Role of Technology in Achieving the United Nation's Sustainable Development Goals

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Abstract

In 2015, 193 countries adopted the United Nation's 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs)

The IMO is actively working towards the SDGs and recognises that most of the elements of the 2030 Agenda will only be realised with a sustainable transport sector supporting world trade and facilitating the global economy.. Ports, as critical nodes in the global supply chain, must respond to worldwide, regional, and local challenges such as climate change and digitalisation.

This paper presents a case study for the application of digital port optimisation technologies for a port in the UAE. Utilising advanced modelling techniques, AI enhanced forecasts, and real-time data, the technology allows vessels to increase their sailing drafts, thereby allowing additional cargo to be loaded for every voyage. Through an analysis of 17 months of shipping data, it was found that the technology facilitated a reduction in shipping related CO_2 emissions of more than 50,000 tonnes.

Keywords: Digitalisation, Port Optimisation, Sustainability, UKC

1. Introduction

Ports and shipping channels are critical components of many nations' transport infrastructure, and make a significant contribution to the economy. With volatile and disrupted global trade comes further pressure on ports to be adaptive and resilient. This is occurring against a backdrop of increasing regulatory and environmental requirements, and social expectations, as well as a changing climate that is presenting more frequent and severe weather events.

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The IMO recognises that most of the elements of the 2030 Agenda will only be realised with a sustainable transport sector supporting world trade and facilitating global economy, and is actively working towards the SDGs. Ports, as critical nodes in the global supply chain, must respond to worldwide, regional and local challenges such as climate change and digitalisation.

With the support of strategic partners including the American Association of Port Authorities (AAPA), the European Sea Ports Organisation (ESPO), and the World Association for Waterborne Transport Infrastructure (PIANC), in 2017 the International Association of Ports and Harbors established the World Ports Sustainability Program. One of the five WPSP themes is 'Resilient Infrastructure' and encapsulates SDGs #9 Industry, Innovation and Infrastructure, #13 Climate Action, and #14 Life Below Water.

This paper will present case study for the application of digital port optimisation technologies for a port in the UAE. An overview of the technology will be provided, with a discussion of the role of technology and innovation in meeting the UN's SDGs. Through an analysis of 17 months of shipping data, the contribution of the new technologies towards reducing shipping related CO2 emissions will be evaluated. The paper will highlight how the port's digitalisation efforts contributed towards the UN's SDGs.

2. Sustainable Development Goals

The United Nation's Sustainable Development Goals are far reaching, with the intention that they provide a framework for peace and prosperity for people and the planet. They incorporate concepts from the elimination of poverty and hunger through to clean energy and sustainable cities.

As part of the IAPH's World Ports Sustainability Program, the SDGs were grouped into specific themes that align with the areas in which ports operate. The five themes are:

- Climate and Energy
- Community outreach and port-city dialogue
- Resilient Infrastructure
- Governance and Ethics; and
- Safety and Security

Of these themes, the focus of this study is Resilient Infrastructure, and in particular, two SDGs which it encapsulates: #9 Industry, Innovation and Infrastructure, and #13 Climate Action.

In relation to SDG #9, Industry, Innovation and Infrastructure, the IMO states[3] that technological advances in the port sector are key to building resilient infrastructure and central to the effective functioning of the whole transportation sector. A more efficient shipping, working in partnership with the port sector, will be a major driver towards global stability and sustainable development for the good of all people. Furthermore, investment, growth and improvement in the shipping and ports sectors are clear indications of a country or region that is enjoying success in the present and planning for future success.

On #13 Climate Action, the IMO's position[3] is that responding to climate change is one of the greatest challenges of our era, and requires appropriate, ambitious and realistic solutions to minimise shipping's contribution to air pollution and its impact on climate change.

The case study presented quantifies the contribution of digital technologies towards these SDGs, driving more efficient shipping operations which lead to reduced CO_2 emissions.

3. Digitalisation

Digitalisation is not a panacea for maritime challenges. However, digitalisation does drive access to more data, in real-time, and with greater precision. Forward thinking ports are finding ways to leverage these developments to deliver operational efficiencies and enhance safety. The digitalisation trend has been underway for some time, but is now more prevalent than ever. The United Nations Conference on Trade and Development (UNCTAD) Review of Maritime Transport 2020 proposes that "adopting technological solutions and keeping abreast of the most recent advances in the field will become a requisite, no longer an option" for the maritime industry[6].

Enabling and enhancing data capture is one area in which digitalisation can deliver immediate benefits. In their Maritime Digitalisation Playbook, the Maritime and Port Authority of Singapore highlight the global trend of port operators to harness data to improve port efficiency, and provide greater visibility of operations. UNCTAD[6] found that enhanced digital data exchange across port stakeholders enables better collaboration and decision-making. In the International Association of Ports and Harbour (IAPH) led and IMO endorsed call to action entitled "Accelerating digitalisation of maritime trade and logistics", released in June 2020, the authors note that while some ports had "seized the opportunities of the fourth industrial revolution", transitioning towards smart ports, many others have "barely grasped the essentials of digitalisation".

