The Silk Alliance: Experience and Initial Lessons from a Green Shipping Corridor Cluster

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1. INTRODUCTION

The shipping industry is in a crucial historical moment where another energy transition is going to shape the industry as we know it today. The drivers and challenges are different from previous energy transitions; however, the long-term system change may happen similarly as it has been observed in the past; starting from niche markets until their expansion merges and substitute with the current regime. There is still uncertainty around the shipping energy transition pathway due to future technology developments, policy, and macro trends that could influence the way the maritime industry could evolve. Moreover, upcoming years could see important changes at IMO with the revision of the GHG strategy potentially aiming for full decarbonisation by 2050, and key conversation around the inclusion of fuel standards, LCA, and carbon tax. Inevitably all of this will give another important signal to the industry.

Despite these uncertainties, there is an increasing urgency in acting now and mitigating climate risks. The focus is on an actionable plan that can drive the implementation of decarbonisation solutions, therefore, the attention is going on 'First movers'. Stemming from the Clydebank Declaration at COP26 in November 2021[1], Green corridors are now most commonly defined as "a shipping route on which the technological, economic, and regulatory feasibility of the operation of zero emissions ships is catalysed through public and private actions" [2]. Green corridors can therefore be seen as niche markets where first movers can create protected spaces that allow the experimentation with the co-evolution of technology, user practices, and regulatory structures for zero emissions ships. The United States and Norway organized the Green Shipping Challenge for COP27 where countries, ports, and companies made more than 40 major announcements on issues such as innovations for ships, expansion in low- or zero-emission fuels, and policies to help promote the uptake of next-generation vessels [3]. Almost 50% of the announcements included the concept of 'green shipping corridor'.

The Silk alliance, established by LR Maritime Decarbonisation Hub (LR MDH), is an initiative of 12 leading cross-supply chain stakeholders to develop a fleet fuel transition strategy that can enable the establishment of a highly scalable green corridor cluster. This paper will briefly describe the underlined approach used e.g. the First mover Framework [4], and it will focus on the experience gained, and the initial lessons learned during the first phase of this initiative. We hope that by sharing this information we encourage greater transparency around green corridor initiatives which would provide direction to learning processes, attract attention, facilitate interactions, and legitimate continuing nurturing for such type of initiative.

2. AN ALLIANCE FOR A GREEN SHIPPING CORRIDOR CLUSTER

2.1 INTERPRETING THE DEFINITIONS OF GREEN SHIPPING CORRIDORS

The concept of "Green shipping corridors" has first been put forward in [2] and since then has been subject to different interpretations leading to different definitions and approaches [5, 6]. Today there are more than ten green shipping corridors initiatives that can be categorised in different ways, whether it be the focus on specific fuel/technologies or the type of ship, the number of ports involved as well as the role they should have within the energy transition. Despite the different definitions of green corridors, we think that the building block of a green corridor initiative should be:

a) participants should cover the entire supply chain involving private and public organisations,
b) their role is to spur early and rapid adoption of fuels and technologies in a way that enables the 'spillover' effect supporting the sector-wide decarbonisation

Fundamentally a green shipping corridor is a way to incentive stakeholders to come together and act as 'first movers' on a specific maritime application to start the energy transition. The most important factor is that there is a concentration of enough demand for new fuels in a relatively small number of ports so that the inland fuel supply infrastructure can be put in place to serve this demand. The terms 'corridor' and 'route-based' can often be a limiting factor because first movers can act at a regional level, as we demonstrate in the case of the Silk Alliance. We use the term "green shipping corridor cluster" to highlight the regional scope of this initiative which can involve

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one or several ports as long as the regional activity captures sufficient fuel demand. Given the international nature of the shipping sector, and "point-2-point" routes or a "route-based" focus are unlikely or very difficult to capture the aggregated demand and required scale to unlock investments in the necessary fuel supply and distribution infrastructure. The "green shipping corridor cluster" instead is an initiative for first movers at a regional level, covering multi-countries, and potentially multi-sectors with the shipping sector acting as a key enabler for a wide energy transition.

