Driving efficiency, competitiveness and innovation in the maritime transportation sector through API-based integration and collaboration

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1. INTRODUCTION

In his first visit to the Philippine Ports Authority (PPA), Department of Transportation (DOTr) Secretary Jaime Bautista directed the Ports Authority to further increase the overall efficiency and productivity of shipping ports (PPA, 2022a). It was well-received by the PPA which then undertook the task of reviewing the entire operations and processes to identify improvements that could lead to the reduction of travel and shipping costs (PPA, 2022b). Part of this agenda is increasing efforts towards digitalization (Business Mirror, 2022).

Digitalization has a huge potential to bring about profound organizational changes which lead to the disruption and redefinition of existing business processes (Tijan et al, 2021). Digitalization includes several domains of applications. Sanchez-Gonzales et al (2019), for instance, enumerate eight digital domains for the digitalization of maritime transport: autonomous vehicles and robotics; artificial intelligence; big data; virtual reality, augmented and mixed reality; internet of things; the cloud and edge computing; digital security; and 3D printing and additive engineering. On the other hand, de la Peña Zarzuelo et al (2020) highlight the following: Internet of Things and sensing solutions; cybersecurity; horizontal and vertical system integration; cloud computing; 3D printing and additive manufacturing; big data and business analytics; augmented reality; and simulation and modeling.

Among these domains of applications, we focus on horizontal and vertical system integration. By integration, we mean the exchange of data and access to functionality among different firms (horizontal integration) and across systems within the same firm (vertical integration) (de la Peña Zarzuelo et al, 2020). Specifically, we aim in this perspective paper to show how the maritime industry may achieve integration through the standardized Application Programming Interface (API).

Application programming interface – or API – is an interface that provides programmatic access to data and functionality within an application or a database. It is "a particular set of rules and specifications that software programs can follow in order to communicate with each other" (Mosqueira-Rey et al, 2018). An easy way to imagine how APIs operate, according to Mulesoft, is to think about them as a waiter in a restaurant (Johl, 2022). In a restaurant, there are two parties, namely the customers and chefs, who are independent of each other. To ensure effective communication between these two parties, we need a waiter who takes the order from the customer to the chef, then delivers the food from the chef back to the customer.

API has been chosen as the technology of integration for two reasons.

First, digitalization without API-first integration can impede seamless inter-connectivity for shared services. Putting them on a later phase means that digitalization is optimized on a specific organization rather than focused on providing seamless inter-connectivity in shipping and logistics. As a crude analogy, this scenario is the same as having a proprietary locked-in interface in the early days of computer industry. Prior to the standardized Universal Serial Bus (USB) interface, different peripherals and vendors are competing in the market by locking-in proprietary interface with the computer manufacturer. While it may create a competitive advantage for the vendor, locked-in interface unnecessarily restricts consumers to the legacy interface. Even if other vendors can provide new significant features, consumers cannot use them simply because of the incompatibility of the interface. With the introduction of a standardized USB interface for peripherals, companies were able to focus on innovations that provide more competitive products and services, including novel peripherals that were previously unimaginable. It is highly likely that APIs can achieve the same impact that USBs did in the computer industry.

Second, API platforms not only will enable integration, both vertical and horizontal; it will also drive innovation that is based on an API economy, whereby a collaboration among business partners is critical for expansion of customer base (Lee and Ha, 2018). For example, the adoption and deployment of (public) APIs in the financial sector proved a gamechanger in the industry, since it made possible the seamless collaboration and integration among financial institutions, FinTech startups, technology companies, and regulators (Zachariadis and Ozcan, 2017). In the transportation sector (e.g., logistics, supply chain, trade and airline), API technologies are becoming ubiquitous, facilitating

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data exchange and connectivity. For example, in the Philippines, DHL, Entrego, Transportify, Lalamove, MrSpeedy are only some of the logistics companies whose API integrations enable new business models.[1] In the maritime sector, APIs for vessel positions, events, vessel data, voyage information, geographical information, power user have been published by MarineTraffic.[2] Apart from these, digital platforms built on APIs, e.g., API marketplaces, are also emerging developments. In Singapore, for instance, the Maritime and Port Authority of Singapore (MPA) has launched the Open/Common Exchange And Network Standardisation Application Programming Interface (API) eXchange (OCEANS-X) platform.[3]

Although APIs have a huge potential to revolutionize the transportation sector, API adoption is very much limited in the Philippine transportation industry. Waze shares its live feed of traffic data via APIs (JSON or XML format)[4] with government agencies such as the Department of Transportation, Metro Manila Development Authority (MMDA) and Pasig City Local Government. Apart from this and a few other cases, in the Philippines, there are not much instances of API technology deployments in the transportation sector in general (exception is private logistics firms) and in maritime sector in particular.

