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RECENT AND FUTURE EFFICIENCY OF THE NEW SUEZ CANAL PORTS PROJECT USING DEA-MODELS

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ABSTRACT

The main aim in this research is to transform the corridor of the new Suez canal hub to be a pioneer zone in maritime transport industry in the world and to make it a kernel for a future industrial zone around the Suez passage. The vision is for Egypt to play a more important role in the global trade system and in supply chain management. The seaborne trade constitutes 80-90% of global trade volumes and 70-80% of global trade value. Such huge shares of world trade volumes and values are considered alone a major asset in developing the region.

This was done by applying Data Envelopment Analysis (DEA) method in measuring and analyzing the efficiencies of the New Suez canal ports projects. DEA window analysis is used to determine the recent and the future efficiency of the ports and to observe the possibility of changes in the port efficiency over time.

The research was conducted to evaluate the efficiencies of ports on the territory of Egypt in order to identify the sources of inefficiencies and formulate proposals for improving the services of those ports and their operations through a four-year window analysis with port efficiency trends and average efficiencies. The progress is made in the measurement of port efficiency in relation to port productive activities - total area of ware-houses, quay lengths and port throughput, for the developed new Suez canal ports..

Keywords: New Suez canal ports, total area of warehouses, quay lengths, port throughput, port efficiency, DEA window analysis

I. INTRODUCTION

Maritime transport was and currently is the backbone of development for many countries, (Banker, R. D., Charnes, A. and Cooper, W. W.) [1]. It related the knowledge of the old era with the newest knowledge of the modern world. Water transportation played a key role in human life since ancient times when mankind inspired with instinct developed different devices in this domain starting with piloting boats manually and ending with the use of mechanical power. The privilege of sea transport is the speed, comfort, safety and the possibility and ability to handle heavy traffic of goods and passengers at low prices. The present research analyses technical efficiency of the developed new Suez canal ports with a DEA- Data envelopment procedure.

The following fig.1.1 is explained the location of the six ports of the developed new Suez canal hub.

Fig.1.1:The Suez canal six ports project

II. PORT PRODUCTION MEASUREMENT

2.1 Importance efficiency measurement of ports

The weaknesses in management of ports authority are the lack of efficiency measurement methodology that likely retards port adoption of new methods and cost excesses. Efficiency measurement an important aspect for ports to evaluate their actual objectives against predefined goals and to make sure that the ports are doing well in the competitive environment. Nevertheless, efficiency measurement is not without any disadvantages. Efficiency measurement enables managers to make decisions based on facts rather than on assumptions and faith [2]. Therefore efficiency measurement has become an integral part of planning and controlling ports. For competitive maritime transport, there is a critical need for management actions to continuously improve the port's efficiency. In the long term, success of both individual seaport and the maritime transport overall will depend on improving efficiency by continually acquiring and applying new knowledge. Measurement aims at comparing the efficiency of port relative to each other, allowing this port to recognize their weaknesses and strengths compared to the industry. Measurement aids in the identification of leaders who exhibit superior efficiency measurement as a result of using best maritime transport practices. By finding examples of superior performance, ports can adjust their policies and practices to improve their own efficiency and become more similar to efficiency leaders in the maritime transport [3]. Efficiency measurement assists managers in staff allocation based on activities' level and determines where excess resources are being utilized.

