Human Systems Management 25 (2006) 197–209
IOS Press

Efficiency-based recruitment plan for chained quick-service enterprise

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Abstract. This paper describes a research method called two-stage design consisting of the determination of the efficiency for each quick-service restaurant of chained enterprise at the first stage by using Data Envelopment Analysis (DEA), and then proposes an approach of Recruitment and Allocation (RA) plan for supporting the everlasting running of the enterprise in the second stage. The technical efficiency, the scale efficiency, the production efficiency, and the return to scale are conducted in the first stage of this two-stage research design. In addition, this study also proposes the potentially improved value to promote the relative efficiency of each chained restaurant through the improvement of inputs or outputs items. Besides, the RA plan is proposed in the second stage of the two-stage design. The RA plan is an efficiency-based quantitative approach to recruit employees as well as to determine the allocation of those recruited employees. This study indeed provides a constructive and quantitative approach of solving the dilemma issue "how to reasonably recruit and allocate employees" for decision makers with profound insight in the quick-service enterprise.

Keywords: Data Envelopment Analysis, production efficiency, RA plan, efficiency-based quantitative approach

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1. Introduction

The personnel expense always plays the major part of all operation costs in the service industry. How to use fewer human resources to get a higher productivity where productivity gains powered by technological innovation [17] or to improve the competitive advantage becomes a critical topic for the service industry. In fact, to output more with less input, to provide more service for creating the efficiency, and to increase effectiveness for promoting the performance and competitiveness are always focal issues for business managers [1]. Indeed, the everlasting running of business depends on the improvement of the organizational performance [20].

Fortuin [10] distinguished the organizational goal into two categories: efficiency and effectiveness. Harry [13] pointed out that the efficiency, the effectiveness, and the productivity are three major parts of performance. Drucker [8] defined that efficiency is to do what you are doing better; that is to do the things right. In addition, there is some relationship between efficiency and effectiveness [21]. The efficiency is defined as the ratio between input and output [9], and the effectiveness is defined as a system's output whether it can achieve the settled goal [14].

In fact, the efficiency and the effectiveness represent different requests of performance, and there is no guarantee that both of them have to achieve simultaneously. But, an efficient organization must handle both of them well, and use the most efficient way to pursue its maximum effectiveness [19]. The measures of performance evaluation count up many ways, the Ratio Approach, the Regression Analysis, the Multiple Criteria Analysis, the Analytic Hierarchy Process, the Balanced Scorecard, the Delphi Hierarchy Process, the Total Factor Productivity, and the Data Envelopment Analysis [6]. The efficiency can be normally evaluated by two approaches: the parametric approach and non-parametric approach. The parametric approach is to calculate parameters by regression models, and then compare the efficiency on the basis of the production function. The non-parametric approach does neither need to assume a production function, nor to estimate the parameter of the production function. The non-parametric approach just applies mathematical programming technique to estimate the efficiency [9].

The performance efficiency determined by the ratio between input and output is used to be the referenced guideline for decision makers to conduct their improvements [2]. But it's difficult to assess the entire quick-service restaurants through a single indication; thus, to establish an evaluated method including multiple indications to evaluate the performance efficiency of each quick-service restaurant is what the operating managers seek to find out. In addition, those indications are applied in the estimation of performance efficiencies for the whole quick-service restaurants. Therefore, to choose a fair and reasonable way to judge chained restaurants in the quick-service enterprise, to set a reasonable target for improvement, and to adjust resources for those inefficient restaurants are important issues in raising the competitive advantage of quick-service enterprise.

Evaluating performance efficiencies of quick-service restaurants for a chained enterprise is a kind of problem for multi-input and multi-output considerations. The Data Envelopment Analysis (DEA) is chosen to evaluate the performance of quick-service restaurants in this study because it has characteristics of judging the performance efficiency for each quick-service restaurant by multiple indications without the assumption of function relationship between input and output items. By the information of input and output items, the relative efficiency of each quick-service restaurant in the chained enterprise can be determined.

The Data Envelopment Analysis (DEA) was revealed by Charnes, Cooper, and Rhodes (CCR) in 1978 [5]. Originally, DEA is applied to evaluate the performance efficiency of the public or non-profit organization, but later is widely applied in many beneficial organizations [18]. The model of DEA is shown by the ratio between output and input items, and has the same meaning of the Total Factor Productivity-TFP [11]. The DEA is based on the concepts of Pareto Optimality and Frontier to calculate the relative efficiencies of the whole decision making units [5] in order to determine their performances as well as to find out those inefficient units and their potentially improved values [5].

Daniel Bell once described that working is a game between people in the post-industrial society where it leads to service orientation, but that working is a game against fabricate in the industrial society is an obvious contrast concept. In service businesses, social skills for most jobs are far more important than those technical skills. Everlasting running is one of the organizational goals for enterprise, and therefore, to pass on its culture of an organization and to sustain the job standardization can be regarded as the most two critical topics. Therefore, the core spirit of quick-service restaurants for the chained enterprise must foster new cadre to pass on its core spirit. Thus, the recruitment and training of employees are great important. Though providing more employees can supply better service, it will increase the personnel cost. On the basis of relative efficiency, the maximum number of employees to recruit and the training arrangement for the international chained quick-service enterprise cannot be neglected.