The digital port optimisation technologies discussed herein capture and transform historic, real-time and forecast data, and integrate it into the port's operations, enabling better, faster, more transparent decision making. The result is more a more efficient port.

4. Shipping CO_2 Emissions

Greenhouse gas emissions (GHG) from maritime transport are estimated to exceed one billion tonnes per annum, representing around 3% of global anthropogenic GHG emissions[2]. International shipping accounts for approximately 87% of total shipping related CO_2 emissions[4]. Despite improvements in engine technologies and operational practices such as slow steaming aimed at reducing vessels' fuel efficiencies, the total GHG shipping related GHG emissions have continued to climb, largely due to the increase in shipping[4]. It is worth highlighting that shipping is the most efficient mode of transport on a CO_2 per tonne-km basis[5].

The Paris Agreement requires emissions to be reduced by 50% by 2050. To achieve these results will take new innovations in the areas of ship and engine design, and alternative fuels. However, an option that is available immediately is to reduce the amount of shipping by increasing the cargo on each vessel. Digital technologies such as DUKC® are achieving this.

Increasing sailing drafts with DUKC® allows vessels to carry more cargo. This reduces the cost of freight, as well as the per tonne fuel usage, greenhouse gas and carbon dioxide emissions.

There are several methods typically employed to derive fuel and emission related estimates for shipping[5]. Danish Shipping[1] has developed a calculator designed to determine emissions for a specific vessel including its type and size, payload capacity, rate of utilisation and speed, with the ability to manually adjust a number of parameters such as engine and fuel types. Without knowledge of the specifics of each individual vessel and voyage, an aggregate approach can be taken.

A top down approach is to determine fuel usage based on reported marine bunker sales. Concerns of this approach are largely centred around the reliability of bunker fuel statistics, given different reporting requirements globally, and the known occurrences of misallocation of fuel types or industry sectors[5].

The approach adopted herewith is based on the work of Psaraftis and Kontovas[5]. In their model. the CO_2 emissions are calculated from fuel consumption information on a per ship basis used directly as an input. The model then determines CO_2 emissions on a tonne-km basis per ship class, accounting for the following variables:

- Deadweight (DWT) (tonnes)
- Payload Capacity W (tonnes)
- Average Cargo Capacity Utilization w (0<w<1)
- Speed of ship at sea V (km/day)
- Percentage of total operational time that ships spend at sea, s (0≤s≤1)
- Total Fuel Consumption at sea, including fuel that is used by Maine Engine and Auxiliaries, F (tonnes/day)
- Total Fuel Consumption in port, including fuel that is used by Maine Engine and Auxiliaries, G (tonnes/day)
- Operational days per year, D (days) (D≤365)
- Sea days in a year: sD
- Port days in a year: pD

The key equations utilised in the analysis are:

$$\text{Sea kilometres per year (km)} = sDV \qquad (1)$$

$$\text{Total fuel consumption per year (tonnes)} = (sF + pG)D \qquad (2)$$

$$\text{Total } CO_2 \text{ in a year (tonnes)} = 3.17(sF + pG)D \qquad (3a)$$
$$= 3.17[s(F\text{-}D)+G]D \qquad (3b)$$

$$\text{Total tonne-km in a year} = (wW)(sDV) \qquad (4)$$

$$CO_2 \text{ per tonne-km} = 3.17[F+(p/s)G]/wWv \qquad (5)$$

A flowchart describing the calculation of CO_2 emissions per tonne-km as determined by Psaraftis and Kontovas is provided in Figure 1.

Their analysis utilised the world fleet database sourced from Lloyds Fairplay, and included 1,732 vessels of relevance for Saqr Port. Their analysis concluded that the CO_2 emissions could be approximated at 6.3 grams per tonne-km for this vessel class (35,000 to 65,000 DWT).

