Supply chain strategies as drivers of financial performance in liquefied natural gas networks

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Abstract

Purpose - This study aims to identify and evaluate supply chain strategies (SCS) that drive financial performance to guide practitioners, especially in liquefied natural gas (LNG) networks, to review and adopt SCS that drive competitiveness and value creation for investors.

Design/methodology/approach - Analytical hierarchy process (AHP) was deployed to prioritise SCS according to their relative impact on financial performance in LNG networks. Interviews with experts were analysed using template analysis to establish latent drivers of financial performance specific to LNG networks.

Findings - Results support the significant role of SCS in improving financial performance. Although findings prioritised collaborative strategy as the most important driver of financial performance in LNG networks, to fully optimise financial outcomes, all the SCS should be implemented across LNG networks as none of the strategy is a standalone driver of financial performance.

Practical implications - The AHP model provides a novel ranking for SCS and measures to guide decision-makers. LNG practitioners may exploit the results to make informed decisions.

Originality/value - The study extends previous literature by proposing a framework and a new LNG empirical model that facilitate understanding of how SCS contribute positively to financial performance, and support practitioners in making strategic supply chain decisions.

Keywords Energy, LNG, Supply chain strategies, Financial performance, AHP, Template analysis.

Paper type Research paper

1. Introduction

Liquefied natural gas (LNG) distribution networks which facilitate the transfer of natural gas across the globe economically are of crucial importance, since natural gas represents a fundamental energy source (Paolucci *et al.,* 2018). Supply chain strategies (SCS) that improve financial performance have been considered as fundamental issues in different research fields from conceptual and empirical perspectives. For example, integrative strategies are linked to financial results (Rajaguru and Matanda, 2019). Similarly, sourcing strategy, information technology (IT), system integration and external relationship are established as SCS that enhance financial outcomes (Shi and Yu, 2013). There is a connection between sustainable SCS and financial performance (Khan *et al.* 2018; Li *et al.,* 2016). SCS supports financial flow, which enables network participants to improve working capital and costs (Zhong *et al.,* 2018; Wuttke *et al.,* 2016).

The application of SCS to LNG distribution networks deserves research efforts, considering it could result in significant increase in revenue and cost saving across the supply chain. LNG networks are value chains used to source, produce, and deliver gas, which consist of exploration and production, liquefaction, shipping, regasification, and distribution (Scheig, 2009). The interconnections in LNG networks further highlighted the implications of SCS for financial performance through improving revenue and minimising costs. Optimising SCS that drive financial performance is a vital strategy for LNG midstream value chain, such as the Nigeria LNG (NLNG) value streams, given the highly capital-intensive nature of LNG midstream activities (Papaleonidas *et al*., 2020). Moreover, since the 2008 global financial downturn, significant restrictions on debt issuance and increased finance cost have restricted liquidity in supply chains (Zubairu *et al*., 2018). Solutions and programmes to improve financial flow have embraced supply chain finance strategies (Caniato *et al.,* 2016). Corporations and supply chains

are continually pursuing SCS to improve working capital and productivity, reduce costs and time, and to enhance sustainability and value for investors (Wang *et al.,* 2020). Indeed, LNG networks should ultimately aim to optimise SCS to improve financial results.

1.1 Problem statement

Corporations and networks are increasingly focusing on SCS to improve financial performance. Managers need to know whether SCS contribute to financial performance, and how to direct investments to enhance competitive advantages and maximise financial gains (Shi and Yu, 2013). Strategy formulation incorporates critical performance measurement, but few studies have investigated supply chain finance drivers and measures. ~~P~~rior studies have considered performance drivers or measures, but not both. Literature searches revealed only one conceptual paper, Shi and Yu (2013) which identified sourcing strategy, IT, system integration and external relationship as supply chain finance drivers, measured using revenue, operating cost, and working capital. Despite significant recent advances in supply chain finance, no single study has proposed a recent and updated framework of supply chain financial performance drivers and measures to supplement existing knowledge. In addition, gas distribution network management involves a variety of decisions concerning a complex organisation of components, including human, material, facilities, infrastructures, and carriers (Paolucci *et al.,* 2018). However, there has been no single supply chain finance study conducted in the LNG sector to assist practitioners in strategic decision-making, indicating significant research gaps.