The empirical case of this research adopts an international chained quick-service enterprise in south Taiwan, and the main purpose is to probe the performance efficiency of each chained restaurants, the employee recruitment, and the training arrangement for chained quick-service enterprise. A two-stage design is conducted in this research. Firstly, the relative efficiency of each chained restaurant, the benchmark restaurants and the improved targets for those inefficient restaurants are determined by DEA (Frontier Software). In the second stage, an efficiency-based quantitative approach called Recruitment and Allocation (RA) plan is proposed to effectively recruit and assign the training for employees. The RA plan functions as the referenced guideline for human resource recruitment in chained quick-service enterprise. In fact, the RA plan provides a constructive and quantitative rule to resolve the long-term existing problem "how to appropriately recruit employees and train them effectively".

2. Model selection

Since our research doesn't assume the production function of decision making units (DMUs), the DEA is selected as a way to evaluate the performance efficiencies of DMUs [22]. The CCR [5] and BCC [3] are two different models of DEA (based on the assumption of scale), and each model has two different orientations, input-orientation and output-orientation. The performance efficiency evaluated by the CCR model is to compare DMUs without considering the effect of scale [5], but for the BCC model, the effect of scale is taken into consideration [3]. The difference between input-oriented model and output-oriented model is that the operation goal of input-oriented business is to decrease the input items under the fixed output items. But to create the maximum production under present resources is the operation goal for output-oriented business. Because a quick-service enterprise pursues to create its maximal profit, this research adopts output-oriented model to determine the performance efficiency of each chained quick-service restaurant under present input resources.

3. The determination of input/output items

This study focuses on the investigation of the performance efficiency for each chained restaurant, and the production function between input item and output item is not assumed, so that the DEA is chosen as the assessing measure of performance efficiency in this study [7]. Golan and Roll thought that the selection of input and output items is one of very important steps while executing DEA [12]. The way to determine the input and output items of DEA model has been paid more attention. The common approach is the use of methods such as interview with organization officers, analysis of organization and management objectives, literature reviews, and experiences, etc., to select proper input and output items [16].

There are several factors to affect the performance of operation for a chained quick-service restaurant. The costs which cannot be controlled by chained quick-service restaurant managers are called the uncontrollable costs in this research, such as the rental cost, the law consulting cost, the share of the management charge from the headquarter, etc.; on the other hand, the costs that can be controlled by managers are called controllable costs. This paper adopts these controllable costs to be its input items. Firstly, we choose eight input items, the total input cost of assets, the crew size, the salary of service teams, the management size, the salary for management teams, the social charge, the public utilities, the maintenance/repair cost, and six output items, the total sales, the net product sales, the profit after control, the cash flow, the total number of customers, the total non-product sales, as the initial defined variables in this research. Table 1 is the description of those variables.

The definition of each variable is given in Table 1, and the input and output values for each DMU are listed in Table 2. Besides, Table 3 describes the correlation coefficients between input items and output items after two items are omitted. In fact, two items, the total input cost of assets and the maintenance/repair cost, are showing the negative correlation, and therefore these two items have to be omitted because the characteristic of "Isotonicity" for each variable; where the "Isotonicity" is the basic assumption of Data Envelopment Analysis [15].

Then apply the backward elimination [15] to delete the input or output items whose weights are nearly zero in sequence until the weight of each left item is not near zero significantly. After executing the backward elimination, the final determined input and output items are listed in Table 4.

Table 1
The description of original input and output items before backward elimination

Input/ output	Name of the item	Illustration of evaluating indexes
Input	Total input cost of assets	Long term investments, capital assets, other assets
Input	Crew size	The amount of service team level
Input	Salary of service team	Defray service team's salaries, including bonus
Input	Management size	The amount of management level
Input	Salary for management teams	Defray managers' salaries, including bonus
Input	Social charge	Labor insurance and health insurance
Input	Public utilities	Water, electricity, and gas fee
Input	Maintenance/Repair cost	Fee to maintain machines
Output	Total sales	In a period, the income of all operation item for the running restaurant
Output	Net product sales	In a period, the income of main product for the running restaurant
Output	Profit after control	In a period, the profit income for the running restaurant
Output	Cash flow	In a period, the total amount of cash flow
Output	Total numbers of customers	In a period, the total customers in a running restaurant
Output	Total non-product sales	In a period, the income of minor products in a running restaurant

4. Empirical analysis

The Frontier software is applied to investigate 27 chained quick-service restaurants for a case international enterprise in south Taiwan by using the input and output data of year 2003 to perform the efficiency analysis and potential improvement analysis. Firstly, the efficiency analysis is described below.