2.2 THE EVOLVING SCOPE OF THE SILK ALLIANCE

The Silk Alliance started as:

"*a project focusing on delivering a decarbonisation plan for a fleet of small-medium containerships operating in a route between Singapore and another port*"

and it has now evolved into:

"*a programme focusing on creating and implementing a green corridor roadmap based around a decarbonisation plan for a fleet that predominantly operates and refuels in Singapore, which includes different vessel types trading across multiple ports from Pacific Islands, South East Asia, North Asia to East Africa*"

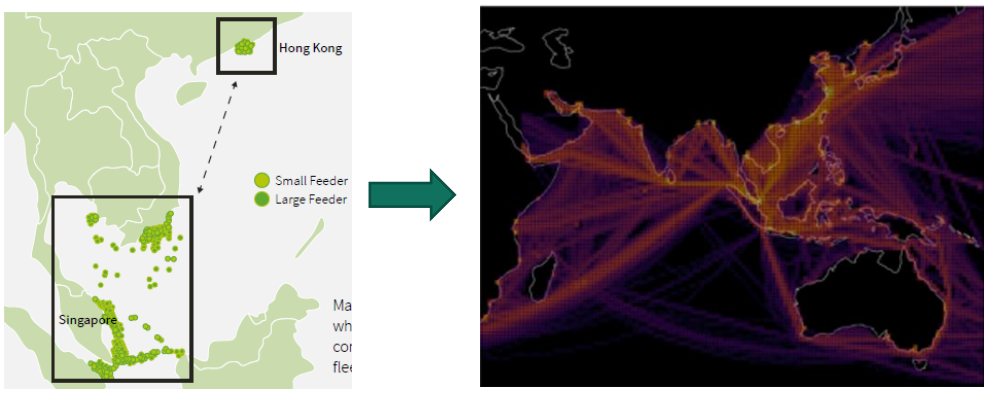

Figure 1: On the left, a representation of the initial concept of a green corridor involving feeders around Singapore as per [4]. On the right, a representation of the activities of the ships that could be part of the Silk Alliance and the region under the scope.

This change in scope means:

a) the Silk Alliance aims to focus on delivering and implementing a roadmap with a phase of continuous monitoring and refining of the roadmap
b) the Silk Alliance is not only looking at containership feeders exclusively operating around Singapore, instead, it is looking at ships with a specific common denominator: a fleet that mainly operates in the same region (regional bounds stretching to the Pacific Islands, South East Asia, North Asia to East Africa) and bunker in Singapore.
c) The Silk Alliance is looking at inland fuel infrastructure from countries with the potential to competitively produce these fuels and are within this region. For example, as found in [7], there are different countries that have the potential to produce hydrogen-based fuels in this region.

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3. THE OVERALL APPROACH

The overall approach is based on the "First Movers Framework" developed in [4]. This framework aims to guide the private and public stakeholders in the supply chain to systematically evaluate decarbonisation strategies for a specific fleet. The framework is designed with the view that both sides, the fuel supply, and the fleet should work in tandem to support the energy transition along a shipping 'corridor' to ensure its success.

