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APPROACH FOR ACHIEVING THE BEST PERFORMANCE IN IT SERVICE DELIVERY

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Abstract. *This paper researches and implements the best practices that lead to best performance in information technology service delivery. A customer quality defined standard is created by benchmarking the information technology service regions. The Data Envelopment Analysis (DEA) methodology is used as a benchmarking tool to locate a frontier which is then used to evaluate the efficiency of each of the organizational units responsible for observed output and input quantities. The inefficient units can learn from the best practice frontier situated along the frontier line. All the regions on the frontier are 100 percent efficient.*
Keywords: Efficiency frontier, Relative efficiencies, Service delivery, Sensitivity analysis

1. **Introduction.** An Information Technology (IT) service delivery company, in which the research took place, is situated in South Africa. The company's information systems (regions) are situated in Pretoria, Johannesburg, Durban, Bloemfontein/Kimberley (Bloem/Kby) and Cape Town. An information system is an arrangement of people, data, processes, information presentation, and information technology that interact to support and prove day-to-day operations in a business, as well as support the problem-solving and decision-making needs of management and end-users (customers) [1]. End-users are people using computer services.

Customers phone the service desk to report events (faults and requests). For example, the installation of software, and setting up of a computer on the network, are requests. The reinstallation of software and fixing computer hardware are faults. Reported events are routed to their respective regions by the service desk to be attended to. The success in producing as large as possible an output (number of resolved events and satisfied clients) from a given set of inputs employees (labour) is not optimized.

The purpose of this paper is to research and implement best practices methodology, Data Envelopment Analysis (DEA), that leads to best performance in IT service delivery, to evaluate the efficiencies of regions in order to satisfy Customer Defined Quality (CDQ). Service delivery's focus is customer satisfaction [2]. The understanding and satisfaction of customer-defined quality emerged in the late 1990 with the goal of covering all the customer requirements in the design of service. Very little of DEA methodology has been done and tested in the service industry. This study makes a contribution to the body of knowledge of operations research through the search for quality improvement techniques.

According to [3-7], the major task is to measure the performances of service delivery regions and to evaluate their efficiencies. By making comparisons between the regions, an expectation exists that best practice regions can be identified and used as benchmarks for improving the efficiency, quality and effectiveness of other regions [5,6,8]. This paper

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uses data envelopment ratio analysis [9] and the advantage is that the efficiencies can also be found by graphical analysis which is easier to understand.

This paper is organized as follows. Sections 2 and 3 discuss the research methodology and the data used respectively. Experiments and results are presented in Section 4, while Section 5 discusses the conclusions.

2. **Data Envelopment Analysis Methodology.** Data Envelopment Analysis (DEA) is used to research and implement best practices. DEA can also be described as a non-parametric estimation method which involves the application of mathematical programming to observed data to locate a frontier which can then be used to evaluate the efficiency of each of the regions responsible for observed output and input quantities [4].

A DEA model is developed that uses input and outputs to compute the efficiency degree of a particular region when this region is compared with all the other regions. The regions that are considered efficient belong to the frontier and, therefore, can be used as performance benchmarks to study the regions that are operating inefficiently [5].

3. **Data.** From an event management system database, and for each month in a year, the date the event was reported and the date the event was resolved, were recorded. These dates were used to determine the ratio of the resolved events to the total number of logged events per month. For example, registering the first of January five times under logged events means that five events are logged, and registering the first of January three times under resolved events, means three events are resolved. Determining the ratio will then be 3/5. The average number of events resolved per month in a year was determined [10]. The data used are for twelve months, started from February 2019 to January 2020. Table 1 explains which variables are used for analysis, their type and a short description of each.

Table 1. Variables

Variables	**Type**	**Description**
Number of resolved events	Output	Number of faults and requests resolved
Success rate	Output	Ratio of number of resolved events to total number of logged events (throughput)
Employees	Input	Number of employees

According to [11], the number of resolved events and success rate are regarded as outputs. Employees are regarded as input. Success rate was determined as the ratio of number of resolved events to the number of logged events. This is an attempt to combine quantitative and qualitative measures. The average inputs and outputs per month for a year for the five regions are given in Table 2.