Reviewing relevant literature spanning 20 years from January 2000 encompassed the 2008 economic downturn, which stimulated interest in supply chain finance, and assisted this paper in devising an updated framework of SCS that drive financial performance. In addition, issues related to the SCS that improve financial results are explored and evaluated in the context of

NLNG supply chain as a case study to establish an empirical model and develop an explicit taxonomy of SCS in LNG networks to guide researchers and practitioners in the design and implementation of SCS that drive financial performance. Nigeria is a major LNG exporting country (GIIGNL, 2018), and the country has the capacity to develop into a leading exporter of LNG due to its abundant natural gas deposit. For a decade, Nigeria has averaged 4th position in terms of LNG exports. However, it has failed to grow over this period. Nigeria in the past couple of years has not maintained its position consistently, which affected its competitiveness as a major LNG exporter (Clarksons, 2016). Given that prior studies have empirically established the positive impacts of SCS on financial performance, there is a potential for LNG networks, such as NLNG, to review, adopt, and manage SCS in various business operations and activities to improve financial outcomes, market share, and competitiveness.

1.2 Research questions

Specific, informative, and clearly formulated research questions minimise bias, error, and ambiguity (Hohenstein *et al.* 2015). Considering the research gaps identified and the importance of SCS to business survival, growth and value creation, this study attempts to address the following research questions:

RQ1: What are the key SCS that drive financial performance?

RQ2: What are the impacts of SCS on LNG networks' financial performance?

1.3 Research objectives

This study proposes the following objectives to address the research question:

OBJ1: To identify the key SCS that drive financial performance

OBJ2: To evaluate the impacts of SCS on financial performance in LNG networks

OBJ3: To identify and analyse tacit factors that influence the performance of SCS in LNG networks

To achieve the first objective of this study, the SCS that enhance financial performance are identified systematically from extant literature using template analysis (King and Brooks, 2017; Brooks *et al.,* 2015), and later validated by specialists. Although the SCS can be identified from the literature or experts' opinions, different organisations or networks may have different priorities in terms of adopting SCS. A given SCS may impact financial performance differently in a certain industry and holds specific importance for its supply chains. Thus, objective two aimed to empirically evaluate the identified SCS using AHP (Saaty, 1980) to determine their relative influence on financial performance in LNG networks. To address the last objective, interviews were conducted with supply chain specialists at NLNG to identify and analyse tacit information that influences the performance of SCS in LNG networks to propose recommendations.

The remainder of this paper is structured as follows: Literature related to supply chain financial performance, and the nature and challenges associated with liquefied natural gas networks is introduced in Section 2. Methodological issues including the empirical evaluation of SCS using AHP and template analysis of interviews are discussed in Section 3. The SCS that drive financial performance are evaluated and analysed in Section 4. Results are discussed in Section 5. Conclusions, implications of the findings for industrial and theoretical development and directions for future study are suggested in Section 6.

2. Literature review

2.1 The linkages between supply chain strategies and financial performance

The links between SCS and corporate financial performance are increasing (Martin and Patterson, 2009). SCS are complex and strategically important in creating and maintaining firms' competitive advantage (Gibilaro and Mattarocci, 2019; Ellinger and Ellinger, 2014). Robust supply chain design creates a major source of competitive advantage for companies

(Okongwu *et al.*, 2015), and SCS affect financial performance positively (Greer and Theuri, 2012). Corporations have realised the importance of SCS and appreciate the distinctive competitive advantages that a well-managed supply chain brings (Stevens and Johnson, 2016). SCS assist in creating or destroying shareholder value due to its influence on financial results (Ellinger *et al.*, 2011). Managers need to identify the SCS that create the most value for investors (Losbichler *et al.,* 2008). Recently, supply chain management has attracted considerable investment (Ellinger and Ellinger, 2014) and managers must justify and demonstrate how such investment boosts financial performance (Shi and Yu, 2013). This need for innovation is compelling executives to recognise, review and adopt SCS strategies that drive corporate financial performance (Zubairu *et al.,* 2018).

2.2 Challenges associated with financial performance in liquefied natural gas networks

The most economical means of transporting natural gas over long distances is by liquefaction of the gas and shipment on specially designed LNG tankers (Özelkan *et al*., 2008). Liquefaction of natural gas allows it to be economically shipped from areas of the globe where natural gas is abundant and inexpensive to produce, to other areas in deficit (Scheig, 2009). Growing requirements for managing LNG networks reflect increasing demand for LNG as energy source (Özelkan *et al.,* 2008). The economic viability of LNG supply chains is driven by desires to minimise cost (Berle *et al*., 2011), maximise the volume, minimise the inventory of storage gas (Özelkan *et al*., 2008), and optimise liquefaction plant utilisation (Berle *et al.,* 2013). However, increasing numbers of participants in the LNG industry has led to increased supply and fallen prices of LNG, which poses significant financial challenges to LNG supply chains, including NLNG systems. This study investigates how LNG supply chain practitioners can embrace SCS to optimise financial flow and improve financial results.