4.1. *Efficiency analysis*

Decision making units (DMUs) are picked up according to the similar scale from an international chained quick-service enterprise in south Taiwan. Based on the data of input and output items, the analyses of CCR model and BCC model are conducted separately. The production efficiency derived from CCR model of DEA includes the technical efficiency and the scale efficiency, but the efficiency of BCC model only indicates the technical efficiency. Therefore, that the production efficiency of CCR divides the efficiency of BCC will get the value of scale efficiency. The production efficiency, the technical efficiency, the scale efficiency, and the return to scale for each DMU are shown in Table 5.

For example, the production efficiency of D31 is 96.85%, its technical efficiency is 100%, and the scale efficiency is 96.85%. It reveals that the production inefficiency of D31 mainly arises from its scale factor because its scale efficiency is 96.85%. Similarity, the production inefficiency of C18 mainly comes from its technical factor because its technical efficiency is 91.74% and few arise from the scale factor because its scale efficiency is 96.18%. The entire results of DEA are listed as below.

Firstly, the production efficiencies from seven restaurants among twenty-seven restaurants equal to one. Secondly, regarding to the technical efficiency, there are sixteen restaurants whose technical efficiencies equal to one. Thirdly, the scale efficiencies of seven restaurants among twenty-seven restaurants equal to one. Fourthly, for analyzing the return to scale, there are six restaurants are categorized into the decreasing return to scale (DRS). Those six DRS restaurants mean that they can try to decrease their scale for efficiency improvement; sixteen restaurants are in the category of constant return to scale (CRS). It indicates that these sixteen restaurants already reach the optimal production scale; there are five restaurants are categorized into the increasing return to scale (IRS). Those five DRS restaurants mean that they can try to increase their scale for efficiency improvement. The detailed information of DRS, CRS, and IRS for those twenty-seven restaurants is listed in Table 5.

4.2. *The potential improvement analysis*

DEA cannot only evaluate the relative efficiency of all decision making units, but also provides target values for those inefficient units [4]. In addition, the Frontier software can report the potential improved value and the improved range of DMUs. For an inefficient DMU, the improved range of an input item represents the percentage that the evaluated unit has to decrease for becoming an efficient one under this item. Contrarily, for an inefficient DMU, its improved range of an

Table 2
The detailed information of original input and output items for each DMU

DMUs	Total input cost of assets	Crew size	Salary of service teams	Management size	Salary for management teams	Social charge	Public utility	Maintenance/Repair cost	Total Sales	Net product sales	Profit after control	Cash flow	Total number of customers	Non-product sales
A19	22 295 654	39	821 196	5	480 757	131 842	328 370	58 160	7 185 936	6 891 632	2 224 409	4 667 223	57 300	294 304
A37	166 781 503	33	494 986	3	313 300	102 363	308 275	432 969	3 729 754	3 586 837	341 646	3 245 191	31 080	142 917
B11	47 588 433	43	629 244	4	346 606	163 701	289 136	171 916	5 334 919	5 120 622	1 188 350	3 932 272	45 041	214 297
B78	33 182 130	44	781 944	4	370 313	155 421	279 729	0	6 820 439	6 558 948	2 203 477	4 355 471	59 781	261 491
B98	47 463 722	49	717 768	4	373 166	123 030	287 130	53 170	5 848 591	5 608 209	1 548 936	4 059 273	48 204	240 382
C18	40 054 041	32	568 318	3	312 864	115 587	268 986	19 768	4 516 573	4 291 241	1 058 816	3 232 425	37 670	225 332
C21	41 025 806	38	597 102	3	318 960	142 150	261 490	23 587	5 125 667	4 914 967	1 375 606	3 539 361	41 228	210 700
C23	47 418 536	38	662 038	4	378 402	116 585	316 877	157 448	6 656 360	6 267 823	1 961 313	4 306 510	50 971	388 537
C55	41 971 505	33	574 725	4	367 908	120 101	365 655	97 784	4 508 649	4 284 422	780 309	3 504 113	36 484	224 227
C65	39 405 451	37	526 962	4	368 118	130 478	294 434	64 551	4 843 130	4 608 101	1 179 852	3 428 249	38 415	235 029
C66	38 633 544	33	538 738	3	282 574	93 140	314 726	107 491	4 160 239	3 959 435	836 181	3 123 254	35 040	200 804
C75	39 356 875	44	704 969	3	337 766	132 837	347 135	66 297	6 050 311	5 773 896	1 641 589	4 132 307	49 184	276 415
C83	38 379 873	43	539 694	3	316 227	126 108	277 522	0	4 406 402	4 200 909	1 061 674	3 139 235	35 510	205 493
C85	39 337 937	22	459 582	2	196 892	78 718	235 176	49 362	3 175 260	2 976 839	494 891	2 481 948	24 110	198 421
C92	38 975 468	33	555 148	3	300 298	109 925	300 825	98 572	4 354 522	4 149 052	898 120	3 250 932	36 090	205 470
C97	34 368 847	31	495 176	3	292 792	86 126	273 417	93 954	3 791 724	3 567 602	663 989	2 903 613	29 195	224 122
D05	39 281 786	27	502 100	3	297 371	112 693	299 971	56 183	4 129 257	3 897 657	869 353	3 028 304	37 126	231 600
D09	30 052 735	35	597 169	3	283 424	113 950	263 084	27 522	4 902 689	4 686 436	1 271 901	3 414 535	38 632	216 253
D12	38 508 696	37	690 382	4	419 162	191 618	276 704	129 332	5 153 802	4 891 324	949 931	3 941 393	42 780	262 478
D16	38 207 072	44	656 896	3	304 882	120 499	283 859	212 722	5 912 851	5 606 837	1 532 074	4 074 763	48 158	306 014
D25	33 689 895	27	489 328	2	224 050	119 899	284 204	63 286	3 897 576	3 676 323	866 759	2 809 564	30 144	221 253
D31	28 897 404	29	539 825	3	287 096	125 291	199 370	9186	4 564 613	4 353 634	1 217 768	3 135 866	40 287	210 979
D39	30 603 294	30	663 238	5	465 280	126 273	240 855	64 057	5 735 990	5 417 252	1 525 661	3 891 591	41 908	318 738
D45	37 081 322	41	797 328	4	358 486	138 099	324 278	70 583	7 352 280	6 988 716	2 199 856	4 788 860	67 175	363 564
D55	29 364 650	42	647 875	4	362 176	145 607	238 654	0	6 078 282	5 801 232	1 907 071	3 894 161	48 147	277 050
D60	31 066 366	33	736 200	3	300 858	122 490	235 821	43 798	6 568 794	6 281 268	2 079 529	4 201 739	58 562	287 526
D72	27 652 288	30	513 580	4	370 762	107 316	215 003	38 312	4 500 080	4 333 050	1 082 055	3 250 995	38 891	167 030

