.467	3.500	1.000	2.139	7.778	1.0123	0.0944
E8	0.097	0.727	0.105	0.291	0.218	1.636	0.468	1.000	3.636	0.6768	0.0631
E9	0.027	0.200	0.029	0.080	0.060	0.450	0.129	0.275	1.000	0.3417	0.0319

DMU	Criteria 10 (O4/I1)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	6.818	1.364	4.205	3.409	13.636	4.773	4.261	13.636	2.1649	0.2172
E2	0.147	1.000	0.200	0.617	0.500	2.000	0.700	0.625	2.000	0.7836	0.0786
E3	0.733	5.000	1.000	3.083	2.500	10.000	3.500	3.125	10.000	1.8371	0.1843
E4	0.238	1.622	0.324	1.000	0.811	3.243	1.135	1.014	3.243	1.0121	0.1016
E5	0.293	2.000	0.400	1.233	1.000	4.000	1.400	1.250	4.000	1.1310	0.1135
E6	0.073	0.500	0.100	0.308	0.250	1.000	0.350	0.313	1.000	0.5429	0.0545
E7	0.210	1.429	0.286	0.881	0.714	2.857	1.000	0.893	2.857	0.9464	0.0950
E8	0.235	1.600	0.320	0.987	0.800	3.200	1.120	1.000	3.200	1.0050	0.1008
E9	0.073	0.500	0.100	0.308	0.250	1.000	0.350	0.313	1.000	0.5429	0.0545

DMU	Criteria 11 (O4/I2)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	5.000	0.425	1.150	1.125	1.875	2.250	2.063	4.800	1.3218	0.1360
E2	0.200	1.000	0.085	0.230	0.225	0.375	0.450	0.413	0.960	0.5638	0.0580
E3	2.353	11.765	1.000	2.706	2.647	4.412	5.294	4.853	11.294	2.0793	0.2139
E4	0.870	4.348	0.370	1.000	0.978	1.630	1.957	1.793	4.174	1.2276	0.1263
E5	0.889	4.444	0.378	1.022	1.000	1.667	2.000	1.833	4.267	1.2419	0.1278
E6	0.533	2.667	0.227	0.613	0.600	1.000	1.200	1.100	2.560	0.9477	0.0975
E7	0.444	2.222	0.189	0.511	0.500	0.833	1.000	0.917	2.133	0.8605	0.0885
E8	0.485	2.424	0.206	0.558	0.545	0.909	1.091	1.000	2.327	0.9010	0.0927
E9	0.208	1.042	0.089	0.240	0.234	0.391	0.469	0.430	1.000	0.5761	0.0593

DMU	Criteria 12 (O4/I3)										Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	Mc	Pi
E1	1.000	6.250	0.906	2.500	2.813	8.438	0.675	2.578	7.500	1.6377	0.1631
E2	0.160	1.000	0.145	0.400	0.450	1.350	0.108	0.413	1.200	0.6207	0.0618
E3	1.103	6.897	1.000	2.759	3.103	9.310	0.745	2.845	8.276	1.7253	0.1718
E4	0.400	2.500	0.363	1.000	1.125	3.375	0.270	1.031	3.000	1.0082	0.1004
E5	0.356	2.222	0.322	0.889	1.000	3.000	0.240	0.917	2.667	0.9473	0.0943
E6	0.119	0.741	0.107	0.296	0.333	1.000	0.080	0.306	0.889	0.5295	0.0527
E7	1.481	9.259	1.343	3.704	4.167	12.500	1.000	3.819	11.111	2.0165	0.2008
E8	0.388	2.424	0.352	0.970	1.091	3.273	0.262	1.000	2.909	0.9919	0.0988
E9	0.133	0.833	0.121	0.333	0.375	1.125	0.090	0.344	1.000	0.5636	0.0561

Synthesize the results to determine the best alternative.
Obtain the final results

weight	4.249	8.564	9.000	2.026	4.082	4.290	0.000	0.000	0.000	3.001	6.049	6.357		
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8	Criteria 9	Criteria 10	Criteria 11	Criteria 12	Score	Rank
E1	0.1183	0.0699	0.0892	0.1583	0.0936	0.1213	0.2653	0.1679	0.2171	0.2172	0.1360	0.1631	5.639	2
E2	0.1631	0.1135	0.1288	0.1110	0.0774	0.0891	0.0872	0.0650	0.0747	0.0786	0.0580	0.0618	4.727	7
E3	0.1271	0.1393	0.1191	0.1637	0.1795	0.1558	0.2044	0.2398	0.2076	0.1843	0.2139	0.1718	7.477	1
E4	0.1297	0.1522	0.1288	0.0638	0.0750	0.0644	0.1126	0.1416	0.1213	0.1016	0.1263	0.1004	5.432	4
E5	0.1068	0.1135	0.0892	0.1249	0.1329	0.1060	0.1560	0.1775	0.1413	0.1135	0.1278	0.0943	5.193	6
E6	0.1020	0.1724	0.0992	0.1146	0.1939	0.1133	0.0461	0.0834	0.0486	0.0545	0.0975	0.0527	5.401	5
E7	0.0795	0.0699	0.1688	0.0696	0.0613	0.1503	0.0410	0.0386	0.0944	0.0950	0.0885	0.2008	5.589	3
E8	0.0558	0.0484	0.0549	0.0832	0.0723	0.0832	0.0591	0.0549	0.0631	0.1008	0.0927	0.0988	3.458	9
E9	0.1177	0.1209	0.1218	0.1110	0.1141	0.1167	0.0284	0.0312	0.0319	0.0545	0.0593	0.0561	4.702	8

6. Ranking of companies under Sector 6

The evaluation criteria							
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7
DMU	O1/I1	O2/I1	O3/I1	O4/I1	O5/I1	O6/I1	O7/I1
E01	1.208	0.646	1.063	0.542	0.896	0.375	0.271
E02	1.292	1.396	0.896	0.479	0.542	0.479	0.167
E03	1.282	0.987	1.282	1.282	0.731	0.295	1.282
E04	1.103	0.926	1.029	0.618	0.588	0.279	0.118
E05	1.068	1.409	1.114	0.795	0.568	0.523	0.364
E06	1.154	1.923	1.308	0.654	0.538	1.442	0.462
E07	1.135	1.385	1.000	0.404	0.385	0.654	0.250
E08	0.981	0.981	0.846	0.635	0.442	0.923	0.308
E09	0.875	0.528	0.931	0.292	0.250	1.389	0.153
E10	1.024	1.048	0.631	0.631	1.190	0.500	0.000
E11	0.730	0.780	0.890	0.880	0.560	0.420	0.160
E12	0.619	1.262	1.214	0.500	0.452	1.238	0.048
E13	0.411	0.589	0.661	0.321	0.464	0.464	0.196
E14	1.076	0.674	0.804	0.620	1.065	0.489	0.054
E15	0.607	0.661	0.536	0.429	0.893	0.839	0.000
E16	0.391	0.522	0.543	0.217	0.457	0.174	0.000
E17	0.750	1.208	0.597	0.403	1.014	0.528	0.181

Weights of inputs and outputs of all DMUs								
DMU	$v1$	$\mu1$	$\mu2$	$\mu3$	$\mu4$	$\mu5$	$\mu6$	$\mu7$
E01	0.0208	0.0000	0.0000	0.0088	0.0000	0.0129	0.0000	0.0000
E02	0.0208	0.0126	0.0033	0.0000	0.0000	0.0000	0.0000	0.0000
E03	0.0128	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0100
E04	0.0147	0.0091	0.0012	0.0015	0.0000	0.0000	0.0000	0.0000
E05	0.0227	0.0000	0.0068	0.0000	0.0072	0.0093	0.0000	0.0000
E06	0.0192	0.0000	0.0000	0.0000	0.0000	0.0000	0.0133	0.0000
E07	0.0192	0.0118	0.0016	0.0020	0.0000	0.0000	0.0000	0.0000
E08	0.0192	0.0140	0.0000	0.0000	0.0006	0.0000	0.0019	0.0000
E09	0.0139	0.0000	0.0000	0.0000	0.0000	0.0000	0.0096	0.0000
E10	0.0119	0.0000	0.0000	0.0000	0.0000	0.0100	0.0000	0.0000
E11	0.0100	0.0000	0.0000	0.0000	0.0044	0.0048	0.0032	0.0000
E12	0.0238	0.0000	0.0000	0.0182	0.0000	0.0000	0.0000	0.0000
E13	0.0179	0.0000	0.0000	0.0074	0.0000	0.0103	0.0017	0.0002
E14	0.0109	0.0000	0.0000	0.0046	0.0001	0.0062	0.0010	0.0000
E15	0.0179	0.0000	0.0000	0.0000	0.0000	0.0116	0.0080	0.0000
E16	0.0217	0.0000	0.0022	0.0085	0.0000	0.0118	0.0000	0.0000
E17	0.0139	0.0000	0.0043	0.0000	0.0000	0.0079	0.0000	0.0030
Average weights	0.0171	0.0028	0.0011	0.0030	0.0007	0.0050	0.0023	0.0008

The weights of the criteria							
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7
M	0.163	0.066	0.175	0.042	0.291	0.133	0.045
Normalized	5.033	2.046	5.407	1.302	9.000	4.119	1.405

