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The sustainability of the Arctic: A case study analysis of container shipping

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Abstract

The Circumpolar North area's geography is changing, however, developing commercial shipping operations aiming to utilize Arctic trade routes is a speculative topic containing uncertainties. The Arctic has a unique, highly fragile ecosystem and the region is in early phases of development. Therefore, it would be a mistake to approach the development of the region with only commercial goals in mind. A comprehensive, forward-looking framework which integrates considerations of planning, development and climate change to create resiliency is necessary for the Arctic future. This cannot be established without cooperation of all related actors and stakeholders. This paper aims to support decision-making by finding potential solutions while discussing possible policies on container shipping within the Arctic; regarding sustainability issues of shipping industry and the Arctic region.

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1. Introduction

Global warming brings broad implications to our civilized and increasingly developed world. Greenhouse Gas Emission (GHG) caused by the industrialized world is the biggest reason behind this unexpected increase in average global temperatures; in other words, climate change. The Paris Climate Agreement has created awareness about climate change, and the fact that it can only be avoided if fossil fuels are not used at all. When measures to fight global warming are introduced, the concept of environmental sustainability will become more mainstream for all industries to drive towards sustainability. The maritime industry primarily has been working on reducing emission on a ship scale, since ships are the origin of the majority of maritime-related emission. The total shipping fuel consumption is dominated by oil tankers, bulk carriers and container ships and between them the container ship type has the highest CO₂ emission (Third IMO GHG Study, 2015). Although shipping is the most climate-friendly form of freight transport per transported unit, the scale of the shipping industry and the massive amounts of fuel used is creating public concern.

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The maritime sector, particularly at a shipping level, should invest in sustainability in order to improve its current and not all too so favourable reputation. Likewise, regulatory changes linked to security, business ethics, health and safety and labour standards have put additional pressure on international container shipping lines to increase sustainability performance (Pruzan-Jorgensen and Farrag, 2010).

Increased temperatures in the Arctic area has been melting the ice and opening up new routes that had previously been deemed impossible and voyage planning seems to be benefitting from it (Wright, 2013). The maritime industry has already been interested in the Northeast Passage, for the shipping industry; these new routes are an opportunity by shortening the Far Eastern Asia to North Western Europe trip distance and time, which will consequently result in less fuel burn. This is a big advantage for the industry to drive fuel costs down and to lower shipping related emissions (Wan et al., 2018) in order to follow the International Maritime Organization (IMO) target which is 50% absolute GHG emission reduction by 2050, compared to 2008 levels (Hughes, 2016).

Currently the Arctic region is dominated by liquid bulk vessels due to high oil and gas activities, and, except for trials (Donnelly, 2018), there is no express container shipping activity in the Arctic. While the industry is working on the economic feasibility and energy-saving potential of the Arctic routes, there is a gap in the sustainability aspect of these operations. Therefore, the role of shipping industry with regards to the development of the region should be evaluated. The scope of this paper is on possible future crossing of the Arctic via the Northeast Passage, in particular Northern Sea Route (NSR), connecting two major global economic regions, North-Eastern Asia and North-Western Europe, by container ships, and the possible negative effects of this crossing may have on the unique environment.

The commercial use of Arctic routes has the potential to bring immense benefits which are accompanied with numerous disadvantages for shipping companies (Celik et al., 2020). Warmer climate is allowing longer periods of ice-free passage, although year-round ice-free access may take decades. This warmer climate is highly likely to cause adverse weather conditions, free-floating ice and even ice-burges, rendering the NSR not suitable for container ships. Not only the ships but also ports along NSR which are underdeveloped and have poor infrastructure will also face the same set of challenges. Commercial shipping will be negatively affected from this situation, “*since markets demand goods be delivered on time* (Chircop, 2016)”. Current facilities do not meet the shipping companies’ fundamental necessities for cargo handling, navigation and rescue, in particular for bigger ships, depths in anchorage area and wharfs in NSR ports are the biggest issues (Zhu et al., 2018). Even though Russia has planned to construct the required infrastructure along the NSR, developing the necessary infrastructure may fall behind global warming melting the polar ice cap, compelling ships to need the assistance of ice breakers or ice-strengthening. Such needs along with high insurance and vessel construction (Pruyn, 2016) expenses mean extra costs for the shipping companies. Transparency on fuel provision of the facilities is yet another problem for shipping companies (Zhu et al., 2018). Furthermore, not having enough port of calls for container shipping along the NSR, and not yet reaching the same risk and safety standards as existing routes like Southern Sea Route (SSR) are big concerns (Humpert and Raspotnik, 2018).