2.3 Research gap

SCS facilitate the alignment of physical product, information systems and financial flows to generate cost savings thereby integrating the focal company, customers, suppliers, financiers and regulators (Gelsomino *et al.,* 2016; Blackman, *et al.,* 2013). Strategy formulation incorporates critical performance measurement, but few studies have investigated supply chain finance strategies and measures. Supply chain financial performance related literature search conducted by this study spanning 20 years from January 2000 encompassed the 2008 financial crisis, which spurred interest in supply chain finance. The literature search revealed that disparate prior studies which considered performance strategies or measures, but not both. There is only one conceptual paper, Shi and Yu (2013) which identified sourcing strategy, information technology (IT), system integration and external relationship as supply chain finance strategies, measured using revenue, operating cost, and working capital. Despite significant recent advances in supply chain finance, no single study has proposed a recent and updated framework of supply chain financial performance strategies and measures to supplement existing knowledge, indicating a major research gap in literature. Natural gas is the fastest growing fuel globally, increasing at 1.6% p.a. (BP, 2017). The most efficient way of transporting gas is by liquefaction into LNG (Özelkan *et al*., 2008). However, there has been no prior study of SCS that drive financial performance in LNG networks to assist practitioners in strategic decision-making, indicating another research gap.

2.4 Research highlights

The following key research highlights are produced to address these research gaps, to achieve the objectives of this study, and to answer the research questions:

i. The SCS that enhance financial performance are identified from the existing literature using template analysis to propose a generic framework for supply chain financial performance (Section 2.5).

ii. Using AHP to analyse expert opinion, the identified SCS were evaluated to determine their relative influence on financial performance in LNG networks (Section 4.1).

iii. Templates analysis of interview data revealed other tacit factors that affect the performance of SCS in LNG networks (Section 4.2).

iv. The scientific and practical implications of the research are provided to guide researchers and practitioners to design and implement SCS that drive financial performance (Section 6.1).

2.5 Identifying the supply chain strategies that drive financial performance

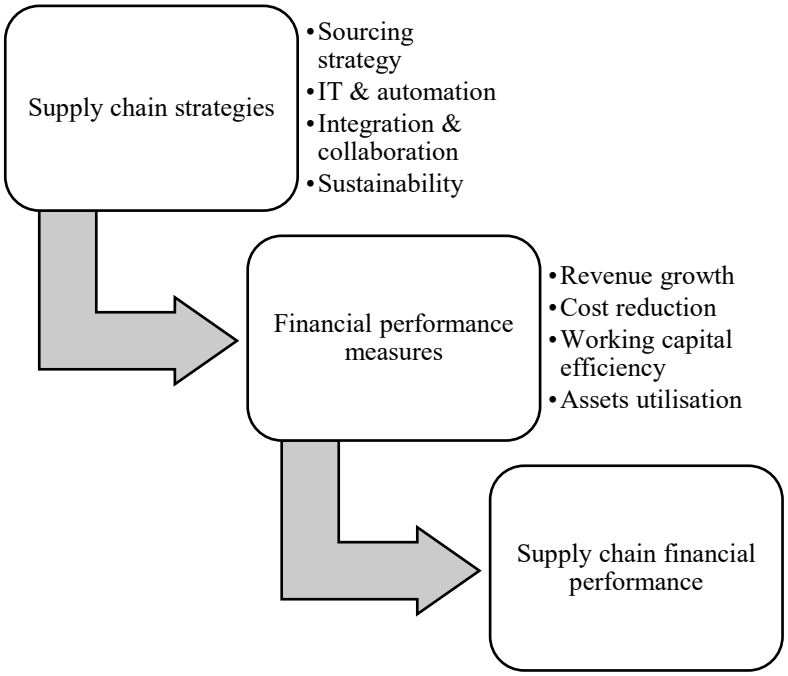
To achieve the first objective of this study and to address a major gap in literature, template analysis (Brooks *et al.,* 2015) was deployed to analyse existing literature to identify key drivers and sub-drivers that enhance financial results, in order to propose an updated framework SCS. Higher-order themes for the initial template were derived from the only qualifying article Shi and Yu (2013) which explicitly stated SCS alongside financial performance measures. Themes for SCS included sourcing strategy, IT, system integration and external relationships; while revenue growth, operating cost reduction and working capital efficiency are financial performance measures.

