

BT 5110 Database and Warehouse

Project Maritime Q2 Report



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Introduction

In Question 2, we extend the reference website by creating a star schema and an interactive interface to show different dimension tables and visualize in order to do exploratory analysis online.

The data used is consolidated and publicly available by the European Maritime Safety Agency (<https://www.emsa.europa.eu>). The dataset used contains ship details, technical efficiency data, verifier data and CO₂ emission records for different ships across year 2018-2020.

The data is available from <https://mrv.emsa.europa.eu/#public/emission-report>. This report gives a briefing to the star schema we created and deployed in database in the framework of Django and how to conduct interactively exploratory analysis on the website interface.

Data Warehouse

1. Star Schema

In this project, we design this database as a star schema with fact table and four dimension tables. The fact table records the measures of the design efficiency of vessels, the total fuel consumption, the total CO₂ emission and so on, which are all additive facts. The four dimension tables record more detailed information about each dimension to support analysis, shown as below [Figure 1](#). Each dimension table has a surrogate key to represent each entry, which is used by the fact table to link to different dimension tables.

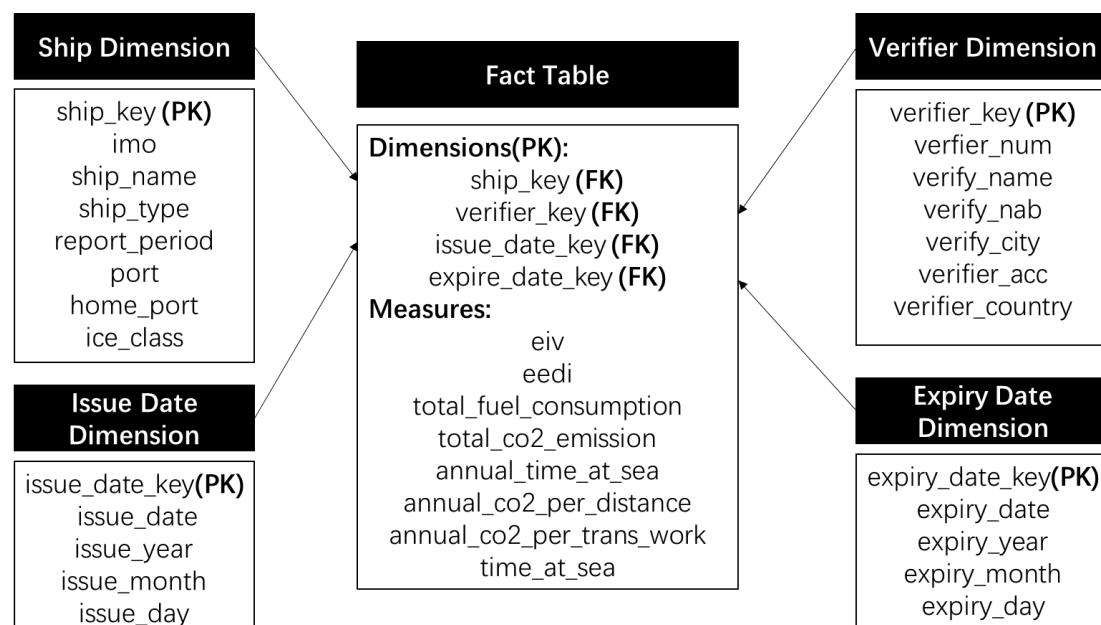


Figure 1. Star Schema Sketch

2. Data Structure

For this question 2, we structure 5 tables which are the *fact table*, *explore*, *explore_verifier*, *expire_date*, *issue_date*. Here are one fact table and 4 dimension tables to structure our star schema. Moreover, we create 4 surrogate keys which are *ship_key*, *verifier_key*, *issue_date_key*, *expire_date_key* and assign each to dimension tables. For fact table, we linked with other dimension tables by surrogate keys, so there are 4 primary keys in the fact table. Also, in fact table, all the features' property are numeric.

The ERM of data structure is shown below.

