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The Complementarity between Dhow Shipping Networks and Standard Shipping Lines in the Gulfs of Persia, Oman and Aden

La complémentarité entre le réseau de boutres et celui des transports maritimes standardisés dans les golfes Persique, d'Oman et d'Aden

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Abstract

This article provides the very first appraisal of the extent of dhow shipping networks and their transport capacity around the Arabian Peninsula (in the Persian Gulf and the Arabian Sea) and the level of interconnection between dhow and containerized shipping. Dhows have a characteristic ogival-shaped wooden hull and a decorated superstructure at the stern. With a modest transport capacity ranging from 200 tons to more than 2,000 tons for the largest, dhows stay below the radars of academic research. Yet, compiled satellite pictures using Google-Earth allow a census to be conducted of dhows along coastlines and to measure their transport capacity and the extent of their network. The article starts with a short survey of the existing literature, and then presents the methodological framework of the study. It tests the spatial complementarity/duality of dhow networks with normal maritime networks (i.e. mainly containerized shipping lines), so as to understand the economic conditions of dhows' survival. Next, it shows that the embeddedness of dhow ports in cities is also part of the explanation of surviving dhow trade. A concluding discussion tackles the necessity of normalization interfaces when a standardized transport network is interconnected with a local traditional transport network in a port.

Résumé

Cet article fournit la toute première évaluation de l'étendue du réseau des boutres et de leur capacité de transport autour de la Péninsule Arabique (dans le golfe Persique et la mer d'Arabie) ainsi que leur degré d'interconnexion avec les réseaux de transport maritime conteneurisés. Les boutres ont généralement une coque ogivale en bois surmontée à la poupe d'un château orné. Avec une modeste capacité de transport allant de 200 tonnes à plus de 2000 tonnes pour les plus gros, les boutres restent sous les radars de la recherche académique. Pourtant, des images satellites compilées par Google-Earth permettent de recenser les boutres le long des côtes et de mesurer leur capacité de transport et les interconnexions de leur réseau. L'article commence par une brève revue de la littérature existante, puis présente le cadre méthodologique de l'étude. Il teste ensuite la complémentarité / dualité spatiale des réseaux de boutres avec les réseaux maritimes standardisés (principalement celui des armateurs de lignes régulières conteneurisées), afin de comprendre les conditions de leur soutenabilité économique. Puis, il montre que l'encastrement des ports de boutres dans les villes participe de cette soutenabilité économique. Une discussion finale souligne la nécessaire présence d'interfaces de

normalisation lorsqu'un réseau de transport normalisé est interconnecté avec un réseau de transport traditionnel dans un port.

Keywords: *dhow networks; short-sea shipping; network interconnections; two-tier transport systems; Persian Gulf; Gulf of Aden.*

Mots clés: *réseau de boutres; cabotage maritime; interconnexions des réseaux; système de transport à deux vitesses; Golfe Persique; Golfe d'Aden.*

1. Introduction

The persistence of dhow shipping in the Indian Ocean, the Persian Gulf and part of the Red Sea is intriguing, especially in the vicinity of Jebel Ali container terminal, the biggest modern terminal within a 6,000km radius. Of course, in the thousand-year history of dhows in the Indian Ocean, the Persian Gulf, the Gulf of Oman and the Gulf of Aden (Martin, 1980; Sheriff, 2010), the arrival of new containerized transport services in the 1970s (Stopford, 2009) is still relatively recent. Dhows have a characteristic ogival-shaped wooden (or fiber glass) hull (Picture 1) and a decorated superstructure at the stern (see Picture 3). During the 1960s, sails were replaced by diesel engines (Agius, 2005, p. 11). These ships have a small transport capacity ranging from 200 tons (Picture 2, the right dhow) to more than 2,000 tons for the largest (Picture 1).

Picture 1: Large dhows mooring at Sharjah port (UAE) in December 2019



Yet nowadays, almost any commodity can be carried easily and cheaply through the global network of container shipping lines, directly or through a hub (Song & Panayides, 2015). Given the difference of capacity between a dhow (like a “500-ton baghlah”; Martin, 1980) and a containership (even a small 1,200 TEU feeder ship), the survival of dhows in such a competitive environment is intriguing. Nevertheless, dhow shipping remains active in the region even if the lack of port statistics on dhows impedes to prove it.

Picture 2: Dhows waiting in front of Djibouti port bay (March 2019)



In Dubai for instance, satellite pictures reveal that more than 400 dhows passed through the port in 2019. Thus, two systems of maritime transport coexist distinctly, both capable of carrying the same types of good. Theoretically, only the most efficient units of production should survive in the fiercely competitive maritime shipping sector (Kessides and Tang, 2010). The size and flow differences between dhows and container ships should not be observable on any route today.

Picture 3: Dhows’ decorated superstructures (Dubai, December 2013)



Yet at least two explanations of this paradox are possible. Dhows and container shipping lines offer either complementary services for the same commodities, or different services fitted for different kinds of commodities and/or different kinds of shippers in a two-tier system. Duality in interconnected ports means that shippers’ demand spreads out in two-tier transport networks between low cost dhows for one network, and standardized modern shipping lines for the other¹. The purpose of this article is to test those explanations with the help of the “footprints” left by ships as taken by satellite pictures displayed by Google maps. Indeed, satellite pictures allow the existence of a complementarity between dhows and container shipping lines to be tested, through the presence or not of both systems in every port/jetty where dhows are spotted.

Additionally, these satellite pictures allow the distance between dhow quays and container terminals to be measured. When closely located, container ships and dhows could exchange cargo through an interface between those two different shipping norms. The question is thus to assess to what extent these networks are interconnected (Rodrigue, Comtois and Slack, 2009), how and in which kinds of port.

Finally, demonstrating the importance of dhow fleets and their connectivity with regular shipping lines may also contribute to improving UNCTAD’s shipping interconnectivity index, which currently excludes them from its scope (UNCTAD, 2019).

¹ Contrary to shipping lines, dhows do direct transports on-demand without any intermediate stopover (Lendjel and Abdillahi Ahmed, 2021). Thus, any couple of ports around the Arabian Peninsula can be interconnected by dhow trip. The dhow “network” (in the abstract meaning defined by Curien (2005) of a network) comprises here a set of 176 “nodes” and 30,800 (or 176×175) potential “links”. See also Dua (2017).

The article starts with a short survey of the existing literature (Section 2), and then presents its methodological framework in the following section. Tests for the complementarity/duality of the means of transport are presented in Section 4, and the level of inclusion of ports within cities is discussed in the next section. A discussion about interfacing shipping norms and the still on-going normalization process concludes the article (Section 6).

2. A Brief Survey of the Existing Literature

The literature about Dhows is quite scarce. Lendjel and Abdillahi Ahmed (2021) apart who aim at characterizing dhows activity from Djibouti port data, the most recent work on dhows is by Verne (2017) which takes an ethnographic approach to dhow trade between Zanzibar and Jakarta. As Verne's survey of the literature puts it, the existing literature on dhows is very poor and has not been updated to cover recent changes in dhow trades. For instance, one of the latest books on transport and logistics in East Africa (Abdillahi Ahmed *et al.*, 2015) does not mention the part played by dhows in this region.