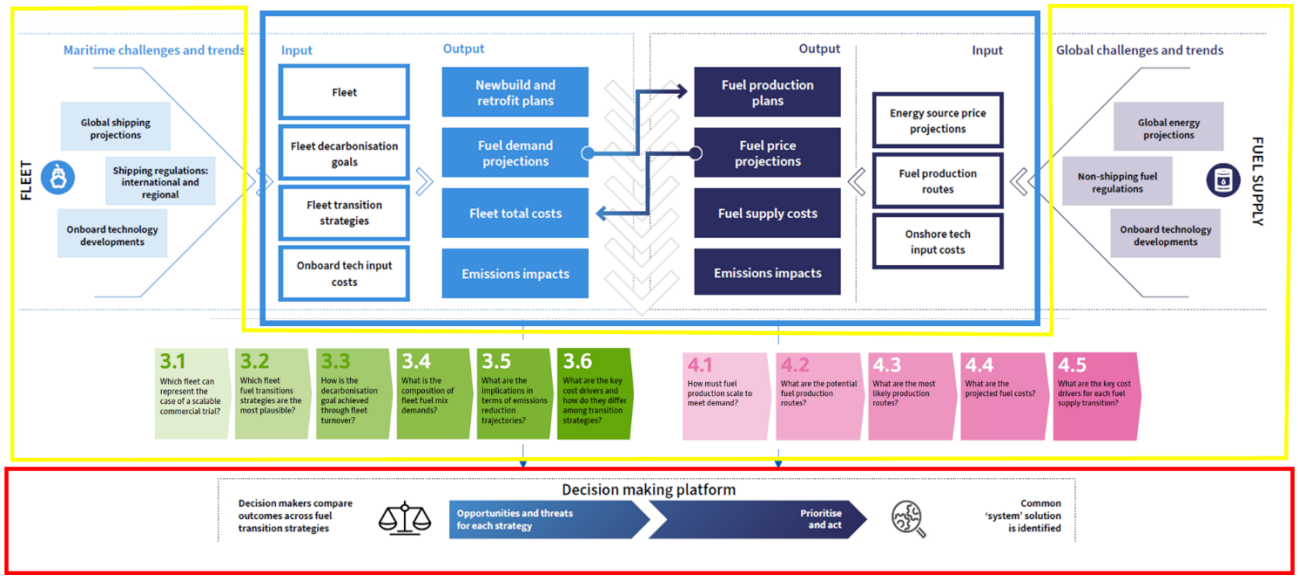

Figure 2, a graphical representation of the First Mover Framework

The framework was first developed for an explorative pre-feasibility study where a first version of different models was developed. As we are applying the framework to the Silk Alliance project, the models of this framework are being further developed and refined based on the ongoing work. The fleet transition model described in the following section is an example of further development.

The First Mover Framework can be divided into three key parts:

- System thinking stage (yellow boxes in Figure 2 and 3): brings together the experiences of all the Members; learnings from existing literature and the industry to bolster the Alliance's common understanding of the challenges. Drawing on these collective experiences the members identify the key questions to be addressed in the following stage.
- Foresight stage: First, key input and scenarios are defined, second a quantitative analysis is undertaken to provide new insights and evidence regarding the costs and benefits of different decarbonisation strategies.
- Co-Creation stage: this final stage aims to create consensus for a common strategy to build an implementation plan through collective a road mapping exercise.

We translate these parts into an agreed work process composed of six different activities as shown in figure 3.

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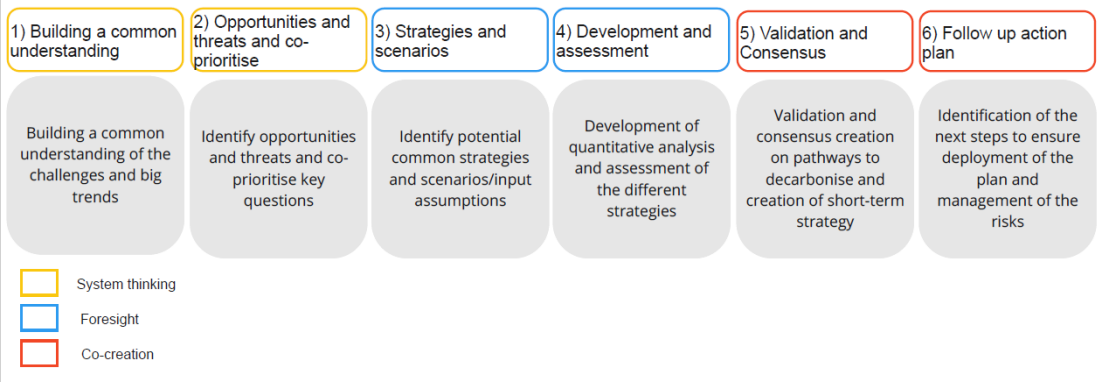

Figure 3. graphical description of the process composed of six different activities to implement the First Mover Framework

4. THE PROGRESS

4.1 BUILDING A COMMUNITY

Members of the Silk Alliance were invited to share their understanding of the challenges that have curbed investments in decarbonisation demonstration projects. These challenges were prioritised, and key questions were identified. This was done through a series of in-person workshops and working group calls. This stage allowed the creation of a new communications channel among the members that were not previously collaborating and the identification of about 75 challenges that were then translated into a series of key questions grouped into three themes:

1. Alignment with expected policy: considers potential changes to the IMO level of ambition, the inclusion of well-to-wake methodology, and carbon taxes.
2. The pace of change: considers implications of different fuel uptake and fleet-turnover speeds. Fleet decarbonisation can occur at a gradual pace, with transition fuels and production methods, or it could be accelerated to skip only to the greenest fuels.
3. The fuels: considers the various fuels available, as individual choices, or as a multi-fuel transition

4.2 THE SCENARIO-BASED ANALYSIS

Scenario-based analysis using models is a fundamental tool for climate actions. Climate change science is largely based upon models which have become indispensable for the formulation of climate policy as well business decisions. In this stage, we used models to assess and compare different fuel transition strategies. Firstly, several scenarios and input assumptions were defined. Secondly, the baseline fleet was identified, and finally, fleet turnover and costs and benefits analysis was carried out.

4.2 (a) Definition of the scenarios

Smaller working groups and a virtual workshop were held to agree on several input assumptions. These include several fixed assumptions such as emissions factors, fuels characteristics, engine, and tanks, fuel prices, and annual growth of transport demand, as well as key input variables: emissions reduction goals, carbon prices, the share of the fuels over time, the relative role of early scrap vs retrofitting as summarised in table 1.

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Table 1, description of the input assumptions

Input assumption	Type
Emissions factors	Fixed for all scenarios
Fuel characteristics	Fixed for all scenarios
Fuel prices	Fixed for all scenarios
Engine and tanks (costs, performance)	Fixed for all scenarios
Transport demand annual growth	Fixed for all scenarios
Emissions reduction goals	2 different cases
Carbon prices	3 different cases
Share of fuels uptake over time	16 different cases
Relative role of early scrap vs retrofitting	4 different cases

To construct the scenarios, we used the process described in [8]. We identified several scenarios by combining the contrasting outcomes of each theme identified in the previous stage. Following this process, we identified 64 different scenarios.

4.2 (b) The baseline fleet

A smaller working group was formed to identify the baseline fleet under the scope and gather fleet data from the shipowners. The baseline fleet is not necessarily every vessel owned and operated by the shipowner's members, as the fleet selection must ensure stable and reliable energy demand can be inferred or derived to give fuel producers the certainty to invest in dedicated production infrastructure.

By processing the fleet data provided by the members and the historical movements of the fleet using AIS data the baseline fleet was defined as:

- vessels already predominantly operating in the identified region and already refueling in Singapore
- vessels mainly operating in the region (up to 75% of the time in the region depending on owners) and likely to refuel in Singapore
- the identified region was chosen considering that the ships can operate their roundtrips and still have the ability to refuel in a single point

The catchment area of the Silk Alliance as well as the major concentration of activity are represented in figure 4.

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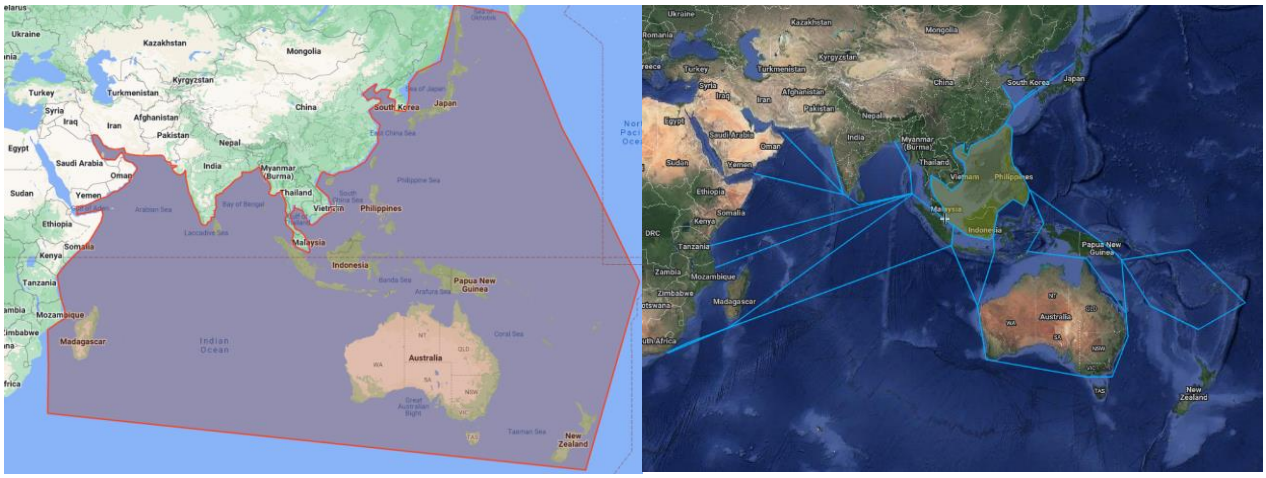

