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Fostering innovation in the blue economy within the United Kingdom (UK): A stakeholders' perspective

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ABSTRACT

In a 2019 European Commission report, the Blue Economy (BE) within the United Kingdom (UK) represented 22% of the European Union's (EU) BE Gross Value Added (GVA) at approximately €39 billion. Coupled with the clear value of the BE to the UK, there is an urgent need to innovate and develop technologies to decarbonise and advance the sector. A deeper understanding of the current position for multiple stakeholders must be considered before any major governmental or long-term strategy decisions can be made. This paper presents the perspective of academic, industrial and governmental stakeholders analysis of how the UK can move forward with developing innovations within the BE. Utilising a questionnaire and round table discussions, specialists from all stakeholders gave their opinions on industry-academia-governmental working relationships and technology transfer readiness. Reasonably high satisfaction was found with key aspects that enable a successful collaborative project between academia and industry towards technology commercialisation; however, there is still room for improvement. This paper offers an analysis of how to further enhance and foster technology development within the UK BE. A collaborative approach is proposed to ensure best practices, and a 'triple helix' (TH) collaboration strategy to be used as a tool for those engaging in these types of working relationships. Future directions on enhancing technology transfer innovation within the UK BE are also suggested.

1. Introduction

1.1. Blue economy

According to Smith-Godfrey (2016), the concept of the 'Blue Economy' (or 'Oceans Economy') originated from the United Nations (UN) Conference on Sustainable Development (Rio de Janeiro, Brazil, 2012).

The UN concept paper on BE (UN, 2012) starts by emphasising the importance of the oceans: Oceans cover 72% of our planet's surface and constitute more than 95% of the biosphere. At the same time, it was stressed that oceans *"provide a substantial portion of the global population with food and livelihoods and are the means of transport for 80% of global trade"* (UN, 2012). According to UN (2012), BE supports the desired outcome of *"improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities and endorses the principles of low carbon, resource efficiency and social inclusion"*.

Lee et al. (2020) provided evidence that the term BE has been used in *"different ways and similar terms such as 'ocean economy' or 'marine economy' are used without clear definitions."*

This is supported by Martínez-Vázquez et al. (2021) who analysed the relevant literature; they note that 'ocean economy' (OE), 'marine economy' (ME), and 'blue growth' (BG) were also used in the literature as synonyms of BE. The World Bank defines 'Blue Economy' (BE) as the *"sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem"*, whereas the European Commission (European Commission, 2020) defines it as *"all economic activities related to oceans, seas and coasts"*.

The BE as a framework for sustainable development was originally

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pioneered by Small Island Developing States (SIDS) - as these states are surrounded by the ocean. However, it was also found to be relevant to all coastal states.

More specifically, the BE espouses the same desired outcome as the Rio+20 Green Economy initiative, namely, *"improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities"* but it is *"fashioned to reflect the circumstances and needs of countries whose future resource base is marine"* (UN, 2012).

In other words, BE could be defined as the 'Green Economy' in a 'Blue World'. The interested reader is referred to Smith-Godfrey (2016) for the various definitions of the BE, and to Lee et al. (2020) and Martínez-Vázquez et al. (2021) for a review of the relevant literature.

Recent international policy making relating to the BE is significantly influenced by the UN Sustainable Development Goals (SDGs) (Steven et al., 2019), specifically SDG 14, "to *conserve and sustainably use the oceans, seas and marine resources for sustainable development",* which fundamentally outlines the importance of the oceans on a global scale. The EU response prioritises the need to protect and enhance marine biodiversity and ecosystem services, while sustainably developing blue growth and jobs (European Commission, 2019; 2020). The European BE encompasses a diverse range of activities and industries that includes coastal tourism, port activities, shipbuilding and repair, maritime transport, marine living resources (such as fishing), marine non-living resources (such as extraction of petroleum and natural gases), renewable offshore energy and bio-technology.

1.2. Blue economy in the United Kingdom (UK)

Much of the work within this paper is focused on the state of the art BE activities in the UK. The reason is that the UK is a leading contributor to the EU BE (European Commission, 2019), and the UK has a leading role within the sectors of offshore oil and gas, wind energy, port activities and shipbuilding and repair as outlined below. It is also acknowledged, however, that due to the departure of the UK from the European Union (February 2020), the EU BE reports after 2020 do not include any UK statistics, which is why previous reports have been utilised.

Due to it being an island grouping, the UK has a distinct sector profile in comparison to other coastal EU member states (European Commission, 2020). The UK BE primarily comprises coastal tourism, marine non-living resources (mainly oil and gas), port activities, shipbuilding and repair and maritime transport as highlighted within Table 1. It is evident that in terms of employment trends, the coastal tourism and port activities sectors predominate, accounting for two thirds of UK BE jobs since 2009. The UK BE as a percentage of national employment has remained steady around 1.5–1.7% during this period, but this masks a 19% decline in coastal tourism jobs and a 108% increase in those relating to port activities over the same period (European Commission, 2019).

At the same time, the BE is embedded in the UK national economy, as we can see from various economic indicators such as the Gross Value Added (GVA), which is a measure of the value of goods and services produced in a sector of an economy. Note that the GVA is linked to the Gross Domestic Product (GDP). Since 2009, over three quarters of the GVA generated by the UK BE sector have come from the above-mentioned two sectors, together with marine non-living resources. Although the latter (primarily offshore oil and gas extraction) continues to be a leading contributor to sector GVA, the impact of the significant fall in the price of oil worldwide after mid-2014 is apparent. The UK shipbuilding and repair sector has also experienced a revival over the last decade, with 63% GVA growth. Overall, the UK BE contributed around €2 billion to UK national GVA in 2017; see Table 1.

The contribution of the UK's BE to the national economy has been around 1.7%–2% and above the EU average as shown in Fig. 1. This is not the case for countries such as Malta (MT), Cyprus (CY), Greece (EL), Denmark (DK), Estonia (EE), which for various reasons (e.g. being maritime nations, island economies or popular tourist destinations) depend more on BE sectors.

The impact of the worldwide fall in the price of oil is shown in the decline in the share of the UK BE in the national economy, 2018 compared to 2009. Despite this reduction in the value, the UK's 2018 GVA value remains above the EU 2018 average. Fig. 2 demonstrates that when comparing each nations percentage contribution to the EU BE, the UK is the largest contributing member state in terms of GVA, followed by Spain (ES) and Germany (DE).

A potential explanation for these values could be due to the UK's leading role within the sectors of offshore oil and gas, wind energy, port activities, and shipbuilding and repair. According to European Commission (2020) the UK also leads in:

- Marine non-living resources with 73% of the jobs and 79% of the total EU-28 GVA. It is noted though that the sector is declining, mainly due to the oil and gas sub-sector.

Table 1
Evolution of the established UK Blue Economy sectors (Source: Adapted from EC (2019)).

