**The Energy Sector Changing Landscape: The importance of understanding resilience in the Marine Energy supply chain.**

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**Introduction**

Supply Chain Management theory explores the importance of understanding and responding to uncertainty and risk within our supply chains, which is critical when needing to examine and challenge the ‘Business as Usual’ environment. Recently key events such as Covid, BREXIT and the Suez Canal disruption in 2020 have emphasized the importance of developing resilience strategies within our supply chains. Evidence suggests that although numerous projects are being implemented in the UK to harness Marine Renewable Energy (MRE), they are often subjected to a range of challenges from, establishing required supply chain capacity for the manufacture and implementation to the ongoing maintenance and monitoring. Supply chains of relatively new and technologically advanced products, such as MRE technologies, are more complex and vulnerable to challenges, risks and disruptions (Noble et al, 2021). This can be due to several factors contributing to increasing the probability of exposure to risks and their associated impact on the supply chain.

The changing landscape in our energy infrastructure and sourcing was emphasised by the Welsh Government announcement that they had a target for 100% renewable energy by 2035 (BBC 2023). Previous research has indicated concern regarding the MRE sector’s readiness to respond quickly to rapid growth in demand and the impact of capacity availability to respond (Mason-Jones et al, 2019) and therefore the increased sensitivity and impact of disruptive events. This has reinforced a call for a better understanding of how to improve supply chain resilience in the marine energy sector. The future resilience of the MRE supply chain sector, depends on adopting a dynamic, responsive holistic strategic approach in response to uncertainty and risk. The study aimed to explore the concept of supply chain resilience behaviours within the MRE supply chain and explore opportunities for improvement strategies.

**Keywords**: Supply chain management, resilience, uncertainty, risk management.

**Relevant background information**

Supply chains are complex and dynamic multi-level structures consisting of diverse entities and configurations ranging from simple forward-flow production distribution networks to closed-loop systems (Sazvar et al., 2021). In the UK, the economic viability of generating electricity from Marine Renewable Energy (MRE) and surviving in a competitive energy market relies to a great extent on the performance of the UK’s energy supply chain. The challenges associated with the MRE sector, such as materials, manufacturing, grid connection, logistics and skilled staffing present significant risks and uncertainties which impact the ability of economic growth and financially viable levelized costs of energy. It is also recognised, in the case of relatively new technological solutions, that the likelihood of uncertainties and disruptions to the supply chain is relatively higher, compared to existing energy sources (Hoffman, 2013). Therefore, introducing innovative interventions to improve supply chain resilience in the MRE sector from the outset is critical to ensuring its long-term sustainability especially within a rapidly changing landscape. Although the likelihood of risks to the supply chain has increased in recent years, the adoption of measures in response to those predicted risks has been low in practice (Sazvar et al, 2021).

It is vital that companies throughout the supply chain incorporate measures to improve resilience into their business practices and thereby also reinforce the resilience of the wider supply chain. A better understanding of which risks are experienced by supply chain companies and what measures are in place to address them are key to initiating the process. One distinctive characteristic of a resilient supply chain is its ability to recover from adverse effects when subjected to operational risks and disruptions (Craighead et al., 2007; Khalili et al., 2017; Sheffi, 2006; Tang, 2006). The first step towards designing a resilient strategy involves identifying the low and high-probability risks that could potentially disrupt the supply chain system.

The viability of expanding the Welsh MRE sector is reliant on highlighting the importance of understanding and identifying which areas of the supply chain are exhibiting resilience behaviour and instigating learning from those examples of good practice, as well as identifying where there are opportunities for improvement.

**Research Approach**

The project had four distinct stages of work as outlined in Figure 1. Stage one and two focused on data collection and Stage three and four focused on application and dissemination. In Stage one, we undertook an in-depth scoping study to explore the context of the research project analysing academic literature and policy documentation focused on the MRE sector. Stage two consisted of three phases of work outlined in Figure 1 that interlinked to provide a sound body of evidence in which to advance the project forward to Stage three of the study. Stage three consisted of collecting and synthesising the information and data obtained from Stage two to develop a resilience measuring tool that would enable organisations to explore their supply chain resilience behaviours and identify opportunities for improvement. Stage four of the project was focused on the dissemination of results and engagement with the research and industrial community.