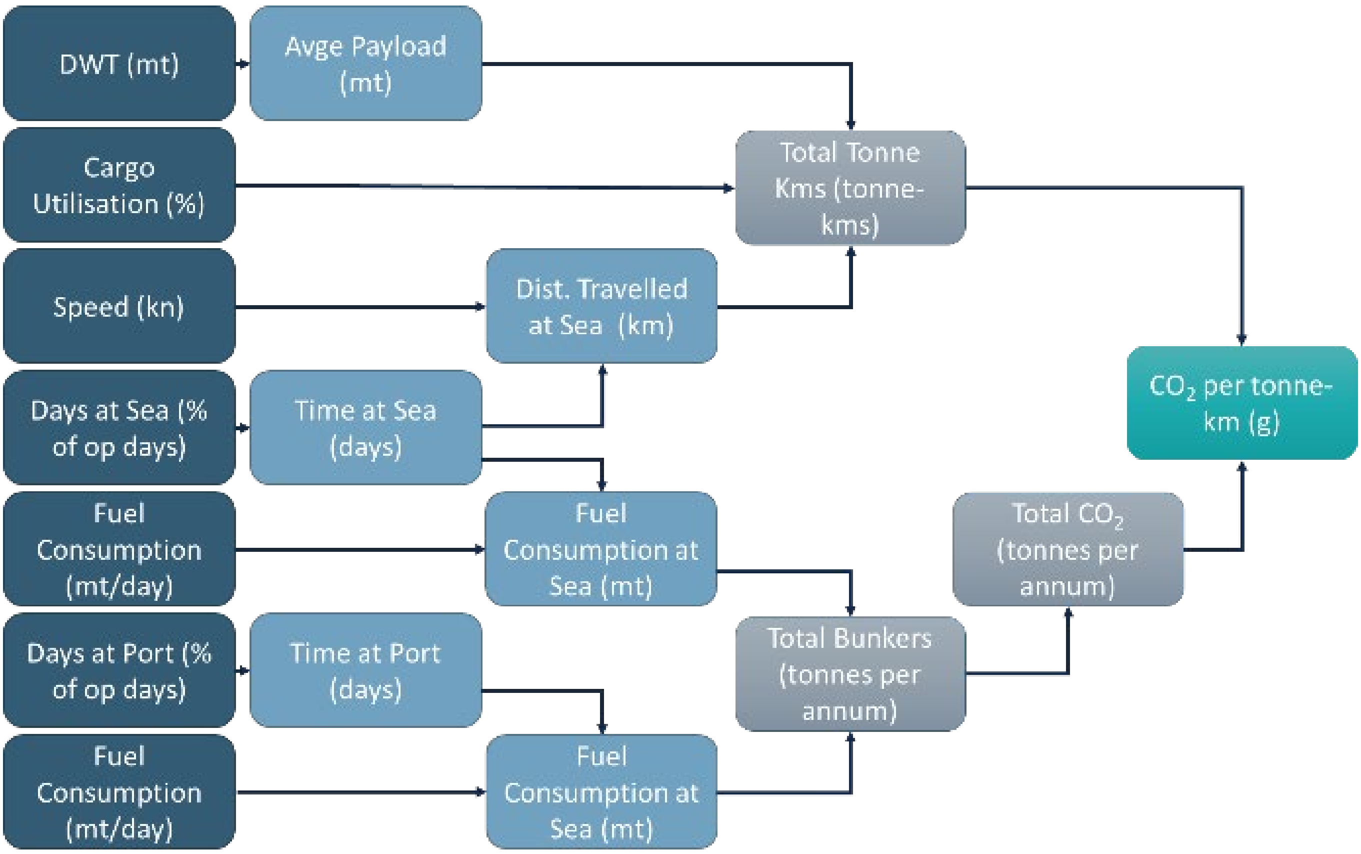

Figure 1 CO_2 emissions calculation flow chart highlights to process to determine the aggregate grams CO_2 per tonnes-km that is used to estimated emissions savings for any voyage. Adapted from Psaraftis and Kontovas[5].

5. Saqr Port Case Study

Saqr Port in Ras Al Khaimah is one of five ports operated by the Ras Al Khaimah Port Authority (RAK Ports). Saqr is one of the Middle East's leading centres of maritime and industrial commerce. Strategically located near the Strait of Hormuz, it is one of the major hubs in the regional industrial supply chain, supplying construction materials for the majority of world-renowned real estate projects in UAE, and beyond.

Saqr Port is comprised of an Inner Harbour with 12 berths, and a Deep Water Bulk Terminals that has capacity to berth two Capesize or three Panamax vessels. At a depth of 12.2m, the Inner Harbour caters to vessels from Handy to Panamax size, although draft restricted. The mean spring tidal range is 2.0m and 1.0m at neaps. With a cargo handling capacity of over 100 million tonnes annually, Saqr is the region's largest dry bulk port.

The main trades are limestone and aggregate exports, and coal imports, although the port also handles clinker, cement, gypsum, and general cargo.

6. Digital Port Optimisation

With the ambition of enhancing their operational efficiency, RAK Ports commissioned OMC International to implement its Dynamic Under Keel Clearance System (DUKC®). This project was unique as Saqr Port was the first in the MENA region to implement this type of innovative technology.