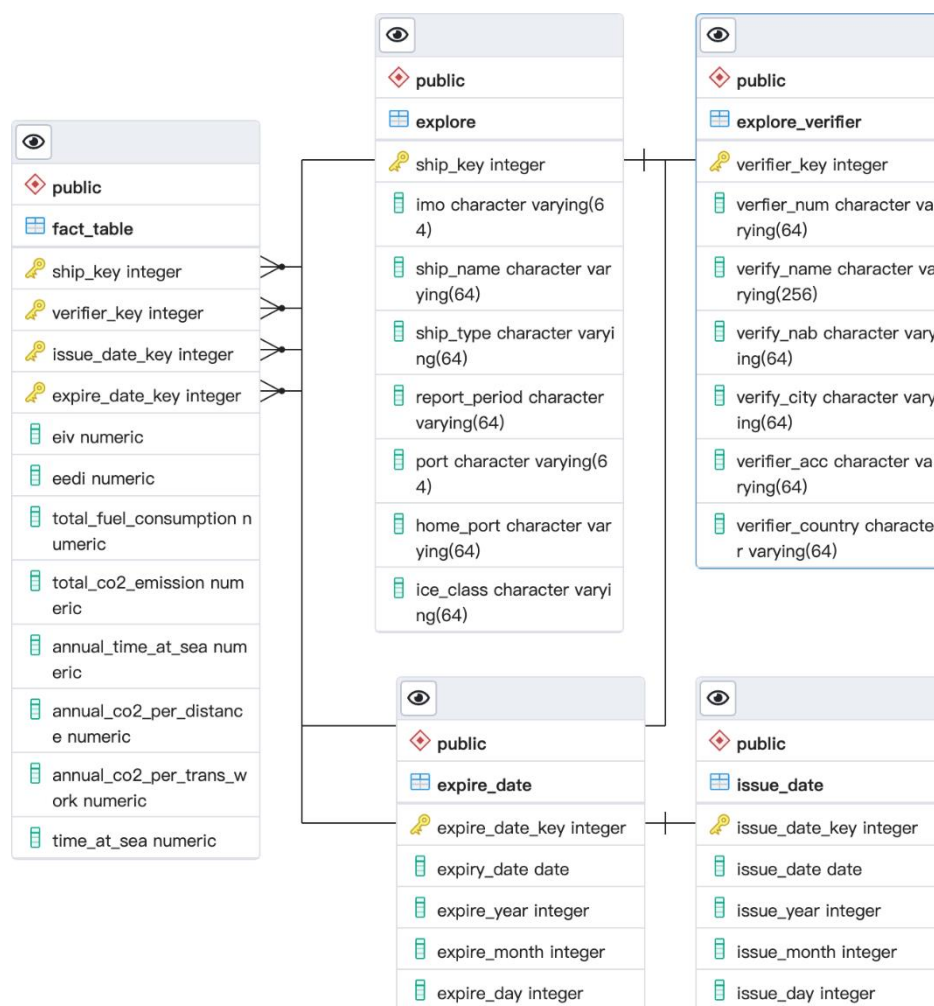


Figure 2. Data Structure ERM

Functions Achieved

1. Explore the Data

a) Main Interface (Fact table)

HomeDBEmissionsAggregationVisualizationExplore the dataTotal CO2 Emission

CO₂ Emission Report

Fact table for ship technical efficiency and CO₂ emission records.

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< PreviousNext >Explore ships moreExplore verifier more

Ship Key	Verifier Key	Issue Date Key	Expire Date Key	EIV (gCO ₂ /t-nm)	EEDI (gCO ₂ /t-nm)	Total fuel consumption	Total CO ₂ emissions	Annual Time spent at sea [hours]	CO ₂ emissions per distance	CO ₂ emissions per transport work	Total Time spent at sea [hours]
10003	20002	30026	40001	15.36		2551.47	7980.84	1783.95	138.2	57.71	1783.95
10005	20003	30006	40001	6.66		3309.7	10369.53	2728.3	100.21	5.44	2728.3
10012	20003	30081	40001	8.37		2315.8	7225.88	3407.42	61.15	4.82	3407.42
10013	20005	30051	40001	22.51		1176.02	3770.32	3306.2	32.85	41.97	3306.2
10015	20005	30003	40001	11.24		5218.71	16275.31	3174.55	162.92	30.18	3174.55
10018	20003	30026	40001	107.58		2196.2	6897.85	616.7	246.02		616.7
10020	20005	30070	40001		15.26	3198.25	10012.14	2739.81	103.98	10.71	2739.81
10022	20003	30025	40001	17.03		2053.7	6415.51	1378.5	95.94	14.17	1378.5
10026	20005	30030	40001	11.25		1908.8	5962.08	1052.75	129.15	14.36	1052.75

