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DESIGN AND DEVELOPMENT OF DATABASE SHIPPING PRODUCTIVITY MANAGEMENT SYSTEM

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Abstract

This paper presents the design and development of a suite of software program which creates a Database Shipping Productivity Management System (DSPMS) together with its user-friendly interface written in Visual Basic and Microsoft Access2000 incorporating appropriate methods and techniques, which a modern shipping manager needs for quick measurement and evaluation of actual past and present status of various productivity performances, and then for logically better and realistic planning to fix the next productivity target and implementing it to improve shipping productivity with a view to achieve company objectives of higher profitability..

GEMİ NAKLİYAT VERİMLİLİK YÖNETİM SİSTEMİ VERİTABANI TASARIMI VE GELİŞTİRME

Özetçe

Bu çalışma, Microsoft Access 2000 ve diğer uygun yöntem ve teknikler yardımıyla Gemi Nakliyat Verimlilik Yönetim Sistemi (DSPMS) veritabanı ve kullanıcı ara yüzeyi oluşturmak için, Visual Basic programlama dili ile yazılmış bir yazılım programı tasarlamayı ve geliştirmeyi hedeflemektedir. Modern bir gemi nakliyat yöneticisi, geçmişte oluşmuş verimlilik düzeyleri

ve mevcut durumdaki verimlilik düzeylerini hızlı ölçme ve değerlendirmeye ihtiyaç duyar. Bu ölçümü gelecekte amaçladığı verimlilik hedefini daha gerçekçi ve daha iyi planlamak ve onu kullanarak şirketin yüksek karlılık hedeflerini de göz önünde bulundurarak, gemi nakliyat verimliliğini artırması gerekmektedir.

Keywords: Database Shipping Productivity Management System (DSPMS), Deadweight Utilization, DWT, Ton-Miles/DWT, Tons Carried/DWT, World fleet, Operating productivity, Financial productivity.
Anahtar sözcükler: Gemi Nakliyat Verimlilik Yönetim Sistemi Veritabanı (DSPMS), Deadweight utilization, DWT, Ton-Miles/DWT, Tons Carried/DWT, Dünya filoları, İşletme verimliliği, Finansal verimlilik.

1. INTRODUCTION

Now-a-days shipping company managers live in a world of rapid changes, extensive interactions and complex situations, and face challenges of operating in a global market. It will be extra burden and troublesome for them to get excess to various academic literature to acquire proper knowledge, techniques and methods developed by various authors, to perform their productivity oriented managerial jobs.

Therefore, objective of this paper is to design and develop a suite of software program which ultimately creates and provides, the modern shipping managers, with a Database Shipping Productivity Management System (DSPMS), along with its simple and user-friendly interface, embedding appropriate methods and techniques, formulas, and generic models, so that they can use it as a hands on tool for measurement, evaluation, future planning and implementation of various productivities for individual ships and the fleets of their companies using past and present data available.

2. PRODUCTIVITY MEASUREMENT IN SHIPPING

According to David (1994) productivity is concerned with the efficient utilization of resources (inputs) in producing goods and /or

services. Shipping is a highly competitive capital-intensive transportation service industry where the ship owners compete by their ability to undercut their competitors and by the record of efficiency and performance as a profit earning reputed carriers or fleets. Productivity is one of the most important variables in determining the overall cargo carrying performance of the fleets measured in terms of ton-miles of cargo transportation provided

The productivity measurements for the shipping companies, which constitute the maritime fleets of a country, are necessary in order to know at what productivity level they should be operating and at what level they are operating now. Productivity can help the shipping companies to assess the efficiency of conversion of their resources (DWT-Dead Weight Tonnage) to produce more services (Ton miles carried) for a given amount of expended resources. Resource planning, such as scheduling of ships through different available routes and maximum utilization of ship's capacity etc., can be facilitated through productivity measurement. Future target of productivity can be fixed considering the present value. Necessary strategies for improving productivity can be determined based on the gap between planed level and the measured level of productivity.

Economic and non-economic objectives of the company can be recognized in the light of productivity improvement efforts. Productivity results can be utilized for planning the profit level of the company because higher productivity means higher profit. The conceptual approaches for measuring productivity includes the estimation of production functions and the estimation of cost functions. In production function approach, (Stopford, 1997; Gwilliam,2002) formula for the productivity of a fleet is given by:

$$\text{Productivity} = \frac{\text{Total ton miles of cargo shipment in the year}}{\text{Total deadweight the fleet actively employed in carrying the cargo in the year}}$$

and it depends upon three main factors:

(i) *Mean Operating Speed, which* determines the time a vessel takes on a voyage. The mean operating speed is important because it determines the amount of cargo that can be delivered during a fixed period and hence the revenue is earned. Sometimes it is better to operate the ship at full speed in a high freight rate market whereas in low freight rates a reduced speed may be more economic because the cost of fuel saving may be greater than the loss of revenue.

(ii) *Deadweight Utilization*, which refers to the extent to which a vessel travels with a full load of cargo. it is the ton mileage of cargo carried divided by ton mileage of cargo that the ship could actually have carried if it had always obtained a full payload. In practice, the deadweight cargo capacity of a ship represents a physical maximum, and it is commercial decision whether this capacity is fully utilized. The ship owner has always the option to accept a part cargo depending on the market condition.

