

# **SHIPPING OPTIMIZATION SYSTEMS (SOS)**

## **SOS APPRAISER**



## **USER MANUAL**

**For**

**'SOS EDITION B', 'SOS EDITION AB',  
'SOS EDITION BC' & 'SOS EDITION ABC'**

**July, 2008**



**SEAS INFORMATION SYSTEMS**

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## **1. INTRODUCTION**

### **1.1. WHAT IS SHIPPING OPTIMIZATION SYSTEMS (SOS)?**

SOS is a suite of decision support systems developed to help the cargo ship operator optimizing the operational outcome of a fleet of cargo ships. All ship types and cargo types are considered, under the liner, tramp, and industrial shipping services. In addition to SOS DATA, which is developed to store and retrieve the shipping data; three SOS systems are developed to support three management levels. On the operational level, SOS VOYAGER is developed to optimize the outcome of each ship voyage. On the tactical level, SOS ALLOCATOR is developed to optimize the yearly outcome of allocating existing ships to the cargo trade areas. On the strategic level, SOS APPRAISER is developed to appraise the purchase, build, or charter of new ships. See Figure 1.1 for the SOS main menu, which passes the processing control to each system. Brief description of these three systems is shown hereinafter:

#### **1.1.1. SOS VOYAGER**

For a liner ship voyage plan, having all port calls being fixed and a route being pre-determined, SOS VOYAGER selects the optimal (best) cargo mix, considering the available cargo quantities, ship capacity in deadweight, volume, or number of TEU. The optimal cargo mix maximizes the liner voyage gross profit. For a tramp/industrial ship-voyage plan, SOS VOYAGER finds the optimal (best) cargo mix, locates ports of call, and sequences port calls, i.e. routing. Figure 1.2 illustrates the tramp/industrial-cargo-mix selection in the Mediterranean Sea. SOS VOYAGER maximizes the tramp voyage gross profit per day, subject to the available cargo quantities, cargo laycan, and the ship capacity in deadweight, volume, or number of TEU. The gross profit equals the net freight minus port dues, canal and strait dues, cargo handling charges, ship fuel consumption, and the fixed cost (without depreciation). If more than one ship competes in carrying the same cargoes, the system offers these cargoes to all competing ships. The optimal cargo mix in this case maximizes the sum of the gross profit per day for all ships. In industrial shipping, the objective is to minimize the gross cost per day. In case cargo is unconfirmed (not yet offered); a cargo deterministic-equivalent quantity is calculated based on the probability distribution of the cargo transport demand. Sensitivity or what-if analysis is considered for some possible scenarios; in case a change is made in the cargo freight rate and quantity, cargo handling rate and charges, and ship speed and fuel consumption.

#### **1.1.2. SOS ALLOCATOR**

For an existing fleet of ships, SOS ALLOCATOR allocates the ships to the cargo trade areas and determines the number of voyages each ship completes in a coming year in each trade area. A cargo trade area is either a liner, tramp, or an industrial serviced area. SOS VOYAGER generates data on the gross profit of each ship voyage for each possible cargo trade area. This data is then passed to SOS ALLOCATOR to plan for the optimal allocation. The optimal allocation is the one maximizing the yearly total gross profit of the fleet allocated voyages, considering the possible frequency of calls within each cargo trade area and the number of working days available for each ship in this year. Figure 1.3 illustrates the allocation of some ships to cargo trade areas worldwide.

### 1.1.3. SOS APPRAISER

SOS APPRAISER finds the best new ship to purchase, build, or time-charter and where to allocate such ship. A group of new candidate ships is given to SOS VOYAGER to compute the voyage gross profit each ship may earn in each possible cargo trade area, as well as for each year of a given lifetime. This data is then passed to SOS ALLOCATER along with data of already existing ships to compute the yearly gross profit each ship may earn each year of its lifetime. This data along with the cash flow data (investment costs, grants, and taxes) are both passed to SOS APPRAISER for selecting the best new ship.