Persons employed (thousand)	2009	2010	2011	2012	2013	2014	2015	2016	2017
Coastal tourism	247.0	243.4	243.7	219.6	233.5	195.9	175.0	191.8	201.3
Marine living resources	46.5	46.4	46.1	45.9	46.2	47.2	46.7	46.6	46.2
Marine non-living resources	40.0	44.4	44.5	48.1	44.4	44.5	44.7	43.5	43.5
Port activities	76.3	80.7	74.8	97.9	101.4	101.0	109.8	158.5	158.5
Shipbuilding and repair	45.4	41.0	38.0	42.0	40.4	44.5	42.9	50.0	50.5
Maritime transport	17.2	17.1	16.7	17.7	16.6	17.7	19.2	16.1	16.1
Blue economy	**472.4**	**473.1**	**463.8**	**471.4**	**482.5**	**450.7**	**438.3**	**506.4**	**516.2**
National employment	*28,319*	*28,290*	*28,404*	*28,650*	*28,917*	*29,559*	*30,016*	*30,424*	*30,783*
Blue economy *(% of national jobs)*	**1.7%**	**1.7%**	**1.6%**	**1.6%**	**1.7%**	**1.5%**	**1.5%**	**1.7%**	**1.7%**

GVA (EUR million)	2009	2010	2011	2012	2013	2014	2015	2016	2017
Coastal tourism	7,105	7,098	7,108	7,073	7,577	7,622	7,529	7,784	8,114
Marine living resources	2,057	1,858	1,930	2,060	2,064	2,538	2,658	2,847	2,778
Marine non-living resources	17,013	17,803	17,273	18,177	18,257	17,691	16,391	11,860	11,860
Port activities	5,262	5,127	5,050	5,405	5,665	6,208	8,246	7,466	7,466
Shipbuilding and repair	1,788	2,272	2,104	2,914	2,415	3,112	3,272	2,897	2,908
Maritime transport	2,601	2,791	2,355	2,621	2,539	3,202	3,961	2,984	2,984
Blue economy	**35,825**	**36,949**	**35,820**	**38,249**	**38,516**	**40,373**	**42,057**	**35,838**	**36,111**
National GVA (EUR billion)	*1,571.4*	*1,666.5*	*1,691.9*	*1,868.3*	*1,852.5*	*2,041.8*	*2,331.1*	*2,142.9*	*2,082.7*
Blue economy *(% of GVA)*	**2.3%**	**2.2%**	**2.1%**	**2.0%**	**2.1%**	**2.0%**	**1.8%**	**1.7%**	**1.7%**

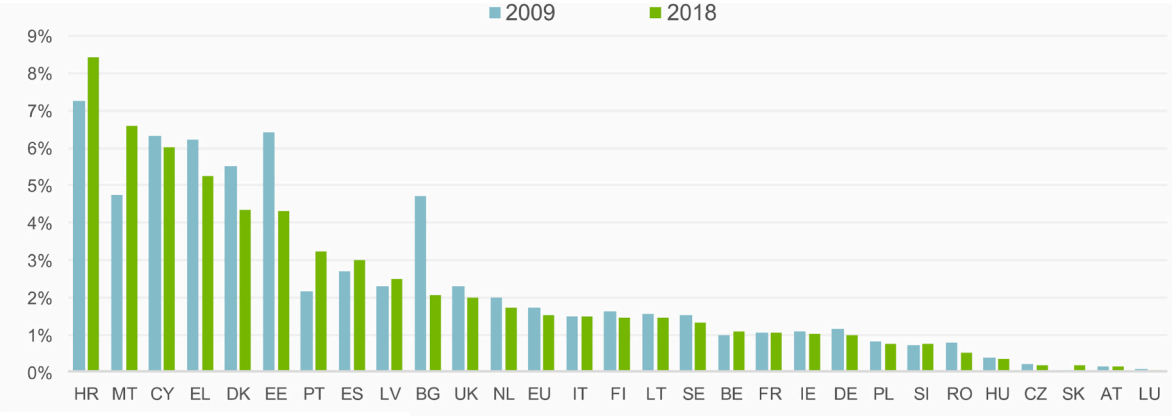

Fig. 1. Comparison of BE GVA as a percentage contribution to the member state's whole national economy from 2009 to 2018 – Source: European Commission (2020)

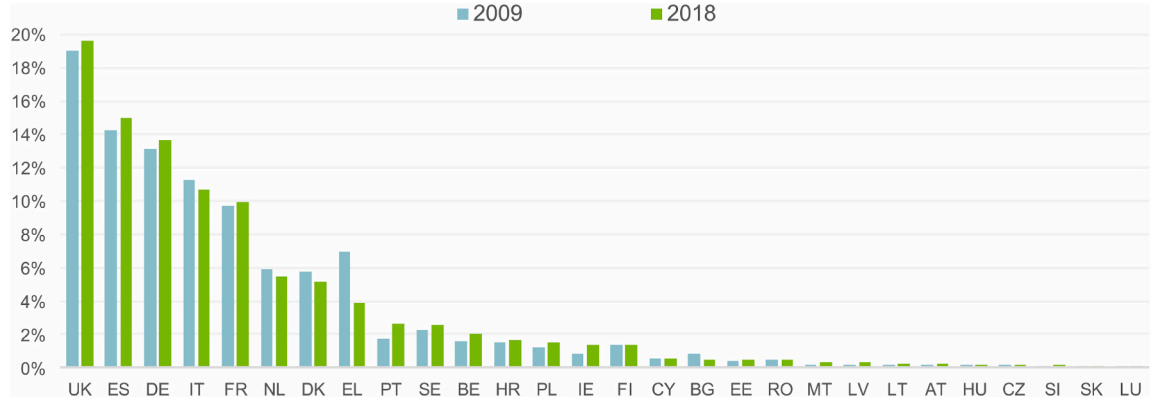

Fig. 2. National percentage contribution of each member state to overall EU-28 Blue Economy in terms of GVA from 2009 to 2018 – Source: European Commission (2020)

- Offshore wind energy with 60% of the jobs and 48% of the GVA, followed by Denmark (DK) (42% of the GVA).
- Port activities, which contributed 22% of the sector total EU GVA and generated 25% of the EU jobs.
- Shipbuilding and repair with 14% of the jobs and 21% of the GVA, followed closely by Germany (GE) with 12% of the jobs and 18% of the GVA.

At a local level within the UK, a report by the Centre for Business Research commissioned by Maritime UK Centre for Economics and Business Research (CEBR) (CEBR, 2019) isolates the regional breakdown of GVA directly contributed by the maritime sector; see Table 2.

The report focuses particularly on maritime activities and excludes coastal tourism; therefore the total contribution of the BE is not presented. The regional breakdown of GVA shows that London, Scotland and the South East accounted for the largest direct contributions to GVA in 2017, and that these three regions contributed 68% of the total UK maritime sector GVA.

At the same time, Table 2 demonstrates particularly clearly how the areas of the UK that are Atlantic Ocean-facing and known as Atlantic Areas (AA) (such as North-West England, Scotland and South West England) rely on the GVA contribution of the BE. The potential for further GVA growth generated by innovation and technological advances is therefore important for these regions.

The report also provides some interesting insights on the major maritime activities. The majority (66% in 2017) of UK maritime-related GVA was found to be contributed by the shipping and marine engineering and scientific industries. The shipping industry is considered to include the activities related to the transportation of passengers (cruise and ferry) as well freight (bulk, container, gas and tanker). The marine engineering and scientific industry consist of sub-sectors such as shipbuilding, marine support activities for offshore oil and gas, marine science and academic activities (including technical consulting).

Table 2
Regionally focused breakdown of GVA added by the maritime sector. Adapted from CEBR (2019).

UK Region	Direct GVA (£ million, 2017)	Percentage
Scotland	£3,700m	22%
Northern Ireland	£220m	1.3%
North West	£1,300m	7.8%
West Midlands	£180m	1.1%
Wales	£260m	1.5%
South West	£1,400m	8.4%
North East	£270m	1.6%
Yorkshire and the Humber	£550m	3.2%
East Midlands	£140m	0.8%
East of England	£1,000m	6.1%
London	£4,600m	27%
South East	£3,300m	19%

Note: Figures subject to rounding to nearest £100 million.
Data source: UKCoS, British Marine, PwC, FAME, ONS, CEBR analysis.

