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Evaluating Efficiency of SEPAH Bank Branches in Mazandaran Province by Using Data Envelopment Analysis

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Abstract: Most banks to evaluate their efficiencies only consider profit criteria and to evaluate different aspects of operations they usually use multiple ratios. The fact is that analysis of financial ratios provides little information.Accordingly, in this study by applying data envelopment analysis technique, efficiency of different branches of Sepah Bank in Mazanadaran in the year of 2009 is investigated. The results show that among 50 evaluated branches, only 5 branches located in Amol, Sari, Haraz Amol, Pasdaran and Gharen have 100 percent total efficiency and also the average efficiency of all branches is about 80 percent. Additionally, dividing the efficiency scores into two categories, that is pure technical efficiency and management efficiency, shows that in only 14 cases the size of management inefficiency is higher than criterion inefficiency and in the rest of cases criterion inefficiency caused by non-optimality of the bank size is the main cause of being inefficient. Finally, by determining pattern units for inefficient branches, the way of reaching the frontier efficiency is introduced for each of these branches.

Key words: Efficiency evaluation, Sepah Bank, Data envelopment analysis, Pattern Finding.

INTRODUCTION

All the endeavors of human are focused on gaining the maximum output by spending the least of those equipments which he has in hand. This tendency could be called reaching the higher efficiency. Efficiency is one of the important criteria for assessing the optimality of economic units and the basic step in enhancing efficiency is measuring it (Folan,2005: 663-680). Banking transactions are recognized worldwide as one of the prominent economic operations in each economical system. For any operation that requires gaining capital and economic resources, certainly one bank or financial organization must be involved. Generally speaking, banks can be known as part of financial system of society economics whose duty are easing transactions and paying and also as the largest financial intermediary they execute money policies for attracting savings, supplying businesses and performing projects and so forth(Bala,2003: 439 – 450). Banking system in Iran is very decisive because in addition to playing an intermediary role in money market, because of not developed capital market and also not developed organizations and tools, it plays an important role in bringing money to mid-term or long-term economic programs. At the same time that banks can be useful in economical promotion and development, their improper and inefficient operations can lead to financial crises. Long story short, a healthy banking system reflects the health of society economy .(Najafi,2005: 45-84)Accordingly, the current study aims at measuring efficiency of each branches of Sepah Bank in Mazandaran province so as to identify efficient branches, reasons for inefficiency and finding a solution for improving inefficient branches. Doing so, data envelopment analysis technique, which is based on linear programming methods and has found wide application in bank efficiency evaluation, has been applied.

2. Analytical Framework and Research Background:

Lin *et al*. (2009) have evaluated 117 bank branches in Taiwan. The obtained results demonstrated that in terms of total efficiency entire banks have apparent inefficiencies such that average total efficiency was 54.8 percent and average of pure technical efficiency was 67 percent. At the end, researchers concluded that this issue is due to low proportion of loans to deposits which causes the resources to be wasted (Lin,2009: 8883–8891). In another study, Chen *et al*. (2005) have evaluated 16 banks in China. They have considered capital and asset as input and net income, ROA and ROE as outputs. Results showed that only 2 banks had scale efficiency, 2 banks had constant efficiency, 7 banks had increasing efficiency and 7 banks had decreasing return to scale (Chen,2005: 229–245)Ahmadpour (2006) has investigated the efficiency of Saderat Bank branches across Mazandaran province. In his work, 141 branches of Saderat Bank were considered and their

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efficiencies were estimated using DEA techniques. In this study, the input variables included number of personnel, number of terminals and how much building of the branch costs and output variables were entire deposits, private sector facilities, and overdraft debts. The outcome of this research proves average efficiency is low (30 percent) in all the branches (AhmadPour,2006). The efficiency of Tejarat Bank supervision was evaluated by Dadgar and Niknemat (2007) through DEA. In their research 38 supervisions of Tejarat Bank were taken into consideration and efficiencies of units were measured applying two models CCR and BCC. The results showed that supervisions of regions No. three, four and five of Tehran are more efficient and supervisions of Qom, Zanjan, West Azerbaijan and East Azerbaijan are inefficient (Dadgar,2007: 11-45). Abrishami *et al*. (2003) have focused on evaluation of banking system efficiency with case study of Melat Bank during years of 1991 untill 2003. Parametric Econometric technique and random frontier cost Translog function were utilized to estimate the amount of cost efficiency. After estimating cost function and appearing inefficiency part it was revealed that ten percent of error model variation is because of inefficiency part. Moreover, the computations associated with cost efficiency showed that proportion of done total cost to minimum bank total cost is 1.07 averagely. Hence, Melat Bank in the above-mentioned period has merely faced seven percent of cost inefficiency.(Abrishami,2004: 173-193)