Recently, top container shipping companies MSC, CMA CGM, Maersk and Hapag-Lloyd have announced that “*using the NSR is not worth the risk of damaging vulnerable Arctic ecosystems*” (Forde, 2019). These concerns, however, may lose their gravity, if the physical conditions of NSR improve faster than expected and/or NSR gains more momentum simply due to the geopolitics of the region. Russia tries to promote NSR as much as possible since realization of NSR would bring considerable benefits. Emerson (2010) states that Russia has a chance to increase economic possibilities of the inner section of its enormous landmass and create an economic and military advantage since all main rivers of Russian mainland end up in the North Sea. That chance becomes a reality with the NSR, which is why the Russians are so eager to promote it. How this ambition will play out in the foreseeable future is yet to be seen though it draws global attention for sure. Nevertheless, since the start of the discussion; commercial shipping operations in the Arctic routes and its possible outcomes have become extremely interesting and debatable topics.

The goal of this research is to support decision-making by finding potential solutions while identifying and discussing possible policies on container shipping within the Arctic; regarding sustainability issues of shipping industry and the Arctic region. This goal leads us to the following question, which will be investigated in this paper: “What are the key responsibilities of container shipping operations aiming to utilize Arctic trade routes in order to support sustainable development within the Arctic region?”

The Arctic region is fragile to external disturbances and the unique ecosystem can be easily impacted by physical stress, hence the environmental impact of a possible NSR is also worrisome. Increased shipping activity in the Arctic could contribute to the breakup of ice sheet even further, while increasing local pollution levels. Thus, a

comprehensive, forward-thinking framework which integrates considerations of planning, development and climate change to create a resilience is necessary for the Arctic future. In order to achieve that, sustainable planning within the framework of ecological principles approach, which is a cross disciplinary approach, has been chosen to identify possible policies on container shipping within the Arctic, regarding considerations for an open commercial Arctic crossing in the future.

Section 2 introduces the Arctic region with its actors and sustainability issues of the shipping industry in the region. Section 3 presents sustainable planning within the framework of ecological principles as assessment frameworks. Section 4 outlines results addressing possible policies for container shipping within the Arctic based on literature review. A critical discussion and the study's conclusions are presented in section 5. Finally, section 6 presents further step of this research.

2. Literature Review

2.1. The Arctic region and its actors

The circumpolar North includes the Arctic and Subarctic, meaning northern lands of the world's eight northernmost countries are also included: namely Canada, United States, Russia, Finland, Sweden, Norway, Iceland and Denmark. It is often assumed that the North is an empty land, aside from certain places, the region is very industrialized, particularly in Russia (Espiritu, 2013). According to the Atlas prepared by University of the Arctic, there are approximately 13.1 million individuals residing in the circumpolar Northern area (Arctic Centre, 2018). The region's economy is mainly based on natural resources, which include mining and drilling activities for metal ores and oil; fishing; and the hunting of wild animals. Government activities is another solid sponsor to the Arctic economy, in particular with military spending. Moreover, tourism has recently become an additional contributor to the Arctic economy and retains a growing pace (Duhaime and Caron, 2008). The countries having economical and/or political interest in the region are using the United Nations Convention on the Law of the Sea 1985 as the framework for settling territorial issues and regulating the use of the sea and its resources (Macalister, 2011).

The Arctic Council functions as an intergovernmental forum that endorses cooperation, coordination and interaction between Arctic States, Arctic indigenous communities and other Arctic inhabitants. The agenda is described as "*Arctic issues, in particular on issues of sustainable development and environmental protection in the Arctic*" (Arctic Council, 2018). As a result of the establishment of the Arctic Council in 1996, all Arctic States can work together in order to solve some of the imminent problems in the Arctic, such as environmental pollution, climate change and how to mitigate it. The Arctic Council is not a decision-making body, and has no authority; rather it is a forum where common issues can be discussed, and suggestions can be made. It is important here for indigenous populations to be represented in the council thus they can participate in the discussions regarding common issues and the possible policies for the Arctic. The Arctic Council granted permanent observer status to six countries in 2013, which included five Eastern-Asian countries, which have a great interest in resource development and new shipping routes in the Arctic. Espiritu (2013) states that the council may have seen an opportunity here to include these states with observer status in order to keep them 'at the table'. After all, these countries will work on their interests and concerns whether or not they are in the council and keeping them included in the transparent environment of the council would be the best outcome for the Arctic.