Most of the literature is devoted to the sailing period of dhows in the Arabian/Persian Gulf and does not include their conversion to fossil fuel propulsion (Martin, 1979, 1980, 1982; Hawkins, 1981; Gilbert, 1997, 2002; Agius, 2005). Historical and ethnographic approaches dominate in the literature (Agius *et al.*, 2010; Sheriff, 2010; Verne, 2017; Bishara, 2017). The anthropological approach of dhows by Dua (2016; 2017; 2020) and Mathew (2016) is interesting to quote here because it explains how colonialism transforms “dhow economy in East Africa into an informal/illegal economy by the late nineteenth century” (Dua, 2017, p. 21). Dhows' “peddling” activity is thus rooted in their ability to bypass “bureaucratic” colonial norms so as to maintain the lowest costs in their struggle with steamship lines (Mathew, 2016). The last real studies on the economics of dhows date back to the 1960s (see Villiers, 1948; Talbot, 1962; Noble, 1963; McMaster, 1966; Hoyle, 1968), with Gilbert's book (2004) being an exception.

This scarcity is not surprising, considering the huge surge (and now domination) of containerized trade since the late 1970s that led to the much-diminished interest in dhow trade.

The literature (mainly written by geographers) on Dhow ports is also very rare (Talbot 1962; Hoyle, 1968; Walker, 1981; Dharmasena, 1987; Dua, 2017). This is probably due to the very low capital intensity ratio of their stevedoring companies. The containerization is also supposed to have fostered port polarization and route rationalization in ways detrimental to small coastal settlements (Fleming et Hayuth, 1994). Indeed, changes brought by containerisation are directly related to the capacity to attract and interconnect traffics from different shipping lines (intermediacy) and to the capacity to attract traffics based on hinterland capacity (centrality). But Gilbert (2002) already stressed that “dhows went to places that steamers could not go”, due to their low draught.² This constraint has persisted all the more so, given the growing size of feeder containerships. Jacobs and Hall (2007), following Hoyle and Charlier (1995), stressed the territorial embeddedness of Global Ports Operators as part of their competitiveness, the support to dhows being probably part of the strategic advantage sought by Dubai's Port Customs and Free Zone Corporation (DPCFZC)³.

²² The average depth in the Persian Gulf is 42m with several shallow areas (Cadène and Dumortier, 2011, p. 13).

³ See also Akhavan (2017) on the role of Dubai Creek, where dhows are located, in the port development.

Martin (1982) provides a rare study on the actual movement of goods carried by sailing dhows in the Indian Ocean in the 1970s. He also describes lots of other aspects of the dhow economy (main ports, handling, boatyards, etc.). He also depicts their decline through the impacts of the container revolution in Oman (Martin, 1980), followed by Mumbai (Dharmasena, 1987) and Colombo (Agius et al., 2010), with Agius et al. stating that wooden dhows are not built anymore, so that traditional boatyards only carry out maintenance and repair work of the remaining, ageing dhows.

If the economics literature about dhows is outdated, several aspects of their economy are shared with other well-known shipping industry segments. Regarding the focus of this article, network economics and particularly hub and spoke networks with feeder vessels are already well known (Fagerholt, 2004; Stopford, 2009; Song and Panayides, 2015). In particular, the connectivity between domestic and international shipping networks has been studied by UNCTAD (2017 and 2019) using a liner shipping connectivity index. But the latter excludes dhows from its scope (see also Nierat and Guerrero, 2019). However, the “time factor” (Notteboom, 2006) is probably useful to understanding the survival of dhows in the region, but also their ability nowadays to bypass strict ISPS processes and norms in modern ports (Mathew, 2016; Dua, 2017). Indeed, any additional port of call in the feeder ship of a regular line adds costs and loss of time (Guy and Urli, 2006 ; Wiegmans et al., 2008; Ducruet and Notteboom, 2015). The competitiveness of dhows is thus dependent on such trade-offs made by big shipping lines that allow dhows – or not – to sail through the mesh of container transport.

Finally, dual transport systems are addressed by development economics such as in Starkey’s World Bank paper about “intermediate means of transport”, or by geographers stressing the development of “two-tier transport systems” in Africa (Godard, 2002; Mareï and Ninot, 2018) and the unknown but necessary role played by informal/artisanal transports in Global South countries supply chains (Mareï and Savy, 2021).

3. Methodology

Data on dhows are missing or difficult to get in most ports. In the absence of official statistics, a close examination of satellite pictures provided by Google Earth makes it possible to get a rough estimate of dhows’ activity around the Arabian Peninsula. Indeed, dhows have characteristics that make their identification possible: an ogival-shaped hull, within a size range of 15m to 55m, a superstructure at the stern of the boat, and the shape of their clustering. For this study, we were therefore able to count and sort them by size class. The classification used includes six classes: very small (< 15m), small (15-20m), medium (20-25m), big (25-40m), very big (40-50m or more) and long boats (40-50m boats that are long but narrower than typical dhows). In order to avoid any confusion between fisher and cargo dhows, we set an arbitrary 20m long threshold value under which dhows are not counted. Long dhows have been included in the census because of their presence in clusters of dhows, even if their shape does not match the usual dhow shape.

Thanks to several interviews made in Djibouti (March 2019) and in the UAE (December 2019), and to previous literature, we were also able to associate each size class to an average tonnage (200 tonnes (t) for small dhows, 300t for medium dhows, 600t for big dhows, 1,000t for long dhows and 1,200t for very big dhows) to provide an initial assessment of dhows’ transport capacity in each country. Indeed, medium dhows usually have the equivalent “capacity of 16 to

18 trucks”, i.e. 300-400 tonnes, according to Said (a dhow shipping agent interviewed in Djibouti). But the largest seen at Sharjah reached a payload of “110 containers or 2,200 tons”, according to a shipping agent interviewed there (UAE, in December 2019). Djibouti port data in 2017 confirm this order of magnitude (DPFZA, 2017; Lendjel and Abdillahi Ahmed, 2021).

This data collection method implies a careful scrutiny of thousands of kilometres of coastline and even of rivers, and would have required much more time if ports and jetties did not have very identifiable characteristics shapes.

Regarding examination of the connectivity of dhow networks, this technique is also helpful to check the presence of a container terminal in the vicinity, which is also a clue to the interconnectivity of these different networks (Rodrigue, Comtois, Slack, 2009). Given the site specificity of a network node (Williamson, 1985; Glachant, 2002) and thus its cost of land, the spatial proximity between a dhow port and a container terminal can't but be a clue of their willingness to interconnect. Hence, their GPS coordinates were also recorded in order to assess the distance between dhow ports and their proximity to container terminals. The classification of interconnections used here includes five classes:

- 1) the “shipping interconnection”, where the dhow port is closely located to the shipping line terminal;
- 2) the “market interconnection”, where the dhow port supplies large cities;
- 3) the “local market interconnection”, where the dhow port is located inside a shore community to supply it;
- 4) the "coastal interconnection", where the dhow port is near a shore community to supply it;
- 5) the "supply service for dhows", where the dhow port is near or inside a shipyard or a fuel station.

When a dhow port such as Sharjah port (UAE) meets two criteria such as “shipping interconnection” and “market interconnection”, preference is given to the former in order to highlight transport network interconnections.