2.2 The Master plan of the recent and the future planned ports

The new Suez canal Hub possesses six ports, for every port there is the recent plan and the future developed plan to achieve the maximum efficiency , and it is clear in the following figures:

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2.2.1The east Port said port

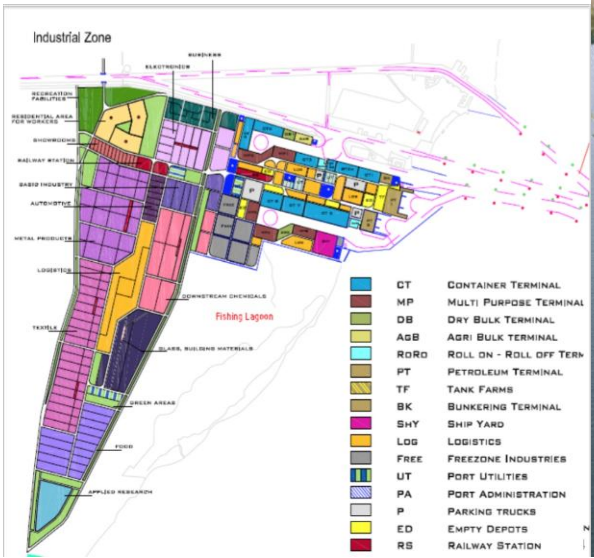

Fig.2.1 The water area of East Port said port

Fig.2.2 The land area of East Port said port

2.2.2 The west Port said port

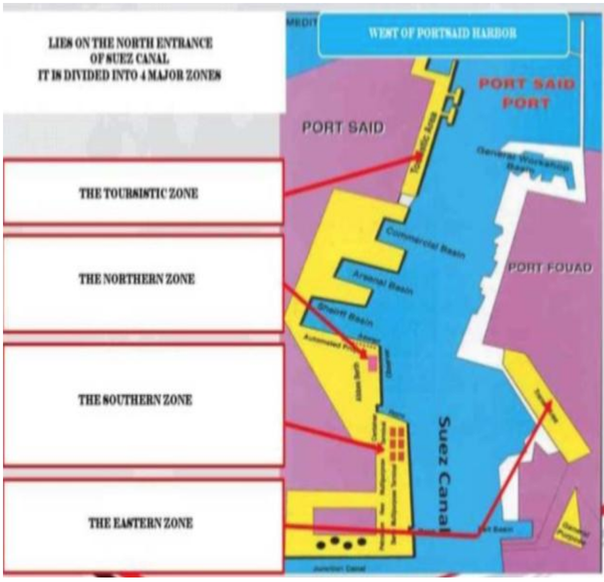

Fig.2.3 The water area of East Port said port

Fig.2.4 The detailed areas of East Port said port

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2.2.3 The Adabia port

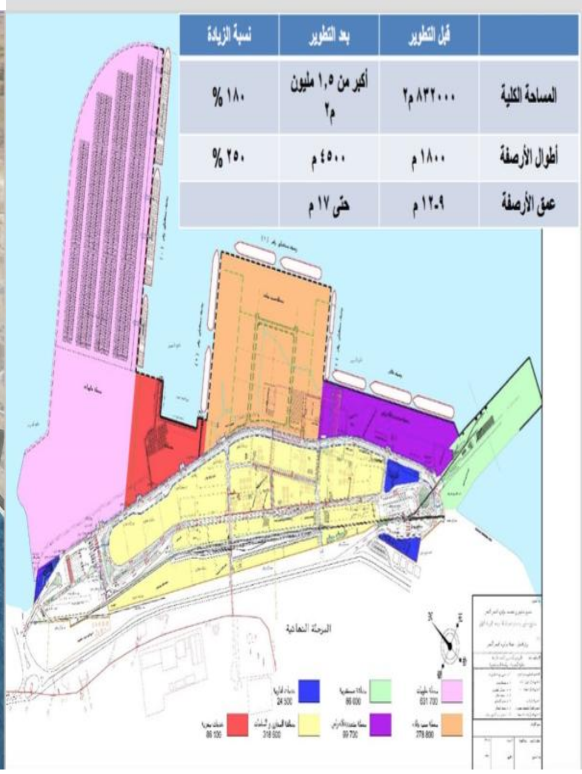

Fig.2.5 The water area of Adabia port Fig.2.6 The detailed elements of Adabia port