IMO as an agency of the United Nations, has been creating a set of rules to follow for member countries' commercial ports and shipping activities, with the aim of limiting shipping-originated emission in order to help against climate change. These rules enforce more energy-efficient ships and the prevention of shipping related pollution. The current legal framework, Polar code, which is obligatory under the International Convention for the Prevention of Pollution from Ships (MARPOL) and the International Convention for Safety of Life at Sea (SOLAS) is one of the most crucial forms of prevention in the Arctic region. In order to protect the regions and safeguard shipping in polar waters here, ships that sail through the Arctic require assessments and Polar Ship Certification (IMO, 2016).

Regardless of national borders, Arctic identity encompasses acknowledging shared challenges, threats and common interests of the entire region (Kenny, 2017). One of the many concerns about the effects of climate change, melting of the permafrost under Arctic settlements, is a growing challenge (NASA, 2018). Urban zones within the eight Arctic countries are used to deal with unique challenges, however some of these challenges are getting harder due to climate

change. As Arctic is the region where the temperatures rise the fastest in the world, probable effects are intricate, hard to estimate and may affect human activities and development negatively. Scandinavia and the Russian Far-North on the western side of the Arctic, according to some models, is likely to get even colder because of the gulf stream (Espiritu, 2013). This would mean more snow and more ice, leading to less hospitable conditions. That uncertainty makes it very difficult to plan and to project what is necessary to promote sustainability in long term.

As stated by Espiritu (2013) on ‘Arctic Sustainability’ research of Barents Institute, the current situation and sustainability-related issues of the Arctic region are:

- Definitions of sustainability are difficult to translate into a Russian context due to the Russian High North being more industrialized in the region. In addition to that is how Russia built itself as a nation, especially during the Soviet Period. In other words, Russia causes severe environmental pollution in the region.
- The Russian policymakers are overwhelmingly focused on economic growth, especially in the High North when it comes to research development on oil and gas, which is the backbone of the Russian economy.
- The Community Sustainability Project, which involves partners from the U.S., Canada, Russia, Finland and Norway was done to define what sustainability means in the Arctic. Furthermore, they found that some places, especially in Russia, are urban areas. Thus, in fact they are looking at Arctic urban sustainability. Issues have arisen around changing policymaker’s views to how to keep communities together, depopulation due to climate change and lack of infrastructure.

2.2. Sustainability issues of shipping industry in the Arctic

With increased global temperatures, the Arctic ice cap is diminishing and enabling longer navigable periods, encouraging shipping companies to utilize northern shipping routes more extensively, particularly using the NSR. Consequently, a significant increase in Arctic shipping activities has been observed. Occurrences of ship collisions and groundings have also increased, however, since increased shipping activities in a maritime route also causes an increase in the frequency of maritime safety incidents (Chircop, 2016). The IMO wants to make use of the Iridium satellite system communications solution to complement the Global Maritime Distress and Safety system in order to improve maritime safety in the Arctic. Not all of the shortcomings of the Polar Code are being worked on, and there is no conclusive work yet on resolving navigational rules for ships in the Arctic to prevent collisions when ice is present in the sea (Chircop, 2016).

The Polar Code, which reflects the common ground on a global level, is an initiative with a limited scope and context but which is also open to adaptive learning (Chircop, 2016). A significant shortcoming here is the narrow environmental scope that covers shipping-related pollution only, while pollution is not the only potential negative effect of shipping. Nonetheless, the current legal framework does not cover all the issues in the region, and various damage to natural resources are not mentioned there either (Walkowski, 2015 as cited in Zhu et al., 2018). Hence, the Polar Code cannot enforce sufficient regulatory initiatives to satisfy sustainable shipping in the unique region, and noise pollution caused by ships, and ships striking mammals, are valid concerns that have not been able to find any meaningful remedy, yet (Chircop, 2016). Ships use of antifouling paints and waste water disposal practices here are not regulated in the Arctic. Furthermore, it is still allowed to transport heavy-grade oil in the arctic region, even though there are concerns about the sufficiency of international laws regarding civil liability on mitigation measures and compensation for damage due to oil pollution in remote areas (Chircop, 2016). Additionally, a separate international environmental liability regime for the Arctic has been recommended by Zhu et al. (2018).