3. Research Methodology:

In this paper, we evaluate the efficiency of Sepah Bank located in Mazandaran Province in 2009 via using data envelopment analysis approach. To do so, by using basic models of data envelopment analysis (BCC and CCR) and non-increasing return to scale model three types of efficiency, technical, pure and scale are calculated. The required computations are done by DEA-Solver software. The units, evaluated in this paper, are homogenous from production process's perspective. Their inputs are personnel number, terminal number and operational costs and also their outputs include average facilities and average deposits.

3.1. Data Envelopment Analysis:

Data envelopment analysis is a method based on mathematical programming which for measuring relative efficiency of each decision making unit (DMU), having several inputs and outputs, develops an efficient frontier (Cook,2009: 1–17). In this method the efficiency of DMU_i is introduced as the proportion of weight summation of inputs to weight summation of outputs. In this course, DEA looks for the most proper weight sets for each DMU_i. These weight sets maximize efficient ratio of DMUi providing that this ratio does not violate 1 for any of the units.

3.1.1. CRR Model:

Charnes *et al*. (1978) under Constant Return to Scale (CRS) assumption have proposed a model which tries to envelop data by generating an experimental frontier; thus, the technical efficiency of each unit was estimated based on this frontier Figure 1 (Charnes,1978: 429-444) Figure 1 depicts a system with one input and one output. Here, to calculate efficiency of unit E, first value of Y is assumed to be constant then efficiency in the shape of $\frac{OF}{OE}$ in the CCR model or $\frac{OA}{OE}$ in the BCC model is calculated.

The main issue in DEA models is determining weights u_r and v_i such that the amount of DMU efficiency be maximized. Let there are n decision making units and DMU_j consumes an m-tuples vector $X_j = (x_{1j}, \ldots, x_{mj})$ input and generates an s-tuples vector $y_j = (y_{1j}, \ldots, y_{sj})$ output. Therefore, the efficiency of DMU_0 is calculated via model 1.

To calculate the efficiency of n decision making units, model 1 should be solved n times. Since the model is nonlinear, to deal with it methods such as fraction programming, fixing the denominator of objective function (input-oriented models) or fixing the numerator of objective function (output-oriented models) are proposed. Once the model was solved, a unit is efficient if the value of objective function is 1 and also all the u_r and v_i are positive. Therefore, the values of these variables in model (1) are considered to be equal or greater than a small number like (ε). A unit with the above conditions is called strong efficient unit. A unit is called weak when the value of objective function is 1 but value of at least one of u_r or v_i is zero. Since the condition of being positive for variables is imposed on model (1), this model is not capable of distinguishing weak efficient from inefficient units; therefore, these two groups are classified as inefficient units.

The models discussed in the data envelopment analysis are of linear programming models; hence, these models have another form named dual models (envelopment form) where for example the envelopment form of BCC model is presented (model 3). The CCR model is one of the Constant Return to Scale models. These models ignore the value of decision making unit when evaluating the performance despite the probable effect of institution size on producing services with more efficiency.

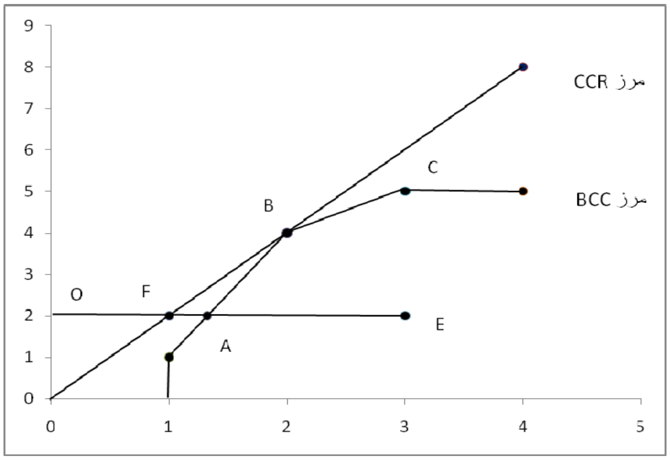

Fig. 1: Efficiency frontier in BCC and CCR models.