API-based transformation has been identified as one of the critical research and development (R&D) themes for maritime transportation (Sunio et al, 2022). To further advance standardized API integration in the maritime industry, stakeholders should first recognize the need to adapt or develop API integrations given the existing equipment, process, and multiple high-volume ports available in the archipelago country. In the next section, we describe the phases of digital transformation via APIs.

2. PHASES OF DIGITAL TRANSFORMATION VIA APIS

Figure 1: Phases of API-based digital transformation roadmap.

Figure 1 presents the four phases of the API-based digital transformation: transitioning legacy systems to the cloud, adoption of open standards and publication of APIs, development of an API platform, and forming API-based partnerships (c.f. Cruz, 2021). Strictly speaking, it is not necessary to pursue these phases in sequence. However, when presented as a roadmap, representing the API-based digital transformation as thus, i.e., in terms of sequential phases, is useful in guiding collective efforts. We briefly describe each phase.

Transitioning legacy systems. Although, in principle, integration of legacy systems is possible with APIs, it is a huge effort. An alternative solution is to migrate first to the cloud. In fact, moving to the Cloud has become a baseline digital transformation imperative. With the cloud, it is easier to roll-out API deployments.

Adoption of open standards and publication of APIs. Without standards, each organization or enterprise can adopt their own API specifications, which primarily arise because of a lack of consensus on what data can be shared across. As a result, API design may vary from one enterprise to another, which can only make integration difficult. What is needed is thus a digital maritime sector whose technical specifications are not only open (i.e., publicly published), but are also standardized (i.e., same design across all APIs) and adopted by the majority – if not all – of the enterprise systems. Setting these technical specifications as the standards for the whole maritime sector and requiring their wider use or adoption by all the participating organizations can only be accomplished with regulation. Since the adoption of sector-wide standards is a difficult process, it can then proceed in tiers, depending mainly on the data sensitivity and type.

Development of an API platform. An API portal is a centralized place put up by an enterprise so that potential partners can discover its APIs which can allow them to connect and access its data. An API marketplace is a platform which allows providers to publish and monetize their APIs and developers to discover and consume useful APIs.

API-based partnerships. The goal of the API-based digital transformation is to build a digital ecosystem that enables the integration and collaboration for the development of innovative products or services. Figure 2 illustrates how this ecosystem may look like. Here APIs connect government agencies, terminals/ports, systems (e.g., National Single Window), shipping lines (RoRo, cargo, passenger, etc.), and application developers. For example, cargo shipping lines may publish their vessel positions and schedules in a central API marketplace, so that third-party app developers can consume these APIs and develop aggregator applications.

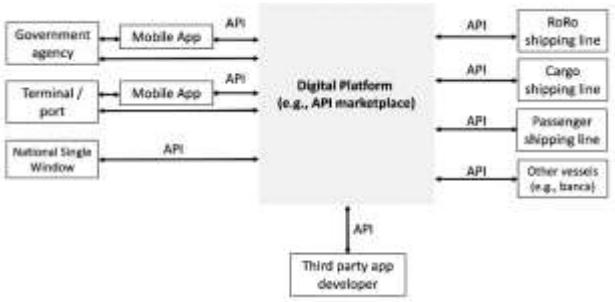

Figure 2: Collaborative digital ecosystem for maritime transport based on APIs

Realizing each phase in this roadmap is definitely not without its challenges (Table 1). First, transitioning to the cloud has huge cost implications associated with it, which may be beyond the financial capacity of many enterprises. Second, a sectoral adoption of open standards may face legal (with respect to data sharing) and technical challenges (in terms of the technical specifications of APIs), and can only be achieved with a strong push from the concerned government regulatory body. Third, aside from the fact that a central API marketplace is costly, there is also the challenge of possible disclination by organizations to participate in this digital ecosystem.