Zhu et al. (2018) calculated the total environmental cost for the Rotterdam – Shanghai route and their results show that “*if this route is more environmentally friendly than others, then moving away from this ‘green’ transport mode means higher transport volumes in other routes, which leads to higher total environmental cost*”. In other words, more investments for lower emissions in Suez Canal Route (SCR), fills the gap between environmental costs for NSR and SCR. The shorter trip time, which will enable an increased frequency for each ship (Melia et al., 2016), thus increasing total capacity for the route. Furthermore, in Bekkers et al. (2015) it is stated that even though shorter shipping distances mean less CO₂ emission, the increased trade volume will offset this benefit and, consequentially, shipping-related CO₂ emission is likely to increase in the Arctic. Additionally, even “*a small black carbon particle produced by ship’s engine will severely influence the Arctic’s ice, snow, and cloud*” (Corbett et al., 2010 as cited in Zhu et al., 2018). Black carbon is a pollutant that can absorb the sunlight much better than the carbon in regular emission gasses, hence

it is a bigger contributor to global warming (Lack, 2016). Measurements done by Finland and Germany and presented to IMO Sub Committee on Pollution Prevention show that the recently adapted marine fuels with low-sulphur ratios are possibly causing a nasty side effect (IMO, 2019). Having much higher number of particles, low-sulphur ratio fuels cause more black carbon emissions. Nevertheless, “*The Arctic is currently not an emission control area however the IMO announced a global sulphur cap of 0.5 to be implemented beginning from 2020 or 2025*” (Schröder et al., 2017).

Arctic Marine Shipping Assessment outputs the environmental impacts associated with current Arctic marine shipping under three categories which are pollution (accidental discharge of oil and toxic chemicals, regular discharges to water including garbage and illegal discharges, emissions to air), disturbances (sound, noise, light and ice breakers) and introductions (invasive species through ballast water, hull fouling and cargo) (AMSA IIc, 2013). Additionally, Arctic Monitoring and Assessment Programme states further potential negative impacts such as negative visual effect and impact on archaeological sites, workforce influx resulting in demographic and cultural change, social and health issues, change or loss of natural resource base and loss of traditional knowledge (AMAP, 2013).

3. Approach

A comprehensive, forward-thinking framework which integrates considerations of planning, development and climate change to create resiliency is necessary for the Arctic future. Its fragile ecosystem can be easily impacted by physical stress. Therefore, sustainable planning within the framework of ecological principles has been chosen as a device within the Arctic whilst consisting ecological balance in the central and the aim is prevention of harm to environments ability to meet its current and future needs due to human activity. This approach, which is used in the discipline of urban and regional planning, can be viewed as the evaluation of biophysical and socio-cultural information in order to reach decision-making opportunities and constraints in the management of ecological systems with the aim of creating natural, lively, safe and healthy environments. Assessment of sustainability is done via utilizing various methods and tools ranging from indicators to comprehensive models. More details can be found in Yigitcanlar and Dizdaroglu (2014). Selection of the most suitable evaluation method depends on the subject of the assessment, the nature and complexity of the environmental impacts and also time and scale. In that perspective, ecosystem sustainability includes “*assessment frameworks, which are basically integrated and structured procedures that assist in the comparison of proposed project and policy alternatives based on their environmental impacts*” (Waheed et al., 2009 as cited in Yigitcanlar and Dizdaroglu 2014).

Ecological principles dictate ensuring the continuity of natural resources. The rate of consumption of these resources should not exceed the rate they are renewed. Also, the rate that contaminants are exposed to the environment should be less than the rate natural resources can process these. Conservation of biodiversity, human health, the quality of air, water and soil is also covered by sustainable planning within the framework of ecological principles. The key characteristics are:

- Maintaining ecological integrity,
- Moving towards resource sustainability,
- Meeting the inherent needs of human beings,
- Emulating natural ecosystems (Shu-Yang et al., 2004 as cited in Yigitcanlar and Dizdaroglu 2014).