2.2.4 The Sokhna port

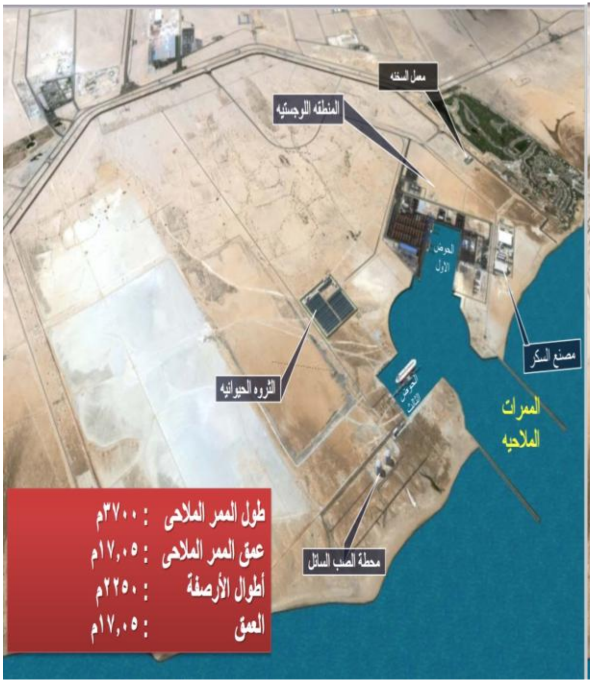

Fig.2.7 The recent master plan of Sokhna port Fig.2.8 The future master plan of Sokhna port

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2.2.5 The Alarish port

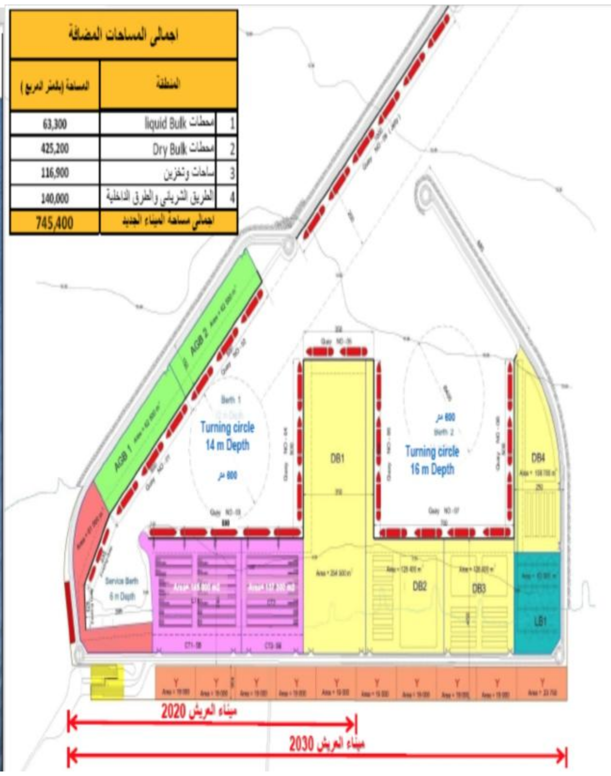
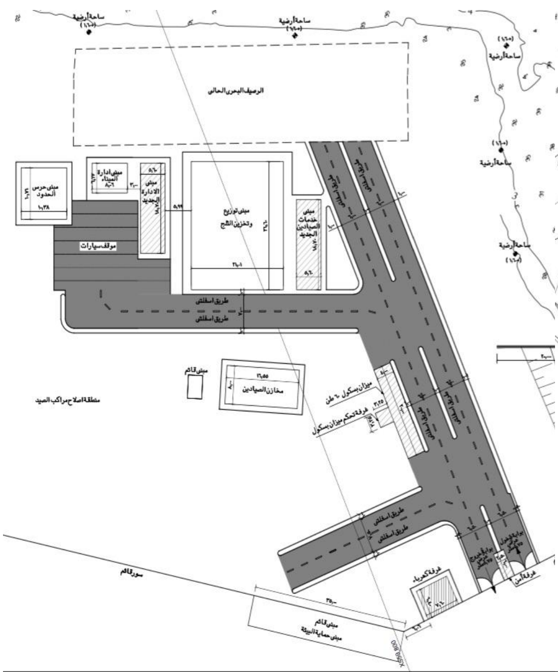