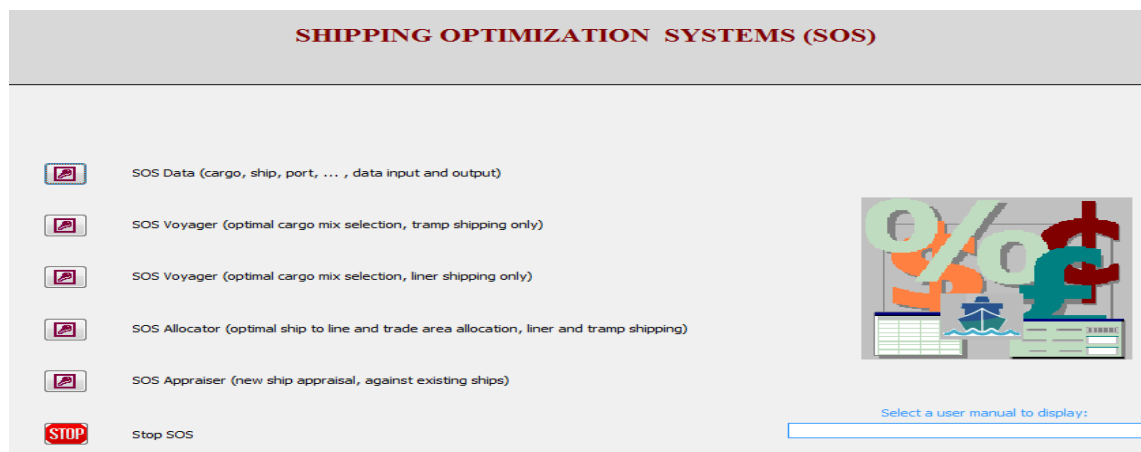


Figure 1.1: SOS main menu.

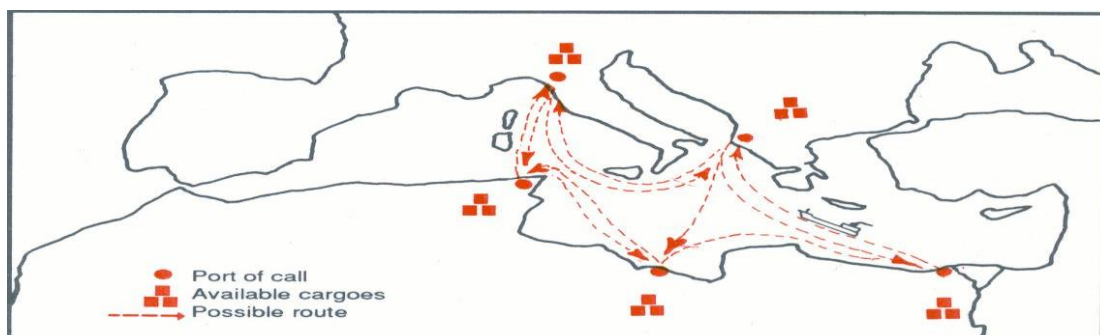


Figure 1.2: Example of the tramp/industrial cargo-mix selection in the Mediterranean Sea.

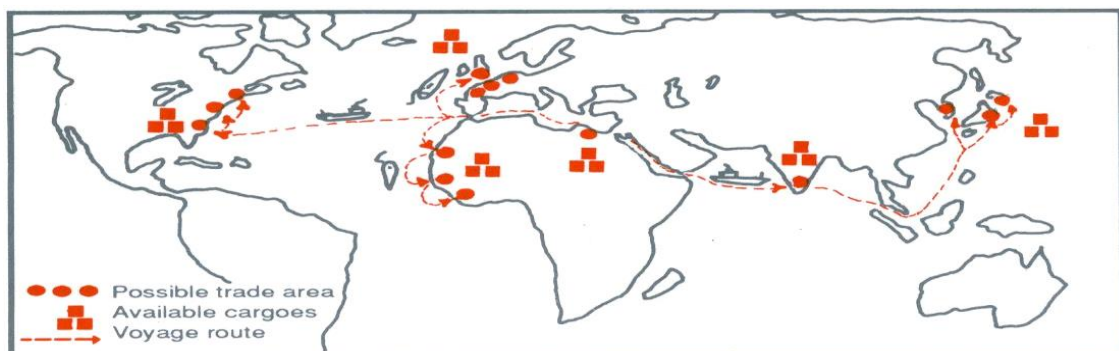


Figure 1.3: Example of allocating some ships to cargo trade areas worldwide.