Figure 4, on the left, catchment area of the Silk Alliance; on the right, a major cluster of activity around Singapore (shaded yellow) and key routes (blue lines) of the identified baseline fleet

Figure 5 shows the heat map activity of the current baseline fleet. The baseline fleet is composed of 337 containerships across small, medium, and large size categories among the current members, with aggregated fuel demand of 3m Tonnes of HFO per year, leading to a CO2e potential reduction of 10m Tonne per year.

The Silk Alliance is now in the process of expanding its baseline to other ship types, starting with bulk carriers. The expanded baseline fleet can create a systematic change for the uptake of new fuels by concentrating effort into a shared strategy across segments.

Figure 5, Heat map activity of the current baseline fleet

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4.2 (c) Building a transition model

Understanding the dynamics that could influence fleet renewal is extremely important to estimate the number of newbuilds and retrofits needed in line with emission reduction goals. In doing so, estimations of costs, benefits, and investments under different scenarios can be made. Due to the large number of variables involved when assessing potential fleet renewal, a computational model that simulates the fleet transition given certain input is one of the best ways to fully understand the dynamics and risks involved in each option.

Drawing on the fleet model developed in the First Mover Framework, we have further refined the model to address the specific areas of interest of the members. In short, the model simulates the evolution of the fleet and for each year assigns fuels to each newbuild based on a pre-determined fuel strategy, while for the existing fleet of that given year, it proceeds with early scrap and newbuild replacement till a defined age limit and then it proceeds with retrofitting with certain constraints on age limit. Early scrap first and retrofitting second, are only applied if emissions goals are not met.

This model has allowed us to explore a wide range of scenarios. By settings different input assumptions, we were able to provide key insights into the questions posed.

4.2 (d) Key preliminary results

This section briefly describes the type of preliminary results of the scenario-based analysis. This is done only for a few scenarios. The interpretation of the results is not discussed here as this is not the scope of this paper.

Figure 6 shows the estimated fuel mix and fuel demand for the baseline fleet according to three different fuel transition strategies based respectively on ammonia, methanol, and methane. A distinction was made between e-fuels and re-fuels. The former indicates fuels with lower emissions factors whereas the latter, re-fuels (renewable energy based fuels) indicates fuels with nearly zero emissions.

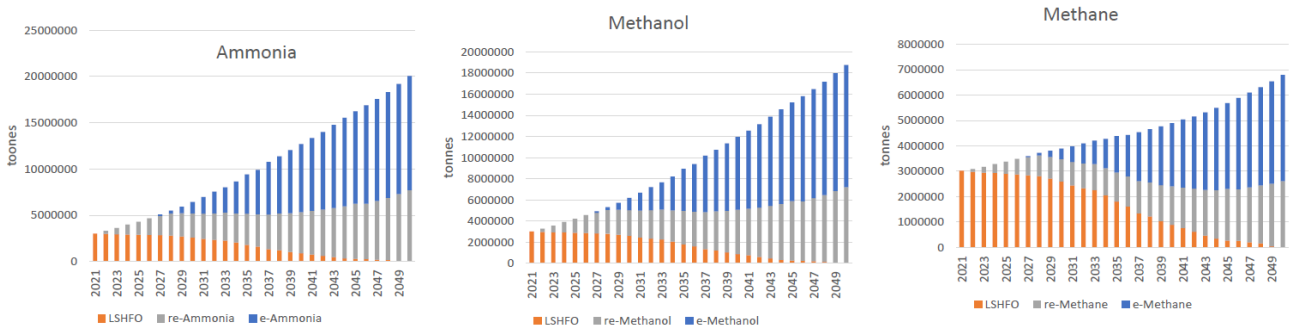

Figure 6 Estimated fuel mix and fuel demand for 3 different scenarios

Figure 7 includes two opposed scenarios that yield very similar results when normalized. In all scenarios, the carbon cost exposure in the early period of the energy transition increases rapidly, so managing and flattening the peak of the carbon costs (e.g. by increasing the adoption of renewable fuels) is one way of gaining a competitive advantage. “Pay-to-pollute” is shown to be a risky strategy – and prices will only be brought under control by switching fuel. The figures also demonstrate how the carbon cost exposure from the 2030s onward is coupled with the pace of renewable fuel uptake.