Pairwise Comparisons

DMU	Criteria 1 (O1/I1)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.935	0.943	1.096	1.131	1.047	1.065	1.232	1.381	1.180	1.655	1.952	2.942	1.123	1.990	3.088	1.611	1.3865	0.0769
E02	1.069	1.000	1.008	1.171	1.209	1.119	1.138	1.317	1.476	1.262	1.769	2.087	3.145	1.200	2.127	3.301	1.722	1.4821	0.0822
E03	1.061	0.993	1.000	1.162	1.200	1.111	1.130	1.307	1.465	1.252	1.756	2.071	3.122	1.191	2.112	3.276	1.709	1.4711	0.0816
E04	0.913	0.854	0.860	1.000	1.033	0.956	0.972	1.125	1.261	1.077	1.511	1.782	2.685	1.025	1.817	2.819	1.471	1.2656	0.0702
E05	0.884	0.827	0.833	0.968	1.000	0.926	0.941	1.089	1.221	1.043	1.463	1.726	2.601	0.993	1.759	2.730	1.424	1.2257	0.0680
E06	0.955	0.893	0.900	1.046	1.080	1.000	1.017	1.176	1.319	1.127	1.581	1.864	2.809	1.072	1.900	2.949	1.538	1.3240	0.0735
E07	0.939	0.878	0.885	1.029	1.062	0.983	1.000	1.157	1.297	1.108	1.554	1.833	2.763	1.054	1.869	2.900	1.513	1.3019	0.0722
E08	0.812	0.759	0.765	0.889	0.918	0.850	0.864	1.000	1.121	0.958	1.344	1.584	2.388	0.911	1.615	2.506	1.308	1.1254	0.0624
E09	0.724	0.677	0.683	0.793	0.819	0.758	0.771	0.892	1.000	0.855	1.199	1.413	2.130	0.813	1.441	2.236	1.167	1.0040	0.0557
E10	0.847	0.793	0.799	0.928	0.958	0.887	0.902	1.044	1.170	1.000	1.402	1.654	2.493	0.951	1.686	2.616	1.365	1.1748	0.0652
E11	0.604	0.565	0.569	0.662	0.683	0.633	0.643	0.744	0.834	0.713	1.000	1.179	1.777	0.678	1.202	1.866	0.973	0.8376	0.0465
E12	0.512	0.479	0.483	0.561	0.580	0.537	0.546	0.631	0.707	0.605	0.848	1.000	1.507	0.575	1.020	1.582	0.825	0.7103	0.0394
E13	0.340	0.318	0.320	0.372	0.384	0.356	0.362	0.419	0.469	0.401	0.563	0.663	1.000	0.382	0.676	1.050	0.548	0.4713	0.0262
E14	0.891	0.833	0.839	0.976	1.007	0.933	0.948	1.097	1.230	1.051	1.474	1.738	2.620	1.000	1.772	2.750	1.435	1.2348	0.0685
E15	0.502	0.470	0.474	0.550	0.568	0.526	0.535	0.619	0.694	0.593	0.832	0.981	1.478	0.564	1.000	1.552	0.810	0.6967	0.0387
E16	0.324	0.303	0.305	0.355	0.366	0.339	0.345	0.399	0.447	0.382	0.536	0.632	0.953	0.364	0.645	1.000	0.522	0.4490	0.0249
E17	0.621	0.581	0.585	0.680	0.702	0.650	0.661	0.765	0.857	0.733	1.027	1.212	1.826	0.697	1.235	1.917	1.000	0.8606	0.0478

DMU	Criteria 2 (O2/I1)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.463	0.654	0.697	0.458	0.336	0.466	0.658	1.224	0.616	0.828	0.512	1.096	0.958	0.977	1.238	0.534	0.6971	0.0382
E02	2.161	1.000	1.414	1.507	0.991	0.726	1.008	1.423	2.645	1.332	1.790	1.106	2.369	2.071	2.113	2.675	1.155	1.5066	0.0825
E03	1.529	0.707	1.000	1.066	0.701	0.513	0.713	1.007	1.870	0.942	1.266	0.782	1.675	1.465	1.494	1.892	0.817	1.0655	0.0583
E04	1.435	0.664	0.939	1.000	0.657	0.482	0.669	0.945	1.755	0.884	1.188	0.734	1.572	1.375	1.402	1.776	0.767	1.0000	0.0547
E05	2.182	1.009	1.427	1.521	1.000	0.733	1.018	1.437	2.670	1.345	1.807	1.117	2.391	2.091	2.133	2.701	1.166	1.5209	0.0833
E06	2.978	1.378	1.948	2.076	1.365	1.000	1.389	1.961	3.644	1.836	2.465	1.524	3.263	2.854	2.911	3.686	1.592	2.0756	0.1136
E07	2.144	0.992	1.403	1.495	0.983	0.720	1.000	1.412	2.623	1.322	1.775	1.097	2.350	2.055	2.096	2.654	1.146	1.4945	0.0818
E08	1.519	0.703	0.994	1.059	0.696	0.510	0.708	1.000	1.858	0.936	1.257	0.777	1.664	1.455	1.484	1.880	0.812	1.0586	0.0580
E09	0.817	0.378	0.535	0.570	0.375	0.274	0.381	0.538	1.000	0.504	0.677	0.418	0.896	0.783	0.799	1.012	0.437	0.5696	0.0312
E10	1.622	0.751	1.061	1.131	0.743	0.545	0.757	1.068	1.985	1.000	1.343	0.830	1.778	1.555	1.586	2.008	0.867	1.1307	0.0619
E11	1.208	0.559	0.790	0.842	0.554	0.406	0.563	0.795	1.478	0.745	1.000	0.618	1.324	1.157	1.181	1.495	0.646	0.8419	0.0461
E12	1.954	0.904	1.278	1.362	0.896	0.656	0.911	1.287	2.391	1.205	1.618	1.000	2.141	1.873	1.910	2.419	1.044	1.3620	0.0746
E13	0.912	0.422	0.597	0.636	0.418	0.306	0.426	0.601	1.117	0.563	0.755	0.467	1.000	0.874	0.892	1.129	0.488	0.6360	0.0348
E14	1.043	0.483	0.683	0.727	0.478	0.350	0.487	0.687	1.277	0.643	0.864	0.534	1.144	1.000	1.020	1.292	0.558	0.7274	0.0398
E15	1.023	0.473	0.669	0.713	0.469	0.344	0.477	0.674	1.252	0.631	0.847	0.524	1.121	0.980	1.000	1.266	0.547	0.7131	0.0390
E16	0.808	0.374	0.529	0.563	0.370	0.271	0.377	0.532	0.989	0.498	0.669	0.413	0.885	0.774	0.790	1.000	0.432	0.5631	0.0308
E17	1.871	0.866	1.224	1.304	0.858	0.628	0.873	1.232	2.289	1.153	1.549	0.958	2.051	1.793	1.829	2.316	1.000	1.3042	0.0714

DMU	Criteria 3 (O3/I1)																	Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	1.186	0.829	1.032	0.954	0.813	1.063	1.256	1.142	1.684	1.194	0.875	1.608	1.321	1.983	1.955	1.779	1.2236	0.0692
E02	0.843	1.000	0.699	0.870	0.804	0.685	0.896	1.059	0.963	1.420	1.007	0.738	1.356	1.114	1.672	1.648	1.500	1.0316	0.0584
E03	1.207	1.431	1.000	1.245	1.151	0.980	1.282	1.515	1.378	2.032	1.441	1.056	1.940	1.594	2.393	2.359	2.147	1.4764	0.0836
E04	0.969	1.149	0.803	1.000	0.924	0.787	1.029	1.217	1.106	1.632	1.157	0.848	1.558	1.280	1.922	1.894	1.724	1.1855	0.0671
E05	1.048	1.243	0.869	1.082	1.000	0.852	1.114	1.316	1.197	1.765	1.251	0.917	1.686	1.385	2.079	2.049	1.865	1.2825	0.0726
E06	1.231	1.460	1.020	1.270	1.174	1.000	1.308	1.545	1.405	2.073	1.469	1.077	1.979	1.626	2.441	2.406	2.190	1.5059	0.0852
E07	0.941	1.116	0.780	0.971	0.898	0.765	1.000	1.182	1.075	1.585	1.124	0.824	1.514	1.243	1.867	1.840	1.674	1.1516	0.0652
E08	0.796	0.945	0.660	0.822	0.760	0.647	0.846	1.000	0.909	1.341	0.951	0.697	1.281	1.052	1.579	1.557	1.417	0.9744	0.0551
E09	0.876	1.039	0.726	0.904	0.836	0.712	0.931	1.100	1.000	1.475	1.046	0.766	1.408	1.157	1.737	1.712	1.558	1.0716	0.0606
E10	0.594	0.704	0.492	0.613	0.567	0.482	0.631	0.746	0.678	1.000	0.709	0.520	0.955	0.784	1.178	1.161	1.056	0.7266	0.0411
E11	0.838	0.993	0.694	0.865	0.799	0.681	0.890	1.052	0.956	1.411	1.000	0.733	1.347	1.106	1.661	1.638	1.490	1.0249	0.0580
E12	1.143	1.355	0.947	1.180	1.090	0.929	1.214	1.435	1.305	1.925	1.364	1.000	1.838	1.510	2.267	2.234	2.033	1.3984	0.0791
E13	0.622	0.738	0.515	0.642	0.593	0.505	0.661	0.781	0.710	1.047	0.742	0.544	1.000	0.821	1.233	1.216	1.106	0.7609	0.0431
E14	0.757	0.898	0.627	0.781	0.722	0.615	0.804	0.951	0.864	1.275	0.904	0.662	1.217	1.000	1.501	1.480	1.347	0.9263	0.0524
E15	0.504	0.598	0.418	0.520	0.481	0.410	0.536	0.633	0.576	0.849	0.602	0.441	0.811	0.666	1.000	0.986	0.897	0.6169	0.0349
E16	0.512	0.607	0.424	0.528	0.488	0.416	0.543	0.642	0.584	0.861	0.611	0.448	0.823	0.676	1.014	1.000	0.910	0.6259	0.0354
E17	0.562	0.667	0.466	0.580	0.536	0.457	0.597	0.706	0.642	0.947	0.671	0.492	0.904	0.742	1.115	1.099	1.000	0.6878	0.0389

DMU	Criteria 4 (O4/I1)																	Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	1.130	0.423	0.877	0.681	0.828	1.341	0.854	1.857	0.858	0.616	1.083	1.685	0.874	1.264	2.492	1.345	1.0350	0.0558
E02	0.885	1.000	0.374	0.776	0.602	0.733	1.187	0.755	1.643	0.759	0.545	0.958	1.491	0.773	1.118	2.204	1.190	0.9156	0.0494
E03	2.367	2.676	1.000	2.076	1.612	1.961	3.175	2.020	4.396	2.032	1.457	2.564	3.989	2.069	2.991	5.897	3.183	2.4497	0.1322
E04	1.140	1.289	0.482	1.000	0.776	0.945	1.529	0.973	2.118	0.979	0.702	1.235	1.922	0.997	1.441	2.841	1.533	1.1802	0.0637
E05	1.469	1.660	0.620	1.288	1.000	1.217	1.970	1.253	2.727	1.261	0.904	1.591	2.475	1.284	1.856	3.659	1.975	1.5199	0.0820
E06	1.207	1.365	0.510	1.059	0.822	1.000	1.619	1.030	2.242	1.036	0.743	1.308	2.034	1.055	1.526	3.008	1.623	1.2493	0.0674
E07	0.746	0.843	0.315	0.654	0.508	0.618	1.000	0.636	1.385	0.640	0.459	0.808	1.256	0.652	0.942	1.858	1.003	0.7717	0.0416
E08	1.172	1.324	0.495	1.027	0.798	0.971	1.571	1.000	2.176	1.006	0.721	1.269	1.974	1.024	1.481	2.919	1.576	1.2126	0.0654
E09	0.538	0.609	0.228	0.472	0.367	0.446	0.722	0.460	1.000	0.462	0.331	0.583	0.907	0.471	0.681	1.342	0.724	0.5573	0.0301
E10	1.165	1.317	0.492	1.022	0.793	0.965	1.562	0.994	2.163	1.000	0.717	1.262	1.963	1.018	1.472	2.902	1.567	1.2056	0.0650
E11	1.625	1.837	0.686	1.425	1.106	1.346	2.179	1.387	3.017	1.395	1.000	1.760	2.738	1.420	2.053	4.048	2.185	1.6815	0.0907
E12	0.923	1.043	0.390	0.810	0.629	0.765	1.238	0.788	1.714	0.792	0.568	1.000	1.556	0.807	1.167	2.300	1.241	0.9554	0.0515
E13	0.593	0.671	0.251	0.520	0.404	0.492	0.796	0.506	1.102	0.509	0.365	0.643	1.000	0.519	0.750	1.479	0.798	0.6142	0.0331
E14	1.144	1.293	0.483	1.003	0.779	0.948	1.534	0.976	2.124	0.982	0.704	1.239	1.928	1.000	1.446	2.850	1.538	1.1838	0.0639
E15	0.791	0.894	0.334	0.694	0.539	0.655	1.061	0.675	1.469	0.679	0.487	0.857	1.333	0.692	1.000	1.971	1.064	0.8189	0.0442
E16	0.401	0.454	0.170	0.352	0.273	0.332	0.538	0.343	0.745	0.345	0.247	0.435	0.676	0.351	0.507	1.000	0.540	0.4154	0.0224
E17	0.744	0.841	0.314	0.652	0.506	0.616	0.997	0.635	1.381	0.638	0.458	0.806	1.253	0.650	0.940	1.853	1.000	0.7696	0.0415