Finally, an interesting post-Brexit fact highlighted in the same report is that maritime professional services such as the ones related to shipbroking, insurance, financial and legal services in the UK have been *"remarkably and reassuringly resilient"* (CEBR, 2019). The report notes

"UK is central to the facilitation of global trade from the fixing of the ship, the contract law, the insurances and when things to go wrong the dispute resolution, facts that we all should be justly proud of". The report also highlights that the UK is a major hub for maritime education, as evidenced by its leading training programmes and apprenticeships.

Indeed the UK is considered to be one of the largest centres for maritime business services globally. According to a report, commissioned by the City of London Corporation and produced by PricewaterhouseCoopers LLP (PwC) the UK has a global market-eading share in insurance (35 per cent share of global marine insurance premiums), shipbroking (26 per cent of global revenue) and law (25 per cent of maritime legal partners practice in the UK) (City of London Corporation, 2019).

The above highlights the importance of the BE for the national and the global economy and the country's leading position in the maritime sector. The potential for further sustainable BE growth generated by innovation and technological advances makes the UK an ideal case study for an investigation of the 'triple helix' (TH) collaboration model torealise this potential.

1.3. BE technology transfer for future innovation: the state of the art

The role of research in developing a BE is essential. This was highlighted in the 2012 UN BE concept paper, which states that a science-based approach *"commencing with the initial assessment and critically the valuation of the blue capital at our disposal"* is essential to provide a sound basis for informed decision-making and management.

It is believed that research and innovation are important in developing and accelerating the BE of any country. A recent communication by the European Commission (European Commission, 2020) calls for a paradigm shift to a 'sustainable BE', which will create tangible opportunities for new jobs and businesses. It is claimed that these will be created by *"work to mitigate the impacts on oceans and coasts to build a resilient economic model based on innovation, a circular economy and a respectful attitude to the ocean"*. Research and innovation are considered essential for achieving EU's ambition; the role of investment (private capital as well as EU public funding) is also highlighted. According to the EC communication, marine and maritime research and innovation are essential *"for achieving the EU's ambition to become climate-neutral by 2050, for protecting and restoring marine ecosystems and for making the blue economy a font of ideas and action to generate sustainable innovation"* (European Commission, 2020).

1.3.1. Triple helix (TH) model

Investments to innovation and to drive technologies out of academic institutions is a key challenge for many Atlantic Area countries such as UK, Ireland, France, Spain and Portugal.

To that extent, successful interaction between industry, academia and the government is vital for effective technology transfer and a key enabler of a sustainable BE. This concept follows an established model known as the TH model (Cai and Etzkowitz, 2020; Todeva, 2020).

The model of TH innovation, which was first theorized in the 1990s (see Etzkowitz and Leydesdorff, 1995), describes how TH actors (i.e., industry, government and universities) can interact to foster economic and social innovation and development. According to Ranga and Etzkowitz (2013), the overall function of TH systems – knowledge and innovation generation, diffusion and use – is *"realized through a set of different activities (i.e., TH strategies) in the knowledge, innovation and consensus spaces*". As a result of the extensive research on the topic, there is now a fine-grained view of the interaction between the TH actors and the circulation of knowledge flows and resources within the above-mentioned spaces, which can help identify barriers and gaps.

Interested readers are referred to Ranga and Etzkowitz (2013), and Galvao et al. (2019) for an exhaustive review of the relevant literature. The latter presents a systematic review of more than 190 papers on TH. This knowledge provides a solid background to our research.

On the other hand, the literature that directly links the TH model with BE is rather scant. Lambrou (2016) reviews the development of maritime clusters, discusses their role in fostering innovation and transferring knowledge between stakeholders. The paper argues that the TH framework constitutes the proposed institutional and relational basis for efficient cluster adaption/transformation. Sampaolo et al. (2021) suggest that Qingda, an exemplary city included in the BE Zone of the Shandong Province in China, is built on a TH, where the Chinese government holds a leading role. More precisely, they argue that innovation systems need to go beyond a TH model and must include a fourth helix represented by civil society.

There are indeed some studies that suggest expanding the traditional TH model to include more players and/or aspects; see for example the Quadruple/Quintuple Innovation Helixes as presented in Carayannis and Rakhmatullin (2014). These models place a stronger focus on cooperation and, in particular, *"the dynamically intertwined processes of co-opetition, co-evolution and co-specialisation within and across regional and sectoral innovation ecosystems"* (Carayannis and Rakhmatullin, 2014). Quadruple helix models have variously added to civil society, green sustainable resources, eco-innovation, smart cities etc. The existing versions of these multi-helix models are slightly modified versions of the classical TH concept. In this paper, we investigate the TH model for UK BE innovation transfer and consider the other possible elements when designing the questionnaire.

1.3.2. Environmental impact of BE and technology transfer (TT)

To add further complexity, in addition to meeting academic, industry and governmental drivers, the climate crisis (Intergovernmental Panel on Climate Change, 2018) demands an urgent and renewed commitment to decarbonisation. Shipping sector emissions have increased by over 70% since 1990. In response the International Maritime Organisation (IMO) — the specialized agency of the United Nations (UN) regulating maritime transport — has set out ambitious goals to halve greenhouse gas (GHG) emissions by 2050 compared to 2008 levels (IMO, 2018).

By comparison, Transport and Environment (T&E) (Transport and Environment T&E, 2018) offers a literature review for the decarbonisation of shipping energy systems and analysed solutions to increase energy efficiency. Initiatives to continue to reduce these emissions include the 'Get to Zero' coalition of over 150 countries aimed at the design, manufacture and implementation of zero emission vessels by 2030. Further to this, there is an aim for these vessels to be powered by zero emission fuel (Energy Transitions Commission, 2020; Global Maritime Fund, 2020). The UK government has produced a number of reports that have all highlighted how the incorporation and utilisation of technologies will play a vital part in decarbonisation strategies to mitigate climate change. Examples include the 'Review of UK Shipping Emissions' (Committee on Climate Change, 2011), 'Clean Maritime Plan' (HM Government, 2019a), and the 'Port Air Quality Strategy' (HM Government, 2019c).

The maritime industry is coming into an era for technology to thrive but due to safety, market volatility and an intensely competitive environment, it faces many barriers to technological advances (Lam and Wong, 2018). Research in this sector has continued but innovations and novel products are getting lost in academic and research institutes. This is complicated further by the commercialisation journey within the maritime and marine industry (MMI), which from conceptualisation to fruition of a fully commercialised product or service is disjointed and problematic. The complexities and obstacles surrounding early stage technology development have also been highlighted for marine technology (Shenoi et al., 2015) and ocean energy (Magagna and Uihlein, 2015). Countries around the world are also turning to the BE to sustainably develop, where the impact is demonstrated in China (Wu et al., 2020), Bangladesh (Sarker et al., 2018), Timor Leste (Voyer et al., 2020) and other Asia-Pacific island countries (Bhattacharya and Dash, 2021).

The motivation and roles of the key stakeholders in delivering UN SDG 14 is vague and more research and inquiry are needed to identify

the expectations of these key stakeholder groups (Lee et al., 2020). In mapping the journey towards balancing environmental and economic concerns within the BE, the 'collective voice' of industrial stakeholders worldwide has been captured to explore the pathways to decarbonisation (Shell and Deloitte, 2020) and the opportunities for increased competitiveness afforded by the digitalisation of the maritime industry (Gkerekos et al., 2019). These provide high-level insights at the global level, but what is missing is a practical direction on how TH stakeholders within the United Kingdom (UK) can achieve this.

The aim of this research is to identify the differing motivations of the TH actors in the UK, in terms of the awareness, exploration and adoption of novel technologies that can contribute to the realisation of the BE. From this, points of development and adaptation are suggested for how TH stakeholders can be better aligned for future technology development. Qualitative and quantitative data collection techniques from questionnaires and round-table discussions were conducted to understand maritime-related cross-sectoral technology transfer in the UK.