Table 2. Inputs and outputs (Event management system, 2019)

Region	**Number of employees**	**Number of resolved events**	**Success rate**
	Input	**Output**	**Output**
Pretoria	17	201	0.66
Bloem/Kby	16	160	0.86
Durban	15	157	0.79
Johannesburg	17	200	0.67
Cape Town	13	123	0.62

4. **Efficiency with DEA.** In this paper's perspective, DEA is used to evaluate the efficiency of information technology service delivery regions which are denoted as regions 1 to 5 (DMUs 1 to 5), according to [5], which also are homogeneous with some decision autonomy [8]. Each region uses one input to produce two outputs. A DEA model is formulated that uses these factors to compute the efficiency degree of a particular region when this region is compared with all the other regions. The regions that are considered efficient relative to the other regions belong to the frontier and, therefore, can be used as performance benchmarks to study the regions that are operating inefficiently. Regions that are inefficient do not belong to the frontier [8,9].

According to [12] the need to compare performance with some known number or quantity in order to understand how well the organization performs brought about the increasing popularity of what is known as performance ratios. A commonly used traditional ratio method in DEA is input-oriented and measures productivity or efficiency as a ratio of output to input [9].

4.1. **Single input, output measure.**

4.1.1. *Number of employees and resolved events.* In Table 2, for instance, Pretoria had 201 resolved events while 17 staff members were employed. In Durban there were 157 resolved events while 15 staff members were employed, etc. These regions are compared and their performance is measured by using the data. The output measure is divided by the input measure to get a ratio. For example, 201 is divided by 17 to get 11.80, as shown in Table 3.

Table 3. Single input, output (Resolved events)

Region	**Resolved events per employee**	**Success rate per employee**	**Relative efficiency (Resolved events)**	**Relative efficiency (Success rate)**
Pretoria	201/17 = 11.80	0.66/17 = 0.039	100%	72%
Bloem/Kby	160/16 = 10.00	0.86/16 = 0.054	85%	100%
Durban	157/15 = 10.47	0.79/15 = 0.053	89%	96%
Johannesburg	200/17 = 11.76	0.67/17 = 0.039	99.60%	72%
Cape Town	123/13 = 9.46	0.62/13 = 0.048	80%	87%

According to Table 3, Pretoria has the highest ratio of resolved events per staff member, whereas Cape Town has the lowest. Since Pretoria has the highest ratio of 11.80, other regions are compared to it and their relative efficiencies are calculated with respect to it. The ratio for any region is divided by the ratio for Pretoria (11.80), multiplied by 100 to convert it to a percentage, as shown in Table 3, column 4.

The other regions are relatively less efficient at using their staff (input) to produce output (number of resolved events) as compared to Pretoria. Pretoria can be used to set a target for other regions. This is an input target since it deals with input measure.

4.1.2. *Number of employees and success rate.* This time, the output measure is success rate and the input measure remains the number of employees since this ratio method is input oriented. The target is the number of employees. This is the variable that is going to be adjusted to affect efficiency. By increasing or decreasing the number of employees, the optimal output will be reached. Once more, success rate is determined as the ratio of the number of resolved events to the total number of logged events per day. In Table 2, for instance, Pretoria had a ratio of 0.66 success rate while 17 staff members were employed. In Durban there was a ratio of 0.79 success rate while 15 staff members were employed, etc. These regions are compared and their performance is measured by using these data.

The output measure is divided by the input measure to get a ratio, as shown in Table 3, column 3.

According to the above data, Bloem/Kby had the highest ratio of success rate per employee, whereas Pretoria had the lowest. Since Bloem/Kby had the highest ratio of 0.054, all other regions are compared to it and their relative efficiency is calculated with respect to Bloem/Kby. The ratio for any region is divided by the ratio of Bloem/Kby (0.054) and multiplied by 100 to convert it to a percentage, as shown in Table 3, column 5.

The other regions are relatively less efficient at using their staff (input) to produce output (success rate) as compared to Bloem/Kby. Bloem/Kby could set a target for other regions. This is still an input target, since it deals with input measure.

4.2. **Extended resources.** The goal of this paper is to consolidate the single input measure, number of employees, with two output measures, resolved events and success rate in a single tool. Again the five regions are compared.

From Table 2, Durban for example, with 15 employees, had an average of 157 events resolved per month and satisfied its clients up to 79 percent. Ratios are still used to compare these regions. Dividing each output measure with the single input (number of employees) gives Table 4.