## 1.2. WHY SOS?

Maximizing the objective of each SOS system results in an optimal *shipping combination* selected from among a number of alternative combinations of ships, cargo trade areas, ports, possible routes, and cargoes. The more combinations are available (thousands of possible combinations may result in a 10-cargo-3-ship tramp cargo mix case) the more intelligent methods are needed in selecting the optimal shipping combination. These methods are much more needed when the objective is a gross profit per day, as being used in SOS VOYAGER. The Operations Research (OR) and the Statistical Methods (SM) introduce such methods. Papers, which discuss these methods and their application in SOS, are El Noshokaty (2013, 2014, 2017, 2019, 2020, 2021, and 2023). SOS presentations are provided with SOS (2023) to briefly describe these papers.

Since SOS is a suite of decision support systems, it requires minimal user intervention and no background in OR and SM. Figure 1.4 shows the SOS data flow diagram (level 0), which describes the input data required and the output reports directed to the ship operator through all its three systems.

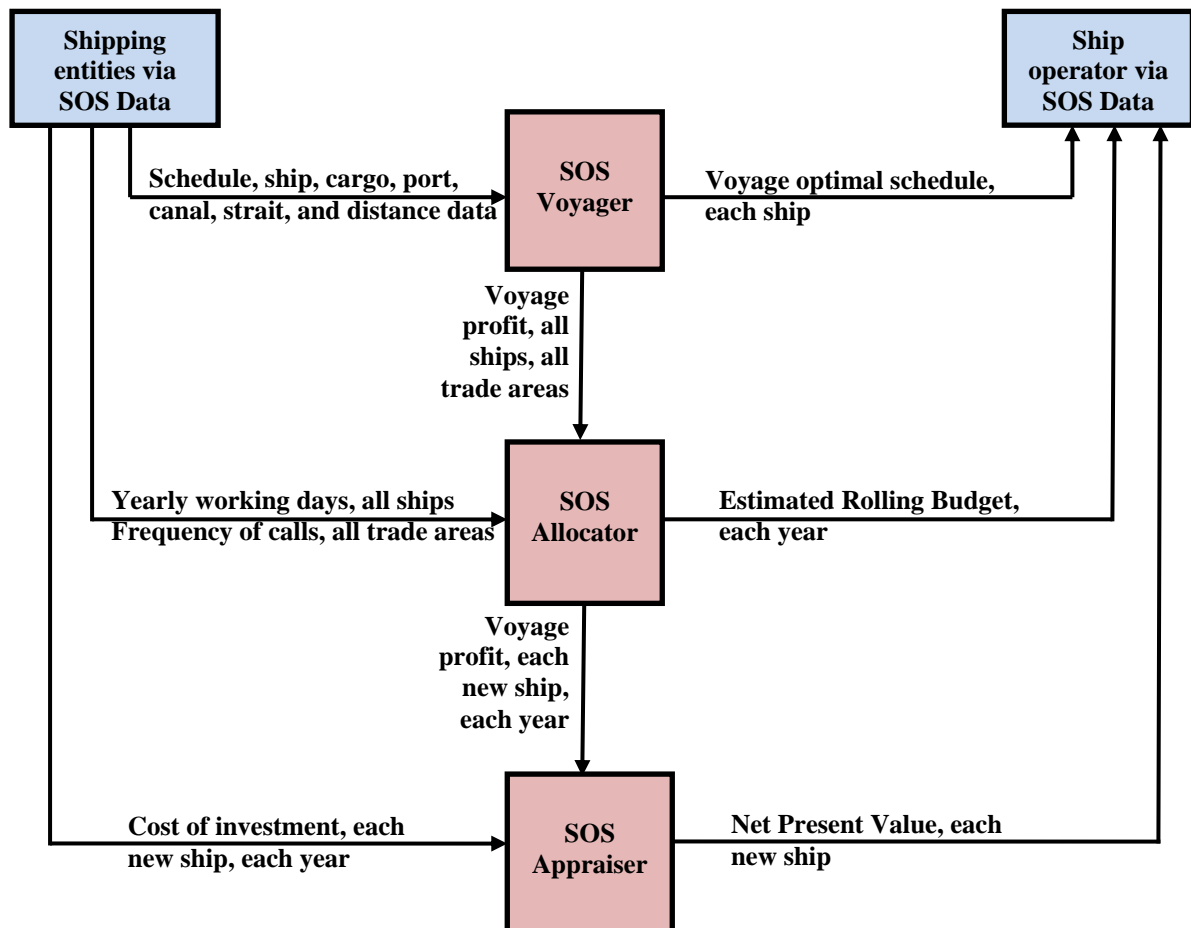


Figure 1.4: SOS data flow diagram (level 0).

Each SOS system includes three subsystems. The first subsystem is called the "Matrix Generator". It reads the shipping data from SOS DATA and automatically generates a matrix of coefficients as required by the OR technique and the statistical methods. The second subsystem includes the OR technique and the statistical methods used. It reads

the matrix, processes it, and locates the optimal shipping combination. The third subsystem is called the "Report Writer". It identifies the optimal shipping combination and writes a shipping and financial report directed to the ship operator (see Figure 1.5 for the SOS subsystem flowchart).

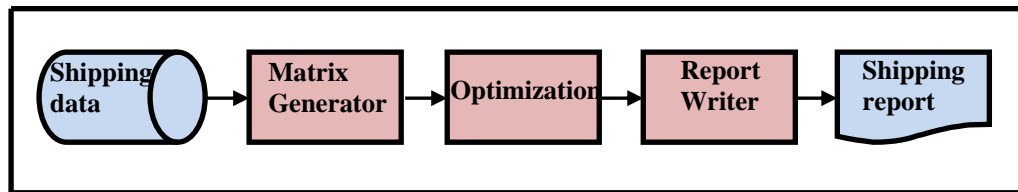


Figure 1.5: SOS subsystem flowchart.

### **1.3. SOS DATA AND SOS VOYAGER STANDARD AND CUSTOMIZED PRODUCTS**

Two products of SOS DATA or SOS VOYAGER are available to the ship operator: standard and customized. SOS ALLOCATOR or SOS APPRAISER has likewise products.