Section 2 outlines the methodology utilised for each of the TH stakeholder groups. Section 3 presents the results and discusses what they represent overall, and from different stakeholders' perspectives. Section 4 describes the suggestions for further investigation based on the dicussions of the results, while Section 5 summarises and concludes the paper.

2. Methodology

The selected methodology within this paper is based upon the analysis of data based on a preliminary questionnaire (see Section 2.1), followed by facilitator-led round table discussions (Section 2.2). These discussions took place during a national workshop, which had been convened to understand and improve the potential for innovation within the UK maritime and marine industry. Very selective representatives from the government (including innovation centres funded by the government), industry (including clusters and associations) and academia (i.e. the 'Triple Helix' actors) came together to identify needs, trends, priority BE sectors and policies.

2.1. Questionnaire design

The design followed a classical approach to conducting research (Newing, 2010). An integrated questionnaire was developed to collect data using two different methods: rating scales (where the participants have to indicate to what extent they agree or disagree with a statement) and open-ended questions (where they provide answers in their own words) were used (as utilised within Orr et al. (2017)).

The study population was selected following a non-probability sampling strategy. A targeted sampling i.e seeking out individuals who are most relevant to the study, followed by snowball sampling i.e. the identified individuals were asked to identify other potential subjects. This is a common approach for studies that focus on specialists that are scarce and hard to identify (Newing, 2010).

The selective participants included: 3 governmental officials from transport and maritime backgrounds; 5 academics with specialisation in maritime, transport, critical infrastructure technology and development; 4 industry specialists from transport and energy companies and 3 consultants from industry knowledge transfer (IKT) organisations (i.e. not-for-profit, technology and innovation centres funded by the government) with a focus on decarbonisation and transport innovation. These participants were representative of the knowledge base in the UK in terms of BE technology innovation and transfer. Each of the 15 participants of the UK workshop was given the questionnaire, which was completed at the start of the workshop.

The questionnaire (Table 3) explores user experiences regarding innovation in the maritime sector, focusing on the usefulness of current opportunities and engagement between the TH. The survey is split into three key topics:

Table 3
Questionnaire outline.

Question. No.	Question	Response
Topic 1 - Relationship between government, academia and industry		
1	How satisfied are you with current key aspects that enable a successful collaborative project between Academia and Industry (in the sense of knowledge transfer and technology commercialisation)?	7 Point Likert Scale From 1: You consider them to be extremely unrealistic to 7: You consider them very suitable for real needs of the region/country
1a	If you selected a rating of less than 6, please list two key aspects that enable a successful collaborative project between Academia and Industry.	Open-ended
2	Please list the key aspects that caused unsuccessful collaborations between Academia and Industry.	Open-ended
3	List the professional and personal skills necessary for the successful establishment of Knowledge Transfer collaborations between Academia, Industry and government?	Open-ended
4	To what extent do you consider that Academia is well prepared and equipped (ex: administrative staff, infrastructure, procedures, researchers' attitude regarding commercialisation, organisational culture etc) to establish collaborations with industry and government?	7 Point Likert Scale 1: Not at all to 7: completely
4a	If you selected a rating of less than 6, please list two reasons for what could be improved to establish collaborations.	Open-ended
5	What about Industry/Business – is Industry prepared to work with Academia? To what extent do you consider that industry is prepared to work with Academia	7 Point Likert Scale 1: Not at all to 7: Completely
5a	If you selected a rating of less than 6, please list two reasons why you feel that Industry are not prepared to work with Academia	Open-ended
Topic 2 - Best practices in Knowledge Transfer and Innovation		
6	Please list what are the main barriers for technology transfer in the UK.	Open-ended
7	Please list what are the main enablers for technology transfer in the UK.	Open-ended
8	What are the most important services offered by Technology Transfer Institutions in the UK?	Open-ended
Topic 3 – Knowledge transfer and innovation policies		
9	To what extent are you familiar with the current national innovation policies? Especially the ones applicable to the Blue Economy?	7 Point Likert Scale 1: Not at all to 7: Completely
10	What do you consider to be lacking in terms of innovation incentives at a national level?	Open-ended response
11	To what extent is innovation management addressed by policymakers on a regional and national level?	7 Point Likert Scale 1: Not at all to 7: Completely
12	List the main pain points of the current national strategy for Research, Development and Innovation? What would you change?	Open-ended
13	What are the constraints in terms of policies in your point of view? If any, please explain which ones	Open-ended

1. Relationship between government, academia and industry
2. Best practices in knowledge transfer and innovation
3. Knowledge transfer and innovation policies

2.2. Round table discussion

Further to this, the same respondents who took part in the questionnaire in Section 2.1 were also involved in round table discussions, structured and led by a mediator on each table. These tables had mixed participants from all the stakeholder groups (government, academia, industry and IKTs), which provided a varied and enriched discussion for each of the topics. The following tasks were put to participants:

- Task 1: What are the needs, market opportunities and trends within UK Triple Helix (TH) stakeholders?
- Task 2: What are the main barriers of communication and relationship between TH stakeholders?
- Task 3: In your experience, what are best practices on Research and Development (R&D), technology transfer and innovation promotion activities?
- Task 4: Which are the innovation policies from Research, Development and Innovation (R&D&I) capacity that support and also constrain innovation development?

Utilised as a business tool to develop and articulate ideas around the Strengths, Weaknesses, Opportunities and Threats (SWOT) of different subjects, this methodology facilitates brainstorming and the development of ideas in a group context (Marilyn and Judy, 2010). The SWOT technique is intended to identify the internal and external factors that are favourable (strengths and opportunities) and unfavourable (weaknesses and threats) to achieving the objectives of the study. SWOT analysis is intended as a starting point for discussion; in this study, it sparked much discussion and debate, and complemented the round table discussions.

In the BE, this technique has been utilised in Roy (2019), Worldwide Fund for Nature (2015) and Hoerterer et al. (2020).

This method was used for the following tasks:

- Task 5: Identification and analysis of SWOT for the broader UK BE
- Task 6: Identification and analysis of SWOT for the UK TH ecosystem

3. Results and discussion

3.1. Questionnaire responses

As mentioned in Section 2.1, 15 representatives from government, industry and academia (i.e. the TH actors) came together to identify needs, trends, priority BE sectors and policies.

The questionnaire presented 16 questions, where for 5 of the questions TH stakeholders could select from a given list to gauge their response and 11 questions which were open-ended and provided answers in their own words. The analysis of these results will be split accordingly.

3.1.1. Likert scale questions

These responses gauge the respondent's feeling towards the question using a Likert scale methodology and from a scale from 1 to 7, where 1 is considered extremely unrealistic and 7 very suitable to real needs of the region/country. Frequency analysis, a descriptive statistical method that shows the number of occurrences of each response chosen by the participants, has been utilised to analyse these questions. Responses have been received by all participants, therefore in the statistics presented below (sample size n = 15). The results from these questions are found in Figs. 3–7.