Table 4. Efficiency ratios

Region	**Events resolved**	**Success rate**
Pretoria	11.8	3.9
Bloem/Kby	10	5.4
Durban	10.47	5.3
Johannesburg	11.76	3.9
Cape Town	9.46	4.8

Pretoria had the highest ratio of resolved events per employee whereas Bloem/Kby had the highest ratio of success rate per employee. Figure 1 in the next section presents the above data.

The problem with comparing ratios is that a different ratio could give a different picture and it becomes difficult to combine these ratios into one ratio, where one could draw one's own judgement. For example, if we consider Durban and Cape Town, Durban gives 1.11 (10.47/9.46) times as efficient as Cape Town on resolved events and also 1.11 (5.3/4.8) times as efficient as Cape Town on success rate. It is not easy to combine these ratios into a judgement. This can be more clearly seen if there are more inputs and more outputs [9].

4.2.1. *Graphical analysis.* Another way of evaluating the efficiency, at least for problems involving two outputs and a single input, is by graphical analysis, as shown in Figure 1. In this figure, all the regions are on the frontier line, except Cape Town. Johannesburg and Pretoria almost make the same data point, since their readings are almost equal (the thickest point in the graph).

Again in Figure 1, a horizontal line is drawn from the y-axis to Pretoria, from Pretoria to Johannesburg, from Johannesburg to Durban, from Durban to Bloem/Kby. A vertical line is drawn from Bloem/Kby to the x-axis. This line is called the efficiency frontier. The efficiency frontier, derived from the examples of best practice contained in the data considered, represents the performance that the regions that are not on the efficiency frontier, in this case Cape Town, could try to achieve. Hence data envelopment is experienced because the efficiency frontier envelopes (encloses) all data available. All the regions on the frontier are 100% efficient. Therefore, all the regions are efficient except Cape Town [9].