Fig.2.9 The recent master plan of Alarish port Fig.2.10 The future master plan of Alarish port

2.2.6 The TUR port



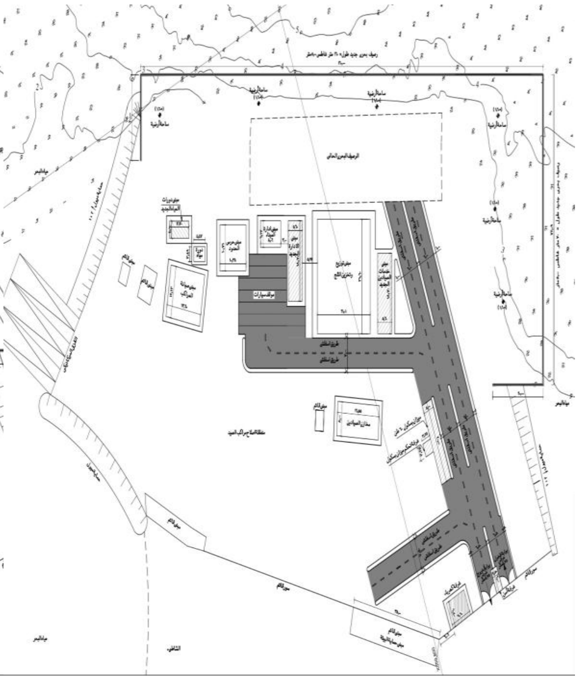


Fig.2.11 The recent master plan of TUR port Fig.2.12 The future master plan of TUR port

III. RESEARCH METHODOLOGY

This conversion is based on the inputs and outputs for its decision making units (DMU) as show in Fig. III.1. According to Cullinane, K. [4], data envelopment analysis will give relative efficiency of decision making units instead of absolute efficiency. Data envelopment analysis is based on mathematical calculation and also it is called as non-parametric test because it is not following any distribution method. The main difference between the two models is in the assumption for returns to scale (RTS). In fact, the CCR model assumes constant returns to scale (CRS), whereas the BCC model allows for variable returns to scale (VRS) [5].

$$\mathbf{X} = \begin{pmatrix} x_{11} & x_{12} & \cdots x_{1s} \\ x_{21} & x_{22} & \cdots x_{2s} \\ \vdots & & \\ x_{m1} & x_{m2} & \cdots x_{ms} \end{pmatrix} \qquad \mathbf{Y} = \begin{pmatrix} y_{11} & y_{12} & \cdots y_{1s} \\ y_{21} & y_{22} & \cdots y_{2s} \\ \vdots & & \\ y_{n1} & y_{n2} & \cdots y_{ns} \end{pmatrix}$$

Fig. 3.1 the inputs for decision making units   Fig. 3.2 the outputs for decision making units

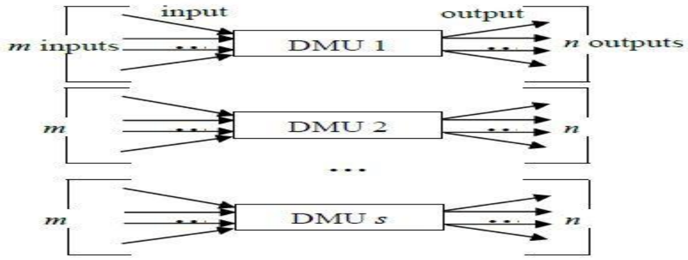


Fig. 3.3 DMU and Homogeneous Units

3.1. Alternative DEA models

3.1.1. The CCR output oriented model

the output oriented model, which aims to maximize outputs while not exceeding the observed input levels [6]