#### **1.3.1. SOS DATA AND SOS VOYAGER STANDARD PRODUCT**

This product is designed as a general-purpose system for the general cargo ship; whether conventional, container, or specialized, liquid and dry bulk carrier, following the liner, the tramp or the industrial shipping mode. In addition, this product is developed on a PC running under windows so that SOS DATA or SOS VOYAGER can reach every ship operator. Three PC configurations are supported; configuration A, configuration B, and configuration C (Section 3 has details). This manual describes the system components of the standard product.

#### **1.3.2. SOS DATA AND SOS VOYAGER CUSTOMIZED PRODUCT**

For any ship type, the ship operator may ask for a ship-customized SOS DATA or SOS VOYAGER to fit his ship type. In addition, for the computer types other than the PC, the ship operator may wish to have SOS DATA or SOS VOYAGER computer-customized to fit his computer type. By using the supercomputers, an increased number of shipping combinations may be accommodated and optimized in a more reasonable time.

### **1.4. SOS VOYAGER DELIVERABLES**

There are two copies of SOS VOYAGER; whether it is a standard or customized product, a demo copy for demonstration and a final copy for the final delivery. A demo copy has a built-in list of names, deadweights, volumes, number of TEU's, and speeds of some dummy ships. This copy demonstrates the use of SOS by these ships. Upon successful trial of this demo copy, the ship operator may ask for a final copy. In the final copy, the list of ships includes the operator's own ships. When ordering a customized product, the ship operator receives a demo copy (or copies if more than one customized trial is made) before he receives his final copy. Both demo and final copies are delivered in compiled code sent on a physical media or by electronic file transfer (email, or downloadable from SOS, 2023). Special demos, training sessions, along with the systems analysis studies, may be arranged in agreement with the ship operator in order to plant SOS VOYAGER into the operator's setup.