4. Results

Considerations for an open commercial Arctic crossing in the future, regarding the sustainability within the framework of ecological principles, possible policies have been identified based on literature review. In this perspective, maintaining ecological integrity and moving towards resource sustainability leads us to define environmental aspects which can be achieved through defining the carrying capacity of the Arctic ecosystems for the container shipping crossing the NSR. Emulating natural ecosystem can be used to develop technologies for both ships and necessary infrastructure in the region. Thus, it is mentioned as ecological and technological design principles. Last but not least, meeting the inherent needs for human beings refers to container shipping companies under economical aspect, and local communities and social responsibilities of shipping lines for the sustainable development of the region under social aspect.

Environmental aspect:

- Route planning should be decided according to ecological protected areas and with ecological priorities.
- Ships should be regulated with respect to their vessel type regarding to which zones within the Arctic region they can operate in.
- Ecologically-sensitive zones along the shipping routes should be continuously mapped - to be considered as sensitive, the zone, including habitat, may be vulnerable that depends on direct and/or potential threats which occurs in the future activities- and the shipping traffic going through these zones should enforce environmental protection rules.
- Speed reduction can be enforced in these zones to limit the noise and disturbance affecting marine habitats.
- Clean fuels which are produced through renewable energy should be enforced in order to lessen the GHG emission in local levels.
- More work is needed to be done on polluters effects on biodiversity and biodiversity should be preserved.
- Emission control checkpoints along the route should be formed.
- Any waste dumping in the Arctic should be prohibited.
 - Ships should store all the waste they produce during their trip on board and offload it at the next available port.
- Construction of renewable electricity generation and transport grid should be built in respect to ecological and technological principles.
- Severe sanctions should be applied in case of violation of rules and regulations.

Social aspect:

- Risk level for this route should be assessed and necessary precautions should be taken.
- Regulations at an international level should be formed to limit the effects of shipping accidents in local communities and compensate them in the event of an accident.
- Shipping traffic and supporting infrastructure should help the development of local communities with regards to ecological and technological design principles.
- Culturally significant areas should be conserved.

Economic aspect:

- Sufficient infrastructure along the route should be established.
- Tariffs for Arctic routes should be more advantageous than rival routes since cost of Arctic crossing for container transport is higher compared to other existing routes.
- Ships need be relatively bigger in size:
 - Bigger ships benefit economies of scale,
 - Bigger ships have sufficient engine power to handle harsh weather conditions

Environmental, social and economic aspects are considered together to safeguard the development of the region. Sustainable shipping can be described as a holistic management perception covering environmental and social responsibility for sustainable development. Progress in shipping here is affected by a wide range of factors varying from regulatory to socio-economic factors, market related aspects and human factors. Having many stakeholders involved in the process, it is crucial for sustainable shipping to consider the needs, concerns and expectations of all involved parties. Hence, engaging in constructive dialogues and creating synergy through partnerships and joint R&D activities will be instrumental for the development of sustainable shipping (EMSA, 2018). In that perspective sustainability can be used to provide transparency, and if at least these aspects could be achieved in Arctic, it would help to create greater confidence in the environment. Taylor et al. (2021) describe an exploratory study which utilizes a dynamics model system on the Arctic region. Creating digital twins of the region for various conditions, optimum solutions for the Arctic sustainability in terms of well-being and economic health has been shown possible when native empowerment, environmental protection and government regulation constraining development are pursued. Thus, comprehensive policies and collaboration with all actors, most importantly collaboration with indigenous people, the Arctic has the potential to enhance resilience in the region. In this respect, it is possible for maritime sector to take steps for environmental sustainability, provided that they also contribute towards economic sustainability.

5. Conclusion and Discussion

The Arctic region, which surrounds the North Pole, is in a crucial location due to the physical, chemical and biological balance in the world, and is very sensitive to climate change as it even responds to small changes in climate. Therefore, especially in research into climate change, the Arctic region can give clues about what will happen next in the global environment (Arctic Centre, 2018). In this respect, the Arctic should be a protected environment. However, when geographic conditions change, national interests shift as well (Celik et al., 2020). Improved accessibility and geo-political interest of countries along with interest in resource development and new shipping routes will inevitably lead to the development of the region. Thus, the Arctic region will perhaps be the single most influential region on Earth in the coming century.