(iii) *Loaded Days at Sea* which is a vessel's time divided between loaded at sea (steaming days) and the unproductive days (in port, off hire, in ballast etc.). A reduction in unproductive time will thus allow an increase in loaded days at sea By optimizing of each of these components the productivity of the fleet can be increased. Probably the most useful ways to tackle and increase the productivity of a fleet are to bring changes in its actual operating performances in response to the market condition. Cargo handling is also important since this determines the port-time.

In cost function approach concept of productivity measurement, one has to deal with the total *shipping cost and total revenues* earned. The costs of shipping (Everett, 1994; Stopford, 1997) are classified in to four main following categories:

(i) *Operating Costs*

(ii) *Voyage cost*

(iii) Cargo Handling Costs

(iv) Capital Costs

It is suggested that in order to develop a cost analysis, it is necessary to include each of the cost components in the unit cost in the above-mentioned categories. There are several ways in which the ship owner earns depending upon his degree of involvement in running the ship and the extent to which he is responsible for paying the various operating, voyage, cargo handling and capital costs.

The basic revenue calculation involves two steps:

(i) First is to determine how much cargo the ship can carry in the financial period, measured in any appropriate unit (tons, ton-miles, cubic meters etc.).

(ii) Second is to establish what price or freight rate the owner will receive per unit transported. That is, the revenue per deadweight of ship's capacity can be viewed as the product of the ship's productivity, measured in ton-miles of cargo transported per annum and the freight rate per ton-mile, divided by ship's deadweight. In cost function approach the productivity of a ship or a fleet is the ratio of total operating *revenues* earned to the total operating expenses for a specified period, that is

$$\text{Productivity} = \frac{\text{Total operating revenues earned in a year}}{\text{Total operating expenses in that year}}$$

Oum (1992) and Goss (1997) also suggested some physical and economical measures of productivity in shipping such as GRT/NRT/Man, DWT/Man, Tons-carried/DWT, cargo Tons/Man, Capital/Man, and Operating expenses/Ton etc.

3. DSPMS CONFIGURATION

A Database Shipping Productivity Management System (DSPMS) together with its user-friendly interface is designed and developed using the

modern concepts and techniques (Kenneth, 2005; Peter, 2006; and Philip, 2007). The configuration of DSPMS is depicted in Exhibit 1. It runs under two-software environments: Visual Basic 6.0 (VB6.0) and Microsoft Access2000. Most of the activities are handled by Visual Basic program DSPMS.VBP while the SHIP.MDB file contains all necessary shipping data. The main program and forms can be saved as user's given name with extension .FRM and the output as user's given name with extension .PRT under VB6.0

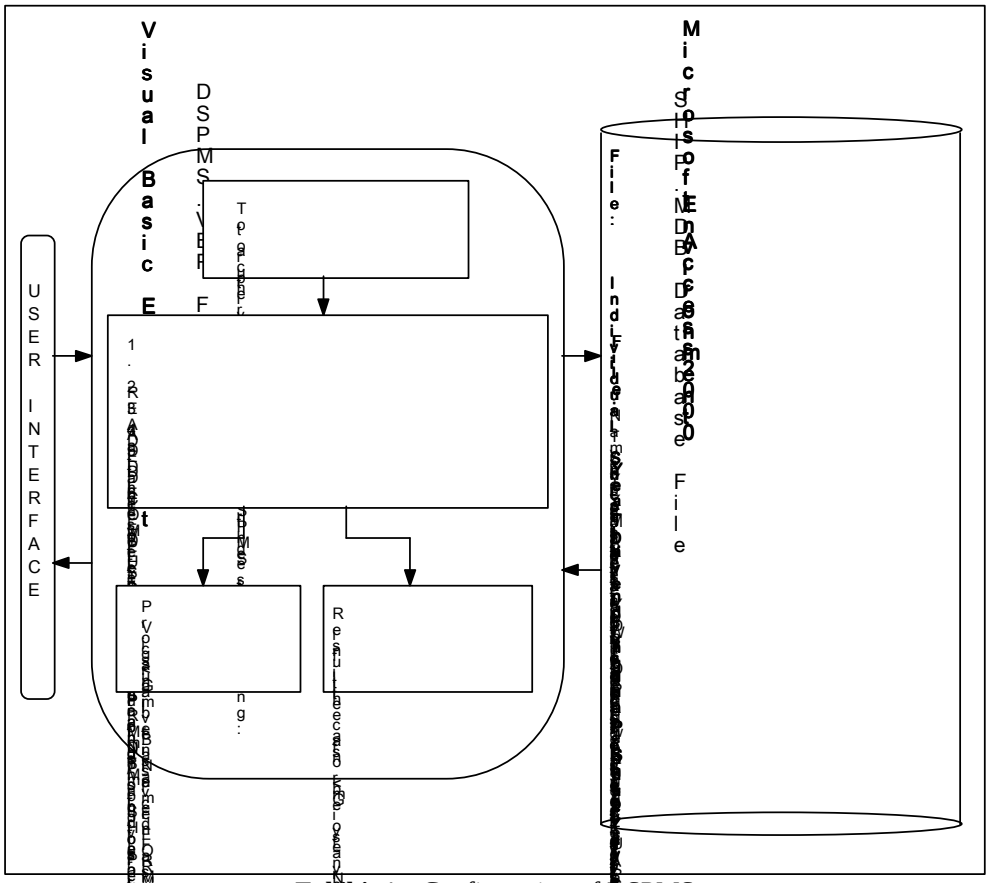


Exhibit 1. Configuration of DSPMS

The main menu in the menu-driven user interface, displayed in Exhibit 2., has five major options: Ship Detail, Productivity Measurement, (in which measurement of all the productivities, such as Fleet Operating Productivity, Fleet Physical Productivity, Ship Productivity, World fleet productivity and yearly highest productivity are included) Query, Reports and Exit. From the main menu screen the user can choose any one topic among the alternatives whereupon the DSPMS assists the user in that area to accomplish his objective. Exhibit 3. shows the (VB6.0) individual ship detail form.