But this satellite photo-based identification technique has several limits. Blurred pictures may mislead the identification process of dhows. Moreover, Google Earth satellite pictures are based on heterogeneous sources (NASA, ESA, CNES, etc.) without an exact coherence for dates: pictures always bear the year of the copyright, but not their exact date. Additionally, the number of dhows may be dependent on waiting time in port, or on non-working days, and lead to an incorrect appreciation of the importance of a port in dhows network. These data must therefore be considered as an approximate reality and need to be handled carefully.

Only a limited number of countries is included in the perimeter of this study. Six of them are around the Arabian Peninsula and the Persian Gulf and have been fully surveyed. An additional five have been incompletely surveyed to give a clue of the extent of the dhow network (see Table 1 and Figure 1). But dhows can be spotted in many other countries from India to Kenya.

Table 1: Perimeter of the data in 2019

<i>Country</i>	<i>Status</i>	<i>Cities</i>	<i>Identified Ports</i>
Bahrein	Complete	2	2
Iran	Complete	38	93

Kuwait	Complete	2	2
Oman	Complete	19	24
UAE	Complete	4	19
Yemen	Complete	10	22
Djibouti	Incomplete	1	2
Iraq	Incomplete	1	1
Pakistan	Incomplete	2	4
Qatar	Incomplete	2	3
Somalia	Incomplete	2	4
Total		83	176

Note that while dhows sail in the Persian Gulf, Arabian Sea and Indian Ocean, other seas host similar maritime activity. In Indonesia, dhow's cousin is called the *pinisi*. Like dhows, pinisis traded sail for diesel engines while retaining their wooden hull and island traffic. Following the same method using Google Earth on the island of Java alone, 39 pinisis were spotted in March 2020 in Jakarta, in the old Batavia harbor of Sunda Kalapa, and 20 in Semarang (Central Java). On Sulawesi, another important island in Indonesia, 23 pinisis have been identified in Makassar, in Paotere Harbor. These partial observations testify to a perennial inter-island maritime traffic, resisting the domination of containerized traffic. Indonesia protects its maritime industry and only allows the transport of goods or passengers on ships flying the Indonesian flag. This institutional environment and the ten thousand islands to be served preserve the traditional maritime transport by pinisis while in the Far East, transport by junks (or “min-ch’uan”, according to K. Teizo, in Watson, 1972) has completely disappeared (Van Tilburg, 2007; Van Dyke, 2011).

Although limited, several interviews of dhow crews in Dubai and Sharjah in December 2019 confirmed the relevance of this perimeter, and the importance of Iran and Yemen among the main dhow trade destinations. We have identified 176 dhow “port”⁴ locations (including 162 with dhows longer than 20m) in 83 cities (including 75 for dhows longer than 20m), across six countries. An additional eight cities from incomplete surveys for five countries are included.

Furthermore, thirty semi-structured interviews were conducted in Djibouti (March 2019), in Dubai and in Sharjah (December 2019) with port authorities, custom officers, managers of docking companies, shippers, shipowners, shipping agents and crew members, in order to obtain more qualitative insights about this activity.

Finally, connections with container line networks have been identified through: i) the distance between dhows quays and container terminals, this distance being the index of the degree of site specificity of the terminal for dhows; ii) the distance between dhows quays and cities; and iii) the configuration of CMA-CGM’s regional services in 2018, considered as a representative sample of liner shipping in the region. These data were collected during 2018-2019.

4. The Connectivity between Standardized and Local Networks

⁴ The dhow « port » may sometimes be a mere jetty in a bay.

The data collected allows an initial appraisal to be made of the importance of dhows in the region. Overall, we identified 4,301 dhows of 20m long and more in the survey. Two thirds of them are medium-size dhows and one in three is large or very large (Table 2).

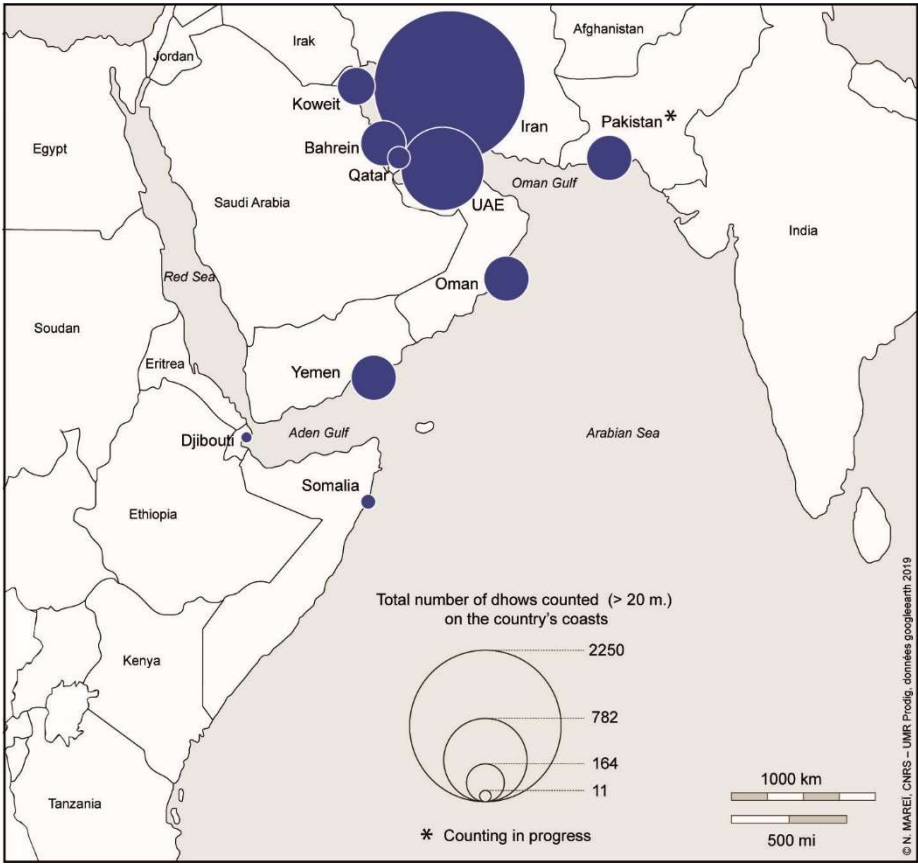
Table 2: The distribution of dhows per size class

Size of dhows	Quantity of dhows	% of total	Estimated capacity (in tons)	% of total tons	Cumulated % of tons
Medium (20-25m)	2,929	68,1%	878,700	48,7%	48,7%
Big (>25m)	1,187	27,6%	712,200	39,5%	88,1%
Very big (>40m)	147	3,4%	176,400	9,8%	97,9%
Long (>40m)	38	0,9%	38,000	2,1%	100,0%
Total	4,301	100,0%	1 805,300	100,0%	

Distribution of dhows per country and city

Dhows are spread in many cities around the Persian Gulf, the Indian Ocean and the Red Sea, even in the Arvand Roud/Shatt al-Arab delta along the Iran-Iraq border, thus proving their ability to interconnect many destinations (Figure 1).