## **2. SOS APPRAISER SYSTEM COMPONENTS**

SOS APPRAISER includes one system menu and one system output report. The system menu directs SOS APPRAISER to appraise a set of new ships to buy, build, or charter, while the system report displays the optimization result to the ship operator.

### **2.1. SYSTEM MENU**

SOS APPRAISER, as shown in Figure 2.1, displays the system menu. The optimization option on this menu passes control to an optimization program. This program reads gross profit details saved by SOS VOYAGER for new and old ships tried on different lines, as liner, and different trade areas, as tramper/industrial. These profit details cover a planning period, say next 10 years. The gross profit details may be displayed by the 'Schedule Ship Gross Profit Details (voyage plan only)' form included in the 'Shipping Schedule Menu' of SOS DATA. SOS APPRAISER requires that the following steps have been completed in SOS DATA:

- In the 'Schedule, Main' form, the question 'Is the schedule part of Estimated Rolling Budget?' should have been checked for each schedule in the planning period.
- The field 'Let Data Entry be customized' in the 'Customized Data Entry, Main' form has the option 'Data entry is customized to fit SOS APPRAISER' has been selected, and, the Customization Period, i.e. the planning period, has been specified.

Based on the profit details, identified for each year of the planning period, SOS APPRAISER passes control to SOS ALLOCATOR to allocate each ship to the most promising lines and trade areas, and, decides the frequency of calls to be completed on these lines and trade areas. This allocation maximizes the yearly total gross profit of all ships, subject to the frequency of calls available on each line or trade area and the yearly working days available for each ship. Optimal allocation may then be displayed by the 'Schedule Ship Gross Profit Details (Estimated Rolling Budget only)' form, which is selected from the 'Shipping Schedule Menu' of SOS DATA.

SOS APPRAISER reads the optimal gross profit details of only the new ships for each year of the planning period, along with other cash flow data captured by SOS DATA. The cash flow data is saved by the 'SOS APPRAISER Cash Flow Data' form selected from the 'Customized Data Entry Menu'. SOS APPRAISER then calculates and prints the present value of each new ship and saves it in SOS DATA. The 'SOS APPRAISER Present Value Data' form selected from the 'Customized Data Entry Menu' displays the saved present value.

### **2.2. SYSTEM OUTPUT REPORT**

SOS APPRAISER outputs the Estimated Rolling Budget report as shown in Figure 2.2. The report is printed automatically at the end of the optimization.