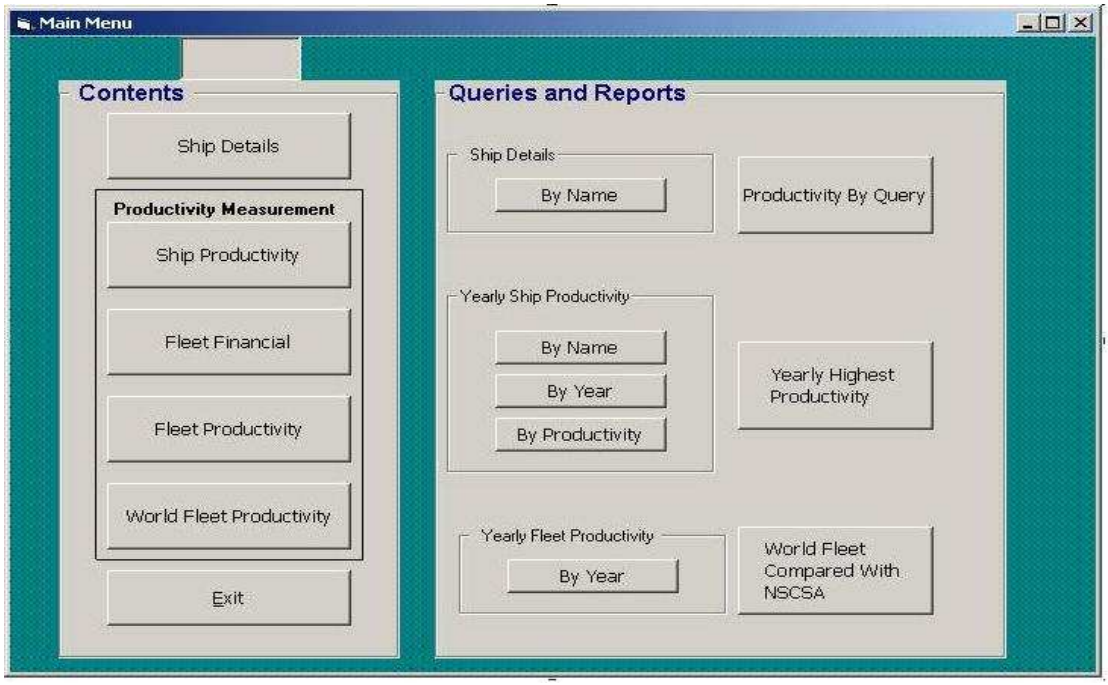


Exhibit 2. Main Menu of DSPMS

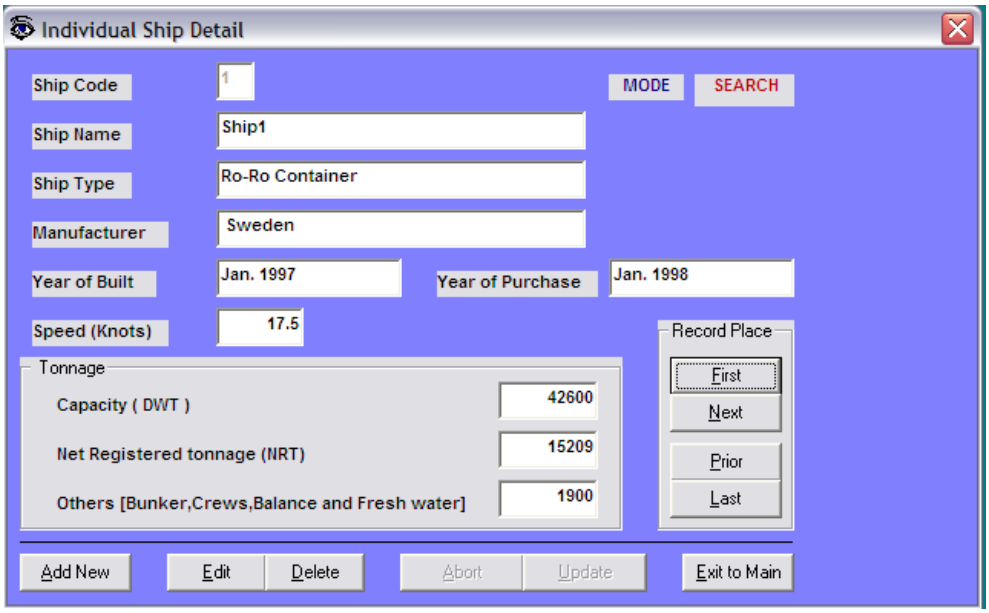


Exhibit 3. Individual Ship Detail

Various productivities (physical and financial) of individual ships as well as for the whole fleet have been computed using the input data or by query provided by the user in the measurement module of DSPMS. Then in the report module the results have been produced by Crystal Report and arranged in the output forms. Various productivity outputs are presented in Exhibit 4. through Exhibit 13. respectively.