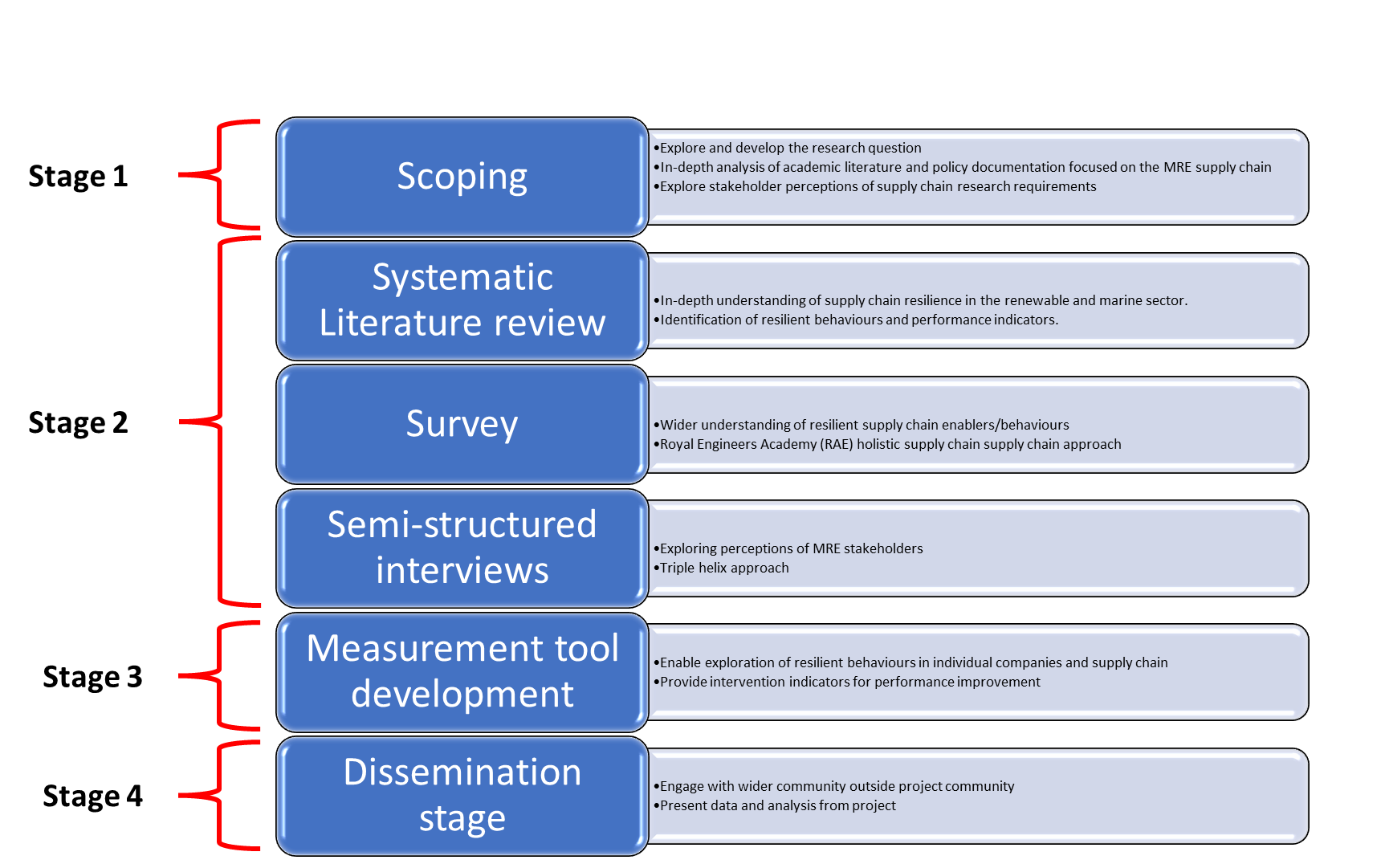


Figure 2: Four stages of the MEECE project include (a) Stage 1: Scoping; (b) Stage 2: Data collection; (c) Stage 3: Measurement tool development; and (d) Stage 4: Dissemination.

**Discussion (including results where appropriate)**

The research enabled us to develop a supply chain resilience tool which we named the Resilience Barometer. Utilising the structures and the methods of the Organisational Learning Capability (OLC), Group Consensus Theory (GCT) (Thomas et al, 2018) and Supply Chain Quick scan (Naim et al, 2002) tools, a prototype resilience measuring tool was developed, this tool is termed as the ‘Resilience Barometer’ (RB) as it provides a measure of a company’s resilience under changing conditions. The Resilience Barometer (RB) has been designed so that it can be used within a single organisation to provide a resilience readiness profile that is constructed from the analysis of thirty key resilience variables highlighted later in this report. However, it is more powerfully utilised with a group of companies to explore a linked supply chain readiness map (allowing the readiness maps of a series of companies to be measured and a collaborative approach to optimisation can therefore take place). The tool enabled the team to understand the current overall supply chain resilience performance of companies in Wales and identify areas of good practice within companies but also identify areas required for improvement so targeted interventions could be actioned.

**Conclusions/implications**

Undertaking the supply chain resilience research highlighted the need for a measurement tool which could be utilised by the MRE sector to examine and instigate improvement interventions to improve its resilience to ensure it implements robust strategies and engages in resilient practices throughout the supply chain. The Resilience Barometer has been trialled and now needs to be applied within organisations. The research and continued application of the Resilience Barometer offers an opportunity to develop innovative supply chain development strategies focused on resilience behaviours and performance. Establishing and managing resilient supply chain strategies enables the Welsh MRE sector to close the gap between supply and demand by ensuring the supply chain is in a position to confidently respond to risks and disruptions as well as focus on the challenges of capacity growth and increasing competition.

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