$$Max\,Z_0 = \frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}$$

$$st:$$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1$$

$$u_r, v_i \geq \varepsilon$$

Model 1. Dual form of CCR model

2.1.3. BCC Model:

Banker *et al*. in 1984, under assumption of variable return to scale, developed the initial studies done by Charnes *et al*. (1978) (Banker,1984: 1078-1092). By using assumptions of model (1), the input-oriented BCC model can be rewritten as model (2). As it can be seen, BCC and CCR models are analogous in all cases and the only difference between these two models is variable w which is subtracted from numerator of all fractions in model (2). The value of this variable can be positive, negative or zero which respectively means increasing, decreasing and constant return to scale. Model (3) shows the envelopment form of the model (2). Model (3) differs from envelopment form of model (1) only in the constraint $\sum_{j=1}^{n} \lambda_j = 1$ (convex constraint). Omitting this constraint results in increasing the feasible region in CCR model and therefore the number of efficient units and average efficiency scores in CCR model are diminished.

Care should be taken that BCC scores can only interpret pure technical efficiency. The pure technical efficiency explains the ability of the organization in applying the physical resources for producing maximum possible output; thus the pure technical efficiency is referred as management efficiency. In order to comprehensive comparison among units, using CCR model is necessary. The CCR scores are a combination of pure technical efficiency and scale efficiency. The ratio of total efficiency (CCR) to pure technical efficiency (BCC) explains the scale efficiency (Mostafa,2007: 309-320). The scale efficiency is a development which an organization can earn from advantages of return to scale by changing its size towards optimal scale. The drawback of scale efficiency value is its disability in stating whether return to scale for the evaluating unit is increasing or decreasing. To encounter this drawback a novel model is used that has non-increasing return to scale. Converting the convex constraint to $\sum_{j=1}^{n} \lambda_j \leq 1$ is the only difference between this model and BCC model. In order to determine the type of return to scale, one must first solve NIRS model for all the DMUs. Afterward, the results of BCC and CCR models are compared. If these two scores were equal, return to scale is constant; otherwise, results of BCC and NIRS are compared. If scores were equal, return to scale is decreasing otherwise increasing (Mehregan,2004).

$$
\begin{aligned}
& Max\, Z_o = \sum_{r=1}^{s} u_r y_{ro} - w \\
& st: \\
& \quad \sum_{i=1}^{m} v_i x_{io} = 1 \\
& \quad \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} - w \leq 0 \\
& \quad u_r, v_i \geq \varepsilon \qquad w \quad free
\end{aligned}
$$

Model 2. The input-oriented BCC model

$$
\begin{aligned}
& Min\, y_o = \theta - \varepsilon \left(\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+ \right) \\
& st: \\
& \quad \sum_{j=1}^{n} \lambda_j y_{rj} - S_r^+ = y_{ro} \qquad (r = 1,2,...,s) \\
& \quad \sum_{j=1}^{n} \lambda_j x_{ij} + S_i^- = \theta x_{io} \qquad (i = 1,2,...,m) \\
& \quad \sum_{j=1}^{n} \lambda_j = 1 \qquad (j = 1,2,...,n) \\
& \quad \lambda_j, S_i^-, S_r^+ \geq 0
\end{aligned}
$$