Figure 3 Main Interface

Main interface we created is shown above in the block *Explore the data*. This interface contains two page buttons, two explore more buttons which are introduced later, and a fact table contains basic information of ships emission. Four surrogate keys represent records in dimension table about ship, verifier, issue date and expire date respectively.

Click on table headers in red box, can order the table by each column.

b) Dimension tables for four surrogate keys

Emission Details for ship: 10003

Ship Key10003

IMO Number8026907

Ship nameZHEN HUA 19

Ship typeOther ship types

Home port

Ice class

Report Period2018

Figure 4. ship record

Emission Details for ship: 20002

Ship Key20002

Verifier Number541

Verifier NameCHINA CLASSIFICATION SOCIETY

Verifier NABDenmark National Accreditation Body (DANAK)

Verifier CityBeijing

Verifier Accreditation number7508

Verifier CountryChina

Figure 4. Verifier record

All the four surrogate keys ([Blue](#) font color as shown below) in the table can be clicked. And it will respectively return different record accordingly from dimension tables.

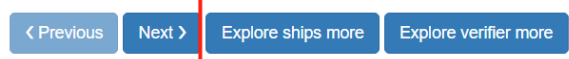
Dimension record displayed after clicking *Ship_Key*, *Verifier_Key*.

There are also two buttons on main page: *Explore ships more*, *Explore verifier more*.

CO₂ Emission Report

Fact table for ship technical efficiency and CO₂ emission records.

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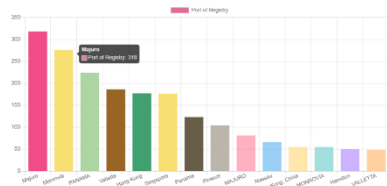
Ship Key	Verifier Key	Issue Date Key	Expire Date Key	EIV (gCO ₂ /t·nm)	EEDI (gCO ₂ /t·nm)	Total fuel consumption	Total CO ₂ emissions	Annual Time spent at sea [hours]	CO ₂ emissions per distance
10003	20002	30026	40001	15.36		2551.47	7980.84	1783.95	138.2

Figure 5. Explore more function

After clicking these two buttons, statistical graphs and tables about ships and verifiers will be displayed respectively.

TOP 14 PORTS: Num of Ships for Port_Registry

This is a page that shows the number of ships for top 11 registry ports.

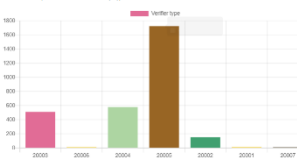


Dimension Table: Details for Ships

ship_key	imo	ship_name	ship_type	report_period	port	home_port	ice_class
10001	7802794	GALE	Roamer ship	2016	Valby	Valby	IX
10002	7801859	DESLIN	Passenger ship	2016	Valby		
10003	8076807	YH-N HUA 19	Other ship types	2016	KINEN-175AN		
10004	8027299	WARDLA CLEDRATION	Passenger ship	2016	Valby		
10005	8139881	CIL PROGRESSOR	Other ship types	2016	SINGAPORE		

Aggregated ship numbers in different verifier types

The data shows numbers of verifier ship types is shown below.