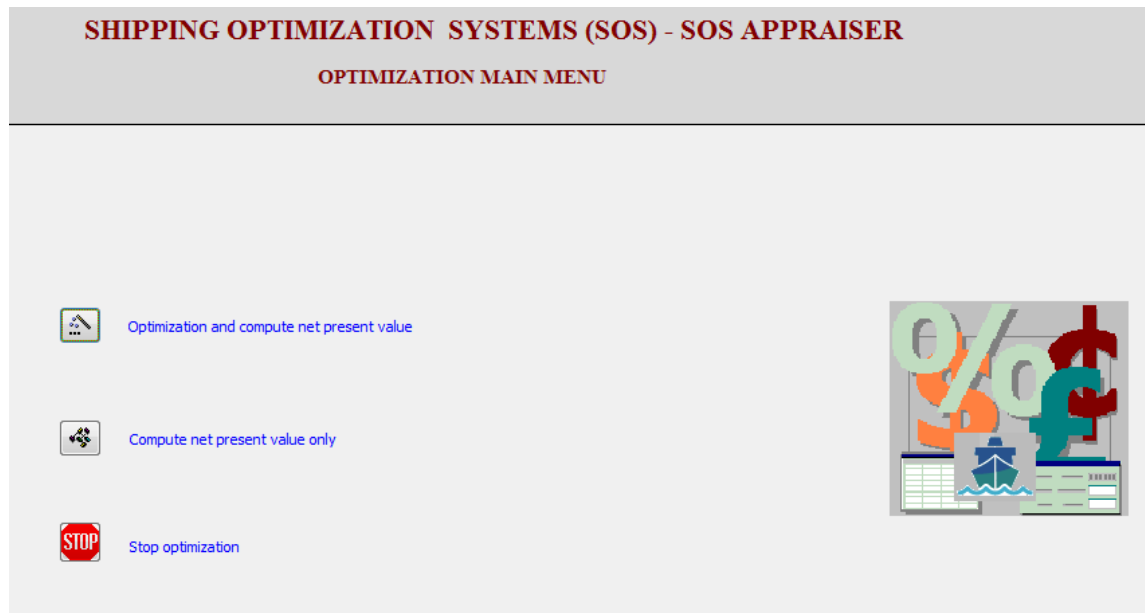


Figure 2.1: SOS APPRAISER main menu.



Figure 2.2: SOS APPRAISER output report.

### 3. SOS VOYAGER SOFTWARE AND HARDWARE REQUIREMENTS

The standard product can run on one of the following configurations:

**Configuration A:** Min hardware is one single-core Intel 3.0 GHz 64-bit PC processor, 4.0 GB RAM, 1.0 MB L2 cache, 0.8 GHz bus speed, and 80 GB HD 5400 RPM. Software used is MS Windows 10 and MS Access 2016. SOS standard product is processed sequentially using one database.

**Configuration B:** Min hardware is one i5 3.2 GHz 64-bit PC processor, 4.0 GB RAM, 6.0 MB L2 cache, 1.6 GHz bus speed, 80 GB HD 5400 RPM, and 100-MBS Ethernet network if more than one PC is used. Software used is MS Windows 10, MS Access 2016 database (front-end), and any recent version of MS SQL Server (back-end). MS Message Passing Interface (MS MPI) V10 is used for parallel processing. SOS standard product is processed in parallel using multiple PCs or (and) multiple processor cores.



This configuration is accessed remotely, faster, more reliable, and can accommodate more data volumes.

**Configuration C:** Any other configurations, either hardware or software, where SOS DATA and SOS VOYAGER can integrate with via web Application Programming Interface (API), including Open Database Connectivity (ODBC). The reason for integration is that this configuration might contain the database where SOS DATA and SOS VOYAGER need to pull data from.

#### 4. SOS APPRAISER OPTIMIZATION CASE

This part of the user manual guides the user in using the menu mentioned in Section 2 to perform the optimization process mentioned in Section 1, using configuration B mentioned in Section 3.

The optimization process assigns an optimal set of lines and trade areas to each ship, in a set containing old and new ships, for each year of a given life time. The optimization objective is to maximize the yearly ship gross profit for all the working ships minus layup cost for all the laid ships, calculated each year. The optimization constraints are the yearly ship working days and the line or trade area demand.

The appraising process reads gross profit and layup cost, along with cash flow data, for each new ship and then computes its net present value.

Before start, the user has to check the existence of 'SOS Edition B', 'SOS Edition AB', 'SOS Edition BC', or 'SOS Edition ABC' described by the following databases and files in the path shown corresponding each:

<b><u>Database/File</u></b>	<b><u>Path</u></b>	<b><u>Description</u></b>
shipping optimization systems.accde	C:\sos	SOS main menu used to pass control to data and programs.
sosdata. accdb	C:\sos	Data capture for cargo, ship, port, route, line/trade area, charter party, and schedule, used for tramp and liner.
sosdata.mdf	C:\sos	SQL Server back-end database.
sosappraiserprog.accde	C:\sos	Optimization program for tramp and liner.
sosallocatorprog.accde	C:\sos	Optimization program for tramp and liner.
sosallocatorproglah.dll	C:\sos	Optimization program for tramp and liner.
sosallocatorproglah1.exe	C:\sos	Optimization for tramp and liner.
libiomp5md.dll	C:\sos	Runtime library for tramp and liner services.
MSMPI	C:\sos	Directory containing msmpisdsk.msi, and msmpisetup.exe.
include	C:\sos	MS MPI include directory, containing mpif.h file.
smpdcall.exe	C:\sos	Call Simple Multipurpose Daemon, process manager.