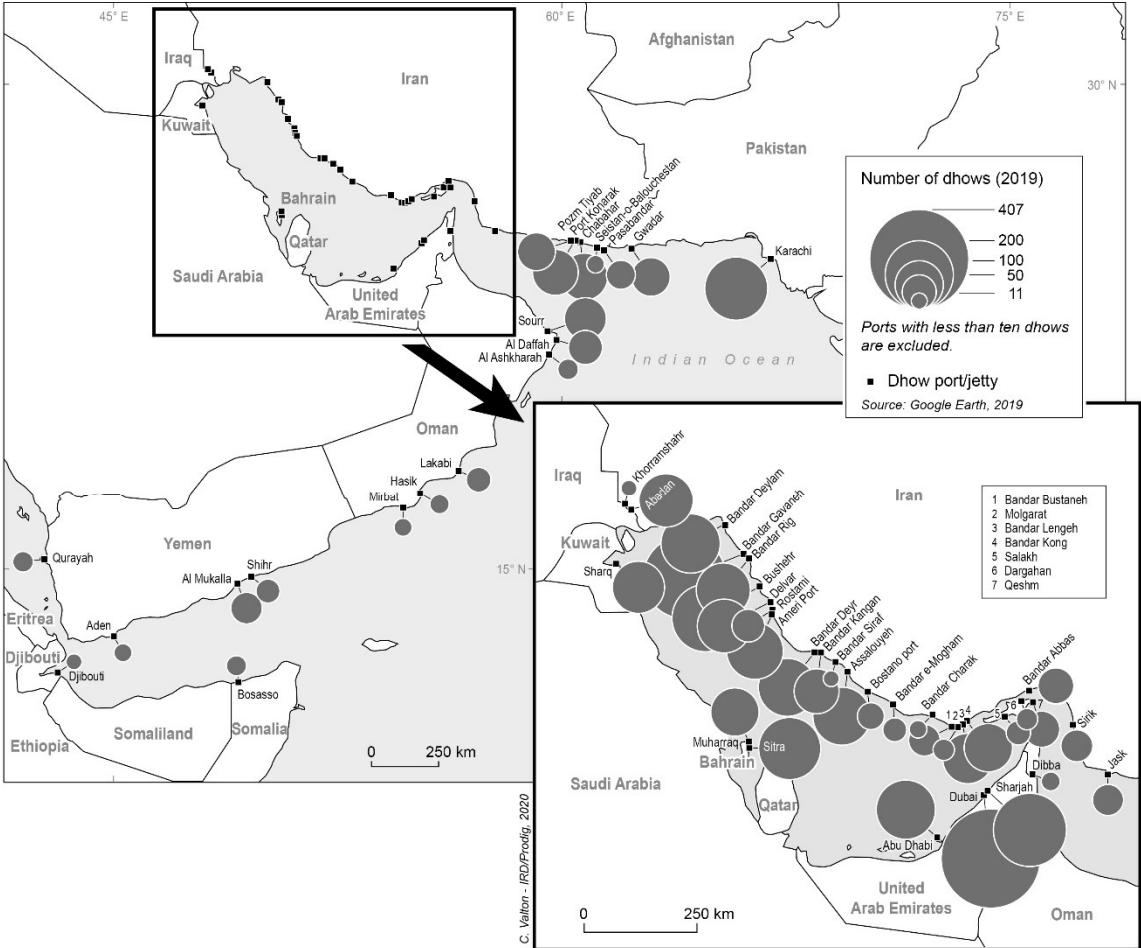
Figure 1: The distribution of dhows around the Arabian Peninsula and the Persian Gulf



With 407 dhows, Dubai appears to be the centre of gravity of the overall dhow network (see Figure 2). This can only result from a supportive policy from DPCFZC. Indeed, port operators considering their degree of embeddedness in efficient supply chain as key of their competitive

strategic advantage (Jacobs and Hall, 2007), dhows increase available supply chain options in Dubai, increasing Dubai's competitive advantage. But the UAE is not the country with the most dhows. We counted three times more dhows in Iran than in the UAE. Ten Iranian ports each shelter more than 100 dhows. And if dhows are often clustered, this is also true for the largest dhows, because almost two in three very large dhows are clustered in three cities (Sharjah, UEA; Bushehr, Iran; Al Mukalla, Yemen). Only one out of six dhow ports hosts very large dhows.

Figure 2: Dhows in cities



Thus, while Dubai may be considered as the hub for dhow transport, due to its proximity with the main point of trade in the region, Iran – probably along with the Pakistan – is by far the leader regarding dhow activity in the whole region (see Figure 2). All the interviews of Iranian dhows seafarers conducted at the Dubai Dhow Wharfage in December 2019 confirmed that Iranian ports were their sole destinations. Many port-cities in the region seem to play a part in the dhow trade. According to the Djiboutian maritime agent interviewed, Aden is the barycentre for dhows in the Gulf of Aden. However, satellite pictures show Al Mukalla to be a bigger Yemeni port (42 dhows) than Aden (14 dhows spotted in 2019). Other places, such as Bandar Ganaveh (Iran) with its 284 dhows, Sharjah (UEA, 222 dhows), Bushehr (Iran, 189 dhows) or Karachi (Pakistan, 165 dhows in one of its ports) seem to play a bigger role. Interviews of dhow crew members in Sharjah in December 2019 confirmed though that Yemeni ports were the main destinations of their dhows. Discrepancies between interviews and satellite pictures may be

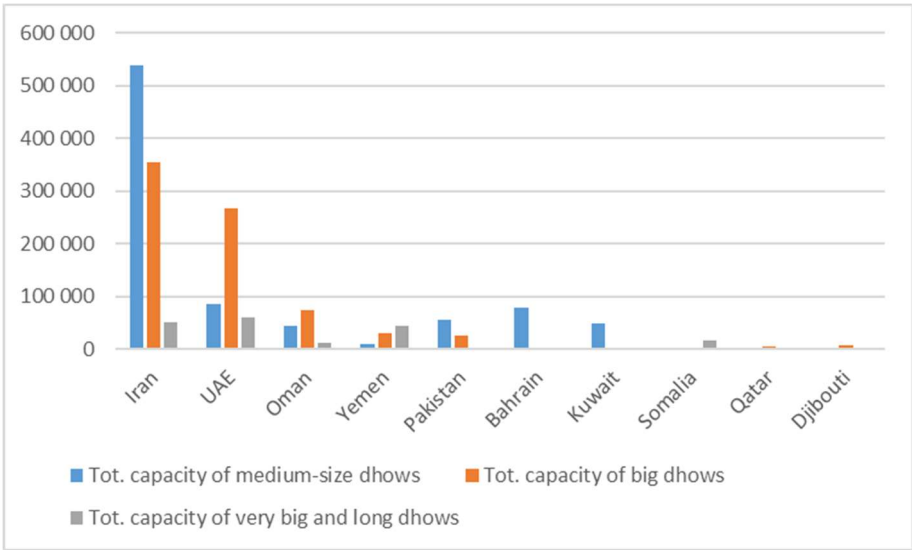
explained by structural trade imbalances, with lots of waiting dhows in export ports such as Dubai and Sharjah, and few waiting dhows in import ports such as Yemeni ports.

In any case, the distribution of dhows all around the Arabian Peninsula proves their ability to interconnect many destinations.