DUKC® is a comprehensive digital solution for UKC management, underpinned by detailed modelling of port operations, numerical analysis of ship motions, hydro-dynamic models, channel survey data, and the AI assisted assimilation of real-time and forecast environmental conditions. Connecting advanced calculation engines with the port's available IoT devices and digital data sources, DUKC® allows the sailing draft of every vessel to be safely maximised.

The DUKC® functionality allows the port and its customers to evaluate what the maximum sailing drafts will be for future tides. DUKC® calculates these maximum sailing drafts based on the specific vessel, its unique stability characteristics for that voyage based on the cargo and how it is loaded, and the prevailing environmental conditions during the transit.

DUKC® was commissioned for use on January 1st 2020 and the benefits for the port and its customers were immediate and significant.

The first vessel to load with DUKC® was the LMZ Phoebe on January 9th 2020. It sailed at a record draft of 12.76m with an additional 3,000t of cargo than it would otherwise have achieved. That record was short lived as on January 20th, the Ganga K sailed at a draft of 12.83m. The next day, the Elbabe again set a record with a draft of 12.85m.

On August 20th the MV Soho Mandate became the first vessel to exceed 13m from the Inner Harbour, at a draft of 13.02m. This equates to an additional 7,000t of cargo. Since then, there have been more than 20 transits at drafts in excess of 13.0m. Notably, on October 15th, the Asia Ruby I sailed at a draft of 13.10m.

7. With 17 months of voyage data since the implementation of DUKC® at Saqr Port, an estimate of the CO_2 emissions reductions achieved in presented.

8. CO2 Emissions Reductions

With an understanding of the average gram of CO_2 produced per tonne-km of shipping, the impact of DUKC® in reducing shipping related CO_2 emissions is estimated by determining the additional tonnage that is carried to each port, and the associated distances. Given the marginal percentage increase in the overall displacement of each individual vessel, it is assumed that the implication of the additional tonnes is negligible in terms of fuel requirements.

For every vessel entered into the DUKC®, the system stores the sailing draft, and the draft benefit achieved. The destination port for the vessel is manually entered. The available dataset spans from January 1st 2020 to May 31st 2021 and contains 225 transits. Transits where the destination port was not listed were removed. The dataset contained 8 entries where the discharge port was listed only as India. In these instances, the distance for the purpose of CO_2 emissions calculations has been assumed as the average of the known Indian discharge ports. Distances between ports were calculated using the sea route distance calculator available at http://ports.com/sea-route/.

The average increase in draft achieved with DUKC® was 0.63m. Of the 225 transits, there were 27 unique destinations. Of these 27 ports, 12 had only a single transit. Chittagong was the most frequented port with 99 transits. It also has one of the longest distances as well as the highest average benefits in terms of increased draft and tonnage.

Taking into consideration the increased tonnage and distance for every DUKC® transit, and applying the CO_2 emissions per tonne km value of 6.3g, the reduction in CO_2 resulting from the efficiencies achieved with DUKC® is estimated at 53,243 tonnes.

To assess the impact of these CO_2 reductions, the equivalency calculator developed by the US Environmental Protection Agency is used (https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator). Some example equivalents include:

- GHG emissions from 215,346,633 km driven by average passenger vehicle;
- CO_2 emissions from:
  - 6,476,619,425 smart phone recharges;
  - 9,671 homes electricity use for 1 year;
- CO_2 sequestered by:
  - 880,384 tree seedlings grown for 10 years;
  - 65,232 acres of forests in 1 year.

9. Summary

The is an imperative for industry to reduce shipping related CO_2 emissions, and this is evidenced through the United Nations' Sustainability Development Goals, endorsed by the IMO. Whilst the challenge remains large and will take multiple and significant innovations to resolve, there are solutions that can be implemented now, with immediate and significant benefits.

This paper has presented a case study for DUKC®, a digital port optimisation technology that allows ships to sail with more cargo and reduced risk. By increasing the tonnes lifted by every vessel, the per tonne-km CO_2 emissions are reduced. Essentially, fewer voyages are required to transport the same volume, therefore fuel use is reduced with a corresponding reduction in GHG emissions.

In this example, the 17 months' analysis shows a reduction in CO_2 emissions of more than 50,000 tonnes, equating to ~5% reduction per transit. Although this may be small in percentage terms relative to the global shipping related emissions, it is significant when viewed in the context of sequestering the same level of CO_2.

Importantly, it is expected that similar benefits could be replicated at any port where vessels are draft constrained, thereby enabling ports with a focus on sustainability to realise CO_2 emissions reductions through DUKC®.

RAK Ports was the first in the MENA region to adopt DUKC®, thereby giving its customers the opportunity to improve their environmental footprint, and demonstrating how digital technologies such as DUKC® can contribute towards achieving Sustainable Development Goals.

In December 2020, RAK Ports was recognised for their sustainability achievements by winning the Seatrade Intelligent Shipping Award for their implementation of DUKC®.

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