Table 3
The correlation coefficient analysis after two items omitted

	Crew size	Salary of service teams	Management size	Salary of management teams	Social charge	Total sales	Net product sales	Profit after control	Cash flow	Total number of customers	Non-product sales
Crew size	1.00	0.66	0.34	0.44	0.56	0.66	0.67	0.58	0.70	0.63	0.36
Salary of service teams	0.66	1.00	0.63	0.64	0.58	0.95	0.95	0.88	0.96	0.93	0.71
Management size	0.34	0.63	1.00	0.46	0.15	0.65	0.64	0.61	0.63	0.58	0.67
Salary of Management teams	0.44	0.64	0.46	1.00	0.54	0.63	0.63	0.52	0.70	0.54	0.47
Social charge	0.56	0.58	0.15	0.54	1.00	0.53	0.54	0.45	0.59	0.54	0.32
Total sales	0.66	0.95	0.65	0.63	0.53	1.00	1.00	0.97	0.97	0.97	0.81
Net product sales	0.67	0.95	0.64	0.63	0.54	1.00	1.00	0.97	0.97	0.97	0.79
Profit after control	0.58	0.88	0.61	0.52	0.45	0.97	0.97	1.00	0.87	0.94	0.77
Cash flow	0.70	0.96	0.63	0.70	0.59	0.97	0.97	0.87	1.00	0.94	0.76
Total number of customers	0.63	0.93	0.58	0.54	0.54	0.97	0.97	0.94	0.94	1.00	0.73
Non-product sales	0.36	0.71	0.67	0.47	0.32	0.81	0.79	0.77	0.76	0.73	1.00

Table 4
The final determined input and output items

Input/ output	Name of the item	Illustration of evaluating indexes
Input	Salary of service teams	Defray service team's salaries, including bonus
Input	Salary of management teams	Defray managers' salaries, including bonus
Input	Social charge	Labor insurance and health insurance
Input	Public utility	Water, electricity, and gas fee
Output	Profit after control	In a period, the profit income for the running restaurant
Output	Cash flow	In a period, the total amount of cash flow
Output	Total number of customers	In a period, the total customers in a running restaurant

output item represents the percentage that the evaluated unit has to increase for being an efficient one under this item.

In fact, it is great helpful if the priority and direction to improve those inefficient units can be obtained. The contribution indexes of input/output items (shown in Appendix 1) will help decision makers to judge the priority and make plans to improve those inefficient units. The target values of input/output items for those inefficient DMUs are listed in Appendix 1. Besides, to make quick improvement, the input or output item with the maximum contribution index is encouraged to improve because a larger contribution index makes the more improvement. The highest contribution index of output item is selected to conduct the improvement if the output directed model is applied.