Model 3. The envelopment form of input-oriented BCC model

RESULT AND DISCUSSION

In this section, at first by using random sampling method, data of 50 branches were applied as sample. Then, efficiency scores of each branch in three dimensions, technical, pure technical (management efficiency) and scale efficiency, were computed by DEA-Solver software. It is worth noting that since performing required changes in input levels is easier for branches, the input-oriented models are used.In table (1), scores of CCR model (technical efficiency), BCC model (pure technical efficiency) and scale efficiency are presented and then to determine the type of return to scale for branches, scores of NIRS model are calculated.As it can be observed in table (1), among 50 evaluating branches, only 5 branches, Amol, Sari, Haraz Amol, Pasdaran, and Gharen have 100 percent technical and scale efficiencies. However, the study of pure technical efficiency reflects that 11 branches, Amol, Sari, Haraz Amol, Marzan Abad, Keshavarzi Sari, Ferdosi Noshahr, Pasdaran, Gharen, Emam Reza Neka, Modares, and Rogan Nor have 100 percent efficiency in management segment. After that, the types of return to scale of branches were identified. The studies shows that 5 branches are operating under condition of constant return, 44 branches under condition of increasing return and 1 branch under condition of decreasing return. Two last columns of table (the reference set and target values for inputs) are about determining pattern units for inefficient branches which are discussed in the rest of the paper.

R	Branches	CCR scores	BCC scores	Scale efficiency	NIRS scores	RTS type	Reference set	Target values of inputs		
								Costs	Terminal	Personnel
1	Amol	1	1	1	1	Constant		9498	19	25
2	Sari	1	1	1	1	Constant		17897	19	25
3	Babol	0.7499	0.7503	0.9995	0.7499	Increasing	(0.0585) 2 (0.7812) 1	8469.054	15.953	20.996
4	Babolsar	0.92	0.9201	0.9999	0.9201	Decreasing	(0.9161) 46 (0.0974) 1	4344.226	10.096	14.345
5	Chalos	0.8613	0.8641	0.9968	0.8613	Increasing	(0.2061) 46 (0.4916) 1	5439.25	11.197	14.972
6	Tonkabon	0.8629	0.8734	0.988	0.8629	Increasing	(0.4276) 20 (0.2286) 1	4456.015	7.766	10.849
7	Behshahr	0.9544	0.9643	0.9897	0.9544	Increasing	(0.2313) 46 (0.3927) 1	4593.643	9.544	12.826
8	Reza Amol	0.8558	0.8996	0.9513	0.8558	Increasing	(0.102282) 2 (0.240043) 1	4110.466	6.504	8.558
9	Khoram Abad	0.5766	0.7596	0.7591	0.5766	Increasing	(0.159) 34 (0.162) 20 (0.011) 1	1749.94	2.306	3.501
10	Ramsar	0.7433	0.7661	0.9702	0.7433	Increasing	(0.301198) 20 (0.147027) 1	3005.162	5.203	7.290
11	Joibar	0.6751	0.7152	0.9439	0.6751	Increasing	(0.296) 34 (0.291) 20 (0.0124) 1	3120.143	4.050	6.180
12	Velaiat Babol	0.7288	0.8163	0.8928	0.7288	Increasing	(0.546) 34 (0.095) 20 (0.007) 1	3247.456	3.644	5.711
13	Amir Kala	0.5598	0.617	0.9073	0.5598	Increasing	(0.097) 34 (0.439) 20 (0.025) 1	3059.978	4.479	6.679
14	Noshahr	0.8684	0.8756	0.9918	0.8684	Increasing	(0.514) 34 (0.299) 2 (0.022) 1	8079.679	8.684	12.158
15	Bazar Sari	0.7699	0.8083	0.9525	0.7699	Increasing	(0.427) 34 (0.143) 2 (0.027) 1	4919.109	5.389	7.699
16	Zirab	0.7827	0.906	0.8639	0.7827	Increasing	(0.12041) 20 (0.11408) 1	1726.711	3.131	4.297
17	Mahmud Abad	0.7742	0.8443	0.917	0.7742	Increasing	(0.22940) 20 (0.14788) 1	2629.827	4.645	6.450
18	Nor	0.741	0.771	0.9611	0.741	Increasing	(0.341425) 2 (0.043892) 1	6527.364	7.321	9.633
19	Bazar Babol	0.7125	0.8218	0.867	0.7125	Increasing	(0.284338) 20 (0.067766) 1	2162.293	3.562	5.106
20	Hazar Amol	1	1	1	1	Constant		5341	8.000	12.000
21	J. Eslami Tonkabon	0.6014	0.7652	0.7859	0.6014	Increasing	(0.211) 34 (0.147) 20 (0.008) 1	1902.841	2.406	3.683