Dimension Table: Verifier Information

ship_verifier_num	ship_verifier_name	ship_verifier_sub	ship_verifier_city	ship_verifier_acc	ship_verifier_country
20001	10266	MTV/Carroll AB	SWEDAC	47192 E1 s	Sweden
20002	541	CHINA CLASSIFICATION SOCIETY	Danmark National Accreditation Body (DNV-UK)	Dongting	China
20003	1	Nippon Kai Kyo Kai	Swedish Accreditation Public Group	Tokyo	VIS-2125-21 Japan
20004	581	HELLNIC LLOYD S.A.	HELLNIC ACCREDITATION SYSTEM	Athens	Greece

Figure 6. Explore the ship dimension

Figure 7. Explore the verifier dimension

The statistical graph [Figure 8](#) and dimension table displayed after clicking Explore ships more are as follows. The graph shows the number of ships of top 14 registry ports, and the table contains more details for each ship.

The statistical graph [Figure 9](#) and dimension table displayed after clicking Explore verifiers more are as follows. The graph shows the number of ships of different verifier types, and the table contains more details for verifier information.

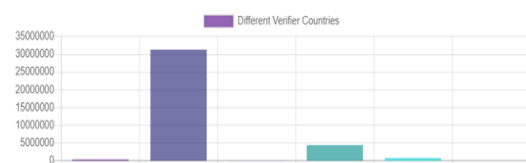
2. Total CO₂ Emission

In this section, we try to calculate and visualize the sum of total CO₂ emission in total and in different groups, including different ship types, different verifier countries and different ship types in each verifier country.

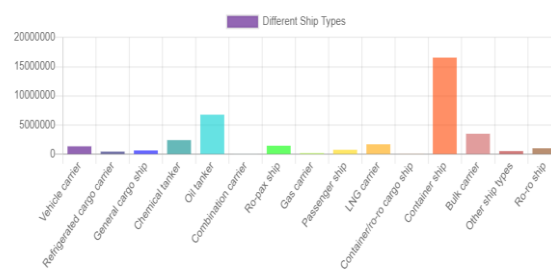
a) Visualization

There are three bar charts showing the sum of total CO₂ emission in different groups.

The Sum of Total CO₂ Emission in Different Verifier Countries



The Sum of Total CO₂ Emission of Different Ship Types



The Sum of Total CO₂ Emission of Different Ship Types in Different Verifier Countries

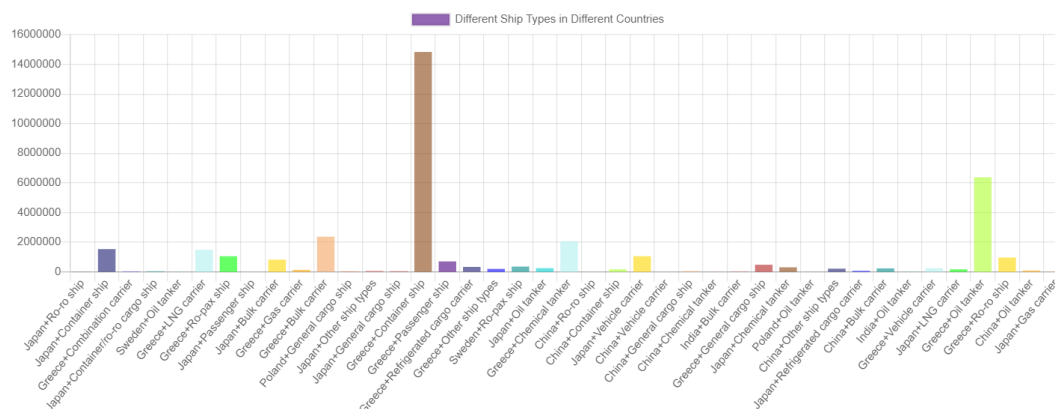


Figure 9. Roll up and cube queries for CO₂ Emission Statistics

b) Calculation Tables

There are two tables showing the calculation results with different calculation methods. The first one uses the CUBE query, which includes all possible grouping sets, while the second one only generates all grouping sets in the order of the input columns.

Total CO₂ Emission (with cube function)

Verifier Country	Ship Type	Sum of CO ₂ Emission
		36980743.85
Greece		31325401.59
	Container ship	16551728.19
Greece	Container ship	14835661.95

Total CO₂ Emission (with rollup function)

Verifier Country	Ship Type	Sum of CO ₂ Emission
		36980743.85
Greece		31325401.59
Greece	Container ship	14835661.95
Greece	Oil tanker	6383243.28