Dhows’ transport capacity and productivity

The distribution of dhow transport capacity per country confirms the importance of dhow trade in Iran and the UAE, but this capacity is not similarly distributed (Figure 3). The biggest dhows call at the UAE, Iran and Yemen, composing a narrower network than the small and medium sized dhows' one.

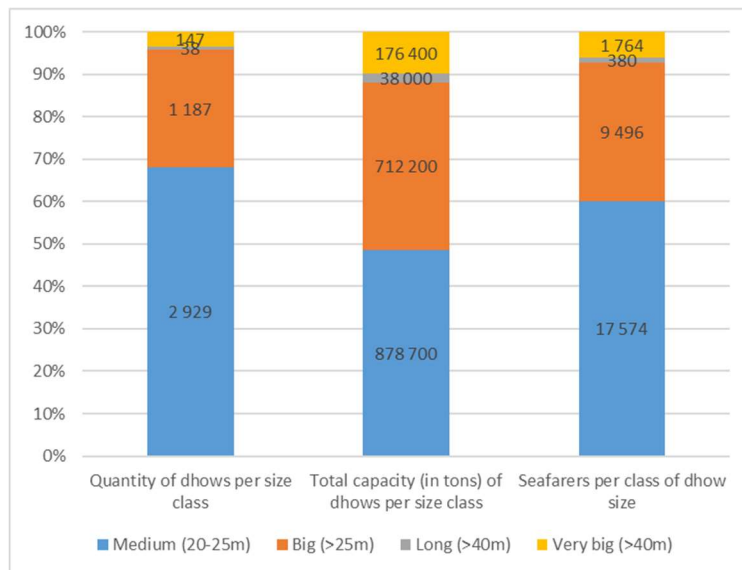
Figure 3: The distribution of dhows’ transport capacity (in tonnes) per size and per country



To provide an indication of the importance of dhows’ transport capacity, a comparison was made with the total transport capacity of CMA-CGM services (in DWT) for the countries within the perimeter of this study. As expected, despite there being 135 times as many dhows compared to CMA-CGM containerhips, the dhows’ total capacity only approximately matches the capacity of this major container line operator in the region (2 million tonnes (mt) for CMA-CGM in the region,⁵ compared to 1.8mt for dhows; see Figure 4). The role of dhows is thus not as anecdotal as one might expect.

Figure 4 : Dhow fleet characteristics

⁵ This order of magnitude was confirmed in an interview made in December 2019 in Dubai with CMA-CGM’s business development and intermodal manager at his Dubai regional office.



Of course, the true measure of transport capacity is not static but dynamic. Unfortunately, while CMA-CGM communicates about the duration of its different services to allow computation of their dynamic transport capacity per year, similar data cannot be found for dhows. Besides, the tramping character of dhow transport involves lots of waiting time that is difficult to assess. A dhow we visited in Djibouti in March 2019 had waited 20 days to get a cargo, and according to its shipping agent, waiting time may last up to two months. Regrettably, Djibouti's port data do not provide dhows' average waiting time (DPFZA, 2017). Similarly, interviews made in the UAE in December 2019 confirmed important waiting times, that were longer for small Iranian dhows (20-25 days) than for large Indian or Pakistani dhows (10-15 days). Handling times are much more important for dhows than for containers ships, due to the low capital intensity of dhows handling services. If big dhows are loaded/unloaded with one 25-40 tons mobile crane (sometimes with the help of their own crane and/or hoist) and a six-docker team so as to reduce loading time, medium and small dhows are only handled manually. Google Street View pictures of Port Khalid in Sharjah (UAE) in March 2015 show that only one in twenty large dhows was loading without any crane, while the exact opposite prevails for small and medium-sized dhows. But lots of dhows also wait for the access to port facilities, given the limited number of cranes and quays available. Two thirds of the 137 dhows spotted by Google Street View in Port Khalid in March 2015 were simply waiting for access to facilities. Compared with the two days average stay of a container ship, we can easily deduce⁶ that CMA-CGM dynamic transport capacity in the region is much bigger than the entire fleet of dhows around the Arabian Peninsula.⁷

If waiting time cannot but lower capital productivity, labour productivity is also quite low. Using several assumptions about the composition of dhow crews, we also estimated the number of seafarers for both activities. Whereas a container ship crew has 20 seafarers (Stopford, 2009, p. 228), the smallest dhow needs only 6 seamen and the biggest 15.⁸ Thus, it may be estimated that there are 30,000 seafarers on board dhows in the region, compared to only 700 on the

⁶ If a 40,000 DWT feeder container ship has twenty times the static capacity of the largest 2,000 DWT dhow, it also stays at least six times less in port than the dhow. Together, these numbers give a dynamic capacity of transport 120 times greater for the feeder container ship.

⁷ Container ships are also likely to sail faster than dhows, thus widening the gap with dhows' dynamic transport capacity.

⁸ An interesting aspect of ICC-IMB reports are their factual aspects regarding crew and the location of the hacking of the ship. In this respect, the hijacked dhows in 2017 both had a 13-14 members crew (ICC-IMB, 2019).

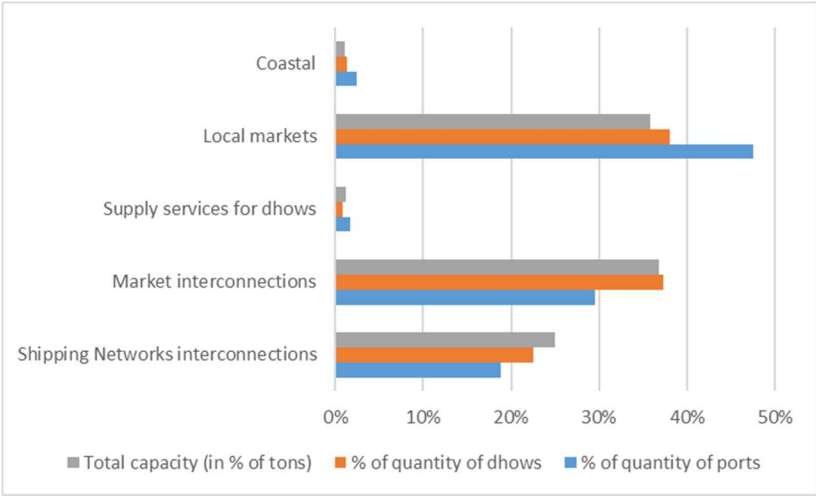
CMA-CGM's regional fleet. Dhow transport is approximately 43 times more labour intensive than container transport, which implies a greater social visibility of dhow seafarers. But, with an almost similar static transport capacity, the potential level of labour productivity of a dhow seafarer is thus 43 times lower than his colleague on board a container ship... Of course, dhow shipping is far less capital intensive than any container transport.

Shipping network interconnections

Overall, interconnected dhow ports with other shipping networks display relatively more capacity with “large dhows” and “very large dhows”, than hinterland ports connected with local markets (see Figure 5).

As expected, no dhow was spotted inside any modern container terminal within the perimeter of the data here. Nevertheless, dhow quays are sometimes located in the vicinity of container⁹ and/or multipurpose terminals, and are thus likely to be interconnected with container shipping lines. Out of the 86 cities studied, only eight have a modern dedicated container terminal in the vicinity of a dhow port. Adding multipurpose ports, one in five dhow quays is connected with shipping networks (either container lines or general cargo lines; see Figure 6). But in some countries, like Oman, the dhow network seems deprived of any connection with a main container terminal (Sohar, in Oman): indeed, there were no dhows in any port, all along the 200 km coastline (or 311 km by road) between Fujairah to Muscat (Sohar being located in the middle).