Fig. 3 (Question 1) demonstrates that generally, there is reasonably high satisfaction with key current aspects that enable a successful collaborative project between Academia and Industry. The mean value from the respondents was 3.2. However, none of the respondents was completely satisfied that the current aspects are suitable within these aspects. For those that responded with a value lower than 6, aspects that could enable a better relationship between Academia and Industry included the need for "*open and clear communication*", "*more communication between the 2 sectors, speaking the same language, understanding needs*", "*understanding and acceptance of risk involved in specific projects*" and a "*better understanding of the core challenges and risks associated*". In

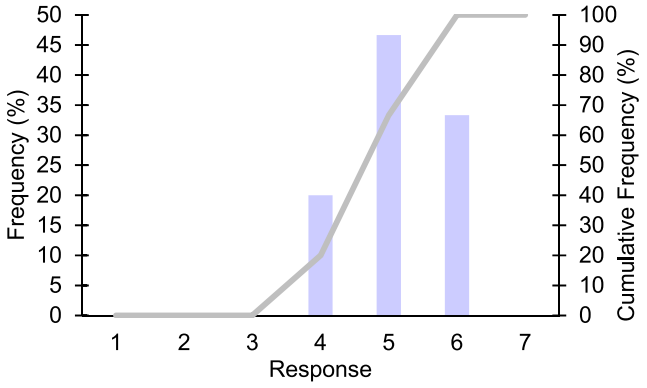

Fig. 3. Reponses to Question 1 ′How satisfied are you with current key aspects that enable a successful collaborative project between Academia and Industry (in the sense of knowledge transfer and technology commercialisation)?''

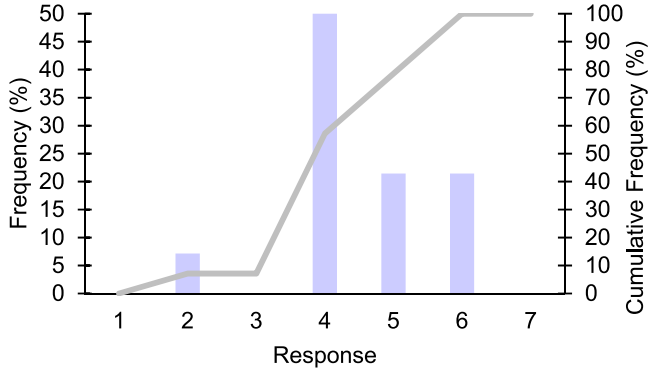

Fig. 4. Reponses to Question 4 'To what extent do you consider that Academia is well prepared and equipped (ex: administrative staff, infrastructure, procedures, researchers' attitude regarding commercialisation, organisational culture etc) to establish collaborations with Industry and government?'

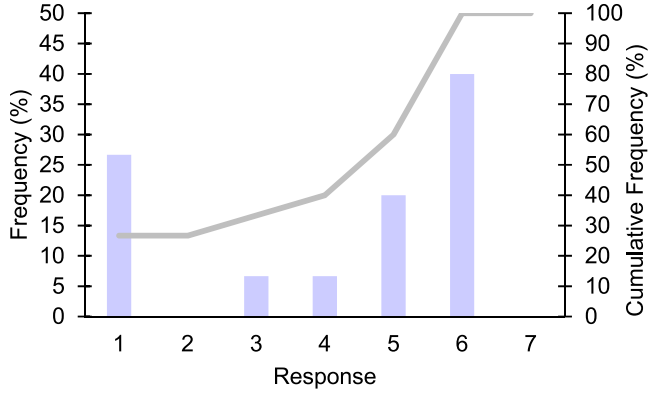

Fig. 5. Reponses to Question 5 'What about Industry/Business – is industry prepared to work with Academia?.

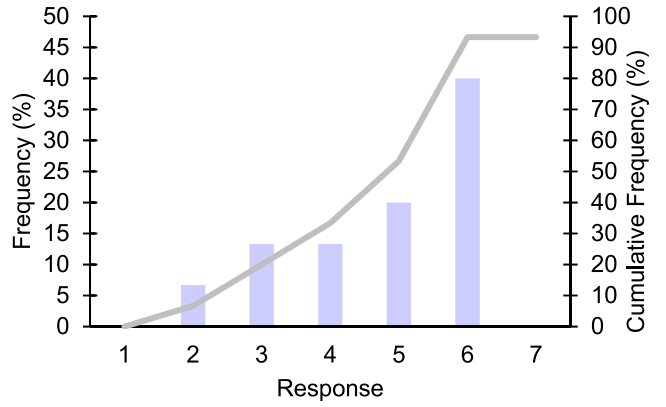

Fig. 6. Responses to Question 9 'To what extent how familiar are you with the current national innovation policies? Especially the ones applicable to the Blue Economy *?'.

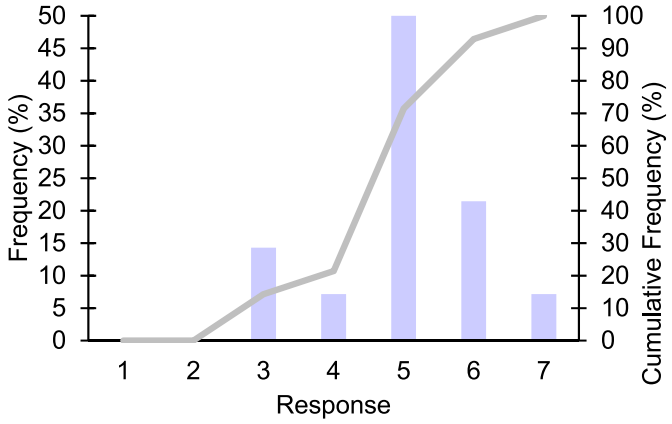

Fig. 7. Responses to Question 11 'To what extent is innovation management addressed by policymakers on a regional and national level?'

terms of improving communication and an understanding of what is really needed this demonstrates that at times, academic and industrial priorities may differ – but if they are to work together, these should be clearly highlighted and have an '*agreed and driven mission statement*'.

By comparison, Fig. 4 (Question 4) has a greater range of results than that of Fig. 3, when participants were asked "*to what extent do you consider that Academia is well prepared and equipped in terms of administrative staff, infrastructure, procedures, researchers' attitude regarding commercialisation, organisational culture to establish collaborations with Industry and government?*" - over 80% of all respondents felt that academia is *not* prepared enough for industrial collaborations. As a follow up question, those who responded with a value of 6 or less were asked for ideas of how this relationship could be improved. The key focus of the responses was associated with and highlighted the importance of Knowledge Transfer Partnerships (KTPs) being the "*commercial focus of researchers*" and the "*marketing of innovation results*". Overall, these comments generally focussed on academia addressing actual industrial needs, in addition to how these projects can be commercially and successfully implemented, rather than simply finding any solution.

When considering the responses to Question 5 "*what about Industry/Business – is the industry prepared to work with Academia?*" (the converse to Question 4), Fig. 5 demonstrates how over 25% of all respondents responded that industry is not prepared at all and with a large skew of the data demonstrating that industry is not ready to work with academia. This question was the only one where participants have selected 1 on the scale. This is a strong selection, where 25% believe that the industry is not at all prepared to work with academia. Follow-up responses to scores below 6 varied from the idea of transferability of technology and IP, to finding the correct person or institution to enable the technology to develop and specifically where to find the most appropriate funding mechanisms. Responses included "*access to the right people in the University is opaque*", "*companies too busy to think strategically and allocate sufficient time to R&D projects*", "*existence of R&D department in industry to liaise with university*" and "*knowing the available UK Government* funds *to apply for*".

Within Fig. 6 (Question 9) respondents had mixed opinions regarding familiarity with prevailing national innovation policies, especially those applicable to the BE. Although 40% feel very familiar with these policies there is a wide spread of results, which indicates there is a mixed understanding of these policies. Understanding to what extent innovation management is addressed by policymakers on a regional and national level is explored in Fig. 7 (Question 10) and for the first time in the given list responses respondents selected a value of 7 - they consider innovation management to be completely addressed. However, 50% of participants selected a value of 5, the most unanimous selection in these given list responses, indicating that whilst there is some innovation management there is still room for improvement.