Taking B98 as an example, its present input values (the salary of service teams, the salary of management teams, the social charge, the public utility) are 717 768, 373 166, 123 030 and 287 130 respectively; and the present output values (the profit after control, the cash flow, the total number of customers) are 1 548 936, 4 059 273, and 48 204, respectively. The contribution indexes of input items are 0%, 0%, 76%, 24% in order, and the contribution indexes of output items are 0%, 100%, 0% in order. The target values of input items are (717 768, 346 315, 123 030, 287 130), and the target values of output items are (2 054 482, 4 359 783, 56 963). The contribution indexes of input and output items for DMUs are shown in Appendix 1. Taking B98 as an example, if we try to change from input items for enhancing its relative efficiency, the improvement en-

Table 5
The production efficiency, the technical efficiency, the scale efficiency, and the return to scale of each DMUs

DMU	Production efficiency	Technical efficiency	Scale efficiency	Return to scale	Set of Peer							Rets
A19	99.78	100	99.78	CRS	A19	0	0	0	0	0	0	1
A37	100	100	100	CRS	A37	0	0	0	0	0	0	6
B11	97.53	98.11	99.41	DRS	A37	C23	D16	D72	0	0	0	0
B78	98.05	100	98.05	CRS	B78	0	0	0	0	0	0	0
B98	92.57	93.11	99.42	IRS	A19	C23	D45	D60	0	0	0	0
C18	88.24	91.74	96.18	DRS	A37	C23	C85	D05	D16	D31	D72	0
C21	94.05	95.98	97.99	DRS	A37	C23	D16	D25	D31	0	0	0
C23	100	100	100	CRS	C23	0	0	0	0	0	0	11
C55	93.27	93.4	99.86	IRS	A37	C23	0	0	0	0	0	0
C65	99.79	100	99.79	CRS	C65	0	0	0	0	0	0	1
C66	92.55	100	92.55	CRS	C66	0	0	0	0	0	0	0
C75	94.11	94.76	99.31	IRS	C23	D16	D45	0	0	0	0	0
C83	89.26	93.36	95.61	DRS	A37	C23	C65	D25	D31	D72	0	0
C85	92	100	92.00	CRS	C85	0	0	0	0	0	0	4
C92	91.23	93.97	97.08	DRS	A37	C23	C85	D05	D16	D25	0	0
C97	91.27	100	91.27	CRS	C97	0	0	0	0	0	0	1
D05	94.21	100	94.21	CRS	D05	0	0	0	0	0	0	2
D09	91.74	95.34	96.22	DRS	C23	C85	D16	D25	D31	D60	0	0
D12	92.34	93.31	98.96	IRS	C23	D55	D60	0	0	0	0	0
D16	100	100	100	CRS	D16	0	0	0	0	0	0	6
D25	93.4	100	93.40	CRS	D25	0	0	0	0	0	0	4
D31	96.85	100	96.85	CRS	D31	0	0	0	0	0	0	4
D39	98.14	98.47	99.66	IRS	C23	D55	D60	D72	0	0	0	0
D45	100	100	100	CRS	D45	0	0	0	0	0	0	2
D55	100	100	100	CRS	D55	0	0	0	0	0	0	2
D60	100	100	100	CRS	D60	0	0	0	0	0	0	4
D72	100	100	100	CRS	D72	0	0	0	0	0	0	4

courages to make change from the social charge first because its contribution index 76% which is the maximum one, then the public utility (24%). On the other hand, if we try to make change from output items, the improvement is encouraged to conduct the improvement of the cash flow because its contribution index is 100%. In fact, the restaurant B98 should study how to promote the cash flow and then plan to improve it up to the target of adding more than NT$ 300 510 ($4\,359\,783 - 4\,059\,273 = 300\,510$).

5. Recruitment and allocation plan

Based on the analyses of improved ranges and the potentially improved vales for input and output items, it reveals that there is no need to add extra resources for those relative inefficient units, but recommends to appropriately decrease them. Since the goal of chained quick-service enterprise is everlasting running, the most important job is to inherit its business culture and to maintain its operation standard. Therefore, the core spirit of chained quick-service enterprise is to recruit and train new cadre to pass on its culture, and such a topic is a major issue for the human resource management. A constructive and quantitative plan for human resource departments of chained quick-service enterprise to determine the recruitment and training assignment proposed in this work is called Recruitment and Allocation (RA) plan.

Practically, an international chained quick-service enterprise needs a set of training project for its personnel management. With the current efficiency of each chained restaurant, how many employees (cadre) to be recruited and which restaurants they should be sent to train form a dilemma problem.

In this research, the relative efficient quick-service restaurant always becomes a benchmark restaurant for those relative inefficient ones. Once a new employee (cadre) is assigned to a relative efficient restaurant, it not only provides a suitable training environment for learning, but also reduces the work loading for this efficient restaurant. The procedure of conducting the proposed Recruitment and Allocation (RA) plan is listed below.

Step 1: Define a unit of allocated human resource and group current relative efficient DMUs (generated by Frontier Software) whose relative efficiencies are equal to one to form the initial set. That is, the DMUs in the initial set function as benchmarks for those inefficient DMUs.