$$\min q_o = \sum_{i=1}^{m} v_i x_{io} \qquad (1)$$

$$s.t. \sum_{r=1}^{m} u_r y_{ro} = 1$$

$$\sum_{i=1}^{m} v_i x_{ij} -. \sum_{r=1}^{s} u_r y_{rj} \geq 0 \qquad j = 1, \ldots, n$$

$$u_i, v_r \geq \varepsilon \quad i = 1, \ldots, m \quad , r = 1, \ldots, s$$

And the dual for it is formulated as:

$$\max z_o = \emptyset + \varepsilon . \sum_{r=1}^{s} s_r^+ + \varepsilon . \sum_{i=1}^{m} s_i^- \qquad (2)$$

$$\text{s.t. } \emptyset . y_{ro} - \sum_{j=1}^{n} \lambda_j . y_{ri} + s_r^+ = 0 \qquad r = 1, \ldots, s$$

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$$\sum_{j=1}^{n} \lambda_j . x_{ij} + s_i^- = x_{io} \qquad i = 1, \dots, m$$

$$\lambda_j , s_i^- , s_r^+ \geq 0 \qquad j = 1, \dots, n \quad , i = 1, \dots, m \ , r = 1, \dots, s$$

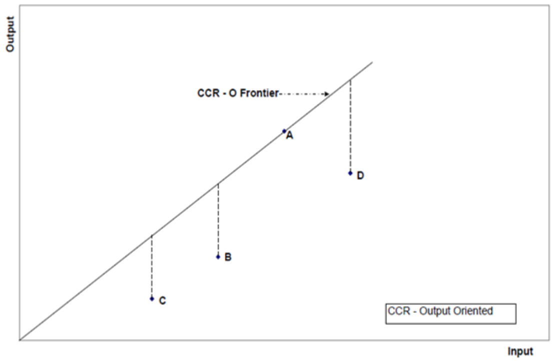

Fig.3.4 DEA - CCR-output model

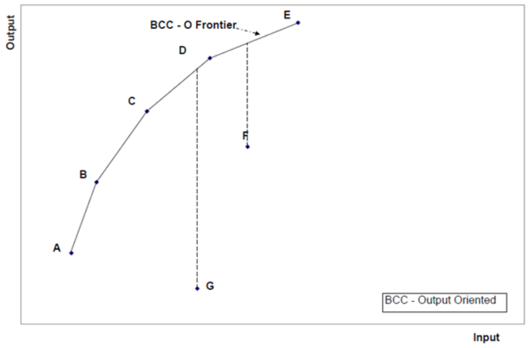

Fig.3.5 DEA - BCC-output model

3.1.2. BCC output oriented model

The objective in BCC-O is to maximize the output production while not exceeding the actual input level[7].

$$\max z_o = \emptyset + \varepsilon . \textstyle\sum_{r=1}^{s} s_r^+ + \varepsilon . \sum_{i=1}^{m} s_i^- \qquad (3)$$

$$\text{s.t.} \ \emptyset . y_{ro} - \sum_{j=1}^{n} \lambda_j . y_{rj} + s_r^+ = 0 \qquad r = 1, \dots, s$$

$$\sum_{j=1}^{n} \lambda_j . x_{io} + s_i^- = x_{io} \qquad i = 1, \dots, m$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j , s_i^- , s_r^+ \geq 0 \qquad j = 1, \dots, n, i1, \dots, m, r = 1, \dots, s$$