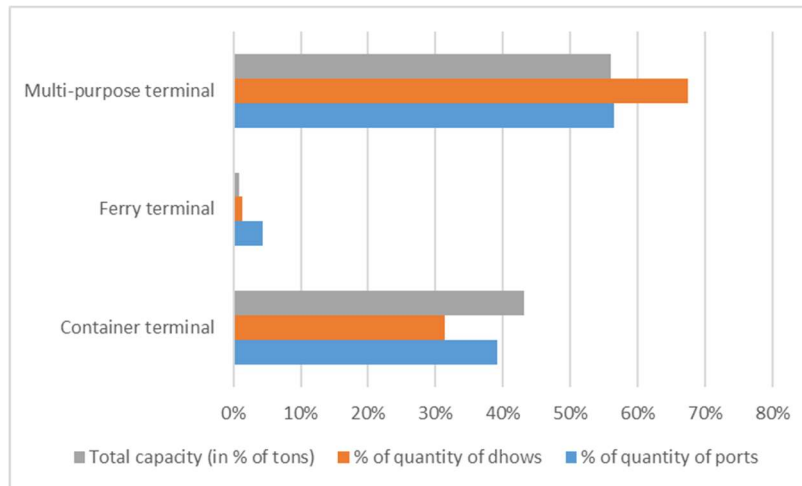
Figure 5 : Vicinities of dhow ports: index of dhows’ interconnection activities



When a container terminal is in the vicinity of a dhow ports, dhows have on average a larger capacity than those mooring in the vicinity of other kind of terminals (Figure 6). In other words, scale economies of container ships have a positive effect on the size of dhows spotted in their vicinity, in this way proving the existence of interconnections between these networks. But the distance from dhow quays to modern container terminals is on average 21 km (direct), except for Bushehr (Iran) and Raysut (Oman), where dhows were mooring inside the terminal.

Figure 6: Shipping network interconnections with dhow ports

⁹ A “container terminal” here means a terminal dedicated to the sole handling of containers by mono-purpose gantry cranes.



Hence, the dhow network clearly seems distinct from the container network and cannot be considered as an immediate feeder component of container lines. Commodities have to be processed through a logistics system to pass from the container network to the dhow network and conversely, involving at least one road haulage leg (see Picture 4).

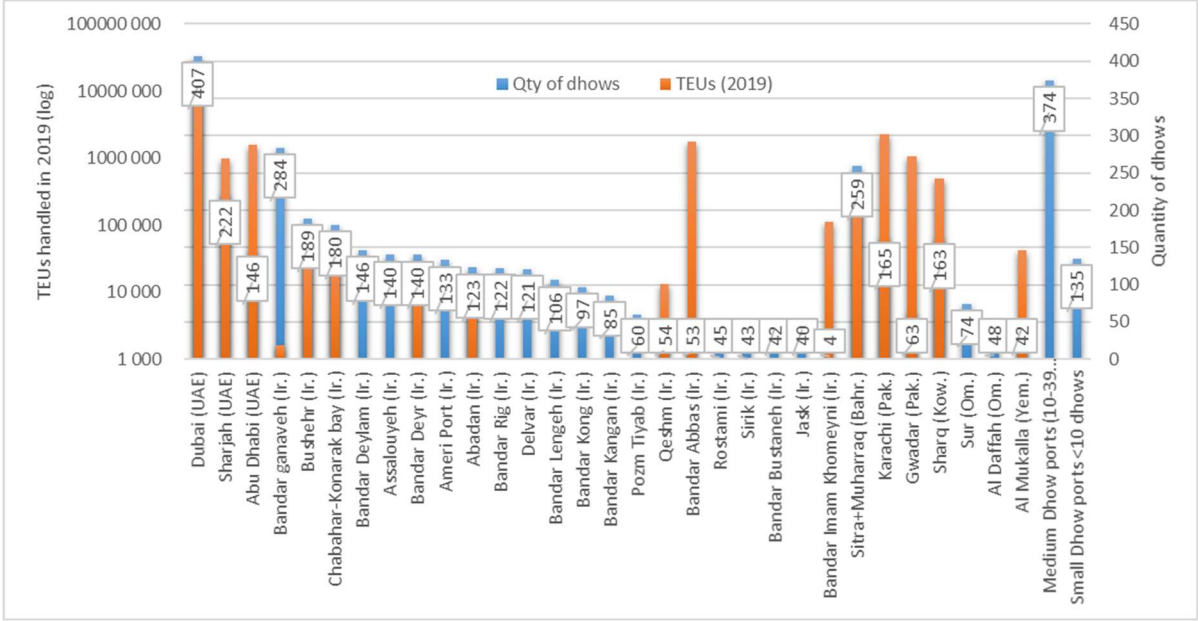
Picture 4: Transshipment of cargo from a container into a large Indian dhow (Sharjah, 2019)



Indeed, even though dhows and containerships are interconnected, they usually moor at different quays: dhows are (mostly) manually handled in the oldest parts of ports embedded in cities, whereas modern handling terminals are distant from cities. The two systems have different levels of handling capital intensity: a 40-tonne mobile crane may be used at best for handling large dhows (see Picture 4), but more frequently only docker teams of half-dozen carry cargoes on their back, in contrast to gantry cranes and straddle-carriers on secured dedicated quays for container ships. The administrative processes differ too (complicated and digitized for containers, paper-based procedure for dhows), as are security norms (ISPS norms for container terminals, open access for dhow quays). This is for instance the case in Dubai where the “dhow wharfage” is located in the vicinity of the city’s traditional markets, in the very city centre. By contrast, Jebel Ali, the container terminal, is on the periphery of the city. As Mohamed – a dhow shipowner – said in our interview in March 2019 in Djibouti, “dhows do not work at container terminals; they work where there are no container terminals, where container ships cannot come”.

But interconnections in the shipping industry are not limited solely to container terminals. Dhow quays are sometimes located in the vicinity of the multi-purpose and/or ferry terminals (Figure 6). In this case, the distance from the dhow quay to the multi-purpose terminal is on average 3km (direct), because some of them are located inside a multi-purpose port (seven dhow ports). Being closer than container terminals, multi-purpose terminals seem thus to play an important role for dhow trade. Interestingly, most of dhows' biggest ports (Bandar Ganaveh excepted) are also handling containers (Figure 7), even without any dedicated container terminal in their vicinity.

Figure 7: Dhows and TEUs handled in main dhow ports in 2019¹⁰



Market interconnections

If interconnections with the other shipping networks play a significant role in the dhow economy, servicing local markets and big market places remain their most important role, through interconnections. Together, three quarters of dhow ports are connected with market places. Dhows supply mostly local markets (almost half of the dhow ports) with small-sized boats (one third of the total transport capacity in tonnes: see Figure 5). As Agius (2005) has stressed, “for the Arabian Gulf and Oman, seaborne trade was of prime importance for the survival of its coastal communities” (Agius, 2005, p. 116). And logically, big market places (three in ten dhow ports) such as Dubai are serviced with larger dhows (37% of their total capacity). Hence, the importance of Dubai for the dhow trade comes probably more from its role as dominant market place in the region than from its hub role for container shipping lines.