DMU	Criteria 5 (O5/I1)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	1.654	1.226	1.523	1.577	1.664	2.329	2.025	3.583	0.753	1.600	1.980	1.929	0.841	1.003	1.962	0.884	1.4941	0.0812
E02	0.605	1.000	0.741	0.921	0.953	1.006	1.408	1.225	2.167	0.455	0.967	1.197	1.167	0.509	0.607	1.187	0.534	0.9034	0.0491
E03	0.816	1.349	1.000	1.242	1.286	1.357	1.900	1.652	2.923	0.614	1.305	1.615	1.574	0.686	0.818	1.601	0.721	1.2188	0.0662
E04	0.657	1.086	0.805	1.000	1.035	1.092	1.529	1.330	2.353	0.494	1.050	1.300	1.267	0.552	0.659	1.289	0.580	0.9811	0.0533
E05	0.634	1.049	0.778	0.966	1.000	1.055	1.477	1.285	2.273	0.477	1.015	1.256	1.224	0.533	0.636	1.245	0.560	0.9476	0.0515
E06	0.601	0.994	0.737	0.915	0.948	1.000	1.400	1.217	2.154	0.452	0.962	1.190	1.160	0.505	0.603	1.179	0.531	0.8981	0.0488
E07	0.429	0.710	0.526	0.654	0.677	0.714	1.000	0.870	1.538	0.323	0.687	0.850	0.828	0.361	0.431	0.842	0.379	0.6415	0.0349
E08	0.494	0.817	0.605	0.752	0.778	0.821	1.150	1.000	1.769	0.372	0.790	0.978	0.953	0.415	0.495	0.969	0.436	0.7377	0.0401
E09	0.279	0.462	0.342	0.425	0.440	0.464	0.650	0.565	1.000	0.210	0.446	0.553	0.538	0.235	0.280	0.548	0.247	0.4170	0.0227
E10	1.329	2.198	1.629	2.024	2.095	2.211	3.095	2.692	4.762	1.000	2.126	2.632	2.564	1.118	1.333	2.608	1.174	1.9855	0.1079
E11	0.625	1.034	0.766	0.952	0.986	1.040	1.456	1.266	2.240	0.470	1.000	1.238	1.206	0.526	0.627	1.227	0.552	0.9340	0.0507
E12	0.505	0.835	0.619	0.769	0.796	0.840	1.176	1.023	1.810	0.380	0.808	1.000	0.974	0.425	0.507	0.991	0.446	0.7545	0.0410
E13	0.518	0.857	0.635	0.789	0.817	0.862	1.207	1.050	1.857	0.390	0.829	1.026	1.000	0.436	0.520	1.017	0.458	0.7743	0.0421
E14	1.189	1.967	1.458	1.811	1.875	1.978	2.770	2.408	4.261	0.895	1.902	2.355	2.294	1.000	1.193	2.333	1.051	1.7766	0.0965
E15	0.997	1.648	1.222	1.518	1.571	1.658	2.321	2.019	3.571	0.750	1.594	1.974	1.923	0.838	1.000	1.956	0.881	1.4891	0.0809
E16	0.510	0.843	0.625	0.776	0.803	0.848	1.187	1.032	1.826	0.383	0.815	1.009	0.983	0.429	0.511	1.000	0.450	0.7614	0.0414
E17	1.132	1.872	1.387	1.724	1.784	1.883	2.636	2.292	4.056	0.852	1.811	2.241	2.184	0.952	1.136	2.221	1.000	1.6910	0.0919

DMU	Criteria 6 (O6/I1)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	0.783	1.272	1.342	0.717	0.260	0.574	0.406	0.270	0.750	0.893	0.303	0.808	0.767	0.447	2.156	0.711	0.6779	0.0341
E02	1.278	1.000	1.625	1.715	0.917	0.332	0.733	0.519	0.345	0.958	1.141	0.387	1.032	0.980	0.571	2.755	0.908	0.8662	0.0435
E03	0.786	0.615	1.000	1.055	0.564	0.204	0.451	0.319	0.212	0.590	0.702	0.238	0.635	0.603	0.351	1.696	0.559	0.5330	0.0268
E04	0.745	0.583	0.948	1.000	0.535	0.194	0.427	0.303	0.201	0.559	0.665	0.226	0.602	0.571	0.333	1.607	0.529	0.5051	0.0254
E05	1.394	1.091	1.773	1.871	1.000	0.362	0.799	0.566	0.376	1.045	1.245	0.422	1.126	1.069	0.623	3.006	0.990	0.9449	0.0475
E06	3.846	3.010	4.891	5.162	2.759	1.000	2.206	1.563	1.038	2.885	3.434	1.165	3.107	2.949	1.718	8.293	2.733	2.6072	0.1310
E07	1.744	1.365	2.217	2.340	1.251	0.453	1.000	0.708	0.471	1.308	1.557	0.528	1.408	1.337	0.779	3.760	1.239	1.1819	0.0594
E08	2.462	1.926	3.130	3.304	1.766	0.640	1.412	1.000	0.665	1.846	2.198	0.746	1.988	1.887	1.100	5.308	1.749	1.6686	0.0838
E09	3.704	2.899	4.710	4.971	2.657	0.963	2.124	1.505	1.000	2.778	3.307	1.122	2.991	2.840	1.655	7.986	2.632	2.5106	0.1261
E10	1.333	1.043	1.696	1.789	0.957	0.347	0.765	0.542	0.360	1.000	1.190	0.404	1.077	1.022	0.596	2.875	0.947	0.9038	0.0454
E11	1.120	0.877	1.424	1.503	0.803	0.291	0.642	0.455	0.302	0.840	1.000	0.339	0.905	0.859	0.500	2.415	0.796	0.7592	0.0381
E12	3.302	2.584	4.199	4.431	2.369	0.858	1.894	1.341	0.891	2.476	2.948	1.000	2.667	2.531	1.475	7.119	2.346	2.2381	0.1124
E13	1.238	0.969	1.575	1.662	0.888	0.322	0.710	0.503	0.334	0.929	1.105	0.375	1.000	0.949	0.553	2.670	0.880	0.8393	0.0422
E14	1.304	1.021	1.659	1.751	0.936	0.339	0.748	0.530	0.352	0.978	1.165	0.395	1.054	1.000	0.583	2.813	0.927	0.8842	0.0444
E15	2.238	1.752	2.846	3.004	1.606	0.582	1.284	0.909	0.604	1.679	1.998	0.678	1.808	1.716	1.000	4.826	1.590	1.5171	0.0762
E16	0.464	0.363	0.590	0.622	0.333	0.121	0.266	0.188	0.125	0.348	0.414	0.140	0.375	0.356	0.207	1.000	0.330	0.3144	0.0158
E17	1.407	1.101	1.790	1.889	1.010	0.366	0.807	0.572	0.380	1.056	1.257	0.426	1.137	1.079	0.629	3.035	1.000	0.9540	0.0479

DMU	Criteria 7 (O7/I1)																		Priorities
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	Mc	Pi
E01	1.000	1.625	0.211	2.302	0.745	0.587	1.083	0.880	1.773	#####	1.693	5.688	1.379	4.983	#####	#####	1.500	35.7042	0.0675
E02	0.615	1.000	0.130	1.417	0.458	0.361	0.667	0.542	1.091	#####	1.042	3.500	0.848	3.067	#####	#####	0.923	21.9718	0.0415
E03	4.734	7.692	1.000	10.897	3.526	2.778	5.128	4.167	8.392	#####	8.013	26.923	6.527	23.590	#####	#####	7.101	169.0141	0.3196
E04	0.434	0.706	0.092	1.000	0.324	0.255	0.471	0.382	0.770	#####	0.735	2.471	0.599	2.165	#####	#####	0.652	15.5095	0.0293
E05	1.343	2.182	0.284	3.091	1.000	0.788	1.455	1.182	2.380	#####	2.273	7.636	1.851	6.691	#####	#####	2.014	47.9385	0.0906
E06	1.704	2.769	0.360	3.923	1.269	1.000	1.846	1.500	3.021	#####	2.885	9.692	2.350	8.492	#####	#####	2.556	60.8451	0.1150
E07	0.923	1.500	0.195	2.125	0.688	0.542	1.000	0.813	1.636	#####	1.563	5.250	1.273	4.600	#####	#####	1.385	32.9577	0.0623
E08	1.136	1.846	0.240	2.615	0.846	0.667	1.231	1.000	2.014	#####	1.923	6.462	1.566	5.662	#####	#####	1.704	40.5634	0.0767
E09	0.564	0.917	0.119	1.299	0.420	0.331	0.611	0.497	1.000	#####	0.955	3.208	0.778	2.811	#####	#####	0.846	20.1408	0.0381
E10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.667	0.548	0.000	0.0000	0.0000
E11	0.591	0.960	0.125	1.360	0.440	0.347	0.640	0.520	1.047	#####	1.000	3.360	0.815	2.944	#####	#####	0.886	21.0930	0.0399
E12	0.176	0.286	0.037	0.405	0.131	0.103	0.190	0.155	0.312	#####	0.298	1.000	0.242	0.876	#####	#####	0.264	6.2777	0.0119
E13	0.725	1.179	0.153	1.670	0.540	0.426	0.786	0.638	1.286	#####	1.228	4.125	1.000	3.614	#####	#####	1.088	25.8954	0.0490
E14	0.201	0.326	0.042	0.462	0.149	0.118	0.217	0.177	0.356	#####	0.340	1.141	0.277	1.000	#####	#####	0.301	7.1647	0.0135
E15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.500	0.000	0.000	0.000	0.000	1.000	0.821	0.000	0.0000	0.0000
E16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.826	0.000	0.000	0.000	0.000	1.217	1.000	0.000	0.0000	0.0000
E17	0.667	1.083	0.141	1.535	0.497	0.391	0.722	0.587	1.182	#####	1.128	3.792	0.919	3.322	#####	#####	1.000	23.8028	0.0450