Step 2: The DMU with the maximum referenced times (shown in Rets column from Table 6) in the initial set is selected as the candidate DMU to add a unit of human resource because a DMU with the maximum referenced times means the most stable unit among those relative efficient DMUs. While the "tie" occurs, a DMU with less resource has the priority. In addition, if a unit human resource is added but turns the candidate DMU from relative efficiency to relative inefficiency, the DMU with next maximum referenced times should be checked until the candidate DMU is determined. To be more specific, a candidate DMU should promise that its relative efficiency won't be changed after adding a unit of human resource. After the candidate DMU is confirmed, the process goes to the next step.

Step 3: A unit of human resource is added to the candidate DMU and the associated changes of input and output items are computed. Besides, the input and output items of other DMUs remain constant. Then calculate the relative efficiencies of the entire DMUs, and then find out the total number of efficient DMUs. If the total number of efficient DMUs remains the same or decreases, these efficient DMUs are grouped as the initial set for the next stage and return to the step 2. Note that, adding a unit of human resource, if the total number of efficient DMUs remains the same or decreasing, it represents that the original benchmarks still exist. On the other hand, if the total number of relative efficient DMUs increases, it reveals that the original benchmarks are getting worse. At this time, go directly to the next step.

Step 4: List the whole records conducting in previous stages, and calculate the number of stages. The number of record stages (iterations) means the maximum employees to be recruited under the present capability, and the candidate DMU in each stage is the training restaurant where new employee is sent to train.

Table 6 shows the result of executing the RA process for the proposed case example. The RA process stops at stage 3 because the number of efficient DMUs increases up to 17 ($17 > 16$). Thus, the maximum employees to be recruited are 2 because the record ends in the 3rd stage. The training restaurants for these two new employees are C23 and D16 in order (shown in Table 6).

6. Conclusions

Nowadays, the performance evaluation is an important topic in the field of management sciences. This topic is gradually highly valued by businesses because a good performance is always the guarantee of management. Performance evaluation is also one of important measures for achieving execution or organization goals, and to stimulate the morale and the efficiency of work. Actually, the affected aspects of effectiveness, efficiency, and productivity would be impacted on the operation of organization if resources are not reasonably allocated. In fact, the performance evaluation could not only establish the support of organizational goals for all staff, but also check the blind points of managers. Though there are several measures to evaluate the performance, DEA is selected as the fair and reasonable measure in this study to analyze the relative efficiency because of its characteristic of multiple indications.

In addition, the recruitment and allocation of human resources will affect the efficiency and effectiveness of management, the speed of setting stores, and the promotion of productivity. If there is no reasonable plan for human-resource recruitment, it will bring significant impact on running the chained quick-service enterprise. Fortunately, the proposed Recruitment and Allocation (RA) plan can solve such a difficult and complicated problem.

By the potentially improved goals and improved range, it shows that the input resources of those relative inefficient DMUs should be reduced appropriately.

Table 6
The result of executing the RA process for the case example

DMU	Initial set		1st Stage		2nd Stage		3rd Stage	
	Mgmt Sizes	RE	Mgmt Sizes	RE	Mgmt Sizes	RE	Mgmt Sizes	RE
A19	5	100	5	100	5	100	5	100
A37	3	100	3	100	3	100	3	100
B11	4	98.11	4	98.81	4	99.88	4	100
B78	4	100	4	100	4	100	4	100
B98	4	93.11	4	94.04	4	94.04	4	95.39
C18	3	91.74	3	91.82	3	93.03	3	93.05
C21	3	95.98	3	96.67	3	97.96	3	97.96
C23	4	100	5	100	5	100	6	100
C55	4	93.4	4	93.79	4	93.79	4	94.37
C65	4	100	4	100	4	100	4	100
C66	3	100	3	100	3	100	3	100
C75	3	94.76	3	95.13	3	96.5	3	96.5
C83	3	93.36	3	93.5	3	94.08	3	94.08
C85	2	100	2	100	2	100	2	100
C92	3	93.97	3	94.18	3	95.34	3	95.51
C97	3	100	3	100	3	100	3	100
D05	3	100	3	100	3	100	3	100
D09	3	95.34	3	96.1	3	97.35	3	97.39
D12	4	93.31	4	93.68	4	93.68	4	93.85
D16	3	100	3	100	4	100	4	100
D25	2	100	2	100	2	100	2	100
D31	3	100	3	100	3	100	3	100
D39	5	98.47	5	98.56	5	98.56	5	98.64
D45	4	100	4	100	4	100	4	100
D55	4	100	4	100	4	100	4	100
D60	3	100	3	100	3	100	3	100
D72	4	100	4	100	4	100	4	100
Total number of Efficient		16		16		16		$17 > 16$
Total number of Mgmt Size	93		94		95		96	stop

Note: RE means Relative Efficiency.