3.2. Returns to Scale Evaluation and Scale Efficiency

Total technical efficiency (TTE) = Xj / Xd

Pure technical efficiency (PTE) = Xw / Xd

Scale efficiency (SE) = X j / Xw

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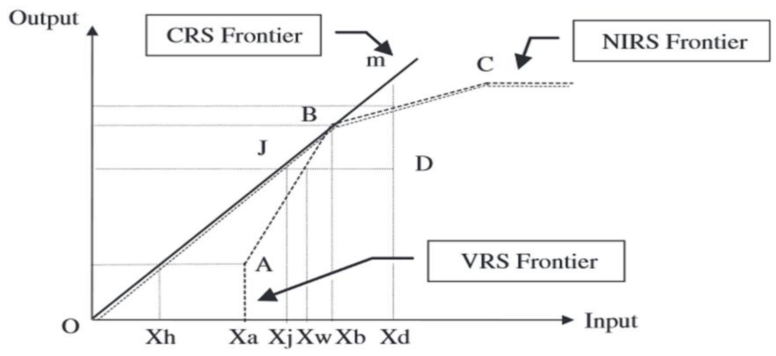

Fig.3.6 Constant, variable, non-increasing returns to scale, Technical and Scale Efficiency

IV. PREPARING THE CROSS SECTION DATA FOR THE EFFICIENCY ANALYSIS

The data collection process is an integral part of the research design and it aims to collect accurate and reliable data using different sources, such as interviews and observations, six sources for data collection using a case study strategy. These are documentation, archival records, interviews, direct observation and participant observation. The Maritime transport sector, the Red sea ports authorities and the Port said port authorities provided to the research statistical data available for the containers and cargo handling for all the developed six ports under research as shown in the following table 4.1 for 2012 as an model for the cross section input data used.

Table 4.1 Descriptive Statistics of the cargo Input and Output Variables during the Analysis Period

Port	Area		Max. Capacity		Achieved Capacity During 2012			Containers Berths			Total no of Berths (Including Containers Berths)			Total Areas of Warehouses and Yards (m^2)
	Total (Km^2)	Land (Km^2)	Cargo (Million Tons)	Containers (Million TEUs)	Cargo (Million Tons)	Containers (Million TEUs)	Passengers (Million)	No.	length (m)	Draught (m)	No.	length (m)	Draught (m)	
Alexandria	8.40	1.60	36.80	0.5	20.9	0.6	0.1	6	914.4	12.8	59	7624.7	12.8	544785.3
El Dekheila	6.20	3.50	22.10	0.5	24.3	0.8	0	6	1520	12.0	20	4586.0	20.0	1639380
Damietta	11.80	8.50	19.75	1.2	23.9	0.7	0	4	1050	14.5	19	5100.0	14.5	1115380
Port Said	3.00	1.30	12.78	0.8	5.03	0.5	0.03	3	350	13.2	32	4452.0	13.2	243253
El Arish	0.23	0.05	1.20	0	0.9	0	0	0	0	0	2	364.0	8.0	34000
East Port Said	72.10	70.60	12.00	2.7	28.6	3.0	0	4	2400	15.0	4	2400.0	15	1800000
Suez		2.30	6.60	0	0.5	0	0	0	0	0	14	2070.0	8.22	18615
Petroleum Dock	162.40	1.16	4.14	0	1.4	0	0	0	0	0	7	828.0	9.0	0
Adabiya		0.85	7.93	0	6.1	0.1	0	0	0	0	9	1840.0	12.0	37000
Sokhna Port	87.80	22.30	8.50	0.4	5.6	0.5	0.2	1	750	17	7	2350.0	17.0	11140
Hurghada	9.90	0.04	0	0	0	0	0.1	0	0	0	1	330.0	10.0	0
Safaga	57.00	0.6	6.37	0	2.5	0	0.7	0	0	0	6	1327.4	14.0	200159
El Tour	1.65	0.43	0.38	0	0	0	0	0	0	0	1	75.0	5.0	385600
Nuweiba	9.90	0.40	1.90	0	0.9	0	0.5	0	0	0	3	385.0	8.0	168500
Sharm El Sheikh	88.13	0.20	0	0	0	0	0.3	0	0	0	2	686.0	10.0	86857
Total	518.51	113.83	140.45	6.1	120.63	6.2	1.93	24	6984.9		186	34368.1		6284669