4. VERIFICATION AND VALIDATION

In order to verify and validate the workability of the software program and the DSPMS (Database Shipping Productivity Management System), and its yield results respectively, *a real life case problem*, the productivity measurement and analysis of a leading international shipping company in the Middle East, is undertaken. Name of the company and the ships of its fleet are not disclosed for commercial secrecy. The ships are named here as 'SHIP1', 'SHIP2' and so on. The company operates a merchant fleet, consisting of 6 (six) ocean going Ro/Ro container ships with a total tonnage capacity of

292,106 DWT. The ships generally trip to North and South America, Europe, Far East and Middle East through various routes. The procedures adopted, efforts given and progress made in performing the above tasks are discussed and presented. Productivity formulas (Stopford, 1997; Goss, 1997) for both production function and cost function approaches have been used.

The productivity related data has been physically collected from the company through a well-designed questionnaire. Overall operational cost and revenue data were collected from their audit reports published annually. Tremendous difficulties were faced in data collection because the companies do not have any computerized information system rather poorly organized and manually maintained old records and some missing files. Up to 8 years old files were searched for previous records. The year wise data collected and parameters computed for productivity measurement of individual ships using production function approach from 1998 to 2005 are as follows:

- Deadweight capacity of each ship (DWT)
- Total miles travelled by each ship during each year
- Total loaded days at sea each year
- Average speed (knot)
- Deadweight Utilization % (DWT%)

The data for the whole fleet are:

- Total deadweight capacity of the fleet (DWT)
- Total tons carried by the fleet each year
- Total miles travelled each year
- Average speed (knot).

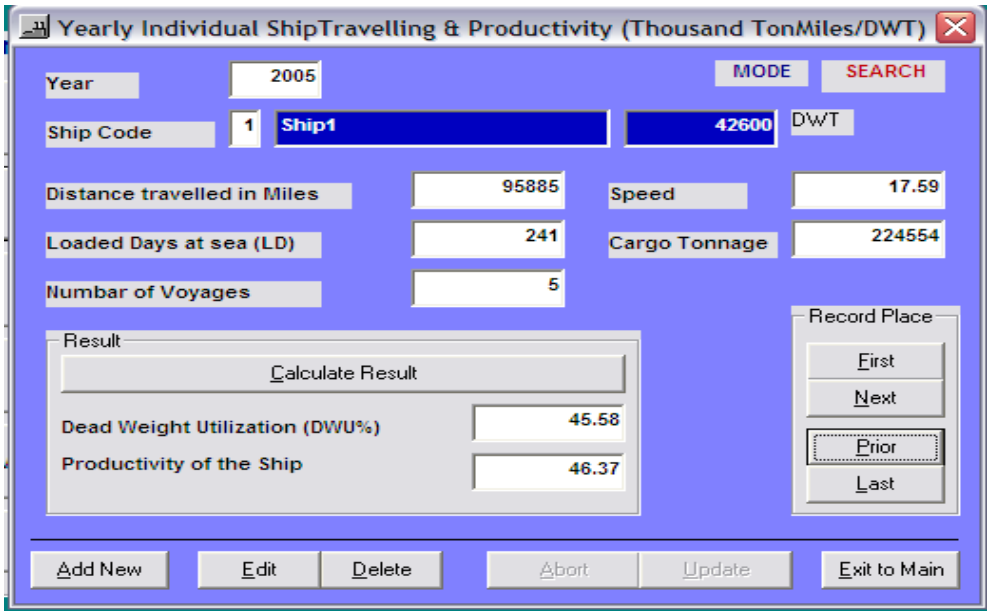


Exhibit 4. Individual Ship's Productivity (Physical) in a particular year

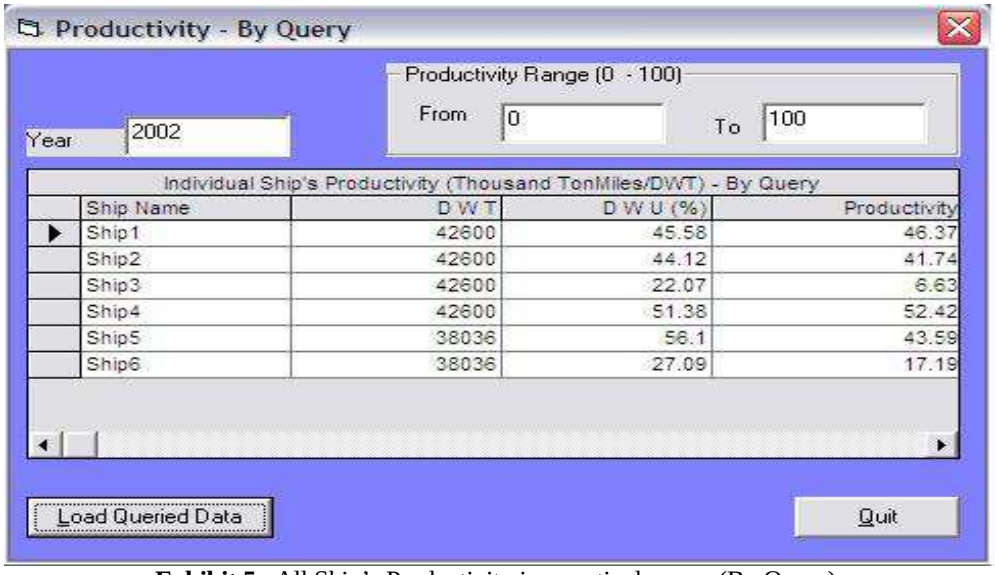


Exhibit 5. All Ship's Productivity in a particular year (By Query)