22	Bazar Amol	0.7458	0.7643	0.9758	0.7458	Increasing	(0.153875) 2 (0.204097) 1	4692.422	6.801	8.949
23	Marzan Abad	0.9826	1	0.9826	0.9826	Increasing	(0.262062) 46 (0.082736) 1	1763.843	3.931	5.475
24	Galogah	0.8531	0.9688	0.8806	0.8531	Increasing	(0.374203) 46 (0.000805) 1	1404.172	3.383	4.885
25	Keshavarz Sari	0.9888	1	0.9888	0.9888	Increasing	(0.549) 34 (0.196) 2 (0.023) 1	6415.872	6.922	9.888
26	Ferdosi Noshahr	0.9703	1	0.9703	0.9703	Increasing	(0.333721) 20 (0.114818) 1	2872.941	4.851	6.875
27	Abas Abad	0.8222	0.8959	0.9177	0.8222	Increasing	(0.30117) 20 (0.08955) 1	2459.176	4.111	5.853
28	M. Emam Qaemshahr	0.9159	0.9225	0.9928	0.9159	Increasing	(0.63823) 46 (0.10776) 1	3405.44	7.792	10.991
29	Bolvar Azadi	0.9051	0.9192	0.9847	0.9051	Increasing	(0.409487) 2 (0.061146) 1	7909.358	8.942	11.766
30	Hamzeh Kala	0.6035	0.7171	0.8416	0.6035	Increasing	(0.469) 34 (0.0136) 2 (0.053) 1	3040.952	3.621	5.431
31	M. Janbazan	0.6818	0.8045	0.8475	0.6818	Increasing	(0.204855) 46 (0.082382) 1	1546.981	3.409	4.723
32	Bazar Babolsar	0.553	0.7483	0.739	0.553	Increasing	(0.217793) 46 (0.063703) 1	1417.858	3.171	4.424
33	Farhangshahr	0.7159	0.8279	0.8647	0.7159	Increasing	(0.204619) 20 (0.102239) 1	2063.943	3.580	5.011
34	Pasdaran	1	1	1	1	Constant		4875	5.000	8.000
35	M. Shahid Bazaz	0.5929	0.7573	0.7829	0.5929	Increasing	(0.273) 34 (0.096) 20 (0.012) 1	1964.969	2.372	3.652
36	Emam Reza Sari	0.7791	0.8343	0.9338	0.7791	Increasing	(0.502) 34 (0.0993) 20 (0.071) 1	3665.112	4.675	7.012
37	Hafez Babol	0.5417	0.7313	0.7407	0.5417	Increasing	(0.084994) 20 (0.106774) 1	1468.098	2.709	3.689
38	Khezr Sari	0.9178	0.9495	0.9666	0.9178	Increasing	(0.917850) 34	4474.519	4.589	7.343
39	J. Eslami Sari	0.7581	0.8539	0.8878	0.7581	Increasing	(0.227416) 20 (0.103747) 1	2200.017	3.791	5.323
40	Salman shahr	0.7346	0.8339	0.8809	0.7346	Increasing	(0.388984) 20 (0.029534) 1	2358.08	3.673	5.406
41	Fazlolah Amol	0.7525	0.8716	0.8634	0.7525	Increasing	(0.038828) 46 (0.140028) 1	1474.887	3.010	4.005
42	Moziraj	0.6012	0.8574	0.7012	0.6012	Increasing	(0.018482) 46 (0.117823) 1	1188.059	2.405	3.186
43	Shirgah	0.7658	0.8466	0.9046	0.7658	Increasing	(0.6528) 34 (0.055) 20 (0.006) 1	3539.744	3.829	6.048
44	Kalardasht	0.8814	0.9379	0.9398	0.8814	Increasing	(0.775819) 34 (0.027795) 1	4046.116	4.407	6.901
45	M. Qaem Amol	0.863	0.9857	0.8755	0.863	Increasing	(0.340480) 46 (0.000049) 1	1271.139	3.065	4.427
46	Gharen	1	1	1	1	Constant		3732	9	13
47	Emam Reza Neka	0.8154	1	0.8154	0.8154	Increasing	(0.116869) 20 (0.079544) 1	1379.711	2.446	3.391
48	Modares	0.8103	1	0.8103	0.8103	Increasing	(0.279400) 46 (0.001037) 1	1052.574	2.534	3.658
49	Amir Mazandarani	0.7679	0.8924	0.8605	0.7679	Increasing	(0.159904) 20 (0.094334) 1	1750.038	3.072	4.277
50	Royan Nor	0.9781	1	0.9781	0.9781	Increasing	(0.385931) 34 (0.001394) 1	1894.651	1.956	3.122