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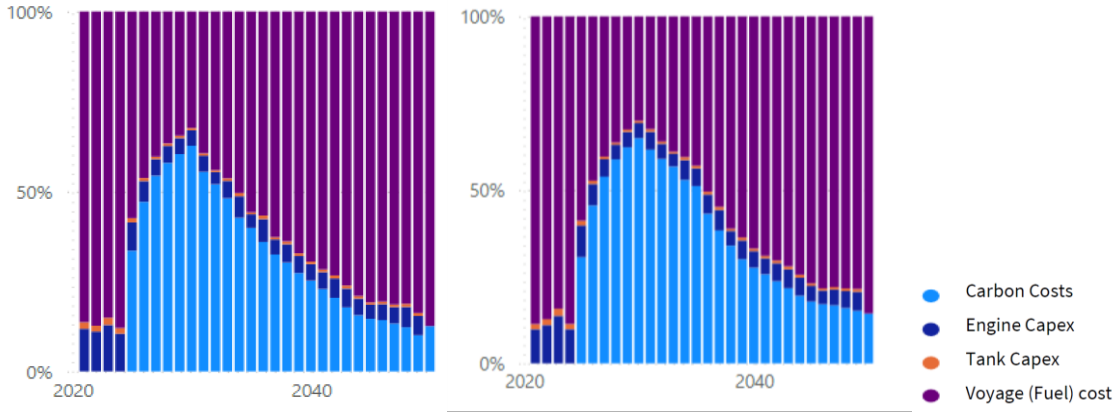

Figure 7, Breakdown of the fleet costs for the Silk Alliance's baseline fleet over time for two different scenarios. On the left, a representation of a scenario with a high carbon price and modelling a rapid uptake of renewable fuels. On the right, a representation of a scenario with a low carbon price and slow uptake of renewable fuels.

Figure 8 shows, the voyage and carbon costs for the baseline fleet calculated for each of the scenarios modelled. One can observe that there is a premium on methane fuel strategies relative to the Ammonia fuel strategies widening in the latter decades of the energy transition.

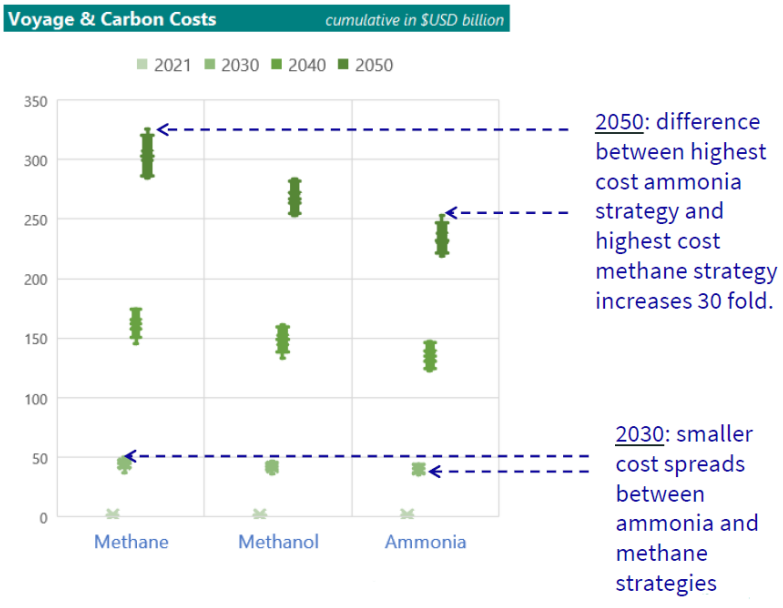

Figure 8, each candlestick represents a range of cumulative OPEX costs derived under different scenarios split by fuel transition strategy: Methane, Ammonia, and Methanol, and at different time intervals.