3.1.2. Open-ended responses

The survey included 11 questions with free text response options, which can be categorised into the following three topics:

3.1.2.1. Topic 1 - relationship between government, academia and industry. Question 2 explored aspects of communication and sought to isolate the factors that were considered to be the cause of previously unsuccessful collaborations between Academia and Industry. Across all stakeholder groups, these factors included "*poor communication*", "*mismatched expectations*" (including time/timelines, resources, Intellectual Property rights and bureaucratic tasks), "*unclear scope/no visualisation of what success is*" (predominantly how the research results might be fully exploited by industry) in addition to "*lack of/inflexibility with* funding".

Indeed, one of the main barriers to effective collaboration between Academia and Industry is the conflict of interest between the stakeholders. Nieminen and Kaukonen (2001) provide some insights into the cultural differences between Academia and Industry suggesting that universities ignore the fundamental interest of the industry - profit maximisation. This obviously contradicts one of the main interests of research-led universities, which is the production of academic papers. More precisely, the number of quality publications and teaching time are still considered as the most important academic criteria directly affecting the promotion of academics and the evaluation of universities in the UK (Razak and White, 2015). Research outputs with originality, rigour and significance are related to the Research Excellence Framework (REF) – the system for assessing the quality of research in UK higher education institutions – the results of which determine the amount of quality research funding received by each institution from the government.

At the same time, industry needs "answers right now"; universities prefer long-term research as this would maximise their funding income and would provide support for doctoral and postdoctoral students. The latter has been highlighted in Lee (1997), who suggests that collaboration with the industry is likely to increase pressure for short-term research "*thereby affecting long-term basic and curiosity-driven research performed by universities*".

Furthermore, conflicts over IP and university administration have been identified in the literature as key barriers to university-industry collaboration. Much of the roundtable discussions focused on these issues as well; see Section 3.3. (task 2). Bruneel et al. (2010) discuss in detail what they refer to as "distributional conflicts" between universities and their industrial partners. According to this research some universities have unrealistic expectations, resulting in overvaluing IP

and setting unrealistic expectations about the commercial potential of university research. This, in addition to lengthy negotiations of IP contracts with university Technology Transfer Offices (TTO) and legal offices, acts as a deterrent to collaboration.

Responses from Question 3 underline the professional and personal skills required for successful knowledge transfer. "*Clear communication*", *"presentation skills"* and *"flexibility"* were offered by all the stakeholder groups. Table 4 demonstrates the differing expectations of successful personal skills. Whilst academia tends to focus on knowledge of the challenges faced by other stakeholders, Government, IKT and Industry stakeholders have a greater focus on commercial knowledge and understanding.

It is evident that despite some synergies such as problem definition, the diversity of the expectations from the group of stakeholders is notable. Some unique perspectives including 'collaboration hub', 'finance' and 'financial risks' from the Government group, 'tolerance of "failures", 'negotiation skill', 'good connector' from the IKT group and 'collective working group' from the industry group are identified to guide the development of future policies for knowledge transfer.

3.1.2.2. Topic 2 - best practices in knowledge transfer and innovation. The responses to Question 6 suggest that the main barriers for effective technology transfer in the UK include time, cost and "*disconnected sectors*". Communication between stakeholder groups can be weak and problematic, which consequentially means that "*the availability of technical skills and ability to implement new technology"* or *"availability of industry/academic networks with regional focus (regional cluster*)" are not visible and as a result they are often missed – to the detriment of the technology transfer. Other barriers identified included "*IP ownership concerns from both academia and industry"*; a fundamental disconnect between "*business needs vs research capability",* which inevitably creates a "*different solution prioritised by different stakeholders for their differing priorities";* and the uncertainties surrounding the UK's imminent departure from the EU.

As a counterpoint to Question 6, Question 7 looks to evaluate the main enablers for technology transfer in the UK. All stakeholders unanimously remarked on the importance of Knowledge Transfer Partnerships (i.e. KTPs, an established and proven UK programme, partly Government-funded, which enables a business to bring in new graduate skills and the latest academic thinking to co-deliver a new-to-the-business innovation project), the in-company graduate KTP Associates, and the national Knowledge Transfer Networks (KTNs). This was further elaborated by the value attached to ensuring there are "*strong academic and industry links" to ensure that the work completed within universities is intertwined with work required within the industry*. Another key factor related to the value of the available funding and support services ("financial support *from the government"* (such as '*R&D tax credits'), "UKRI" (i.e., the non-departmental public body that directs research and innovation* funding *in the UK), "Innovation Loans", "Innovate UK" (i.e., UK's innovation agency), and "Catapult centres" (i.e., not-for-profit, technology and innovation centres that connect businesses with the research and academic communities)*. A further point that was highlighted was the importance of '*de-risking technology*' to make the research potentially more commercially viable and enhancement of Technology Readiness Level (TRL). Question 8 investigates the most important services offered by Technology Transfer Institutions in the UK. As with Question 7, all stakeholders mentioned the value of KTPs as a highly-valued service. This reinforces the appropriateness of the current UK national KTP programme on BE technology transfer. Comments suggested that these initiatives offer a means of supporting and introducing each of the stakeholders to one another in ways such as "support *in knowing how to access* funding *or commercialise technology"*, "*brokering introductions"*, "*research and evidence "link" bases*" and "*connecting different organisations"*.

3.1.2.3. Topic 3 - knowledge transfer and innovation policies. Question 10 asks participants what they understand to be lacking in terms of innovation incentives at a national level. The answers to this question were very diverse and demonstrates the importance of engaging with the different stakeholders, which is highlighted in Table 5. For example, within academia there are "*too many innovation initiatives"* but also, not enough incentives for certain technologies including "*decarbonisation and desulphurisation"*. One theme that is common to all the stakeholders is that innovation incentives are aimed at "*too large scale*" - for example: "*big players dominate the innovation [and it is difficult] for other universities to get in"*.

Question 12 explores the main pain points of the current national strategy for Research, Development and Innovation, and participants' mitigation suggestions. Main pain points include "*not sufficient"*

Table 4
Open-ended responses to Question 3.

Respondent Stakeholder Group	Response
Academia	• Good understanding of problem domain by academia and business partners objectives • Industry dominating knowledge • Academic partners' understanding of industry challenges and applied techniques • Industrial partners need to be able to abstract the key challenges with resources input
Government	• Use of data from industry • Adapt to need of industry • Collaboration hub • Finance • Understanding of different organisational priorities • Awareness of other projects related to our work • Spread financial risks of investments
IKT	• Tolerance of "failure" • Negotiation/legal skill • Commercially aware • Good "Connector"/fixer working across shop floor to director level
Industry	• Competency • Business focus-solutions/expectations • Open minded, understand industry language and needs • Collective group for ideas industries knowledge

Table 5
Open-ended responses to Question 10.

Respondent Stakeholder Group	Response
Academia	• Too many innovation initiatives • Full economic costing for KTP for example • Shipbuilding; technology to decarbonisation and desulphurisation • The cost of innovation in the industry
Government	• Lack of awareness • Lack of funding. In the maritime sector, the funding is much lower than other transportation modes
IKT	• Super-easy low-level vouchers (£10k for example) to encourage companies to dip a toe into engagement with university or RTO • Funding innovations to large scales • Demonstrators to market to jobs • More info on existing projects • Funding • Integrated view (i.e., effect of blue economy on wider economy) • Ambitions • X-sector collaborative incentives
Industry	• Limited scope and communications • Difficult to engage with some SMEs • Places with ideas or innovation meet ups • Hackathon • No links • Big players dominate the innovations, difficult for other universities to get in

promotion and a need for "*better promotion awareness*". Suggested improvements included shifting the focus of innovation to "*focus on sustainability from circular economy*", "*driving the transformation of the economy*" and having more of a "*simple mission statement*" - for example it was highlighted that "*Maritime 2050 is too large*" a document to explicitly follow. National strategy pain points could also be resolved by the suggested "*improvement of regional devolution of innovation skills*" and "*more focus and flexibility on regional strengths*".