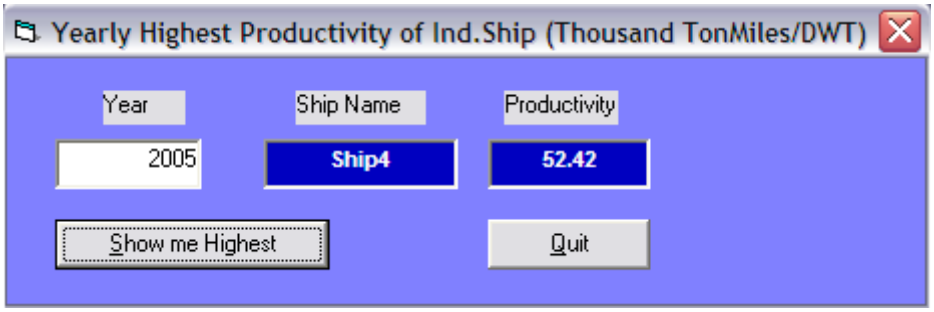


Exhibit 6. Highest Ship's Productivity in a particular year (By Query)

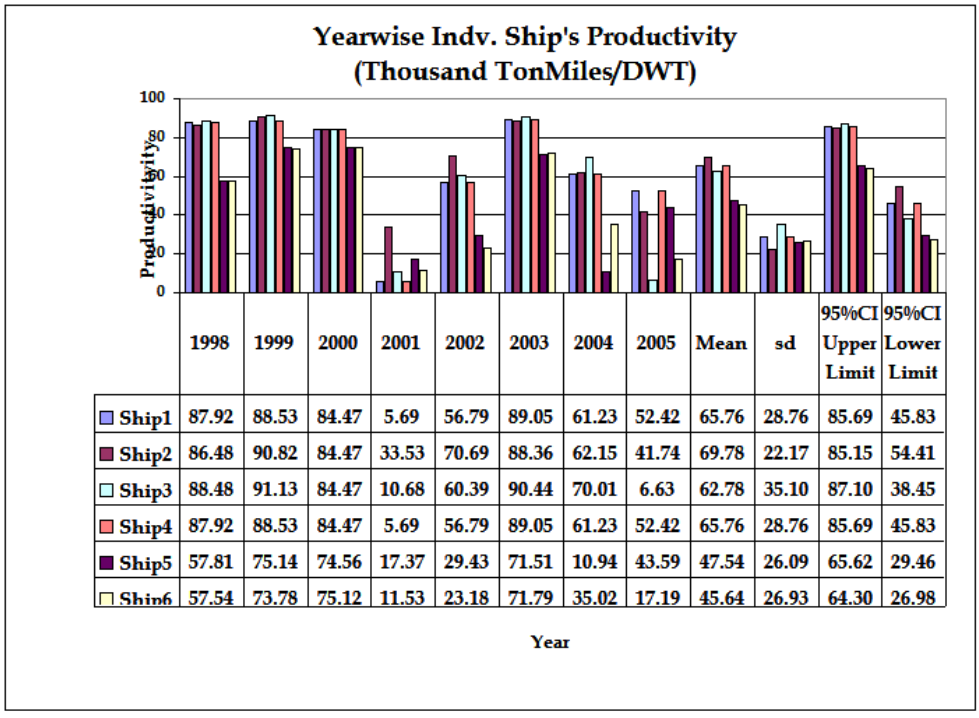
5. PRODUCTIVITY MEASUREMENTS AND ANALYSIS

Yearly individual ship's productivity in thousand Ton-Miles/DWT for all (individual) ships in the fleet, using production function approach, were produced/computed by the DSPMS program for the last eight years from 1998 to 2005. The ship wise and year wise productivity results and analysis reveal that SHIP3 achieved the single highest productivity value of 91.13 thousand TonMiles/DWT in 1999 (Exhibit 7) whereas eight years (1998-2005) highest average productivity value of 69.78 thousand TonMiles/DWT was attained by SHIP2 (Exhibit 7).

The financial productivity (using the cost function approach, a ratio of yearly operating cost to yearly operating revenue) of individual ship in any particular year, such as year 2005 and that for the whole fleet for the same period of eight years (1998-2005) with mean, sd, and 95%CI are presented in Exhibit 8. and Exhibit 9 respectively.

The physical productivity (in thousand Ton-Miles/DWT) of the whole fleet in any particular year, for example, year 2005 presented in Exhibit 10. and a comparison of same productivity between world fleet (Others) and the company fleet for eight years (1998-2005) with mean, sd, and 95%CI in tabular and graphical forms is depicted Exhibit 11.

Another measure of physical productivity in Tons-Carried/DWT of the 'World Fleet (Others)' and the company fleet in any particular year, for example, year 2002 is shown in Exhibit 12. and that for the eight years (1998-2005) with mean, sd, and 95%CI in tabular and graphical forms is presented in Exhibit 13. It may be mentioned that according to the United Nations Conference on Trade and Development (UNCTAD) [*Review of Maritime Transport*,(1997-2006)] the 'World Fleet Others' consists of vessels excluding tankers, combined carriers and bulk carriers and the tonnage capacity of less than 50,000 DWT. The company fleet, here taken as a case example, falls in the 'World Fleet Others' category by the type, size and DWT of its ships.