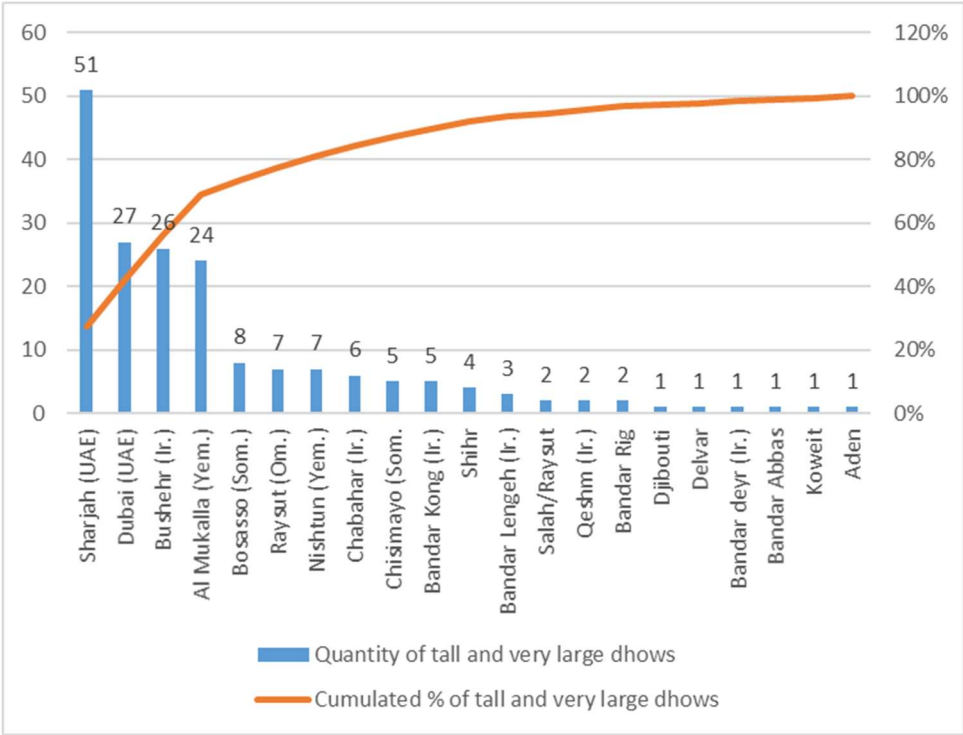
Thus, the dhow network can itself be split into two “sub-networks”: the first one dedicated to big market places and to shipping interconnections; the other one dedicated to local markets. This was confirmed by Said, a shipping agent specialised in the dhow market interviewed in Djibouti (Lendjel and Abdillahi Ahmed, 2021). He provided the example of a “large 1,400-

¹⁰ Source: 2019 Port Data compiled by the authors.

tonne dhow carrying Indian sugar from Mumbai to Djibouti once a year” for the former, and a “loop trade between Aden (Yemen) and Berbera (Somaliland) or Djibouti for the Charchari¹¹ women” for the latter.

These sub-networks do not share the same perimeter of sailing. Thanks to their size, “only very large dhows can cross the Indian Ocean to Pakistan or India during the dhow season (7 months a year due to the wind and bad weather);¹² the others are limited to coastal shipping in the Persian Gulf, the Gulf of Aden and the Red Sea” said Mohamed, the dhow shipowner interviewed. As seen in Figure 8, 20 ports host long and very large dhows, and only three of them harbour two thirds of these dhows.

Figure 8: Quantity and cumulated % of long and very large dhows per city



Sharjah (UAE), Bushehr (Iran) and Al Mukalla (Yemen) are ports in a kind of triangular trade conducted by biggest dhows around the Arabian Peninsula.¹³ The distance factor is likely to explain the use of these biggest dhows thanks to scale economies generated by the taper effect of fixed costs with the distance (Prentice and Prokopp, 2016, p. 74). Conversely, small and medium-sized dhows are widespread in all ports, probably for shorter routes, as already noted by Agius for trade in the Persian Gulf (Agius, 2005, p. 120). These sub-networks were confirmed by several interviews with Iranian, Pakistani and Indian crews conducted in Dubai and Sharjah in December 2019.

For coastal populations, short-sea shipping is a convenient way for being supplied. But the level of economic development and of highway connections also matter, because the more the value of time increases at this level, the more the road haulage is chosen to the detriment of short-sea

¹¹ “Charchari” is the Somali word for merchant. <http://www.djibnet.com/mabraze/topic/8918-les-charcharis-djiboutiennes/>
¹² See Agius, 2005, Chapter 10; McMaster, 1996.
¹³ Google Street Views of Sharjah port display 50 very large dhows in March 2015, i.e. one in three dhows. This number confirms the permanent, prominent role of Sharjah’s Port Khalid in the shipping economy of large dhows.

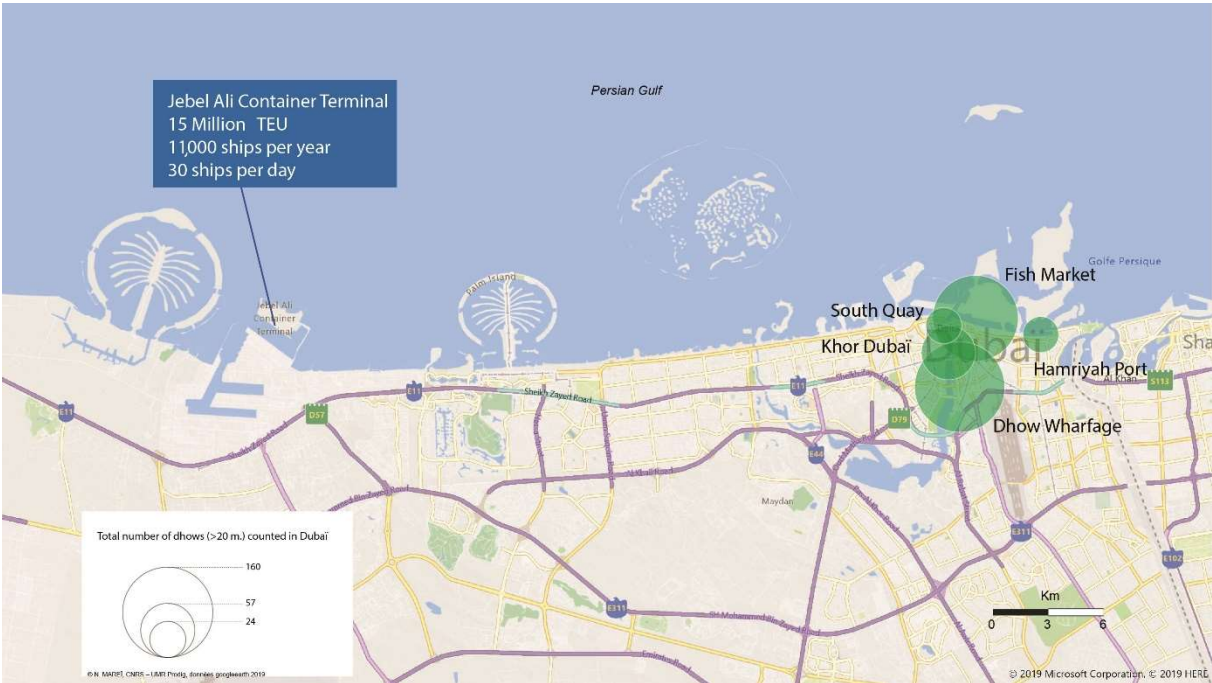
shipping (Bergantino and Bolis, 2008). In the case of Oman, we have already pointed out that we observed no dhows in any port from Fujairah to Mascat, all along the 200 km coastline. Yet this area is precisely the most populated part of the country, Salalah excepted. Likewise, in Iran, most of the population is located inside the country and not along the coast. In other words, dhows are supplying markets of small (and poor?), isolated coastal communities.