No matter what, the utilization of the NSR is a speculative topic containing uncertainties. The Arctic is a highly interconnected region which is in its early phases of development. Therefore, it would be a mistake to approach the development of the region with only commercial goals in mind. Thus, the sustainability concept, which aims to change the economic development procedure in order to increase life standards and quality for all humankind and conserve the ecosystem with social systems that create a liveable environment, is essential for most if not all development activity within the Arctic. Thus, shipping gets its fair share of criticism and the industry needs to address these concerns going forward. Propeller polishing, NO_x and SO_x emissions, and, spills and leaks, have all had a direct impact on wildlife, habitats and food chain. Moreover, in addition to an unhealthy ecosystem, underwater noise is significantly disrupting marine life, especially mammals who depend on sound to communicate and waste management has direct implications on wildlife. It is an important task for the industry and IMO to re-visit regulations. Not only the fuel, but also the engine and the ship efficiency are important factors in minimizing emissions. For the commercial traffic, ships having low or zero emission engines could be enforced to minimize the impact to the climate. Last but not least, safety for seafarers, vessels and the natural environment, are among the main aspects to tackle when considering traversing the Arctic. Sailing in these northern routes has always been hazardous due to the unpredictable weather conditions and ice in the sea, and the navigable season is always subject to change due to these factors. A stronger commercial crossing will demand for more safety systems including charting and monitoring, controlling the ships' movements in the Arctic. Therefore, a sustainable shipping concept should be put into practice, pursuing a shipping activity with minimal impact to the environment.

As the geography and ecosystem of Circumpolar North area are changing, increased temperatures in the Arctic cause drastic habitat changes and even habitat loss for top predators such as polar bears and ringed seals. These changes do not pose a risk for the Arctic ecosystem only. When such animals disappear, indigenous human populations that rely on and hunt animals as traditional way of life will also be unfavourably affected. Thus, making decisions regarding the future of the region and the protection of its cultural and ecological features with the participation of all relevant local groups will make the process transparent and facilitate the implementation of the decisions by ensuring that the decisions are adopted by local stakeholders.

The route NSR will be using for commercial traffic should be established while avoiding marine protected zones. Therefore, identifying such zones should be considered a high priority task before the route that NSR will take is determined. Another aspect that must be tackled before the realization of an Arctic crossing for commercial traffic is the legal framework that will regulate this traffic. This cannot be established without cooperation of all related actors and stakeholders. However, existing problems such as lack of legal framework, limited sailing period in the region throughout the year, physical challenges and sustainability goals, will take time to be resolved or tackled. Thus, all issues in the region and the shipping industry need to be addressed, necessary policies should be identified and comprehensive regulations, considering ecological, cultural and economic aspects, should be put in practice.

Russia will benefit the most from commercial use of the NSR if it becomes a viable route. If the country's claim to control is respected, the northern lands of Russia will benefit development, and the passage will become a high value economic and military asset. NSR may have enormous potential to succeed, although that potential depends on the political relations. Hence more questions arise: Will the passage be treated as a route by Russian waters? How Russia will treat and manage the NSR in the future? Will the route offer trustworthy, stable and safe management for shipping? How can shipping companies' network and power to negotiate with Russian authorities be an advantage towards its competitors such as rail transport and SSR? Another question is on the transit fee for that route. If the transit is toll free, the NSR can attract shipping companies easily. However, if a country along the path decides to

charge toll fee for the passage, shipping companies will have a relatively tough decision to make. However, it may be essential to adjust the toll in a way that NSR will still be attractive while infrastructure, construction and other necessities, in respect to ecological and technological design, are funded.

6. Further Research

Even though there are scientific predictions about the region, many factors, such as geo-political interests of Northern countries and the dynamics of container shipping routes are still open for debate. Moreover, new developments related to the topic are happening frequently. Despite all these uncertainties, which make it very difficult to plan and to project the necessities to promote sustainability in long term, analysis of the potential validation approaches with senior experts is part of further step of this research.

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