	1998	1999	2000	2001	2002	2003	2004	2005	Mean	sd	95%CI Upper Limit	95%CI Lower Limit
Ship1	87.92	88.53	84.47	5.69	56.79	89.05	61.23	52.42	65.76	28.76	85.69	45.83
Ship2	86.48	90.82	84.47	33.53	70.69	88.36	62.15	41.74	69.78	22.17	85.15	54.41
Ship3	88.48	91.13	84.47	10.68	60.39	90.44	70.01	6.63	62.78	35.10	87.10	38.45
Ship4	87.92	88.53	84.47	5.69	56.79	89.05	61.23	52.42	65.76	28.76	85.69	45.83
Ship5	57.81	75.14	74.56	17.37	29.43	71.51	10.94	43.59	47.54	26.09	65.62	29.46
Ship6	57.54	73.78	75.12	11.53	23.18	71.79	35.02	17.19	45.64	26.93	64.30	26.98

Exhibit 7. Year wise Individual Ship Productivity (Thousand Ton-Miles /DWT)

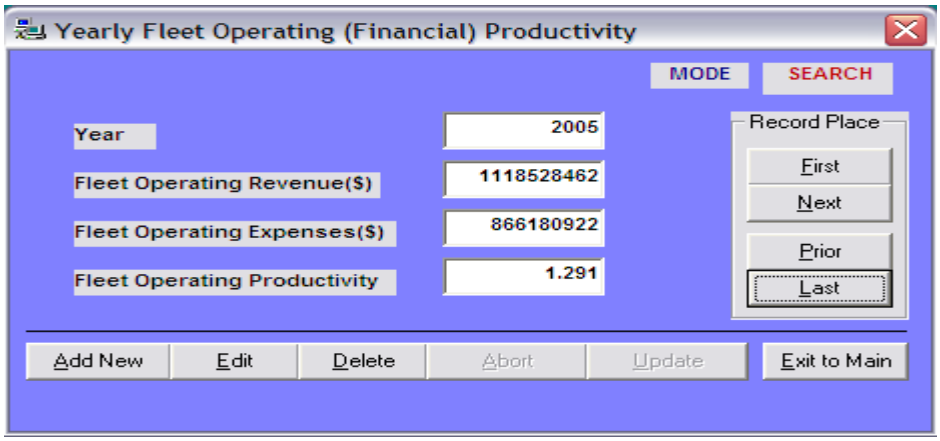


Exhibit 8. Operating (Financial) Productivity of the Fleet in a particular year

Year	OperatingRevenue	OperatingExpenses	Operating Productivity	Mean	sd	95% CI
1998	526656985	474777944	1.109			
1999	678628273	597178781	1.136			
2000	1492091820	901045541	1.656			1.326
2001	940724487	966939393	0.973	1.178	0.2132	
2002	922369695	811190745	1.137			1.031
2003	111746596	105326992	1.061			
2004	1080081806	1015100560	1.064			
2005	1118528462	866180922	1.291			