Finally, Question 13 asks about the personal opinion of any constraints in terms of specific policies. All stakeholders cited uncertainty in its different forms. Most prevalent is funding uncertainty (in terms of quantity, competition, the time-consuming nature of bid writing and centralisation of governmental funding) and the consequential knock-on effects this may have, which are associated with political party manifestos and resulting policies, long term government strategy and inevitably, Brexit. Shared by academia and industry is the difficulty in establishing successful collaborations. Academics noted they find it difficult to "*break barriers within institutions and across other universities*" and industry professionals highlighted "*it is difficult to collaborate at all as it slows everything down*" and both parties note how there were "*too many policies and regulations from each stakeholder making collaboration almost impossible*". Finally, IKTs noted how when action plans highlight a "*need for research*" this does not always follow a strategy and can often "*not address core business needs*".

3.2. Round table discussion

The round table discussions facilitated further understanding by probing the opinions of stakeholders. These discussions combined a mix of stakeholders from academia, industry and governmental backgrounds and were chaired by a member of the project team who guided and structured the conversations around the 6 tasks outlined in Section 2.2. The collected information was processed, integrated and analysed, and the results are summarised and presented below.

When considering the contextualisation of these findings, they are in line with the literature. Interested readers are referred to Razak and White (2015) for a discussion of the enablers and barriers in implementing the Triple Helix model of innovation. Bruneel et al. (2010) present an excellent discussion on barriers, especially related to differences in the orientations of industry and universities, and barriers related to conflicts over IP, and dealing with university administration.

3.2.1. Task 1: the needs, market opportunities and trends within UK TH stakeholders

3.2.1.1. Needs. One of the main needs for TH stakeholders was the requirement for research outcomes to be communicated effectively. Although a company or research institution may have dedicated R&D resources, there is a lack of a publishing platform on which to share research outcomes. Furthermore, it was clear that academic and company priorities were at the forefront of their decision-making rather than contributing to the 'greater good' of industrial development. The contextual issues that could underpin this include Intellectual Property (IP) concerns and how commercialisation and financial gain further complicate this issue.

There was also a need for the UK maritime industry to be less 'hidden', as a previously low profile might account for the sustained lack of investment in this sector prior to 2017.

3.2.1.2. Market opportunities. When considering the main market opportunities, participants discussed that having major maritime organisations based in the country (e.g., the IMO) was extremely important for the UK. This together with a strong academic research base provides a solid research and regulatory foundation for major sectoral technological advancements. Other opportunities for the UK maritime sector include the potential to integrate cross-disciplinary emerging technologies. Examples of these technologies include sensors and Artificial Intelligence (AI) and could be very strategic (HM Government (2019b) – when contemplating the application of these technologies, it led to a discussion of opportunities for the maritime sector in the sustainability agenda and decarbonisation. Industry could potentially meet the IMO GHG emission goals (IMO, 2020) by taking more of an active role in the circular economy and developing a deeper understanding of how creating jobs in these fields would boost the industry. Finally, there was widespread consensus across all TH stakeholders that the UK's KTP scheme is a long-running, proven and successful mechanism. The potential for KTPs to realise some of these opportunities was a well-received discussion.

3.2.1.3. Trends. In terms of trends, stakeholders discussed how multimodal logistic chains are becoming more of a popular option, and specifically how transport options can be adapted and interchanged in receiving shipments is helping to boost sustainability. While cross-sectoral collaborations on new technologies were raised as 'trending' it was also highlighted that the specific application of these technologies to each TH stakeholder group is where the difficulty lies.

3.2.2. Task 2: main barriers to communication between TH stakeholders

The discussions centred around three main issues - IP concerns, non-beneficial to industry research products and connectivity between different stakeholders; see also discussion in Section 3.1.2 (Topic 1). IP concerns focused on the protection of projects where multiple parties are involved, where aspects of the ownership of the innovation lies with each participant and how the IP is managed after a project is completed. The application and validation of research were raised as a communication barrier, as the different stakeholders have different priorities when approaching the research task. Academics focus on research output in terms of publications and research impact, whereas industrial partners have more of a profit-driven motivation towards the project.

3.2.3. Task 3: best practice in Research and Development (R&D), technology transfer and innovation promotion activities

The discussion focused on the UK Catapult network as "*Catapult helps SMEs apply for UK* funding *bids*" and how this was a "*bridging function*". Further to this, it was also noted how Catapult UK also enabled Academia and ndustry to connect and function in the same spaces. In terms of funding, it was also highlighted how Innovate UK plays a pivotal role for industry accessing funding for innovation activities.

3.2.4. Task 4: which are the innovation policies from research, Development and Innovation (R&D&I) capacity that support and also constrain innovation development?

Participants mainly highlighted that macro-political and economic conditions such as Brexit could be a constraint to innovation and growth due to the uncertainties of what is going to happen. There also needs to be a change in the 'speed of response', which ties into the notion of flexibility and a positive outlook regarding the idea of change. Participants also utilised this discussion to consider how there should be a greater focus on regional strengths and opportunities. As a result, a 'one size fits all' approach is no longer relevant and greater efforts should be made to enhance regional areas of industrial expertise and assets.

3.2.5. Task 5: Identification and analysis of SWOT for the broader UK blue economy

A major theme that was built upon was the position of the UK as an island and its consequent reliance on the BE for trade. In fact, according to HM Government (2019a), the maritime sector facilitates 95% of UK trade and despite being on an island, the UK public is 'unaware' of how impactful the maritime industry is on the country. This might be true for the general public (especially people not familiar with the industry); a

possible explanation is that the UK BE is neither a top GVA contributor nor a top industry by employment (see Section 1.2).

There are strengths, weaknesses, opportunities and threats associated with being an island trading nation. Some of the weaknesses that are outlined in Table 6, notably "*other governmental priorities to other larger economic sectors*"', could be mitigated by taking advantage of the opportunities associated with the BE in the UK. For example, "*digitisation and requirement for change to advance*" and the maritime industry having an opportunity to '*decarbonise and a low carbon future to align with circular economy and environmental pressure*"' will accelerate the adoption of cross-sectoral technologies and applications. This will demonstrate to the Government that it cannot focus on a few sectors and must consider them more holistically.

Overall, the analysis is in line with our findings and the literature. Eurostat data shows that the UK is a leading European BE - the largest contributing member state in terms of GVA (see Section 1.2). At the same time, the UK is considered to be one of the largest centres for maritime business services globally (CEBR, 2019; City of London Corporation, 2019). On the other hand, there is much uncertainty related to Brexit; access to EU funding has been limited and there is some evidence of declining trade with the EU.

As outlined in Table 4 as issues, transparently outlining and setting new project objectives will ensure all parties understand what is expected of them, ensure the power dynamics are addressed effectively and build a relationship of trust. Further to this, it will also ensure that from the beginning of the project there are clear partnership objectives that will clearly define what project success and failure look like.

3.2.6. Task 6: Identification and analysis of strengths, weaknesses, opportunities and threats (SWOT) for UK TH ecosystem

Participants' responses to this question are summarised in Table 7. There is clearly a base of potential opportunities for the UK within the TH ecosystem. Some of these opportunities intertwine with the threats such as Brexit uncertainty and post-Brexit opportunities. Some of the strengths can be utilised to minimise the weaknesses highlighted. For example, "*lack of cross-university collaboration*", "*lack of investment in UK maritime*", "*lack of commercialisation of projects*" and "*degree of fragmentation of efforts*" could be relieved by harnessing and utilising the already '*established maritime industry*" and "*good maritime academic research*" and "*innovation and expertise*". Whilst these weaknesses can be minimised they cannot be eliminated without any kind of intervention. Similarly, the core strengths of the UK TH stakeholders' ecosystem has to be harnessed to utilise and maximise the opportunities outlined within the round table discussions. A potential example of how this could be achieved are opportunities such as "*transferable technologies/skills*", "*lots of initiatives and innovations*" and the "*low carbon future*" can all be addressed through hosting "*headquarters of regulators/industry stakeholders/associations*". As these institutions are based within the UK, it is logistically easier to harness their attention and influence once the technologies have been developed.