After identifying a base definition from the initial template, additional data from qualifying literature extracts were applied to develop the final template. Iterative modifications were applied where weaknesses appeared relating to how well data was captured, and whether it was relevant and potentially important (King and Brooks, 2017). The final template identified sourcing strategy, IT and automation, integration and collaboration, and sustainability as higher-order themes of SCS that drive financial performance (Figure 1). Sourcing strategy and IT remain much the same as in the initial template, but integration and collaboration combine both system integration and external relationships. Sustainability is a new higher-order theme which develops as further data emerges. Sustainability is a growing issue globally.

Corporations are responding to this important concern by implementing sustainable practices not only within their operations but also across their supply chain networks (Khan *et al.* 2018). Prior literature provided a strong support for the impact of sustainable practices, including the impact of green supply chain processes on financial performance (Li *et al.,* 2016). It is also confirmed that supplier social performance is linked to financial performance (Subramaniam *et al.,* 2019). Similarly, companies that pursue sustainable supplier selection strategies have superior financial performance to their competitors (Salam and Ali, 2020).

Performance measurement is a vital strategic tool which assists corporations and supply chains to evaluate their objectives; however, only few articles offer clear measurement tools for SCS. The literature review implies that all approaches to performance strive for competitive business survival and growth which are appraised using financial performance measures, because all intangibles, environmental and social factors incurred associated financial benefits and cost implications for supply chains (Zubairu *et al.,* 2018). Financial performance is closely related to supply chain effectiveness, and important SCS such as sourcing strategy, technology, system integration and external relationships play important roles in enhancing financial results (Kauppi *et al.,* 2018), which are measurable using revenue, cost and working capital (Zhong, *et al.,* 2018; Shi and Yu, 2013; Ellinger *et al*., 2011). Other studies argue that assets utilisation should be included as a financial performance measure taking into consideration all the dimensions of economic value-added, revenue, cost, working capital, and assets utilisation (Elgazzar *et al.,* 2012; Hahn and Kuhn, 2012).

Figure 1. Framework for supply chain financial performance



Literature analysis presents conceptual findings rather than generalised conclusions because the framework was developed from multifarious SCS related studies using different research approaches and methods, conducted across diverse industries of different sizes and across different locations. Subsequently, this research empirically analyses the impact of SCS on LNG supply chain financial performance to achieve study objectives two and three.

3. Methodology

Methodologies are selected to offer the best available approach to tackle research questions (Dinwoodie and Xu, 2008). A case study approach (Creswell and Poth, 2018) was deemed appropriate for this study that aims to generate insights regarding the SCS that drive financial performance in the LNG networks from the context of NLNG. A case study is an in-depth study into a topic or a phenomenon within its real-life contemporary setting or context (Saunders *et al.,* 2016). An in-depth inquiry was designed to ascertain the SCS that drive financial performance in LNG networks and why, and to understand the effects of SCS on financial results and influences for action (Dubois and Gadde, 2002). To achieve such insights,

case study research draws on quantitative or qualitative research and frequently uses a mixed methods approach to fully understand the dynamics of the phenomenon (Saunders *et al.,* 2016). This study employs multiple methods of data collection and analysis to fully apprehend experts' opinion regarding the SCS that improve financial performance within NLNG network as the case study. Qualitative data used by this study included literature review and interviews which were analysed using template analysis (Brooks et al., 2015) and quantitative data was analysed using AHP (Saaty, 1980). Combining quantitative and qualitative methods assists in confirming research validity, credibility, authenticity of data, analysis and interpretation and minimises the risk of bias (Creswell and Poth, 2018). Synthesising AHP and template analysis improves the nobility of this paper as the first that combined these two methods to study energy supply chain finance.