4.1. Determining Pattern Unit for Inefficient Branches:

One of the basic capabilities of DEA technique is making pattern units (virtual) for inefficient units. In this regard, reference set of each inefficient unit makes a virtual unit with 100 percent efficiency such that this unit generates outputs similar to inefficient units by consuming fewer resources (input-oriented models) or by using the same resources, generates more outputs (output-oriented models). Since the model in this study is input-oriented, improvement of input variables region is considered. A procedure for making virtual units related to each of inefficient branches is to use shadow prices obtained from solving dual model of that branch. The reference units are those efficient units that after solving dual model the amount of slack variable associated with their constraint is zero, in the other words, the shadow prices of these constraints are against zero. Below the column of reference units in table (1), row number of reference unit and in parenthesis the shadow price related to reference unit are presented. In this study, this operation has been accomplished by DEA-Solver software. Results of sampling for the inefficient branches are demonstrated in "Target values of inputs" column. In this section, optimal levels for the amount of costs, number of terminals, and number of personnel that each inefficient branch must gain are introduced. For example Babol branch with technical efficiency of 74.9 percent in order to reach 100 percent efficiency should change the amount of three aforementioned variables to 8469, 16 and 21, respectively.

5. Conclusion:

In this study, the efficiency of 50 branches of Sepah Bank in Mazandaran province in 2009 was evaluated. The obtained results showed that only 5 branches, Amol, Sari, Haraz Amol, Pasdaran, and Gharen, have total efficiency of 100 percent. That is, their amount of pure technical efficiency (BCC) as well as scale efficiency is 100 percent. In the other words, in these branches the application of resources in technical and scale dimensions have been fulfilled in the best way. At the same time, the weakest units were Bazar Babolsar, Hafez Babol, and Maidan Shahid Bazaz. Dividing the total efficiency scores (CCR) into two factors, pure technical efficiency (management efficiency) and scale efficiency, proved that among 45 inefficient units only 6 branches (Keshavarz Sari, Marzan Abad, Royan Nor, Ferdosi Noshahr, Emam Reza Neka and Modares) have %100 pure technical efficiency and their scale efficiencies were under 1. This means that, the inefficiency of these 6 units is basically from the factor of their size. The pure technical efficiencies of other 39 units were below 1. On the other hand, the pure technical efficiency of 14 units is greater than their scale efficiency and this means that the inefficiency of these units is fundamentally relevant to the size of them. Moreover, all these 14 units were operating in increasing return to scale condition thus as their size increases, the amount of total efficiency will improve. At the same time, only unit No. 14 (Babolsar) was operating in decreasing return to scale condition so the size of the organization should be decreased. Next, for each of the inefficient units, pattern units have been defined and the required amounts of changes in inputs of branches were determined. So by changing their inputs, the inefficient units move toward efficiency frontier. The results of finding patterns showed that the maximum required decrease in operational costs is related to unit 44 (Kalardasht branch) with the amount of 3456. Also, the maximum required modification in the number of terminal and personnel is related to unit No. 3 (Babol branch) with the amount of 6 and 7.According to the result, it is recommended that inefficient units perform potential saving on their resources based on improvement procedure defined by pattern units. The amount of resources consumed by branches for generating the current outputs is presented in table (1). Since, branches primarily are operating under the condition of increasing return to scale a proper solution for them could be developing their activities through merging some of the branches. The results reflected that in 31 cases the management efficiency (BCC) is lower than scale efficiency. This difficulty is mainly resulted from wrong decisions made by management and shortcoming in executing operations. To improve, following methods can be applied: learning operations from the advanced units, enhancing the efficiency of organization and promoting the managerial skills, moving toward the planned goals and making sure that policies are exactly being executed.

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