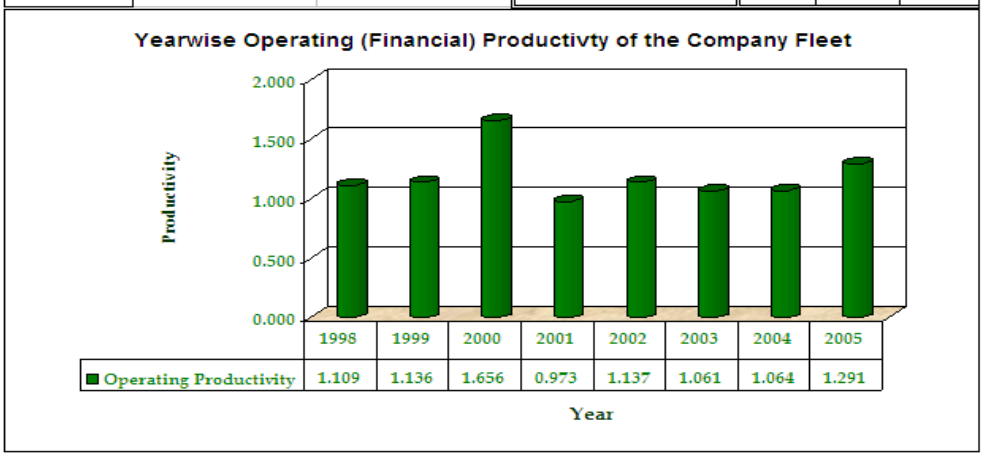


Exhibit 9. Year wise Operating (Financial) Productivity of the Company Fleet

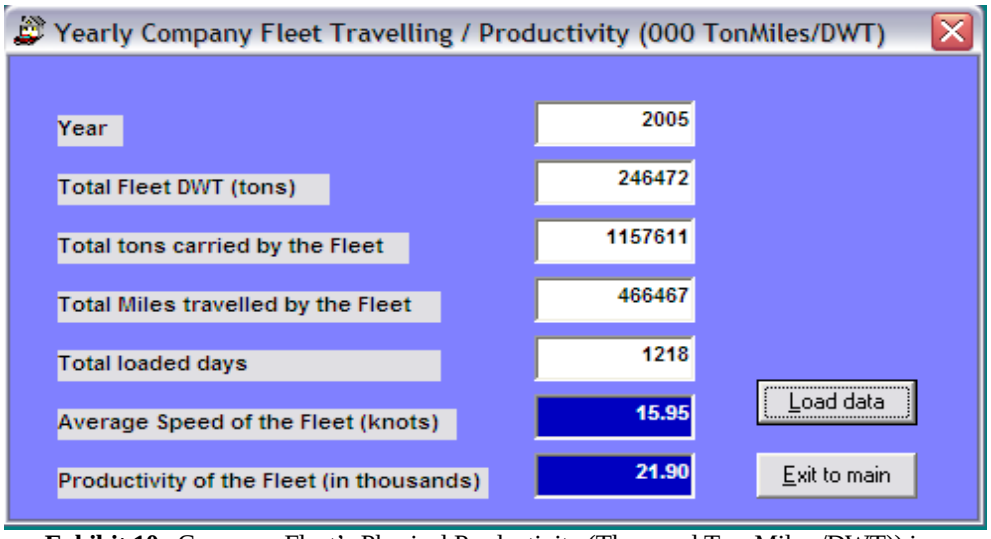


Exhibit 10. Company Fleet's Physical Productivity (Thousand Ton-Miles /DWT)) in a particular year

Year	World Fleet Productivity (000) Ton-Miles/DWT	Company Productivity (000) Ton-Miles/DWT
1998	33.5	46.7
1999	32.8	36.7
2000	33.4	15.3
2001	28.0	5.35
2002	30.2	35.8
2003	33.6	33.6
2004	34.9	39.3
2005	33.6	21.90
Mean	32.50	29.33
sd	2.26	13.85
95%CI_UpperLimit	34.06	38.93
95%CI_LowerLimit	30.94	19.73

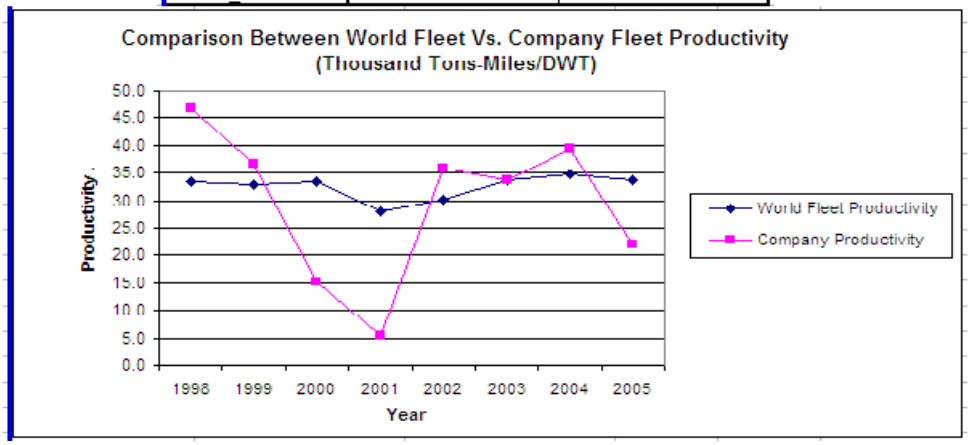


Exhibit 11. Year wise World Fleet vs. Company Fleet Productivity

Exhibit 12. World Fleet vs. Company Fleet Productivity (Tons-Carried/DWT) in a particular year

Productivity = (Total Tons Carried / Total DWT)

Year	Word Fleet Productivity (Tons-Carried/DWT)	Company Fleet Productivity (Tons-Carried/DWT)
1998	6.4	7.93
1999	7.1	4.58
2000	7.3	9.08
2001	7.1	3.5
2002	7	4.7
2003	7.2	6.74
2004	7.6	5.5
2005	7.4	8.46
Mean	7.14	6.31
sd	0.35	2.04
95%CI_UpperLimit	7.38	7.73
95%CI_LowerLimit	6.89	4.89

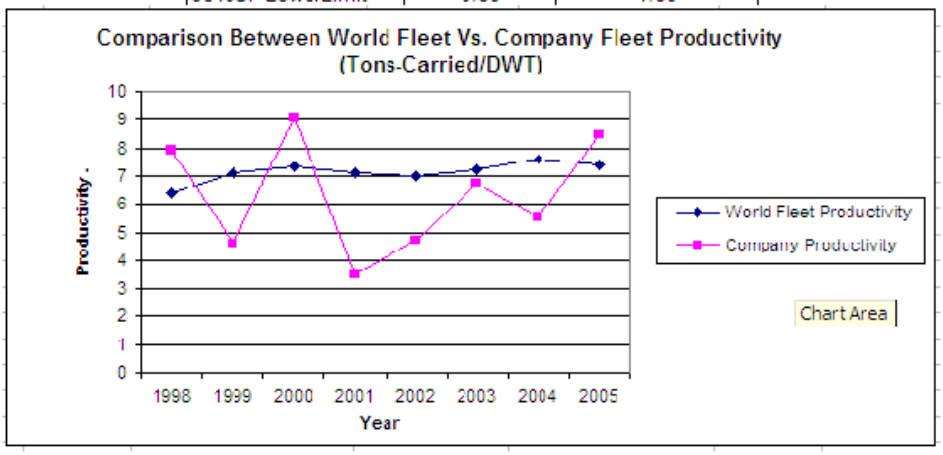


Exhibit 13. Year wise World Fleet vs. Company Fleet Productivity (Tons-Carried/DWT)