5. Level of Inclusion of Dhow Ports in Cities

Port embeddedness and port proximity to traditional markets are also likely to explain partially the survival of dhow trade. As mentioned earlier, dhow quays are not located inside container terminals but close to market places. Indeed, half of dhow quays are embedded in cities, in old port areas that host non-standardized traditional activities, while new port areas have left the cities for the sake of space and do not deal with dhows because of ISPS norms. No fences prohibit the access to dhows in most ports. The high labour intensity of dhow activity is also part of this proximity.

Dubai Creek dhow wharfage (Picture 3) provides a good example of this embeddedness. As can be seen on the map (Figure 9), 407 dhows were located along five different quays of the Khor Dubai channel, while Jebel Ali container terminal is 40 km away (as the crow flies). Only the biggest dhows moor in the Palm Deira facilities, a fenced area managed by Dubai Customs whose access is probably restricted for the safer use of mobile cranes than for the sake of security.¹⁴ Seamen access freely the city from the Dubai Creek facilities, giving social visibility to this trade. Furthermore, people can wander along the dhow wharfage and easily talk to seamen.

Figure 9: Map of dhows’ localization in Dubai



Dhow trade appears here as a very simple and convenient way to do business. Its very proximity with markets reduces transaction costs, shippers’ waiting time and their organizational costs. A

¹⁴ Security is also a constant concern for Dubai Customs, with many cameras spread along the port area.

Somali shipper of cars interviewed in December 2019 in Sharjah (UAE), in front of his dhow, was able to monitor easily the conditions for loading his shipment. The clustering of dhows diminishes the search costs for brokers, shipping agents and freight forwarders. It even probably diminishes the number of brokers and intermediates involved in the standardized process of container transport. Available dhows waiting in a cluster help to maintain the lowest price of transport for the shipper.

The map highlights the existence of a two-tier maritime transport system (Mareï and Ninot, 2018) with an old capillary distribution network with nodes embedded in cities on the one hand, and interconnected, containerized paralleled networks outside cities, on the other. Hence, dhow transport is likely to be a low cost process compared to containerized transport. But it is too soon to assert such a hypothesis and a closer inquiry needs to be done beforehand.

6. Concluding Discussion

As shown previously, the transport capacity of the dhow fleet matches that of CMA-CGM's regional services around the Arabian Peninsula and the Persian Gulf. Moreover, a quarter of the total dhow transport capacity is assured by dhows calling in the vicinity of container terminals. Indeed, data reveal a size effect with larger dhows mooring in the vicinity of container terminals and other shipping networks. Thus, a statistical link exists between dhows' location and container facilities, proving the existence of interconnections between both networks, particularly in places such as the UAE or Djibouti, where almost nothing is produced locally. This link and its order of magnitude are likely to shift the level of UNCTAD's shipping interconnectivity index in some countries, such as the UAE.

But a Google Street View of Port Khalid dhow wharfage in Sharjah (large dhows' most important port located at 500 meters from the container terminal) reveals interesting data about interconnections with other shipping lines. While no container can be seen in the vicinity of any dhow, three 40-foot containers are waiting in front of the sole modern cargo ship mooring between two dhows. Thus, dhow cargoes are supplied loose by trucks on open trailers and piled up on the quayside waiting to be loaded. Only two tank containers were spotted on a large Indian dhow registered with the Indian Shipping Directorate. The quasi-absence of any containers carried by dhows – and thus of any trans-shipment – confirms that those networks are not directly connected. Even closely located, dhows clearly do not belong to containerized transport networks. Dhows and containerized shipping lines are parts of a two-tier system with low-cost dhows providing artisan services on one the one hand, and high level, standardized modern shipping lines operating on the other hand. But the same goods are carried in both networks. Goods carried by containers are probably unpacked in Emirati warehouses – or sometimes directly on the dhow wharfage, as we observed first hand in December 2019 – so as to be shipped by dhows to shore cities. Indeed, in this two-tier transport network, shippers' demands can be distributed either between different destinations or between different shippers' cost and time expectations. Three dhows out of four call at ports without any container terminal in their vicinity to supply markets. The complementarity of dhow networks with container shipping probably therefore contributes to the economic survival of dhows.

Given the distribution of dhows in the Persian Gulf, especially in Iran, it may also well be asked whether US-led sanctions against trade with Iran are not also a cause for their economic survival (Cadène and Dumortier, 2011, p. 19). Indeed, lots of dhows are mooring in, or in the vicinity

of cities along the Iranian coast. But with 75 million inhabitants, Iran is not a small country, and important cities are located on the coast (ibid, pp. 108-111). Their volumes of demand and their proximity with Dubai's large markets are large enough to generate important short-sea shipping across the Persian gulf – even without US sanctions. Likewise, around the Arabian Peninsula, a major container operator such as CMA-CGM sometimes no longer serves Yemeni ports for security reasons. Ms Abdourahman Cher, the commercial General Manager of the Doraleh multi-purpose port in Djibouti, stated in an interview we had in March 2019 that “shippers use dhows to send their shipment to Yemen instead of container ships through [the] Al Hudaydah terminal”. Hence, “small is probably beautiful” to avoid war risks, and to minimize the consequences of potential cargo losses for shippers¹⁵.

Additionally, two dhow sub-networks have been highlighted with smaller dhows supplying local markets for one network and bigger dhows interconnecting shipping networks and large markets for the other. Thus, a two-tier sub-system exists within the dhow network, itself part of the dhow and container shipping two-tier system.

Like for every two-tier system, the comparison of dhows with container ships also sheds light on what is really paid for when using containerized transport: i.e. the cost required for *normalized* transport in all its aspects. The addition of all costs (transport costs, transaction costs and bureaucratic costs) has not been made here, but one can easily imagine the pros and cons of dhow trade compared to standardized transport of containers. It is an essential element in maintaining artisanal or small-scale transport all around the world. From a sociological standpoint, this may also contribute to understanding the role of ports as (de-)normalization interfaces for social acceptance and for the spread of cargo through local norms.

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¹⁵ Mathew (2016) raises an interesting point in his history of dhows: “*Nākhudās* tended not to specialize in a commodity or invest in economies of scale; rather, they carried diverse cargoes including passengers and contraband on every trip. The larger merchants who backed *nākhudās* generally spread their capital among many different vessels and cargoes, [...] risks were mitigated by a diversified commercial portfolio, backstopped by a broad personal network” (p. 31).

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