Synthesize the results to determine the best alternative. Obtain the final results									
wieght	5.033	2.046	5.407	1.302	9.000	4.119	1.405	Score	Rank
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7		
E01	0.0769	0.0382	0.0692	0.0558	0.0812	0.0341	0.0675	1.8782	4
E02	0.0822	0.0825	0.0584	0.0494	0.0491	0.0435	0.0415	1.6421	9
E03	0.0816	0.0583	0.0836	0.1322	0.0662	0.0268	0.3196	2.3095	1
E04	0.0702	0.0547	0.0671	0.0637	0.0533	0.0254	0.0293	1.5366	13
E05	0.0680	0.0833	0.0726	0.0820	0.0515	0.0475	0.0906	1.7982	6
E06	0.0735	0.1136	0.0852	0.0674	0.0488	0.1310	0.1150	2.2912	2
E07	0.0722	0.0818	0.0652	0.0416	0.0349	0.0594	0.0623	1.5834	11
E08	0.0624	0.0580	0.0551	0.0654	0.0401	0.0838	0.0767	1.6300	10
E09	0.0557	0.0312	0.0606	0.0301	0.0227	0.1261	0.0381	1.4882	14
E10	0.0652	0.0619	0.0411	0.0650	0.1079	0.0454	0.0000	1.9197	3
E11	0.0465	0.0461	0.0580	0.0907	0.0507	0.0381	0.0399	1.4298	15
E12	0.0394	0.0746	0.0791	0.0515	0.0410	0.1124	0.0119	1.6947	8
E13	0.0262	0.0348	0.0431	0.0331	0.0421	0.0422	0.0490	1.1000	16
E14	0.0685	0.0398	0.0524	0.0639	0.0965	0.0444	0.0135	1.8636	5
E15	0.0387	0.0390	0.0349	0.0442	0.0809	0.0762	0.0000	1.5628	12
E16	0.0249	0.0308	0.0354	0.0224	0.0414	0.0158	0.0000	0.8465	17
E17	0.0478	0.0714	0.0389	0.0415	0.0919	0.0479	0.0450	1.7385	7

7. Ranking of sectors in the organization

The evaluation criteria						
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6
DMU	O1/I1	O1/I2	O2/I1	O2/I2	O3/I1	O3/I2
S1	1.087	1.042	1.130	1.083	3.729	3.574
S2	1.143	1.043	0.952	0.870	3.728	3.404
S3	0.962	1.190	1.077	1.333	3.689	4.567
S4	1.381	1.450	1.048	1.100	4.333	4.550
S5	1.286	1.038	1.238	1.000	4.218	3.407
S6	1.091	1.043	0.909	0.870	4.071	3.894

Weights of inputs and outputs of all DMUs					
DMU	*v1*	*v2*	*μ1*	*μ2*	*μ3*
S1	0.0289	0.0140	0.0000	0.0373	0.0000
S2	0.0476	0.0000	0.0000	0.0058	0.0096
S3	0.0277	0.0134	0.0000	0.0357	0.0000
S4	0.0476	0.0000	0.0345	0.0000	0.0000
S5	0.0261	0.0173	0.0081	0.0301	0.0000
S6	0.0455	0.0000	0.0000	0.0000	0.0105
Average weights	0.0372	0.0074	0.0071	0.0182	0.0033

The weights of the criteria						
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6
M	0.191	0.952	0.488	2.437	0.090	0.449
Normalized	0.70	3.52	1.80	9.00	0.33	1.66

Pairwise Comparisons								
	Criteria 1 (O1/I1)							Priorities
DMU	E1	E2	E3	E4	E5	E6	Mc	Pi
S1	1.000	0.951	1.130	0.787	0.845	0.996	0.945	0.1564
S2	1.051	1.000	1.189	0.828	0.889	1.048	0.994	0.1645
S3	0.885	0.841	1.000	0.696	0.748	0.881	0.836	0.1384
S4	1.270	1.208	1.436	1.000	1.074	1.266	1.201	0.1987
S5	1.183	1.125	1.337	0.931	1.000	1.179	1.118	0.1850
S6	1.004	0.955	1.135	0.790	0.848	1.000	0.949	0.1570

	Criteria 2 (O1/I2)							Priorities
DMU	E1	E2	E3	E4	E5	E6	Mc	Pi
S1	1.000	0.998	0.875	0.718	1.003	0.998	0.925	0.1530
S2	1.002	1.000	0.877	0.720	1.005	1.000	0.927	0.1533
S3	1.143	1.141	1.000	0.821	1.146	1.141	1.058	0.1749
S4	1.392	1.390	1.218	1.000	1.396	1.390	1.288	0.2130
S5	0.997	0.995	0.872	0.716	1.000	0.995	0.923	0.1525
S6	1.002	1.000	0.877	0.720	1.005	1.000	0.927	0.1533

	Criteria 3 (O2/I1)							Priorities
DMU	E1	E2	E3	E4	E5	E6	Mc	Pi
S1	1.000	1.187	1.050	1.079	0.913	1.243	1.073	0.1779
S2	0.842	1.000	0.884	0.909	0.769	1.048	0.904	0.1499
S3	0.953	1.131	1.000	1.028	0.870	1.185	1.022	0.1695
S4	0.927	1.100	0.973	1.000	0.846	1.152	0.994	0.1649
S5	1.095	1.300	1.150	1.182	1.000	1.362	1.175	0.1948
S6	0.804	0.955	0.844	0.868	0.734	1.000	0.863	0.1431

	Criteria 4 (O2/I2)							Priorities
DMU	E1	E2	E3	E4	E5	E6	Mc	Pi
S1	1.000	1.246	0.813	0.985	1.083	1.246	1.051	0.1732
S2	0.803	1.000	0.652	0.791	0.870	1.000	0.843	0.1390
S3	1.231	1.533	1.000	1.212	1.333	1.533	1.293	0.2131
S4	1.015	1.265	0.825	1.000	1.100	1.265	1.067	0.1758
S5	0.923	1.150	0.750	0.909	1.000	1.150	0.970	0.1599
S6	0.803	1.000	0.652	0.791	0.870	1.000	0.843	0.1390

	Criteria 5 (O3/I1)							Priorities
DMU	E1	E2	E3	E4	E5	E6	Mc	Pi
S1	1.000	1.000	1.011	0.861	0.884	0.916	0.943	0.1569
S2	1.000	1.000	1.011	0.860	0.884	0.916	0.943	0.1568
S3	0.989	0.990	1.000	0.851	0.875	0.906	0.933	0.1552
S4	1.162	1.162	1.175	1.000	1.027	1.064	1.096	0.1823
S5	1.131	1.131	1.143	0.973	1.000	1.036	1.067	0.1774
S6	1.092	1.092	1.104	0.939	0.965	1.000	1.030	0.1713

	Criteria 6 (O3/I2)							Priorities
DMU	E1	E2	E3	E4	E5	E6	Mc	Pi
S1	1.000	1.050	0.783	0.785	1.049	0.918	0.924	0.1528
S2	0.952	1.000	0.745	0.748	0.999	0.874	0.880	0.1455
S3	1.278	1.342	1.000	1.004	1.341	1.173	1.180	0.1952
S4	1.273	1.337	0.996	1.000	1.336	1.168	1.176	0.1945
S5	0.953	1.001	0.746	0.749	1.000	0.875	0.880	0.1456
S6	1.090	1.144	0.853	0.856	1.143	1.000	1.007	0.1664

Synthesize the results to determine the best alternative. Obtain the final results									
wieght	0.704	3.517	1.801	9.000	0.332	1.658		Score	Rank
	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6			
S1	0.156	0.153	0.178	0.173	0.157	0.153		2.833	3
S2	0.164	0.153	0.150	0.139	0.157	0.145		2.469	6
S3	0.138	0.175	0.169	0.213	0.155	0.195		3.311	1
S4	0.199	0.213	0.165	0.176	0.182	0.194		3.151	2
S5	0.185	0.153	0.195	0.160	0.177	0.146		2.757	4
S6	0.157	0.153	0.143	0.139	0.171	0.166		2.491	5

Appendix D: DEA-AHP Results Using Jablonsky Approach

Relative strength of evaluation scale elements							
	Excellent	VG	Good	Poor	VP	Mc	Pi
Excellent	1.00	3.00	5.00	7.00	9.00	3.94	0.5100
Very Good	0.33	1.00	3.00	5.00	7.00	2.04	0.2638
Good	0.20	0.33	1.00	3.00	5.00	1.00	0.1296
Poor	0.14	0.20	0.33	1.00	3.00	0.49	0.0636
Very Poor	0.11	0.14	0.20	0.33	1.00	0.25	0.0329

1. **Ranking of companies under Sector 1**

The evaluation criteria						
DMU	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3
E1	0.090	1.125	0.0017	7.000	87.500	0.130
E2	0.067	1.000	0.0021	6.333	95.000	0.198
E3	0.067	0.381	0.0016	6.250	35.714	0.147
E4	0.090	1.500	0.0021	9.000	150.000	0.214
E5	0.039	1.400	0.0012	4.444	160.000	0.133
E6	0.143	1.111	0.0019	7.143	55.556	0.096
E7	0.080	2.667	0.0016	7.000	233.333	0.140
E8	0.063	0.500	0.0014	6.250	50.000	0.136
E9	0.046	0.813	0.0011	3.929	68.750	0.096
E10	0.106	0.944	0.0019	11.250	100.000	0.200

Weights of inputs and outputs of all DMUs						
DMU	*v1*	*v2*	*v3*	*μ1*	*μ2*	
E1	0.0644	0.4448	0.0000	0.6902	0.0032	
E2	0.0000	0.0000	0.0021	0.9722	0.0000	
E3	0.0195	0.0000	0.0015	0.9176	0.0000	
E4	0.0000	0.0000	0.0024	0.0000	0.0111	
E5	0.0000	0.9286	0.0009	0.0000	0.0104	
E6	0.0212	0.0000	0.0016	1.0000	0.0000	
E7	0.0714	0.9524	0.0000	0.0000	0.0143	
E8	0.0340	0.0000	0.0011	0.7152	0.0016	
E9	0.0000	0.5405	0.0010	0.8250	0.0000	
E10	0.0263	0.0000	0.0018	0.0000	0.0111	
erage weigh	0.0237	0.2866	0.0012	0.5120	0.0052	
The weights of the criteria						
M	21.613	1.786	415.511	0.218	0.018	4.198