How to make right and reasonable adjustments of input resources for those inefficient DMUs? The decision makers could start from the maximum contribution index of input or output items for an exemplified restaurant to adjust. The most important goal of an enterprise is to inherit its business culture and sustain its job standards because of the objective of everlasting running. Besides, a relative efficient restaurant is regarded as the benchmark restaurant, and the referenced times of a relative efficient DMU is directly related to its strength of stability among those relative efficient DMUs. Therefore, based on the previous concept, the proposed RA plan in this research could provide a constructive and quantitative guideline for the chained quick-service enterprise to determine the maximum number of employees to be recruited and the quick-service restaurants that new employees are sent for training.

Actually, the main goal of managing a business is to output more with less input. An efficiency-based approach is proposed to conduct the recruitment decision and training allocation. This approach could help execute the estimation of maximal recruiting number of employees and their allocation for training in new age of the chained quick-service enterprise where the high efficiency is its missions.

Acknowledgements

We would like to thank professor Milan Zeleny and the anonymous referees who provided the comments to improve this work.

Appendix 1

Table A1
The actual value, target value, the improved range (percent %), and the contribution index (IO Cont) of input and output items for each DMU

DMU	Relative efficiency	Item	Input 1	Input 2	Input 3	Input 4	Output 1	Output 2	Output 3
A19	100	Actual	821 196	480 757	131 842	328 370	2 224 409	4 667 223	57 300
		Target	821 196	480 757	131 842	328 370	2 224 409	4 667 223	57 300
		IO Cont	0	100	0	0	100	0	0
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
A37	100	Actual	494 986	313 300	102 363	308 275	341 646	3 245 191	31 080
		Target	494 986	313 300	102 363	308 275	341 646	3 245 191	31 080
		IO Cont	63	0	37	0	0	100	0
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
B11	98.11	Actual	629 244	346 606	163 701	289 136	1 188 350	3 932 272	45 041
		Target	629 244	346 606	115 901	289 136	1 585 937	4 007 929	47 080
		IO Cont	74	13	0	13	0	100	0
		Percent %	0	0	−29	0	34	2	5
		Diff	0	0	−47 800	0	397 587	75 657	2039
B78	100	Actual	781 944	370 313	155 421	279 729	2 203 477	4 355 471	59 781
		Target	781 944	370 313	155 421	279 729	2 203 477	4 355 471	59 781
		IO Cont	0	100	0	0	100	0	0
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
B98	93.11	Actual	717 768	373 166	123 030	287 130	1 548 936	4 059 273	48 204
		Target	717 768	346 315	123 030	287 130	2 054 482	4 359 783	56 963
		IO Cont	0	0	76	24	0	100	0
		Percent %	0	−7	0	0	33	7	18
		Diff	0	−26 851	0	0	505 546	300 510	8759
C18	91.74	Actual	568 318	312 864	115 587	268 986	1 058 816	3 232 425	37 670
		Target	568 318	312 864	115 587	268 986	1 154 133	3 523 414	41 061
		IO Cont	73	18	5	4	3	72	25
		Percent %	0	0	0	0	9	9	9
		Diff	0	0	0	0	95 317	290 989	3391
C21	95.98	Actual	597 102	318 960	142 150	261 490	1 375 606	3 539 361	41 228
		Target	597 102	318 960	119 889	261 490	1 433 239	3 687 648	44 309
		IO Cont	75	17	0	8	6	94	0
		Percent %	0	0	−16	0	4	4	8
		Diff	0	0	−22 261	0	57 633	148 287	3081
C23	100	Actual	662 038	378 402	116 585	316 877	1 961 313	4 306 510	50 971
		Target	662 038	378 402	116 585	316 877	1 961 313	4 306 510	50 971
		IO Cont	73	18	0	9	8	93	0
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0

Table A1
(Continued)