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V. THE EFFICIENCY ANALYSIS OF THE SIX PORTS USING DEA- MODELS

Based on the results from the software used, open source DEA for researches and operational research folks. The first case is the achieved efficiency case, the average efficiency of the six ports for general cargo and containers, according to the models of DEA-CCR (average efficiency value) are 40, 59, 100,100,100 and 0 %, represented the efficiency in terms of the usage of input resources thus indicating that they would need to improve their usage of input resources. The efficiency score of the West Port said , El Arish, and El Tur ports is less than 1 or 100% , it reflects that this ports is inefficiency. The efficiency score of the other ports, the East Port said, the Adabia and the Sokhna is efficient ports and can be all represent as a frontier for the other ports.

The second case is the developed future plan of the six ports, the average efficiency of the six ports for general cargo and containers, according to the models of DEA-CCR (average efficiency value) are 100, 21, 30, 26,19 and 25 %, represented the efficiency in terms of the usage of input resources thus indicating that they would need to improve the output by increasing the throughput to be efficient in the future. The efficiency score of the El Arish, the East Port said, the Adabia, the Sokhna and El Tur ports is less than 1 or 100% , it reflects that this ports are inefficiency. The efficiency score of the East Port said is 100% or 1 and it will be the frontier for the other ports in the future case.

	Efficiency	Graph	
West port said	39.8 %	40%	
El Arish	59.2 %	59%	
East Port said	100 %	100%	✓
Adabia	100 %	100%	✓
Sokhna	100 %	100%	✓
El Tur	0.1 %	0%	

Fig.5.1 The achieved efficiency of the ports

	Efficiency	Graph	
West port said	100 %	100%	✓
El Arish	20.6 %	21%	
East Port said	30.4 %	30%	
Adabia	26.2 %	26%	
Sokhna	19.4 %	19%	
El Tur	24.5 %	25%	

Fig.5.2 The Future Planned efficiency of the ports

	Throughput-Cargo	Throughput-Container	warehouse areas	Berths length
West port said	5.03 to 13.451	0.5 to 1.256	243253 to 243253	4452 to 4452
El Arish	0.9 to 1.521	0 to 0.063	34000 to 34000	364 to 364
East Port said	28.6 to 28.6	3 to 3	1800000 to 1800000	2400 to 2400
Adabia	6.1 to 6.1	0.1 to 0.1	37000 to 37000	1840 to 1840
Sokhna	5.6 to 5.6	0.5 to 0.5	11140 to 11140	2350 to 2350
El Tur	0.001 to 0.749	0 to 0.074	43990 to 43990	75 to 75

Table 5.3 The achieved efficiency of the ports

	Throughput-Cargo	Throughput-Container	warehouse areas	Berths length
West port said	30 to 30	5 to 5	243253 to 243253	4452 to 4452
El Arish	1.2 to 5.822	0 to 0.97	745400 to 47208.129	864 to 864
East Port said	12 to 53.235	2.7 to 8.872	4300000 to 431648.405	7900 to 7900
Adabia	7.93 to 30.323	0 to 5.054	494907 to 245875.674	4500 to 4500
Sokhna	8.5 to 43.801	0.4 to 7.3	1500000 to 355153.751	6500 to 6500
El Tur	0.38 to 1.55	0 to 0.258	389747 to 12566.979	230 to 230

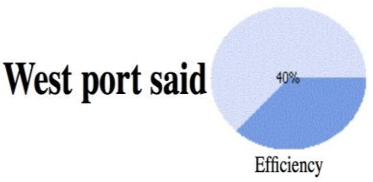
Table 5.4 The Future Planned efficiency of the ports