The '.accde', '.dll', and '.exe' files are protected against code viewing. If the database files provided are not protected, the user has to check that all libraries required are incorporated into the database. To do this, click the Database Tools on the database tool bar, click the Visual Basic on the drop-down menu, click the Tools on the visual basic tool bar, and then click the References on the drop-down menu and check that the libraries shown in Figure 4.1 with check marks are selected.

When a non-protected database file is opened and a message bar appears at top notifying the blocking of contents, select the database options, trust center, trust center settings, message bar, and then select 'Never show information about blocked contents'. If there is a problem in running macros, select the database options, trust center, trust center settings, macro settings, and then select 'Enable all macros'.

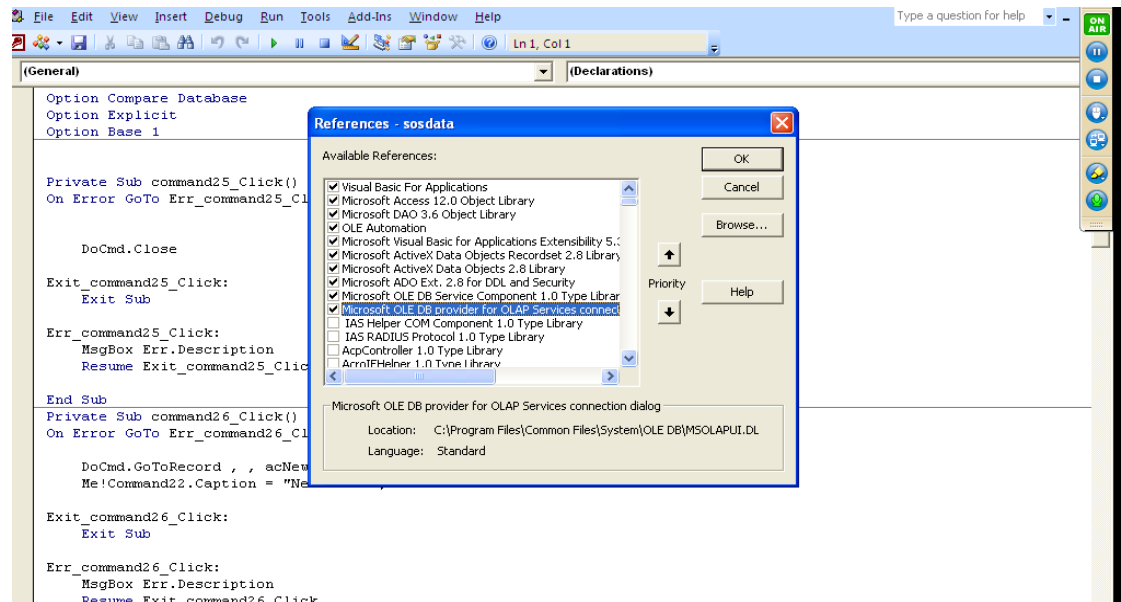


Figure 4.1: Libraries referenced by SOS APPRAISER (Access 2016)

'sosdata.mdf' is attached to MS SQL Server. 'sosdata.accb' is linked to SQL Server. 'msmpisdsk.msi' in MSMPI directory is installed. 'include' is a directory needed by '.exe' programs. If more than one PC is used in the parallel processing, each additional PC should contain in its C:\sos directory the following files:

- sosallocatorproglah1.exe,
- libiomp5md.dll,
- mpiexec.exe,
- Include,
- smpdcall.exe.

Make sure that c:\sos in these PCs is shared and write enabled and then execute 'smpdcall' on each PC before running any SOS optimization program.

In case networking and big data volumes of SOS DATA is not so desired, while the shipping problems at hand are large enough and need fast processing, MS SQL Server and 'sosdata.mdf' may not be used. In this case, the user will be using SOS 'Edition AB', where 'sosdata.accdb', 'sosallocatorprog.accde' and 'sosappraiserprog.accde' versions of configuration A are used instead of that of configuration B.