6. DISCUSSION OF THE PRODUCTIVITY RESULTS

The results of various productivity measures for the individual ships and the whole fleet and their subsequent analysis are discussed here very briefly. It is observed from the detailed productivity results and analysis of all the individual ships and the whole fleet of the company that the vessels with same deadweight tonnage of 42600 DWT and same year of built (1997) was fluctuating. Some of them were experiencing a positive trend up to certain year and then declined again and vice versa. The average productivity of all the individual ships for the eight years (1998-2005) ranges from 45.64 to 69.78 thousand Ton-Miles/DWT. The ship 'SHIP2' achieved the highest average productivity 69.78 thousand Ton-Miles/DWT in that period (Exhibit 7).

The average productivity (Ton-Miles/DWT) of the company's whole fleet from 1998 to 2005 is 26.87 thousand Ton-Miles /DWT. The fleet achieved the highest productivity of 46.7 thousand Ton-Miles /DWT in the year 1995 and the lowest was 2.19 thousand Ton-Miles /DWT in 2002, may be due to preparation of Gulf War II (Exhibit 12).

Company's fleet productivity in 'Ton-miles/DWT' was experiencing a decreasing trend from 1998 to 2001, i.e. up to the preparation of Gulf War II, then inclined in 2002 and followed a steady trend up to 2004 and further declined in 2005. The company achieved its fleet productivity above to that of the World Fleet in 1998, 1999, 2002 and 2004 respectively. The company's fleet productivity average 29.33 Ton-miles/DWT is little lower than the world fleet average 32.5. Ton-miles /DWT.

In another productivity measure in 'Tons Carried/DWT' company's fleet was productivity was following a random fluctuations from 1998 to 2001, then followed a inclining trend up to 2005 The company achieved its fleet productivity above to that of the World Fleet in 1998, 2000 and 2004 respectively. The company's fleet productivity average 6.31 Tons Carried/DWT is lower than the world fleet average 7.14 Tons Carried/DWT (Exhibit 13).

Company's fleet operating (operating revenue/operating expenses) productivity had the average value of 1.17 in the same period of eight years from 1998 to 2005 with the highest value of 1.65 in 2000 and lowest value of 0.97 in 2001 (Exhibit 9).

7. RECOMMENDATIONS

The following important summarized recommendations are made from the productivity measurements and analysis:

- Exhibit 7 shows the overall trend of productivity measured in Ton-Miles/DWT for most of the individual ships was found improving up to 1999 and declined in 2001; the reason might be due to the Gulf War II.

- As individual ships, the average productivities of the vessels 'SHIP5' and 'SHIP6' are very low in comparison to those for the vessels 'SHIP2', 'SHIP1', 'SHIP4' and 'SHIP3. More attention is necessary is to improve their productivities.

- Once the vessel 'Ship3' had achieved the highest productivity of 91.13 thousand Ton-Miles/DWT in 1999 and since then it's productivity was following a downward trend and decreased to a value of 6.63 thousand Ton-Miles/DWT in 2005. The company management should investigate the reasons for the constant downward trend and needs to improve the productivity of the vessel.

- The yearly average of individual productivities of all the ships has been declined since 2003. Efforts should be given to improve the average.

- It is evident from Exhibit 11. that the company's fleet productivity in Ton-Miles/DWT had achieved higher productivities than that of world fleet in 1998 and 1999 and then experiencing a downward trend up to 2001 and sharply improved in 2002 which is a good sign, but again with fluctuations. Average productivity value of the fleet should be improved to bring the fleet into international level.

- The company's fleet productivity in terms of tons carried/dwt (Exhibit 13) has been experiencing upward trend since 2001 and crossed the world average in 2005. This trend should be maintained.

- It appeared from the cost function productivity analysis (Exhibit 9) that the operating productivity (operating revenue/operating expenses) of the company's fleet was the lowest at .97 in 2001 during the Gulf War II. So the management should analyze the option to see whether leasing of some of the ships is better than operating those directly.

8. CONCLUSIONS

Measurements of all the parameters and the various forms of productivities of individual ships and the whole fleet consisting of eight ships of a leading international shipping company in the Middle East were performed using both production function and cost function approaches for the last four to twelve years period depending on the availability of the company's data in different areas. Productivity indexes were calculated and some statistical analysis, such as average, standard deviation and 95% confidence limits was performed to see the year-to-year productivity status and trends of the individual ships and the whole fleet of the company. It appears from the measurement and analysis that the overall productivity is following a decreasing trend. There are some more areas, which need concentration, such as analysis is necessary whether leasing of some ships is better than to operate. The latest addition of two ships (Ship5 and Ship6) needs more attention to improve their productivities. Strategy of abandoning some of the ships is to be taken if it is not possible to improve their productivities, which are declining now although once they achieved the highest productivities.

It is very important to note that the practical application and demonstration of all the above mentioned formulas, models and methodologies for productivity measurement and analysis are solely dependent on the data to be available and supplied by the shipping companies. They should concentrate to keep the necessary data and information required and related to productivity measurements. This case study may be useful to the

shipping companies and government agencies to access their present shipping productivity as well as for further improvement with a view to develop maritime industry for greater contribution to the national economy.

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