DMU	Relative efficiency	Item	Input 1	Input 2	Input 3	Input 4	Output 1	Output 2	Output 3
C55	93.4	Actual	574 725	367 908	120 101	365 655	780 309	3 504 113	36 484
		Target	574 725	344 375	109 152	312 381	1 114 762	3 751 791	40 575
		IO Cont	100	0	0	0	0	100	0
		Percent %	0	−6	−9	−15	43	7	11
		Diff	0	−23 533	−10 949	−53 274	334 453	247 678	4091
C65	100	Actual	526 962	368 118	130 478	294 434	1 179 852	3 428 249	38 415
		Target	526 962	368 118	130 478	294 434	1 179 852	3 428 249	38 415
		IO Cont	80	20	0	0	8	92	0
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
C66	100	Actual	538 738	282 574	93 140	314 726	836 181	3 123 254	35 040
		Target	538 738	282 574	93 140	314 726	836 181	3 123 254	35 040
		IO Cont	49	0	52	0	0	0	100
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
C75	94.76	Actual	704 969	337 766	132 837	347 135	1 641 589	4 132 307	49 184
		Target	704 969	337 766	125 598	304 101	1 842 888	4 360 974	55 098
		IO Cont	74	26	0	0	0	100	0
		Percent %	0	0	−5	−12	12	6	12
		Diff	0	0	−7239	−43 034	201 299	228 667	5914
C83	93.36	Actual	539 694	316 227	126 108	277 522	1 061 674	3 139 235	35 510
		Target	539 694	316 227	117 196	277 522	1 137 181	3 362 500	38 036
		IO Cont	78	18	0	4	4	79	17
		Percent %	0	0	−7	0	7	7	7
		Diff	0	0	−8 912	0	75 507	223 265	2526
C85	100	Actual	459 582	196 892	78 718	235 176	494 891	2 481 948	24 110
		Target	459 582	196 892	78 718	235 176	494 891	2 481 948	24 110
		IO Cont	0	100	0	0	0	100	0
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
C92	93.97	Actual	555 148	300 298	109 925	300 825	898 120	3 250 932	36 090
		Target	555 148	300 298	109 925	293 438	955 767	3 459 599	38 407
		IO Cont	73	20	6	0	3	73	24
		Percent %	0	0	0	−3	6	6	6
		Diff	0	0	0	−7 387	57 647	208 667	2317
C97	100	Actual	495 176	292 792	86 126	273 417	663 989	2 903 613	29 195
		Target	495 176	292 792	86 126	273 417	663 989	2 903 613	29 195
		IO Cont	55	0	45	0	0	100	0
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
D05	100	Actual	502 100	297 371	112 693	299 971	869 353	3 028 304	37 126
		Target	502 100	297 371	112 693	299 971	869 353	3 028 304	37 126
		IO Cont	61	31	8	0	0	0	100
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0

Table A1
(Continued)

DMU	Relative efficiency	Item	Input 1	Input 2	Input 3	Input 4	Output 1	Output 2	Output 3
D09	95.34	Actual	597 169	283 424	113 950	263 084	1 271 901	3 414 535	38 632
		Target	597 169	283 424	113 950	263 084	1 334 004	3 581 257	42 326
		IO Cont	65	23	4	8	19	81	0
		Percent %	0	0	0	0	5	5	10
		Diff	0	0	0	0	62 103	166 722	3694
D12	93.31	Actual	690 382	419 162	191 618	276 704	949 931	3 941 393	42 780
		Target	690 382	345 720	121 800	276 704	2 003 387	4 224 044	53 737
		IO Cont	66	0	0	34	0	100	0
		Percent %	0	−18	−36	0	111	7	26
		Diff	0	−73 442	−69 818	0	1 053 456	282 651	10 957
D16	100	Actual	656 896	304 882	120 499	283 859	1 532 074	4 074 763	48 158
		Target	656 896	304 882	120 499	283 859	1 532 074	4 074 763	48 158
		IO Cont	72	28	0	0	0	100	0
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
D25	100	Actual	489 328	224 050	119 899	284 204	866 759	2 809 564	30 144
		Target	489 328	224 050	119 899	284 204	866 759	2 809 564	30 144
		IO Cont	72	28	0	0	0	100	0
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
D31	100	Actual	539 825	287 096	125 291	199 370	1 217 768	3 135 866	40 287
		Target	539 825	287 096	125 291	199 370	1 217 768	3 135 866	40 287
		IO Cont	92	7	0	1	0	0	100
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
D39	98.47	Actual	663 238	465 280	126 273	240 855	1 525 661	3 891 591	41 908
		Target	663 238	339 192	126 273	240 855	1 841 006	3 951 941	51 223
		IO Cont	67	0	2	31	0	100	0
		Percent %	0	−27	0	0	21	2	22
		Diff	0	−126 088	0	0	315 345	60 350	9315
D45	100	Actual	797 328	358 486	138 099	324 278	2 199 856	4 788 860	67 175
		Target	797 328	358 486	138 099	324 278	2 199 856	4 788 860	67 175
		IO Cont	29	22	22	27	0	0	100
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
D55	100	Actual	647 875	362 176	145 607	238 654	1 907 071	3 894 161	48 147
		Target	647 875	362 176	145 607	238 654	1 907 071	3 894 161	48 147
		IO Cont	95	0	0	5	33	0	67
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0

Table A1
(Continued)

DMU	Relative efficiency	Item	Input 1	Input 2	Input 3	Input 4	Output 1	Output 2	Output 3
D60	100	Actual	736 200	300 858	122 490	235 821	2 079 529	4 201 739	58 562
		Target	736 200	300 858	122 490	235 821	2 079 529	4 201 739	58 562
		IO Cont	96	0	0	4	31	0	69
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0
D72	100	Actual	513 580	370 762	107 316	215 003	1 082 055	3 250 995	38 891
		Target	513 580	370 762	107 316	215 003	1 082 055	3 250 995	38 891
		IO Cont	95	0	0	5	26	0	74
		Percent %	0	0	0	0	0	0	0
		Diff	0	0	0	0	0	0	0

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