Table 1: Critical API-based digital transformation challenges

Phase	Main Challenges

[1] https://logisticsbid.com/ph/philippine-logistics-companies-with-api-integration-dhl-entrego-lalamove-mrspeedy/
[2] https://www.marinetraffic.com/ja/ais-api-services
[3] https://sbr.com.sg/shipping-marine/news/maritime-week-mpa-kickstarts-development-oceans-x-api-marketplace
[4] https://developers.google.com/waze/data-feed/overview

Transitioning legacy systems	Cloud migration costs
Adoption of open standards and publication of APIs	Legal aspects of data sharing across multiple systems by different organizations; difficulty in achieving consensus around the technical specifications of open APIs
Development of an API platform	Development costs of building a central marketplace for the whole maritime sector
API-based partnerships	Disinclination by enterprises to join the digital ecosystem

3. EXAMPLE INITIATIVES AND APPLICATIONS

We list below a list of possible projects (based on the authors' knowledge and literature review) that can be pursued for the digital transformation of the maritime transport sector via APIs. Since, as mentioned earlier, the use of API in the maritime sector is currently limited, the suggestions below are simply to show a proof of value of API deployments for particular use cases to encourage wider adoption of this technology. These examples are mostly related to above-mentioned Phase 2 on the publication of APIs. The last example on API platform and marketplaces is related to Phase 3.

- *Ro-Ro schedule information.* To get information about the schedule of RoRo, one may either visit the website of the shipping line or check social media sites such as the Facebook group, "Domestic RoRo Passenger Vessel Schedule in the Philippines". APIs can revolutionize the delivery of relevant and on-time information to potential customers. Each RoRo company can publish information about their RoRo passenger vessel schedule through APIs, which can be consumed and called, enabling the development of schedule aggregator applications. An alternative is a schedule information system based on GTFS Realtime.[5]
- *Vessel location tracking.* While APIs for real-time Automatic Identification System (AIS) position data are not at all new (VesselFinder[6] has already long implemented it), there is no known API deployment related to vessel location for Philippine maritime vessels (especially mid-sized bancas).
- *API-First Digitization of Legacy Equipment*. API integration with existing system can be developed with IoT-enabled embedded systems for high-value equipment. One simple example would be to utilize computer vision and Artificial Intelligence to read analog meters that can be sent to the cloud network.
- *Digitalization of trucking and logistics on shipping ports.* The gates of ports can be equipped with smart CCTV containing Computer Vision algorithm of Automatic License Plate Recognition optimized to Philippine setting. It can then be used to automatically send reports on the arrival time, dwell time, and departure time of each trucking service. With API integration, relevant real-time tracking of status updates is provided to the potential customer, aggregators, trucking services, and logistics. As an added feature, real-time operational metrics are provided to the port management authority.
- *Global trade and supply chain*. One critical system for international trade facilitation is the National Single Window (NSW), a "facility that allows parties involved in trade and transport to lodge standardized information and documents with a single-entry point to fulfil all import, export, and transit-related regulatory requirements. If information is electronic, then individual data elements should only be submitted once."[7] The NSW is a highly convenient tool for private sector stakeholders since all information associated with a trade or related transport transactions is submitted and retrieved from a single system.[8] In the Philippines, TradeNet is its NSW.[9] One goal of TradeNet is to connect it to Association of Southeast Asian Nations (ASEAN) Single Window (ASW). The technology that enables this integration between TradeNet's and ASW's gateways is API.
- *API platform and marketplaces*. Having a centralized API platform for the entire maritime transport industry where partners can publish their own APIs and at the same time discover APIs by other parties which they can consume is essential for the API economy. This can be similar to Singapore's OCEANS-X API platform.

4. CONCLUSIONS

In this paper, we present the case for the digital transformation of the maritime transport sector through API-based integration. API is positioned as the technology of integration because it will not only facilitate efficiency and competitiveness in the sector by enabling communication and exchange among various disparate systems, but will also drive innovation through collaboration and partnerships. A digital transformation roadmap, consisting of four phases, is then proposed. Finally, we provide a few suggestions on possible API projects for the maritime sector.

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