4.3 BUILDING AN IMPLEMENTATION PLAN

The results of the scenario analysis were used as a basis for a discussion during the third workshop. Although convergence to a single fuel strategy has not been reached, members continued to carry out this process as part of the implementation plan. We envisage that this stage may involve other analytical assessments and iterations, especially to account for the perspectives of fuel producers and governments. Figure 9 shows the initial draft used

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for discussion which provides the breakdown of the implementation plan highlighting the need to synchronise activities across the fleet, the fuel supply production, and the port as well as the key enablers.

Main milestones	
FLEET decarbonisation strategy	Define/agree on the strategy
	Consideration on timelines for fleet renewal, retrofit/conversion
	Forecast investment required
	Safety onboard & Forecast of the training requirements
FUEL/s production strategy	Engagement and selection
	Define/agree on the strategy
	Forecast investment required
	Consideration on timelines for fleet renewal, retrofit/conversation
PORT and bunkering infrastructure	Feasibility study (technical design)
	Consideration on timelines
	Safety at port & Forecast of the training requirements
Key enablers	Offtake agreement
	Policy incentives
	Finance mechanism
	Partnerships, bringing in new members

Figure 9, the initial template of the implementation plan used for discussion

The next steps will focus on expanding the alliance to ensure other key stakeholders are involved and designing the implementation plan.

5. INITIAL LESSONS LEARNED

This section includes several lessons learned from the work done so far by the LR Maritime Decarbonisation Hub and our engagement with the members and external actors. This initial list is mostly derived from our experience as a facilitator and from the role we have as a decarbonation hub. The section is composed of two parts. The first part includes a list of lessons and reflections on our experience in initiating and developing a green corridor project within the current landscape. The second part includes a list of lessons from the work itself undertaken so far.

5.1 THE SILK ALLIANCE AND THE CURRENT LANDSCAPE

5.1 (a) Actions and flexibility

The focus should be on actions rather than definitions – right from the start. The ultimate definition and scope will be set based on what has been achieved – so clarity and specificity on what actions are required to get the vessels on the water are needed. This may mean looking at the issues from completely different angles that are not constrained by the definitions that the process started with. For example, we may need to extend beyond the currently defined scope of shipping's aggregate demand, and instead widen the scope to capture regional demands, including energy and fuel demand from other sectors.

5.1 (b) Plan and implementation

The implementation plan until 2030 is a starting point. Concerns are raised that green corridor initiatives are only there for the mere purpose of generating an implementation plan or roadmap. This is an essential part of the process, but the effort should go also into the actual implementation and putting in place an iterative process to

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update the plan while the landscape changes over time. Therefore, the need for a programmatic approach with an agile implementation.

5.1 (c) The network of green corridors

While green corridor initiatives are still in their infancy, efforts have been made to create a network of green corridors to incentivise sharing and collaboration. If we accept that the focus of green corridors shouldn't be limited to the simple substitution in specific routes, and instead work more on how they may branch, pile up, merge, and contribute to systematic changes, then collaboration among green corridors should be the priority. Although each initiative has its peculiarity, and scalability potential and can be deployed in different configurations to maximise impact and accelerate the transition, we suggest that joined-up projects with other green corridors in parallel may positively determine or change the direction of green corridor initiatives. The aim of publishing details in this paper was to deliver greater transparency around the Silk Alliance green corridor cluster, and we call for more open discussion and sharing of information among other green corridors.

5.1 (d) Linkages with policy and technology developments

Green corridors are to be perceived as crucial to kick-start the transition, but they cannot do this on their own. A successful network of green corridors could create these linkages with ongoing external processes such as policy and technology developments. This remains a challenge because the effort in creating linkages is still very fragmented even among the members of a single initiative.

5.2 THE SILK ALLIANCE AND THE PROGRESS MADE

5.2 (a) Collective first movers

Green corridors are not about bringing first movers together but more about bringing key players together and making them act collectively as first movers; this is itself a challenge. Making organisations engage with competitors to become "collective first movers" remains a gradual process.