Table 6
SWOT Analysis for the whole of UK Blue Economy.

Strengths	Weaknesses
• As an island, the UK is dependent on the maritime industry for international trade • Competitive • Strong and historical connection and expertise within the maritime industry and organisation	• National and governmental fragmentation and lack of accountability • Other governmental priorities to other larger economic sectors such as manufacturing or construction • Despite being on an island, the UK public is 'unaware' of the impact maritime has on the country • Procedures, policy and markets are difficult to change
Opportunities	**Threats**
• Digitisation and requirement for change to advance • Decarbonisation and low carbon future to align with circular economy and environmental pressures • High quantity of goods movement dependent on the maritime industry	• Brexit (Access to funding, imports/exports, economic uncertainty) • Other major seaport competition in the EU • Climate change • Lack of training of staff due to digitisation/decarbonisation • Government strategy (or lack of, long term)

Table 7
SWOT Analysis for UK TH stakeholders ecosystem.

Strengths	Weaknesses
• Innovation and expertise • Good maritime academic research • Headquarters of regulators/Industry stakeholders/associations • Established maritime industry base (strong businesses) • Cross-sectional expertise/talent base in emerging technologies (e.g. sensors)	• Lack of commercialisation of projects (due to wider issues such as IP, legal reasons or misunderstanding each other) • Lack of cross-university collaborations • Degree of fragmentation of efforts (insufficient focus on innovation competition/funding) • Risk/change averse shipping companies • Direct port calls • Port size constraints • Low on the priority list • Maritime image nationally – public don't appreciate size, breadth or importance • Lack of investment in UK maritime
Opportunities	**Threats**
• Cross sectoral expertise • Transferrable technologies/skills • Lots of initiatives/innovations KTP institutions • The UK strategically located • We do have the expertise • Closely located to decision makers (IMO, IACS etc.) • Container vs Ro-Ro after Brexit • Competition from other countries makes us focus more on doing research • Post-Brexit logistics patterns • Modal shift to coastal as shipping is not a pollutant (waterborne freight options from a systems perspective) • Optimizing existing KTI infrastructure usage (MarRI-UK etc) • A change of public perception (with green maritime/career options) • Coastal communities collaborating around common challenges • Low carbon future	• No main hub • Perception from shippers (have different designs of their network) • Not really considered as a maritime knowledge provider • Economic downturns and resulting governmental policy • Brexit uncertainty • Availability of European funding

4. Future directions

It is clear that there are still further developments that have to occur for networks and partnerships to not only survive but thrive. Whilst this paper has outlined the current position of TH stakeholders in the UK maritime sector, it is important to understand what could be undertaken in the future to enhance working relationships. To do this, this paper suggests some potential future directions to enhance technology transfer innovation within the UK BE.

4.1. Best practice and failure reporting

Inevitably, as these relationships form there will be some instances when elements of a project will fail. Understanding failure and the potential 'forensic style' investigation of what has happened could be very useful for future project development and decision-making. This would also enable an informed bottom-up approach and highlight if there is a pattern of failure and how this cycle might be broken. In turn,

understanding failure will enhance performance and best practices.

Another potential opportunity for TH stakeholders is to connect best practices and the development and production of a well-informed collaboration strategy. This best practice and failure reporting forum would give academia more opportunities to enhance their business focus and better align with industry and industry to develop a greater understanding of academic capacity and ability. Within the UK there is such a great amount of potential due to the presence of major sector bodies such as the IMO and an active research base in industry and universities. There is the potential to build on regional strengths and assets to develop "locally grounded but globally scaled directions" (Lee et al., 2020). When stakeholder collaboration occurs at a local level, both accessibility and depth of understanding can be realized and fundamentally understood – particularly when the project partners are so directly invested in the success of the project.

4.2. An online, comprehensive funding platform

Finally, to be able to mobilise these localized collaborations or even initiate any kind of partnership, a major factor is the sourcing of appropriate funding (qu.13, Table 3). A key comment was that there was simply 'too many initiatives' and it therefore became unclear and at times misleading where best to apply. Although the focus here is specifically UK funding streams, there is a clear opportunity to expand this solution to other countries. In the UK, services such as UKRI, innovation loans, Innovate UK, Catapult centres, Newton Fund and government R&D tax credits are well used by some, but not always accessible. In addition, the government also produces large and wide-ranging strategic plans such as Maritime 2050 (HM Government, 2019b). However, these are high-level documents that exclude details of key funding streams. This opens up the potential for an overarching platform to ease the navigation of funding options and where sector and TH stakeholders can both advertise funding but also invite partnerships with other companies, industries, institutions and governmental agencies. Such a development would both improve the 'visibility' of the UK maritime industry and enhance and structure cross-sector collaboration.

5. Conclusion

To understand and gauge TH stakeholders' opinions, a questionnaire was designed, which was composed of free text and quantitative data responses in addition to round table discussions. The results highlighted the need for further research with TH stakeholders to develop systems, partnerships and funding schemes that are functional for all parties involved. Further to this, there are missed opportunities for cross sector collaboration and alignment with central governmental strategy. When considering the overall results from these questions, it is clear that there was definitely a mixed perception of whether academia is well prepared to establish relationships with industry and government (Fig. 4) but also, the reciprocal and the preparedness of industry to work with academia (Fig. 5). It was also evident that there is work to be done to improve relationships between TH stakeholders.

Going forward an improvement of the methods of communication are urgently required. It needs to be clearly understood that the differences between TH stakeholders will be an asset and a key driver for success if effective inter- and cross-sectoral relationships are to emerge. The utilisation of the different resources, and associated perceptions of risk and time will be imperative to the triumph of any new project.

Academia is not optimally prepared for industrial relationships (Fig. 4). To improve on this, commercialisation experience and empathy for the pressures of the private sector must be developed within higher education institutions. Further to this, from both industrial and governmental partners it was clear that academics need to have a business-focused approach to industrially-led research projects. Whilst academic and industrial priorities may not always align, in terms of KTPs, academics need a greater awareness of the project focus to solve an actual industrial need or requirement, rather than simply "furthering knowledge".

Reciprocally, Fig. 5 considers the lack of preparedness of industry to work with academia. Key problems have involved difficulties finding the right people or academics to work with and associated bureaucracy, the timeline is difficult to understand and which governmental funds to apply for (as there are so many). Across the group there is mixed awareness of the current national BE and wider governmental national innovation policies – highlighting there is still more that needs to be done to bring everyone up to the same level.

What has been evident from engaging these TH stakeholders is the importance of the structure and framework that KTPs and KTNs provide for industrial/academia collaborations. However, in their current state, these collaborations still need some key improvements to make them effective for all stakeholders, such as an inherent commitment to improving an understanding of timelines and visibility of funding. In terms of improving the complexities surrounding funding, visibility is twofold - how the money is accrued and what funding stream will be utilised and applied for, and how the money will be spent throughout the duration of the project. This transparency and greater input of detail at the start of each project should inherently improve major themes highlighted within this paper such as communication problems/skills and IP concerns. Utilising and implementing these suggestions could help to enhance and improve TH stakeholder engagement and on-going relationships.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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