DMU	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3
Median	0.0733	1.0556	0.0016	6.6667	91.2500	0.1382
Max	0.1429	2.6667	0.0021	11.2500	233.3333	0.2143
Min	0.0389	0.3810	0.0011	3.9286	35.7143	0.0962
Excellent	>	>	>	>	>	>
Very Good	0.120	2.130	0.002	9.722	185.972	0.189
Good	0.073	1.056	0.0016	6.667	91.250	0.138
Poor	0.046	0.516	0.001	4.476	46.821	0.105
Very Poor	0.039	0.381	0.0011	3.929	35.714	0.096

AHP with absolute measurement									
DMU	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3	DMU	Rank using M	Rank
E1	0.2638	0.2638	0.2638	0.2638	0.1296	0.1296	E1	116.40	5
E2	0.1296	0.1296	0.5100	0.1296	0.2638	0.5100	E2	217.13	2
E3	0.1296	0.0329	0.1296	0.1296	0.0329	0.2638	E3	57.835	7
E4	0.2638	0.2638	0.5100	0.2638	0.2638	0.5100	E4	220.30	1
E5	0.0329	0.2638	0.0636	0.0636	0.2638	0.1296	E5	28.19	9
E6	0.5100	0.2638	0.2638	0.2638	0.1296	0.0329	E6	121.32	3
E7	0.2638	0.5100	0.1296	0.2638	0.5100	0.2638	E7	61.63	6
E8	0.1296	0.0636	0.1296	0.1296	0.1296	0.1296	E8	57.328	8
E9	0.1296	0.1296	0.0329	0.0329	0.1296	0.0636	E9	16.99	10
E10	0.2638	0.1296	0.2638	0.5100	0.2638	0.5100	E10	117.82	4

2. Ranking of companies under Sector 2

The evaluation criteria						
	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3
E1	0.090	1.125	0.002	7.000	87.500	0.130
E2	0.067	1.000	0.002	6.333	95.000	0.198
E3	0.067	0.381	0.002	6.250	35.714	0.147
E4	0.090	1.500	0.002	9.000	150.000	0.214
E5	0.039	1.400	0.001	4.444	160.000	0.133
E6	0.143	1.111	0.002	7.143	55.556	0.096
E7	0.080	2.667	0.002	7.000	233.333	0.140
E8	0.063	1.500	0.001	6.250	150.000	0.136
E9	0.046	0.361	0.001	3.929	30.556	0.096
E10	0.106	0.944	0.002	11.250	100.000	0.200
E11	0.158	3.167	0.002	16.667	333.333	0.222
E12	0.143	3.333	0.002	14.286	333.333	0.238
E13	0.125	3.333	0.003	11.875	316.667	0.238

Weights of inputs and outputs of all DMUs					
	$v1$	$v2$	$v3$	$\mu 1$	$\mu 2$
E1	0.0077	0.0000	0.0004	0.2162	0.0000
E2	0.0000	0.0000	0.0006	0.0119	0.0024
E3	0.0000	0.0000	0.0006	0.2241	0.0000
E4	0.0000	0.0000	0.0007	0.0000	0.0029
E5	0.0000	0.0000	0.0005	0.0000	0.0020
E6	0.0210	0.0000	0.0003	0.2590	0.0000
E7	0.0000	0.9524	0.0000	0.2857	0.0000
E8	0.0000	0.0000	0.0005	0.0000	0.0022
E9	0.0000	0.0000	0.0005	0.2005	0.0000
E10	0.0000	0.0000	0.0006	0.0000	0.0027
E11	0.0136	0.0000	0.0005	0.0000	0.0029
E12	0.0000	0.0000	0.0007	0.0000	0.0029
E13	0.0000	0.0000	0.0007	0.0143	0.0029
Average weights	0.0033	0.0733	0.0005	0.0932	0.0016

The weights of the criteria						
M	28.650	1.272	187.310	0.488	0.022	3.193

	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3
Median	0.0900	1.4000	0.0019	7.0000	150.000	0.1471
Max	0.1583	3.3333	0.0025	16.6667	333.333	0.2381
Min	0.0389	0.3611	0.0011	3.9286	30.556	0.0962
Excellent	>	>	>	>	>	>
Very Good	0.136	2.689	0.0023	13.444	272.222	0.208
Good	0.090	1.400	0.0019	7.000	150.000	0.147
Poor	0.049	0.569	0.0013	4.543	54.444	0.106
Very Poor	0.039	0.361	0.0011	3.929	30.556	0.096

AHP with absolute measurement								
	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3	Rank using M	Rank
E1	0.1296	0.1296	0.1296	0.1296	0.1296	0.1296	28.6275	9
E2	0.1296	0.1296	0.2638	0.1296	0.1296	0.2638	54.2046	7
E3	0.1296	0.0636	0.1296	0.1296	0.0636	0.1296	28.5422	10
E4	0.1296	0.2638	0.2638	0.2638	0.1296	0.5100	55.2272	6
E5	0.0329	0.1296	0.0636	0.0636	0.2638	0.1296	13.4782	13
E6	0.5100	0.1296	0.2638	0.2638	0.1296	0.0329	64.4330	4
E7	0.1296	0.2638	0.1296	0.1296	0.2638	0.1296	28.8012	8
E8	0.1296	0.2638	0.1296	0.1296	0.1296	0.1296	28.7983	11
E9	0.0636	0.0329	0.0329	0.0329	0.0329	0.0636	8.2509	12
E10	0.2638	0.1296	0.1296	0.2638	0.1296	0.2638	32.9684	5
E11	0.5100	0.5100	0.2638	0.5100	0.5100	0.5100	66.5692	3
E12	0.5100	0.5100	0.5100	0.5100	0.5100	0.5100	112.6860	1
E13	0.2638	0.5100	0.5100	0.2638	0.5100	0.5100	105.5120	2

3. Ranking of companies under Sector 3

The evaluation criteria								
DMU	O1/I1	O1/I2	O2/I1	O2/I2	O3/I1	O3/I2	O4/I1	O4/I2
E1	1.417	375.991	0.274	72.687	0.000	0.031	0.000	0.130
E2	2.220	156.137	0.306	21.529	0.000	0.034	0.002	0.145
E3	1.703	288.591	0.228	38.591	0.000	0.050	0.001	0.221
E4	2.739	143.023	0.290	15.116	0.001	0.049	0.004	0.209
E5	1.347	72.404	0.254	13.661	0.001	0.046	0.003	0.161
E6	1.925	186.258	0.229	22.199	0.000	0.032	0.001	0.144
E7	2.132	136.742	0.269	17.235	0.000	0.028	0.002	0.102
E8	1.622	187.222	0.245	28.333	0.001	0.078	0.003	0.389
E9	3.165	71.835	0.153	3.481	0.003	0.063	0.010	0.234
E10	2.716	37.879	0.121	1.684	0.002	0.034	0.012	0.172
E11	0.587	4.490	0.036	0.272	0.002	0.019	0.014	0.105
E12	1.548	282.813	0.334	60.938	0.000	0.051	0.001	0.266
E13	1.741	134.815	0.335	25.926	0.001	0.063	0.003	0.259
E14	1.795	110.465	0.104	6.395	0.001	0.087	0.006	0.366
E15	2.264	64.396	0.131	3.736	0.001	0.037	0.006	0.158

Weights of inputs and outputs of all DMUs						
	v1	*v2*	*μ1*	*μ2*	*μ3*	*μ4*
E1	0.0004	0.1060	0.0000	0.0030	0.0000	0.0000
E2	0.0027	0.0105	0.0004	0.0066	0.0000	0.0000
E3	0.0015	0.0843	0.0010	0.0011	0.0000	0.0000
E4	0.0025	0.1589	0.0020	0.0000	0.0000	0.0000
E5	0.0051	0.0000	0.0000	0.0124	1.1397	0.0000
E6	0.0013	0.0833	0.0011	0.0000	0.0000	0.0000
E7	0.0028	0.0108	0.0004	0.0068	0.0000	0.0000
E8	0.0035	0.1570	0.0009	0.0064	0.0000	0.5185
E9	0.0037	0.2328	0.0020	0.0000	2.6747	0.0000
E10	0.0070	0.0708	0.0000	0.0000	0.0000	0.9804
E11	0.0138	0.0306	0.0000	0.0000	0.0000	1.2987
E12	0.0021	0.0010	0.0000	0.0064	0.0000	0.0000
E13	0.0048	0.0000	0.0000	0.0143	0.0000	0.0000
E14	0.0007	0.5404	0.0000	0.0000	0.0000	1.5873
E15	0.0062	0.0439	0.0026	0.0000	0.0000	0.0000
Average weights	0.0039	0.1020	0.0007	0.0038	0.2543	0.2923

The weights of the criteria								
M	0.179	0.007	0.983	0.037	65.720	2.493	75.550	2.866

	O1/I1	O1/I2	O2/I1	O2/I2	O3/I1	O3/I2	O4/I1	O4/I2
Median	1.7948	136.7424	0.2455	17.2348	0.0008	0.0464	0.0033	0.1717
Max	3.1651	375.9912	0.3347	72.6872	0.0028	0.0872	0.0137	0.3889
Min	0.5874	4.4898	0.0356	0.2721	0.0001	0.0190	0.0005	0.1023
Excellent	>	>	>	>	>	>	>	>
Very Good	2.708	296.242	0.305	54.203	0.002	0.074	0.010	0.316
Good	1.795	136.742	0.245	17.235	0.001	0.046	0.003	0.172
Poor	0.829	30.940	0.078	3.665	0.000	0.025	0.001	0.116
Very Poor	0.587	4.490	0.036	0.272	0.000	0.019	0.000	0.102

AHP with absolute measurement										
DMU	O1/I1	O1/I2	O2/I1	O2/I2	O3/I1	O3/I2	O4/I1	O4/I2	Rank using M	Rank
E1	0.1296	0.5100	0.2638	0.5100	0.0329	0.1296	0.0329	0.1296	5.6497	15
E2	0.2638	0.2638	0.5100	0.2638	0.1296	0.1296	0.1296	0.1296	19.5595	12
E3	0.1296	0.2638	0.1296	0.2638	0.1296	0.2638	0.1296	0.2638	19.8809	11
E4	0.5100	0.2638	0.2638	0.1296	0.2638	0.2638	0.2638	0.2638	39.0429	5
E5	0.1296	0.1296	0.2638	0.1296	0.2638	0.1296	0.1296	0.1296	28.1111	8
E6	0.2638	0.2638	0.1296	0.2638	0.1296	0.1296	0.1296	0.1296	19.1855	13
E7	0.2638	0.1296	0.2638	0.1296	0.1296	0.1296	0.1296	0.0329	19.0345	14
E8	0.1296	0.2638	0.1296	0.2638	0.1296	0.5100	0.2638	0.5100	31.3436	7
E9	0.5100	0.1296	0.1296	0.0636	0.5100	0.2638	0.5100	0.2638	73.6890	1
E10	0.5100	0.1296	0.1296	0.0636	0.5100	0.1296	0.5100	0.1296	72.9696	2
E11	0.0329	0.0329	0.0329	0.0329	0.5100	0.0329	0.5100	0.0636	72.3575	3
E12	0.1296	0.2638	0.5100	0.5100	0.1296	0.2638	0.1296	0.2638	20.2641	9
E13	0.1296	0.1296	0.5100	0.2638	0.1296	0.2638	0.1296	0.2638	20.2540	10
E14	0.1296	0.1296	0.1296	0.1296	0.2638	0.5100	0.2638	0.5100	40.1612	4
E15	0.2638	0.1296	0.1296	0.1296	0.2638	0.1296	0.2638	0.1296	38.1465	6