5.1(b) An iterative process

We benefitted from bringing actors together that were a subset of the entire supply chain in the first stage of industry engagement (e.g. the Silk Alliance has not yet formally onboarded fuel producers or governments). While the theory indicates the need for system-wide collaboration, this intentional decision made the initial kick-off a manageable process. As we expand the membership, the process will become iterative because we will need to work with new and current members to revisit the first stages of the process. On one hand, the iterative process breaks down the process into manageable stages, particularly when dealing with a vast number of stakeholders across the board, and helps to refine the process with each iteration, while on the other hand, the iterative process requires a longer time to execute.

5.1 (c) Creating consensus

Moving from generalisations into "specifics" has proven to work as we have garnered interest and engagement from the members when looking at the results of an energy transition tailored to their specific fleet. However, the creation of consensus is challenging itself and consensus cannot happen particularly at this stage when the onboarding for all stakeholders has not yet happened. Workshops or roundtables are ways to drive consensus and decision-making, but due to the complexity of the problems and delivery of analysis and results in these forums, alternative means of knowledge sharing among members should be explored to supplement these efforts. In cross-industry

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partnerships, engagement in open floor discussion is bettered by 1-1 and smaller engagements and working groups so partners grow comfortable operating in these novel and innovative spaces.

5.1 (d) The baseline fleet and the scope

Identifying the 'baseline fleet' may change the scope of the green corridor. We benefitted from the AIS data analysis to identify the baseline fleet because it helped us to assess the activity, the wider scope, and the regional nature of the Silk alliance green corridor cluster programme. The point-to-point concept was not suitable for the identified fleet which instead acts in a relatively large cluster.

5.5 (e) Regional scope and alternative finance

The regional focus of the Silk Alliance opens the opportunity to incentivise the development of fuel supply infrastructure in strategic positions across developing countries. Governments and financial institutions should nurture not-yet profitable investments in this area as there is the expectation that they will become important for realising a just transition with societal and collective goals in the future. The investment barrier remains the largest challenge so discussions and workstreams need to be created to address this high priority area.

6. CONCLUSIONS

The topic of green shipping corridors is becoming increasingly important as many recognise the potential benefits involved in such type of initiative. There have been several announcements of green shipping corridors whose scope can vary significantly depending on the interpretation. However, we argue that the focus of these initiatives is to kickstart the uptake of alternative fuels that can generate spill-over effects for a wider sector transition whatever definition is taken into account.

The debate still focuses on defining and identifying the important elements of a green corridor and how to approach it, suggesting that green corridors remain in an infancy stage with various methodologies and approaches so far taken. However, we think that scenario analysis and feasibility studies are only the starting point to advance and establish a roadmap for green corridors The real challenge would be the actual implementation of a green corridor. It is one thing to flesh out a vision of the transition, which is technically feasible, but it is another thing entirely to put an implementation plan into practice at scale.

The Silk Alliance, a green corridors cluster, is evolving as we progress with the work. We aim on delivering and implementing a roadmap. This will require the involvement of other stakeholders that are looking at the same catchment area.

One example is energy suppliers and governments with an interest in inland fuel infrastructure with the potential to competitively produce these fuels and are within this region. We know there are different fuel candidates, however, the fuel supply infrastructure at least at the beginning could focus on the common building blocks such as hydrogen. We would welcome collaborations across different actors to create such building blocks.

Another example is financial institutions with access to the climate fund. The creation of a robust consensus across the value chain remains a challenge. So far, we noted the intention from the members of piloting the main fuel candidates and working further on potential convergence to one or more fuels, but nothing is possible without securing the financing. More effort needs to go into identifying a funding and risk-sharing mechanism to turn roadmaps and plans into actions

We adopted a system approach for this green corridor cluster. To help current and future members, we are using a framework designed with the view that both sides, the fuel supply, and the fleet should work in tandem to support the energy transition along a shipping 'corridor' to ensure its success. The framework is intended to guide but further extensive analytical assessments are essential to unlock investments. We detailed the initial lessons learned

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during the first cycle of the process; however, work will continue and will be completed with further iterations with new members. Simultaneously, we will look at opportunities to start parallel activities with other green corridor initiatives that may lead to synergies and further acceleration of the shipping energy transition.

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