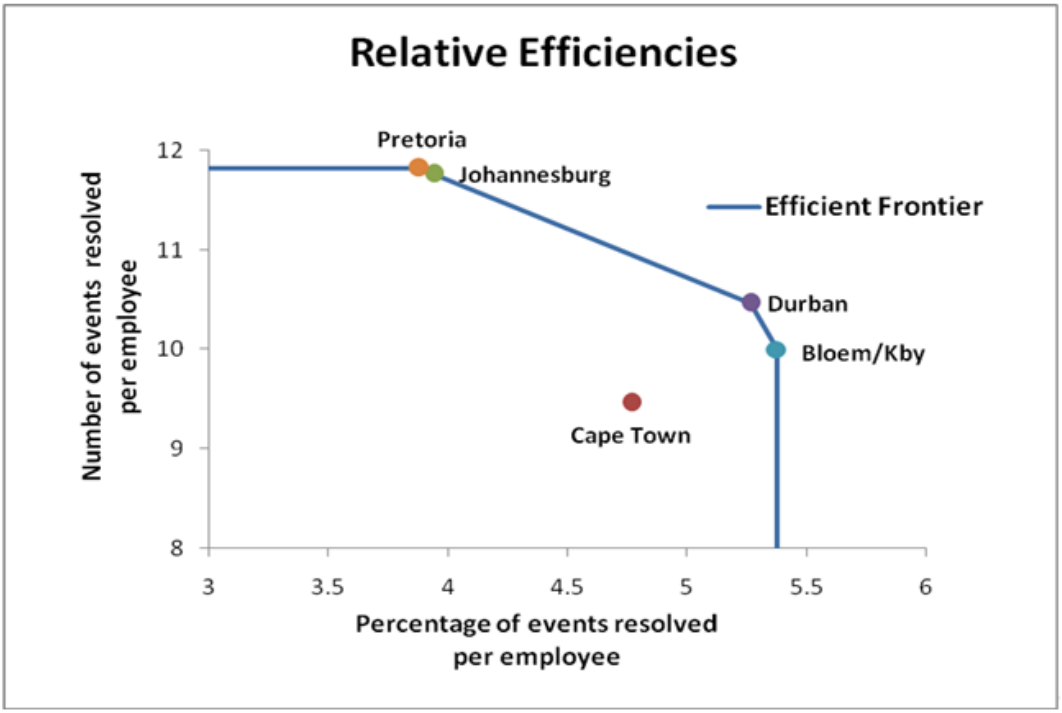

FIGURE 1. Relative efficiencies highlighted by the efficiency frontier

4.2.2. *Quantifying efficiency score for Cape Town.* Cape Town is less efficient, but by how much? It has 13 staff members, 123 resolved events, 9.46 resolved events per employee, 62% success rate, and 4.8 success rate per employee. The ratio of resolved events/success rate = (123/62) = 1.98; that is, there are 1.98 resolved events for every percentage of success rate. This ratio is the same as resolved events per employee to success rate per employee. Considering Figure 2, Cape Town is not on the efficiency frontier. A line drawn from the origin through Cape Town to the efficiency frontier line has a slope of 1.98. If Cape Town were to retain this ratio, but to vary the number of staff it employs, its performance would lie on the line from the origin through its current position as shown above. It might be reasonable to say that the best possible performance that Cape Town could be expected to achieve is labelled Best in the graph. This is the point where the line from the origin through Cape Town meets the efficiency frontier.

According to [9], DEA gives only the relative efficiencies, efficiencies relative to the data considered. It does not and cannot give absolute efficiencies.

4.2.3. *Sensitivity analysis.* Sensitivity and post-optimality analyses guide the analyst on how the solution to the problem will be modified when the input variables or the model changes. The analysis is crucial when the input variables or model has not been specified suitably. A solution is sensitive when the outcome to the problem is modified by changes to the input data. The solution or model is not sensitive when there is no significant change due to alteration of input data. It is a crucial requirement that the input data and the model itself be thoroughly tested for accuracy and consistency with the problem statement [13].

While ratios are easy to compute, their interpretation is problematic, especially when they provide conflicting answers. While this may be generally true, statistics can be used to understand this. For example, using the number of resolved events, Pretoria is at the top, while using success rate, Pretoria is almost at the bottom. This may look like conflicting results, but in reality they are not. More employees can resolve more events, if there are events to resolve. The illustration above, Figure 3, shows that it is possible to move beyond the efficiency frontier created by DEA previously.