4. Ranking of companies under Sector 4

The evaluation criteria												
DMU	O1/I1	O1/I2	O1/I3	O1/I4	O2/I1	O2/I2	O2/I3	O2/I4	O3/I1	O3/I2	O3/I3	O3/I4
E1	0.385	0.314	0.587	0.428	1.258	1.026	1.916	1.397	0.355	0.289	0.540	0.394
E2	0.507	0.351	0.789	0.401	2.028	1.403	3.155	1.604	0.075	0.052	0.117	0.059
E3	0.340	0.261	0.512	0.345	1.649	1.266	2.486	1.676	0.531	0.408	0.801	0.540
E4	0.068	0.077	0.098	0.236	0.953	1.070	1.362	3.290	0.078	0.088	0.112	0.271
E5	0.901	0.393	1.441	0.547	2.827	1.234	4.521	1.716	0.000	0.000	0.000	0.000
E6	0.547	0.428	0.965	0.353	1.322	1.034	2.333	0.853	0.000	0.000	0.000	0.000
E7	0.352	0.526	0.496	0.439	1.023	1.526	1.441	1.274	3.290	4.909	4.633	4.096
E8	0.625	0.509	0.648	0.364	1.039	0.846	1.077	0.605	0.086	0.070	0.089	0.050
E9	0.733	0.455	1.377	0.526	1.285	0.798	2.412	0.922	20.220	12.555	37.958	14.503
E10	0.751	0.183	2.040	0.085	4.649	1.135	12.628	0.529	0.000	0.000	0.000	0.000
E11	0.914	0.237	1.819	0.174	4.729	1.225	9.414	0.900	0.000	0.000	0.000	0.000
E12	0.076	0.042	0.124	0.032	1.868	1.022	3.037	0.782	0.332	0.182	0.540	0.139
E13	0.136	0.111	0.072	0.067	1.299	1.057	0.693	0.644	0.579	0.471	0.309	0.287
E14	0.222	0.240	0.301	0.480	0.914	0.984	1.237	1.973	0.000	0.000	0.000	0.000
E15	2.097	1.341	0.544	10.237	1.740	1.113	0.451	8.495	0.000	0.000	0.000	0.000
E16	0.784	3.606	0.823	1.208	0.288	1.326	0.303	0.444	61.347	281.987	64.338	94.472
E17	1.300	0.242	0.788	5.696	5.292	0.987	3.205	23.180	22.827	4.257	13.826	99.990

Weights of inputs and outputs of all DMUs							
	$v1$	$v2$	$v3$	$v4$	$\mu1$	$\mu2$	$\mu3$
E1	0.0000	0.0077	0.0027	0.0040	0.0048	0.0076	0.0000
E2	0.0009	0.0075	0.0000	0.0000	0.0000	0.0057	0.0000
E3	0.0000	0.0068	0.0003	0.0035	0.0000	0.0071	0.0000
E4	0.0000	0.0045	0.0002	0.0024	0.0000	0.0048	0.0000
E5	0.0040	0.0061	0.0000	0.0010	0.0000	0.0069	0.0000
E6	0.0000	0.0077	0.0042	0.0000	0.0052	0.0055	0.0000
E7	0.0013	0.0101	0.0000	0.0000	0.0000	0.0079	0.0000
E8	0.0058	0.0018	0.0061	0.0000	0.0153	0.0000	0.0000
E9	0.0000	0.0000	0.0227	0.0029	0.0068	0.0043	0.0003
E10	0.0000	0.0078	0.0186	0.0000	0.0000	0.0083	0.0000
E11	0.0044	0.0067	0.0000	0.0011	0.0000	0.0076	0.0000
E12	0.0000	0.0065	0.0032	0.0000	0.0000	0.0056	0.0000
E13	0.0010	0.0087	0.0000	0.0000	0.0000	0.0067	0.0000
E14	0.0000	0.0041	0.0002	0.0021	0.0000	0.0043	0.0000
E15	0.0027	0.0009	0.0028	0.0000	0.0072	0.0000	0.0000
E16	0.0193723	0	0	0	0	0	0.00032
E17	0.0028	0.0046	0.0000	0.0006	0.0000	0.0051	0.0000
Average weights	0.0025	0.0054	0.0036	0.0010	0.0023	0.0051	0.0000

The weights of the criteria												
M	0.928	0.429	0.645	2.229	2.070	0.957	1.438	4.969	0.017	0.008	0.012	0.040

DMU	O1/I1	O1/I2	O1/I3	O1/I4	O2/I1	O2/I2	O2/I3	O2/I4	O3/I1	O3/I2	O3/I3	O3/I4
Median	0.5466	0.3144	0.6479	0.4012	1.3221	1.0698	2.3335	1.2737	0.0856	0.0880	0.1170	0.1391
Max	2.0966	3.6055	2.0400	10.2374	5.2918	1.5264	12.6278	23.1798	61.3466	281.9866	64.3379	99.9903
Min	0.0684	0.0418	0.0725	0.0320	0.2885	0.7978	0.3025	0.4442	0.0000	0.0000	0.0000	0.0000
Excellent	>	>	>	>	>	>	>	>	>	>	>	>
Very Good	1.580	2.508	1.576	6.959	3.969	1.374	9.196	15.878	40.926	188.020	42.931	66.707
Good	0.547	0.314	0.648	0.401	1.322	1.070	2.333	1.274	0.086	0.088	0.117	0.139
Poor	0.164	0.096	0.188	0.106	0.495	0.852	0.709	0.610	0.017	0.018	0.023	0.028
Very Poor	0.068	0.042	0.072	0.032	0.288	0.798	0.303	0.444	0.000	0.000	0.000	0.000

AHP with absolute measurement														
DMU	O1/I1	O1/I2	O1/I3	O1/I4	O2/I1	O2/I2	O2/I3	O2/I4	O3/I1	O3/I2	O3/I3	O3/I4	Rank using M	Rank
E1	0.1296	0.1296	0.1296	0.2638	0.1296	0.1296	0.1296	0.2638	0.2638	0.2638	0.2638	0.2638	2.757	8
E2	0.1296	0.2638	0.2638	0.1296	0.2638	0.5100	0.2638	0.2638	0.1296	0.1296	0.1296	0.1296	3.427	5
E3	0.1296	0.1296	0.1296	0.1296	0.2638	0.2638	0.2638	0.2638	0.2638	0.2638	0.2638	0.2638	3.058	7
E4	0.0329	0.0636	0.0636	0.1296	0.1296	0.1296	0.1296	0.2638	0.1296	0.1296	0.1296	0.2638	2.293	12
E5	0.2638	0.2638	0.2638	0.2638	0.2638	0.2638	0.2638	0.2638	0.0329	0.0329	0.0329	0.0329	3.608	3
E6	0.1296	0.2638	0.2638	0.1296	0.1296	0.1296	0.1296	0.1296	0.0329	0.0329	0.0329	0.0329	1.918	14
E7	0.1296	0.2638	0.1296	0.2638	0.1296	0.5100	0.1296	0.1296	0.2638	0.2638	0.2638	0.2638	2.512	11
E8	0.2638	0.2638	0.1296	0.1296	0.1296	0.0636	0.1296	0.0636	0.1296	0.1296	0.1296	0.1296	1.572	16
E9	0.2638	0.2638	0.2638	0.2638	0.1296	0.0329	0.2638	0.1296	0.2638	0.2638	0.2638	0.2638	2.460	9
E10	0.2638	0.1296	0.5100	0.0636	0.5100	0.2638	0.5100	0.0636	0.0329	0.0329	0.0329	0.0329	3.132	6
E11	0.2638	0.1296	0.5100	0.1296	0.5100	0.2638	0.5100	0.1296	0.0329	0.0329	0.0329	0.0329	3.607	4
E12	0.0636	0.0329	0.0636	0.0329	0.2638	0.1296	0.2638	0.1296	0.2638	0.2638	0.2638	0.1296	1.896	15
E13	0.0636	0.1296	0.0329	0.0636	0.1296	0.1296	0.0636	0.1296	0.2638	0.2638	0.2638	0.2638	1.425	17
E14	0.1296	0.1296	0.1296	0.2638	0.1296	0.1296	0.1296	0.2638	0.0329	0.0329	0.0329	0.0329	2.740	10
E15	0.5100	0.2638	0.1296	0.5100	0.2638	0.2638	0.0636	0.2638	0.0329	0.0329	0.0329	0.0329	4.011	2
E16	0.2638	0.5100	0.2638	0.2638	0.0329	0.2638	0.0329	0.0329	0.5100	0.5100	0.5100	0.5100	1.792	13
E17	0.2638	0.1296	0.2638	0.2638	0.5100	0.1296	0.2638	0.5100	0.2638	0.2638	0.2638	0.5100	5.183	1

5. Ranking of companies under Sector 5

The evaluation criteria												
DMU	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3	O3/I1	O3/I2	O3/I3	O4/I1	O4/I2	O4/I3
E1	0.909	0.400	0.500	1.955	0.860	1.075	3.409	1.500	1.875	3.409	1.500	1.875
E2	1.667	1.000	1.000	1.000	0.600	0.600	0.417	0.250	0.250	0.500	0.300	0.300
E3	1.042	1.471	0.862	2.083	2.941	1.724	2.083	2.941	1.724	2.500	3.529	2.069
E4	1.081	1.739	1.000	0.351	0.565	0.325	0.676	1.087	0.625	0.811	1.304	0.750
E5	0.750	1.000	0.500	1.250	1.667	0.833	1.250	1.667	0.833	1.000	1.333	0.667
E6	0.688	2.200	0.611	1.063	3.400	0.944	0.125	0.400	0.111	0.250	0.800	0.222
E7	0.429	0.400	1.667	0.414	0.387	1.611	0.100	0.093	0.389	0.714	0.667	2.778
E8	0.220	0.200	0.200	0.580	0.527	0.527	0.200	0.182	0.182	0.800	0.727	0.727
E9	0.900	1.125	0.900	1.000	1.250	1.000	0.050	0.063	0.050	0.250	0.313	0.250