This case uses the findings of the case mentioned in the 'SOS ALLOCATOR user manual'. Assume that El Kosseir is not owned yet by Seas Shipping Company (SSC) and CFO of the company is supposed to appraise the purchase of this ship. As reported by SOS VOYAGER, if tried on East Mediterranean line, El Kosseir could earn a voyage gross profit of \$ 752,500. As reported by SOS ALLOCATOR case, El Kosseir is planned to work

in the next year on the Arabian Gulf-US for 8 voyages, Black Sea-Far East for 1 voyage, and lay up for 1 day, with \$ 6,825,300 gross profit per year ( $\$ 752,500 \times 8 + \$ 810,300 \times 1 - \$ 5,000 \times 1$ ). Consider the next year as year one in El Kosseir's 10-years life time. Table 4.1 shows El Kosseir yearly gross profit and other cash flow data during the next 10 years. Table 4.2 shows some investment data related to El Kosseir. While SOS ALLOCATOR generates the gross profit data, SOS DATA captures other data items in tables 4.1 and 4.2.

Table 4.1: Yearly cash flow data of El Kosseir in the next 10 years

Year	Gross profit in US\$	Other cash flow in US\$
1	6,825,300	-1,500,000
2	7,120,000	-1,750,000
3	7,870,000	-1,900,000
4	8,560,000	-2,100,000
5	9,330,000	-2,400,000
6	10,200,000	-2,700,000
7	10,970,000	-3,050,000
8	11,880,000	-3,450,000
9	12,740,000	-3,850,000
10	13,535,000	-4,160,000

Table 4.2: El Kosseir investment data

Investment data item	Value
Cost of investment in US\$	24,700,000
Risk-based rate of return in %	7
Rate of economic inflation in %	5

Given the data in tables 4.1 and 4.2, SOS APPRAISER can calculate the present value of El Kosseir. To perform this task, do the following:

- Open SOS DATA to read more on the yearly gross profit, yearly cash flow, and the investment details. The details of El Kosseir yearly gross profit are shown in the 'Schedule Ship Gross Profit Details (Estimated Rolling Budget only)' form selected from the 'Shipping Schedule Menu'. This assumes that SOS ALLOCATOR has already calculated the gross profit details of El Kosseir for each year of its lifetime. The details of El Kosseir other cash flow are shown in the 'SOS APPRAISER Cash Flow Data' form selected from the 'Customized Data Entry Menu'. The details of El Kosseir investment data is shown in the 'SOS APPRAISER Present Value Data' form selected also from the 'Customized Data Entry Menu'.
- Quit SOS DATA by selecting Stop option from the 'Data Entry Main' menu.
- Run SOS APPRAISER, click the 'Compute net present value only' option on the 'Optimization Main Menu'. Examine the printed report at the end of the optimization. It computes a net present value of El Kosseir equals \$ 13,634,102. See Figure 4.2 for more details.
- It takes SOS APPRAISER few milliseconds to optimize (far more time using configuration A).

- SOS APPRAISER follows the mathematical model that is fully described in El Noshokaty (2013) for liner and El Noshokaty (2017) for tramp.



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NET PRESENT VALUE				Period from date	Period to date	Inflation rate
				01/01/2013	31/12/2022	0.05

Ship id	Price / hire	Scrap value	Risk-based return rate	Discounted gross profit	Discounted cash flow	Net present value
5	24700000	0	0.07	51985996	13651893	13634102

Figure 4.2: The Net Present Value report.

In the report, El Koseir is designated by '5'.

## References

El Noshokaty, S. (2013) 'Shipping Optimisation Systems (SOS): Liner Optimisation Perspective', *International Journal of Shipping and Transport Logistics*, vol. 5, pp. 237-256.

El Noshokaty, S. (2014) 'Block-Angular Linear Ratio Programmes', *International Journal of Operational Research*, Vol. 19, No. 3, pp. 338-357.

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