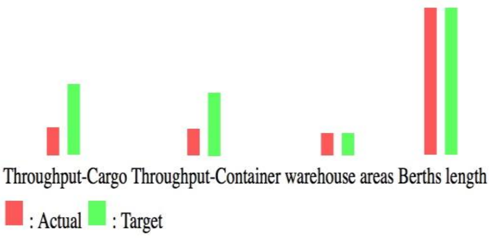
	Efficiency	West port said	El Arish	East Port said	Adabia	Sokhna	El Tur
West port said	39.796	39.796	0	100	23.21	100	0
El Arish	59.166	30.354	59.166	100	100	76.034	0.133
East Port said	100	8.985	0	100	4.348	17.021	0
Adabia	100	30.354	59.166	100	100	76.034	0.133
Sokhna	100	38.059	50.536	100	100	100	0.095
El Tur	0.133	30.354	59.166	100	100	76.034	0.133

Table 5.5 The achieved efficiency of the ports

	Efficiency	West port said	El Arish	East Port said	Adabia	Sokhna	El Tur
West port said	100	100	0	30.431	0	5.479	0
El Arish	20.611	100	20.611	22.542	26.151	19.406	24.518
East Port said	30.431	100	0	30.431	0	5.479	0
Adabia	26.151	100	20.611	22.542	26.151	19.406	24.518
Sokhna	19.406	100	20.611	22.542	26.151	19.406	24.518
El Tur	24.518	100	20.611	22.542	26.151	19.406	24.518

Table 5.6 The Future Planned efficiency of the ports



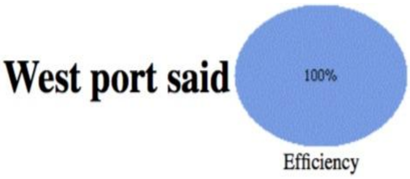


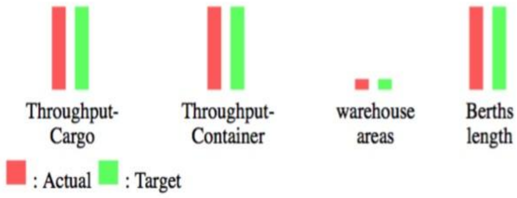
Reference | Peer Group: East Port said , Sokhna
Frequency : 0

Number of decimals : 3

	Throughput-Cargo	Throughput-Container	warehouse areas	Berths length
Slacks	0.811	0	0	0
Weights	0	2	0	0
Values	5.03	0.5	243253	4452
Targets	13.451	1.256	243253	4452

table 5.7 The achieved efficiency of the ports





Reference | Peer Group: West port said
Frequency : 6

Number of decimals : 3

	Throughput-Cargo	Throughput-Container	warehouse areas	Berths length
Slacks	0	0	0	0
Weights	0	0.2	0	0
Values	30	5	243253	4452
Targets	30	5	243253	4452

Table 5.8 The Future Planned efficiency of the ports

VI. CONCLUSIONS AND RECOMMENDATIONS

Measuring the relative efficiency of the new Suez canal ports, data envelopment analysis has been used. The research had applied radial - output oriented (DEA-CCR) for measuring the relative efficiency of the new Suez canal ports project in Egypt. The selection of input and output variables are based on the variable having close relationship with the efficiency of ports were considered. The input variables has been selected for this study is

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terminal area, storage , length of berths and output variables are considered in this study is containers and Cargos throughput.

Based on the analysis results, In the first case (the recent achieved efficiency) the highest efficiency from the East Port said, the Adabia and the Sokhna ports had achieved , so efficiency curves for this ports takes as frontier curves for the other ports, and thus for the recent time the other ports must be increased its throughput.

In the second case (the future planned of the six ports) only the West port said port is the efficeint one, and will be the forntier of the others. This is clear as the other five ports had a big input resourses in the future than it, then it must be increased the throughput of this five ports to be efficeint ones too.

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