Weights of inputs and outputs of all DMUs							
DMU	$v1$	$v2$	$v3$	$\mu 1$	$\mu 2$	$\mu 3$	$\mu 4$
E1	0.0278	0.0077	0.0000	0.0000	0.0000	0.0000	0.0133
E2	0.0167	0.0000	0.0000	0.0100	0.0000	0.0000	0.0000
E3	0.0417	0.0000	0.0000	0.0000	0.0171	0.0000	0.0024
E4	0.0189	0.0131	0.0000	0.0241	0.0000	0.0000	0.0012
E5	0.0155	0.0126	0.0000	0.0213	0.0011	0.0000	0.0000
E6	0.0030	0.0303	0.0000	0.0000	0.0118	0.0000	0.0000
E7	0.0046	0.0000	0.0375	0.0000	0.0000	0.0000	0.0200
E8	0.0020	0.0000	0.0163	0.0000	0.0000	0.0000	0.0087
E9	0.0009	0.0013	0.0080	0.0094	0.0009	0.0000	0.0000
erage weigh	0.0146	0.0072	0.0069	0.0072	0.0034	0.0000	0.0051

The weights of the criteria												
M	0.493	0.994	1.045	0.235	0.474	0.498	0.000	0.000	0.000	0.348	0.702	0.738

DMU	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3	O3/I1	O3/I2	O3/I3	O4/I1	O4/I2	O4/I3
Median	0.9000	1.0000	0.8621	1.0000	0.8600	0.9444	0.4167	0.4000	0.3889	0.8000	0.8000	0.7273
Max	1.6667	2.2000	1.6667	2.0833	3.4000	1.7241	3.4091	2.9412	1.8750	3.4091	3.5294	2.7778
Min	0.2200	0.2000	0.2000	0.3514	0.3867	0.3250	0.0500	0.0625	0.0500	0.2500	0.3000	0.2222
Excellent	>	>	>	>	>	>	>	>	>	>	>	>
Very Good	1.411	1.800	1.398	1.722	2.553	1.464	2.412	2.094	1.380	2.539	2.620	2.094
Good	0.900	1.000	0.862	1.000	0.860	0.944	0.417	0.400	0.389	0.800	0.800	0.727
Poor	0.356	0.360	0.332	0.481	0.481	0.449	0.123	0.130	0.118	0.360	0.400	0.323
Very Poor	0.220	0.200	0.200	0.351	0.387	0.325	0.050	0.063	0.050	0.250	0.300	0.222

AHP with absolute measurement														
	O1/I1	O1/I2	O1/I3	O2/I1	O2/I2	O2/I3	O3/I1	O3/I2	O3/I3	O4/I1	O4/I2	O4/I3	Rank using M	Rank
E1	0.2638	0.1296	0.1296	0.5100	0.1296	0.2638	0.5100	0.2638	0.5100	0.5100	0.2638	0.2638	1.26	4
E2	0.5100	0.1296	0.2638	0.1296	0.1296	0.1296	0.1296	0.1296	0.1296	0.1296	0.0329	0.0636	0.93	8
E3	0.2638	0.2638	0.1296	0.5100	0.5100	0.5100	0.2638	0.5100	0.5100	0.2638	0.5100	0.2638	1.79	1
E4	0.2638	0.2638	0.2638	0.0329	0.1296	0.0329	0.2638	0.2638	0.2638	0.2638	0.2638	0.2638	1.23	2
E5	0.1296	0.1296	0.1296	0.2638	0.2638	0.1296	0.2638	0.2638	0.2638	0.2638	0.2638	0.1296	0.95	7
E6	0.1296	0.5100	0.1296	0.2638	0.5100	0.1296	0.1296	0.1296	0.0636	0.0329	0.1296	0.0329	1.20	5
E7	0.1296	0.1296	0.5100	0.0636	0.0329	0.5100	0.0636	0.0636	0.1296	0.1296	0.1296	0.5100	1.52	3
E8	0.0329	0.0329	0.0329	0.1296	0.1296	0.1296	0.1296	0.1296	0.1296	0.1296	0.1296	0.1296	0.47	9
E9	0.1296	0.2638	0.2638	0.1296	0.2638	0.2638	0.0329	0.0329	0.0329	0.0329	0.0636	0.0636	0.99	6

6. Ranking of companies under Sector 6

The evaluation criteria							
DMU	O1/I1	O2/I1	O3/I1	O4/I1	O5/I1	O6/I1	O7/I1
E1	1.208	0.646	1.063	0.542	0.896	0.375	0.271
E2	1.292	1.396	0.896	0.479	0.542	0.479	0.167
E3	2.083	1.604	2.083	2.083	1.188	0.479	2.083
E4	1.563	1.313	1.458	0.875	0.833	0.396	0.167
E5	0.979	1.292	1.021	0.729	0.521	0.479	0.333
E6	1.250	2.083	1.417	0.708	0.583	1.563	0.500
E7	1.229	1.500	1.083	0.438	0.417	0.708	0.271
E8	1.063	1.063	0.917	0.688	0.479	1.000	0.333
E9	1.313	0.792	1.396	0.438	0.375	2.083	0.229
E10	1.792	1.833	1.104	1.104	2.083	0.875	-
E11	1.521	1.625	1.854	1.833	1.167	0.875	0.333
E12	0.542	1.104	1.063	0.438	0.396	1.083	0.042
E13	0.479	0.688	0.771	0.375	0.542	0.542	0.229
E14	2.063	1.292	1.542	1.188	2.042	0.938	0.104
E15	0.708	0.771	0.625	0.500	1.042	0.979	-
E16	0.375	0.500	0.521	0.208	0.438	0.167	-
E17	1.125	1.813	0.896	0.604	1.521	0.792	0.271

Weights of inputs and outputs of all DMUs								
	v1	*μ1*	*μ2*	*μ3*	*μ4*	*μ5*	*μ6*	*μ7*
E1	0.0208	0.0000	0.0000	0.0088	0.0000	0.0129	0.0000	0.0000
E2	0.0208	0.0126	0.0033	0.0000	0.0000	0.0000	0.0000	0.0000
E3	0.0128	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0100
E4	0.0147	0.0091	0.0012	0.0015	0.0000	0.0000	0.0000	0.0000
E5	0.0227	0.0000	0.0068	0.0000	0.0072	0.0093	0.0000	0.0000
E6	0.0192	0.0000	0.0000	0.0000	0.0000	0.0000	0.0133	0.0000
E7	0.0192	0.0118	0.0016	0.0020	0.0000	0.0000	0.0000	0.0000
E8	0.0192	0.0140	0.0000	0.0000	0.0006	0.0000	0.0019	0.0000
E9	0.0139	0.0000	0.0000	0.0000	0.0000	0.0000	0.0096	0.0000
E10	0.0119	0.0000	0.0000	0.0000	0.0000	0.0100	0.0000	0.0000
E11	0.0100	0.0000	0.0000	0.0000	0.0044	0.0048	0.0032	0.0000
E12	0.0238	0.0000	0.0000	0.0182	0.0000	0.0000	0.0000	0.0000
E13	0.0179	0.0000	0.0000	0.0074	0.0000	0.0103	0.0017	0.0002
E14	0.0109	0.0000	0.0000	0.0046	0.0001	0.0062	0.0010	0.0000
E15	0.0179	0.0000	0.0000	0.0000	0.0000	0.0116	0.0080	0.0000
E16	0.0217	0.0000	0.0022	0.0085	0.0000	0.0118	0.0000	0.0000
E17	0.0139	0.0000	0.0043	0.0000	0.0000	0.0079	0.0000	0.0030
Average weights	0.0171	0.0028	0.0011	0.0030	0.0007	0.0050	0.0023	0.0008
The weights of the criteria								
M	0.163	0.066	0.175	0.042	0.291	0.133	0.045	

	O1/I1	O2/I1	O3/I1	O4/I1	O5/I1	O6/I1	O7/I1
Median	1.2292	1.2917	1.0625	0.6042	0.5833	0.7917	0.2292
Max	2.0833	2.0833	2.0833	2.0833	2.0833	2.0833	2.0833
Min	0.3750	0.5000	0.5208	0.2083	0.3750	0.1667	0.0000
Excellent	>	>	>	>	>	>	>
Very Good	1.799	1.819	1.743	1.590	1.583	1.653	1.465
Good	1.229	1.292	1.063	0.604	0.583	0.792	0.229
Poor	0.546	0.658	0.629	0.288	0.417	0.292	0.046
Very Poor	0.375	0.500	0.521	0.208	0.375	0.167	0.000

AHP with absolute measurement									
	O1/I1	O2/I1	O3/I1	O4/I1	O5/I1	O6/I1	O7/I1	Rank using M	Rank
E1	0.1296	0.0636	0.1296	0.1296	0.2638	0.1296	0.2638	0.159	9
E2	0.2638	0.2638	0.1296	0.1296	0.1296	0.1296	0.1296	0.149	11
E3	0.5100	0.2638	0.5100	0.5100	0.2638	0.1296	0.5100	0.328	3
E4	0.2638	0.2638	0.2638	0.2638	0.2638	0.1296	0.1296	0.218	7
E5	0.1296	0.1296	0.1296	0.2638	0.1296	0.1296	0.2638	0.130	14
E6	0.2638	0.5100	0.2638	0.2638	0.1296	0.2638	0.2638	0.219	6
E7	0.1296	0.2638	0.2638	0.1296	0.0636	0.1296	0.2638	0.138	12
E8	0.1296	0.1296	0.1296	0.2638	0.1296	0.2638	0.2638	0.148	13
E9	0.2638	0.1296	0.2638	0.1296	0.0329	0.5100	0.1296	0.187	8
E10	0.2638	0.5100	0.2638	0.2638	0.5100	0.2638	0.0329	0.319	1
E11	0.2638	0.2638	0.5100	0.5100	0.2638	0.2638	0.2638	0.295	4
E12	0.0636	0.1296	0.1296	0.1296	0.0636	0.2638	0.0636	0.104	15
E13	0.0636	0.1296	0.1296	0.1296	0.1296	0.1296	0.1296	0.108	16
E14	0.5100	0.1296	0.2638	0.2638	0.5100	0.2638	0.1296	0.338	2
E15	0.1296	0.1296	0.0636	0.1296	0.2638	0.2638	0.0329	0.160	10
E16	0.0329	0.0329	0.0329	0.0329	0.1296	0.0329	0.0329	0.058	17
E17	0.1296	0.2638	0.1296	0.1296	0.2638	0.1296	0.2638	0.173	5