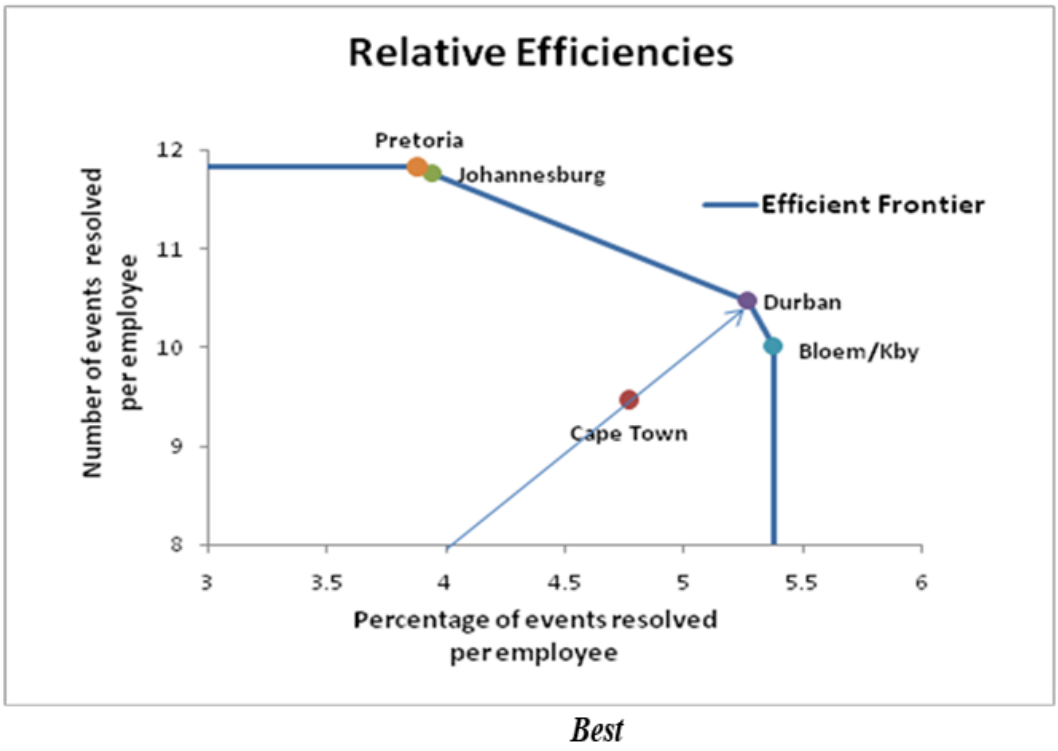

FIGURE 2. Relative efficiencies

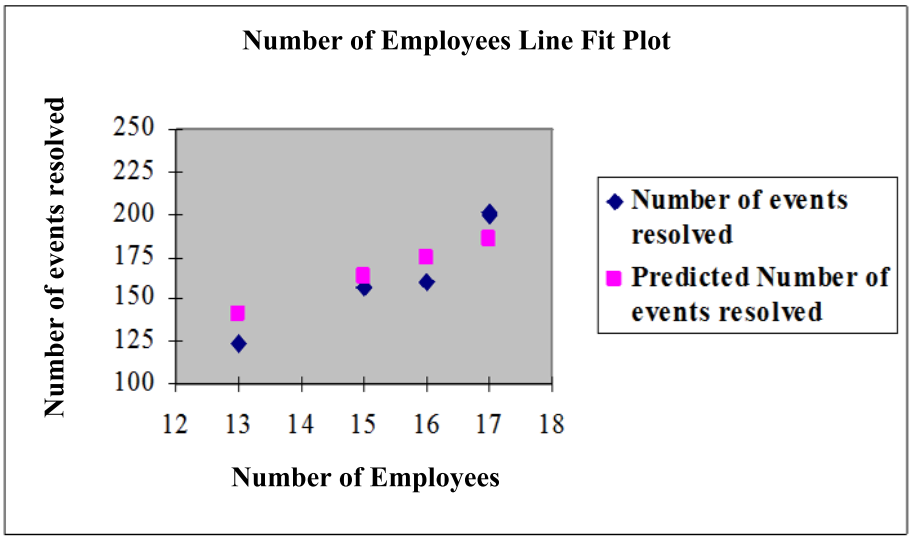

FIGURE 3. Number of employees line fit plot

Residuals are defined as the departure or deviation from the overall trend. In other words, it is the difference between the actual and the estimated values. Figure 4 shows a plot of residuals. This is to assess the model adequacy by checking whether the model assumptions are satisfied. The basic assumption is that the residuals are uncorrelated with zero mean and constant variance. The residuals in Figure 4 look evenly distributed with no pattern, meaning that they are uncorrelated. Figure 5, representing the normal probability plot, shows no serious deviations from the forty five degree line. We conclude from the plots that the residuals are normally distributed. The regression model is adequate.

In Table 5, the current number of employees cannot resolve all the logged events. When there are more employees, statistics shows that all logged events can be resolved. This is