7. Ranking of sectors in the organization

The evaluation criteria						
DMU	O1/I1	O1/I2	O2/I1	O2/I2	O3/I1	O3/I2
E1	1.087	1.042	1.130	1.083	3.729	3.574
E2	1.143	1.043	0.952	0.870	3.728	3.404
E3	0.962	1.190	1.077	1.333	3.689	4.567
E4	1.381	1.450	1.048	1.100	4.333	4.550
E5	1.286	1.038	1.238	1.000	4.218	3.407
E6	1.091	1.043	0.909	0.870	4.071	3.894

Weights of inputs and outputs of all DMUs					
DMU	*v1*	*v2*	*μ1*	*μ2*	*μ3*
E1	0.0289	0.0140	0.0000	0.0373	0.0000
E2	0.0476	0.0000	0.0000	0.0058	0.0096
E3	0.0277	0.0134	0.0000	0.0357	0.0000
E4	0.0476	0.0000	0.0345	0.0000	0.0000
E5	0.0261	0.0173	0.0081	0.0301	0.0000
E6	0.0455	0.0000	0.0000	0.0000	0.0105
Average weights	0.0372	0.0074	0.0071	0.0182	0.0033

The weights of the criteria						
M	0.191	0.952	0.488	2.437	0.090	0.449

	O1/I1	O1/I2	O2/I1	O2/I2	O3/I1	O3/I2
Median	1.1169	1.0435	1.0623	1.0417	3.9004	3.7342
Max	1.3810	1.4500	1.2381	1.3333	4.3334	4.5672
Min	0.9615	1.0385	0.9091	0.8696	3.6889	3.4037
Excellent	>	>	>	>	>	>
Very Good	1.293	1.314	1.179	1.236	4.189	4.290
Good	1.117	1.043	1.062	1.042	3.900	3.734
Poor	0.993	1.039	0.940	0.904	3.731	3.470
Very Poor	0.962	1.038	0.909	0.870	3.689	3.404

AHP with absolute measurement									
DMU	O1/I1	O1/I2	O2/I1	O2/I2	O3/I1	O3/I2		Rank using M	Rank
E1	0.1296	0.1296	0.2638	0.2638	0.0636	0.1296		0.984	3
E2	0.2638	0.1296	0.1296	0.0329	0.0636	0.0329		0.338	5
E3	0.0329	0.2638	0.2638	0.5100	0.0329	0.5100		1.861	1
E4	0.5100	0.5100	0.1296	0.2638	0.5100	0.5100		1.564	2
E5	0.2638	0.0329	0.5100	0.1296	0.5100	0.0636		0.720	4
E6	0.1296	0.1296	0.0329	0.0329	0.2638	0.2638		0.387	6

Appendix E: Models Comparisons

Table 14 Results of Ranking Sectors in the Organization

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
S1	0.97	4	0.578	4	0.98358	3	2.833	3
S2	0.85	6	0.2016	5	0.33758	6	2.469	6
S3	1		0.9627	2	1.8611	1	3.311	1
S4	1		1	1	1.56393	2	3.151	2
S5	1		0.8172	3	0.72046	4	2.757	4
S6	0.817	5	0	6	0.38654	5	2.491	5

Table 15 Results of Ranking Companies in Sector 1

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
E1	0.847	6	0.460	6	116.403	5	0.97	5
E2	0.972	5	0.570	5	217.133	2	1.19	2
E3	0.734	8	0.146	8	57.835	7	0.90	7
E4	1.000		0.829	2	220.304	1	1.24	1
E5	0.829	7	0.390	7	28.187	9	0.67	9
E6	1.000		0.624	4	121.318	3	1.14	3
E7	1.000		1.000	1	61.627	6	0.94	6
E8	0.660	9	0.088	9	57.328	8	0.79	8
E9	0.536	10	0.000	10	16.986	10	0.66	10
E10	1.000		0.687	3	117.817	4	1.11	4

Table 16 Results of Ranking Companies in Sector 2

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
E1	0.681	9	0.330	9	28.628	10	0.753	8
E2	0.833	7	0.552	7	54.205	6	0.890	6
E3	0.627	10	0.255	10	28.542	11	0.688	10
E4	0.900	5	0.679	4	55.227	5	0.942	4
E5	0.560	12	0.166	12	13.478	12	0.504	12
E6	0.906	4	0.543	8	64.433	4	0.908	5
E7	0.800	8	0.635	5	28.801	8	0.721	9
E8	0.573	11	0.225	11	28.798	9	0.607	11
E9	0.456	13	0.000	13	8.251	13	0.497	13
E10	0.840	6	0.579	6	32.968	7	0.862	7
E11	1.000		1.000	1	66.569	3	1.015	3
E12	1.000		0.944	2	112.686	1	1.101	2
E13	1.000		0.893	3	105.512	2	1.126	1

Table 17 Results of Ranking Companies in Sector 3

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
E01	1		1	1	5.650	15	0.16	15
E02	0.99	11	0.4322	10	19.559	12	0.55	10
E03	1		0.5388	6	19.881	11	0.37	14
E04	1		0.5108	8	39.043	5	1.05	6
E05	0.813	14	0.0091	14	28.111	8	0.87	8
E06	0.94	12	0.2885	11	19.185	13	0.39	12
E07	0.888	13	0.2171	12	19.035	14	0.46	11
E08	1		0.7108	3	31.344	7	0.86	9
E09	1		0.6015	4	73.689	1	2.78	3
E10	1		0.1894	13	72.970	2	2.83	2
E11	1		0.4331	9	72.357	3	3.03	1
E12	1		0.9149	2	20.264	9	0.39	13
E13	1		0.5214	7	20.254	10	0.91	7
E14	1		0.5944	5	40.161	4	1.56	4
E15	0.752	15	0	15	38.147	6	1.41	5

Table 18 Results of Ranking Companies in Sector 4

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
E01	0.773	14	0.1562	13	2.757301	8	0.837	12
E02	1		0.4374	8	3.427309	5	1.056	9
E03	0.94	10	0.352	10	3.057565	7	0.965	10
E04	0.934	11	0.2565	11	2.292625	12	0.946	11
E05	1		0.6452	6	3.608266	3	1.359	7
E06	0.828	12	0.208	12	1.917618	13	0.781	13
E07	1		0.3809	9	2.511909	10	1.186	8
E08	0.686	17	0.1479	14	1.572197	16	0.625	16
E09	1		0.5535	7	2.459636	11	3.043	4
E10	1		0.7835	4	3.132136	6	1.671	5
E11	1		0.6563	5	3.606781	4	1.620	6
E12	0.763	15	0.0793	16	1.895808	14	0.653	15
E13	0.743	16	0	17	1.425444	17	0.479	17
E14	0.799	13	0.1453	15	2.739811	9	0.776	14
E15	1		0.9277	3	4.011086	2	4.235	3
E16	1		0.9471	2	1.79247	15	9.983	2
E17	1		1	1	5.182553	1	11.623	1

Table 19 Results of Ranking Companies in Sector 5

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
E01	1		0.8145	3	1.264	3	5.639	2
E02	1		0.6508	4	0.927	8	4.727	7
E03	1		1	1	1.788	1	7.477	1
E04	1		0.6437	5	1.225	4	5.432	4
E05	0.723	8	0.3175	8	0.952	7	5.193	6
E06	1		0.6183	6	1.201	5	5.401	5
E07	1		0.8548	2	1.522	2	5.589	3
E08	0.287	9	0	9	0.471	9	3.458	9
E09	0.864	7	0.4509	7	0.992	6	4.702	8

Table 20 Results of Ranking Companies in Sector 6

DMU \ Model	DEA Model		Dia and Ben Abdelaziz (2011)		Jablonsky (2011)		Proposed Model	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank
E01	1		0.6447	8	0.159457	10	1.8782	4
E02	1		0.6355	9	0.149378	11	1.6421	9
E03	1		0.9347	2	0.328372	2	2.3095	1
E04	0.859	13	0.5216	13	0.217586	6	1.5366	13
E05	0.904	12	0.6274	10	0.130397	14	1.7982	6
E06	1		1	1	0.218789	5	2.2912	2
E07	0.913	11	0.5774	12	0.137915	13	1.5834	11
E08	0.823	14	0.4805	14	0.148281	12	1.6300	10
E09	0.963	8	0.7407	4	0.186521	7	1.4882	14
E10	1		0.8809	3	0.31903	3	1.9197	3
E11	0.783	15	0.3973	15	0.294994	4	1.4298	15
E12	0.929	10	0.6451	7	0.103605	16	1.6947	8
E13	0.591	16	0.1047	16	0.107909	15	1.1000	16
E14	1		0.6469	6	0.338318	1	1.8636	5
E15	0.959	9	0.5899	11	0.159679	9	1.5628	12
E16	0.514	17	0	17	0.058273	17	0.8465	17
E17	0.989	7	0.6778	5	0.172705	8	1.7385	7

Appendix F: Clarification on Jablonsky (2011) Paper

Reply Reply All Forward

Re: Question about your Paper

Josef Jablonsky [Jablon@vse.cz]

To: AL-BASARAH MAJDI

Attachments: (2) Download all attachments
pic29656.gif (1 KB); DEA - Jablonsky.xlsx (22 KB) [Open as Web Page]

Monday, October 14, 2013 5:53 PM

Dear Majdi Al-Basarah,

Thank you for message and your interest in my paper.
Your main question is how to assign DMUs to the elements of the evaluation scale. I agree that it could be explained better in the paper. But it is not possible to say exactly how to assign the criterion values to the elements on the scale. It depends on decision makers. One possibility can be as follws: split criterion values according to given pre-defined intervals (e.g. if the scale has 5 elements create intervals given by percentiles 0-20%, -40%, -60%, -80%, 100%, where 0/100 corresponds to the worse/best criterion value).
Best regards,

Josef

****
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AL-BASARAH MAJDI <g199524900@kfupm.edu.sa> 14.10.2013 09:21	Komu	"jablon@vse.cz" <jablon@vse.cz>
	Kopie	
	Předmět	Question about your Paper

Dear Sir,

My name is Majdi Al-Basarah and I'm studying for my masters degree in Industrial Engineering at King Fahd University of Petroleum and Minerals. Currently, I'm working on my thesis proposal and I'm thinking of doing some work related to data envelopment analysis.

I came across your paper titled "Multicriteria approaches for ranking of efficient units in DEA models" and I'm interested to do my thesis based on your AHP-DEA model.
I'm trying to regenerate the example you provided in the paper but I faced some difficulty generating Table#6 results. It was not clear to me what approach/procedure is used to assign the evaluation scale values to the DMUs. I appreciate if you can help me clarifying this step.
In the attached excel file you can find the work I've done.

Best Regards,
Majdi Al-Basarah

NOMENCLATURE

AHP	:	Analytic Hierarchy Process
CCR	:	Charnes, Cooper and Rhodes
DEA	:	Data Envelopment Analysis
DMU	:	Decision Making Unit
MCDM	:	Multi-Criteria Decision Making
PM	:	Performance Measurement
PMS	:	Performance Measurement System

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