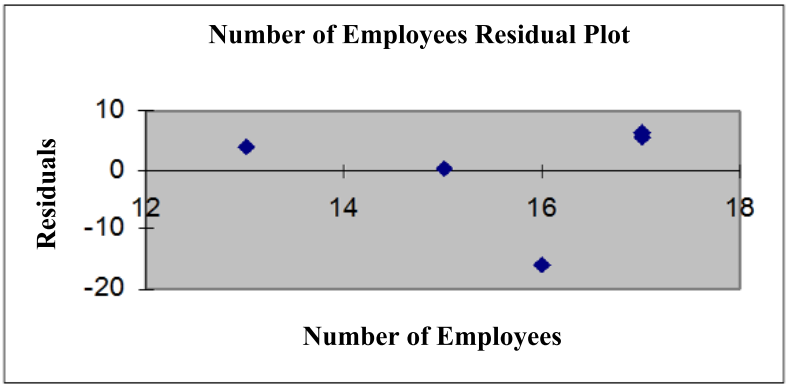

FIGURE 4. Number of employees residual plot

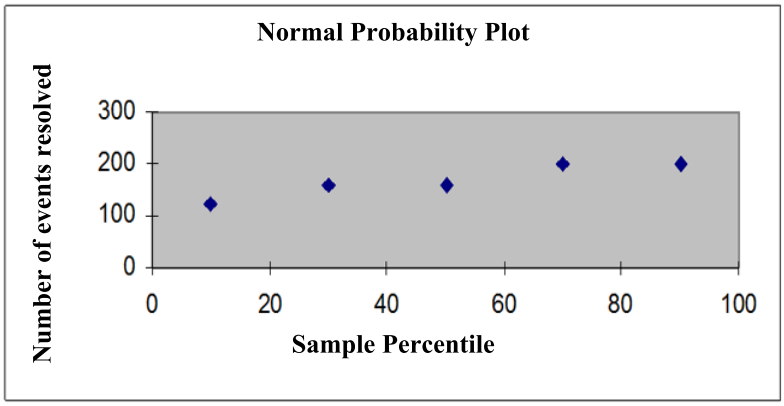

FIGURE 5. Normal probability plot

TABLE 5. Predicted outputs

	Number of employees	Predicted number of resolved events	Predicted success rate	Number of logged events
1	17	195	0.64	305
2	16	176	0.94	186
3	15	157	0.79	199
4	17	195	0.65	299
5	13	119	0.60	198
Regression			Intercept	−126.25
			Number of employees	18.875
	Number of employees	**Predicted number of resolved events**	**Predicted success rate**	**Number of logged events**
1	23	308	1.01	305
2	17	195	1.05	186
3	18	214	1.07	199
4	23	308	1.03	299
5	18	214	1.08	198

the number of employees necessary to resolve all the logged events, using the regression equation in order to perform extrapolation. The assumption is that the extra people can resolve the unresolved events at the same rate as the existing employees, which may not be valid if the unresolved events are more difficult to resolve than the resolved events.

This may be a way to move beyond the current efficiency frontier and create new quality standards.

5. **Conclusion.** In this paper, the success in producing as large as possible an output (number of resolved events and success rate) from a given set of inputs employees (labour) was optimized. Data envelopment analysis determined the relative performance efficiencies of the homogeneous regions. The excellence of the service could be determined by determining success rate ratio. It was demonstrated that the ratio analysis indicated Cape Town as being inefficient. The best practice regions could be identified and used as benchmarks for improving the efficiency, quality and effectiveness of the inefficient region, in this case Cape Town.

As future work, the current research can be extended to include more variables as inputs. The suitability of these variables to DEA analysis, so that these variables can be applied and interpreted, has to be researched. Analysis of different efficiency measures of individual regions using data over a longer period also has to be investigated.

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REFERENCES

[1] J. Whitten, D. Bentley and K. Dittman, *System Analysis and Design Methods*, 7th Edition, McGraw-Hill, New York, 2007.
[2] X. J. Tang and Y. Todo, A study of service desk setup in implementing IT service management in enterprises, *Technology and Investment*, vol.4, pp.190-196, DOI: 10.4236/ti.2013.43022, 2013.
[3] W. F. Bowlin, *Measuring Performance: An Introduction to Data Envelopment Analysis (DEA)*, Technical Report, University of Northern Iowa, Department of Accounting, Ceder Falls, Ia., 1995.
[4] W. W. Cooper, R. G. Thompson and R. M. Thrall, Extensions and new developments in DEA, *Annals of Operations Research*, vol.66, pp.3-45, 1996.
[5] A. Charnes, W. W. Cooper, A. Y. Lewin, L. M. Seiford et al., *Data Envelopment Analysis: Theory, Methodology and Applications*, Kluwer Academic Publishers, Dordrecht, Holland, 1994.
[6] R. Banker, A. Charnes, W. Cooper and A. Schinnar, A bi-extremal principle for frontier estimation and efficiency evaluations, *Management Science*, vol.27, pp.1370-1382, 1981.
[7] C. Yin, W. Gao, Z. Li, Z. Wu and Y. Wang, Improved two-stage DEA model: An application to logistics efficiency evaluation enterprise in Xiamen, China, *International Journal of Innovative Computing, Information and Control*, vol.15, no.2, pp.535-549, 2019.
[8] R. Banker, A. Charnes and W. Cooper, Some models for estimating technical and scale efficiency in data envelopment analysis, *Management Science*, vol.30, no.9, pp.1078-1092, 1984.
[9] J. E. Beasley, *Data Envelopment Analysis*, http://people.brunel.ac.uk/∼mastjjb/jeb/or/contents.html, Accessed on 1 Sept. 2020.
[10] P. Dorian, *Data Preparation for Data Mining*, Kaufmann Publishers, San Francisco, CA, 1999.
[11] S. Carlson, *The Pure Theory of Production*, P.S. King & Son, London, 1999.
[12] G. A. Marcoulides, *Modern Methods for Business Research*, Inc. Publishers, New Jersey, Mahwah, Lawrence Erlbaum Associates, 1998.
[13] D. Anderson, D. Sweeney and T. Williams, *Quantitative Methods for Business*, 8th Edition, South-Western College Publishers, Cincinnati, Ohio, 2006.