3.1 Template analysis of literature and interviews

Qualitative data collection involved literature review and interviews with experts, both were analysed using template analysis to identify generic and exclusive constructs of SCS that drive financial performance in LNG networks. The most common technique of analysing qualitative data is thematic analysis (Howell, 2013). Template analysis is a branch of thematic analysis with a strong emphasis on research in real-world settings. Adaptability, balancing openness and structure, efficiency and transparency are key strengths of template analysis as compared to other types of thematic analysis (King and Brooks, 2017). Template analysis facilitates theory building (McCluskey *et al*., 2011) and was utilised by this study to evaluate relevant literature and identify the key SCS that enhance financial performance to build a conceptual framework. Template facilitates theory building (McCluskey *et al*., 2011).

Template analysis ensures replicability, using hierarchical coding to balance a structured process of analysing textual data with the flexibility for modification where needed, which facilitates rigorous interview analysis (King and Brooks, 2017). The transparent process of

template analysis has auditability advantages, which is a significant aspect of quality assurance in qualitative analysis (Carcary, 2009). Template analysis was applied in many real-world studies, including psychology, healthcare, and business management (King and Brooks, 2017), which is beneficial for this empirical case study. Template is used for the qualitative part of this mixed methods research because it relates well with quantitative methods (Kelliher and Anderson, 2010). The main components and procedures of template analysis were followed in this study (King and Brooks, 2017):

i. Familiarisation with data: Before commencing the literature analysis, the researchers read transcripts of qualifying literature several times for familiarisation. Greater familiarisation with the data enabled high-quality SCS analysis.

ii. Preliminary coding: Preliminary coding is usually carried out on a data sub-set. The researchers coded the first four of fifteen interviews, noting data items relevant to addressing the research questions and highlighting points of interest and material that support a priori themes.

iii. Clustering: Based on the preliminary analysis, emerging SCS related themes were clustered into meaningful groups in hierarchical order, with higher-order themes encompassing one or more levels of more narrowly focused themes.

iv. Producing an initial template: The clusters of themes served as the basis for producing an initial template. The initial template is presented in a hierarchical structure within each cluster.

v. Applying and developing the final template: The initial template was subsequently revised and refined as further data emerged from the remaining transcripts to develop the final template of SCS.

vi. Final interpretation/writing up: The SCS that drive financial performance in LNG systems were drawn from the final template, interpreted, and discussed.

3.2 Analytical hierarchy process

AHP method was chosen for the quantitative part of this study to evaluate SCS strategy in LNG networks. In comparison with other multi-criteria decision-making methods, AHP has been widely applied successfully in many practical decision-making problems (Berrah and Clivillé, 2007). AHP technique is particularly effective for multi-attribute decisions that involve both tangible and intangible factors (Alberto, 2000). The decision to incorporate AHP was based on its ability to analyse several factors and gain a weight for each factor, to prioritise and optimise each of the four SCS in LNG networks. Using AHP, the relative importance of individual criterion for SCS established from template analysis of literature texts was determined (Roh *et al.,* 2015). AHP enabled this study to measure the impacts of SCS on financial performance. AHP as a multi-criteria decision-making technique assists in decomposing, organising, and analysing a complex problem into a hierarchy of interrelated decision criteria and alternatives (Mangla *et al.,* 2015). AHP has its limitations, which include practical application when many judgements are involved in the decision problem where it is difficult to obtain consistency from several subjective judgements (Sureeyatanapas *et al.,* 2018). The number of pairwise comparisons determining the outranking relations in an N-dimensional comparison matrix is *N(N-1)/2*. The number of pairwise comparisons matrix can be excessive and where there are a large number of alternatives and criteria, the opportunity to conduct AHP is substantially curtailed (Özcan *et al.*, 2011). This is not a problem in this work considering the concise nature of the case study with a set of four criteria and alternatives, respectively. However, caution should be taken when adopting AHP, due to other drawbacks such as vagueness, uncertainty, and bias (Mangla *et al.,* 2015). In this study, AHP was combined with template analysis because the method has the robustness to work with other analytical techniques to facilitate valuable conclusions for practical decision-making. AHP has a wide applicability and an integrated approach to problem solving (Wetzstein, *et al.,* 2018).

AHP facilitates the evaluation of subjective judgements of different decision-makers through criteria weightings (Wetzstein, *et al.,* 2018). Akin to a study by Luthra *et al*. (2016), the four essential AHP procedures are followed by this study:

i. Formulating the objective of the study: the overarching objective of this study is to propose strategies to improve supply chain financial performance in LNG networks.
ii. Formatting fair wise comparisons: experts expressed their preference regarding the relative influence of each of the established SCS on LNG supply chain financial performance between two factors using a scale of 1 to 9 (Saaty, 1980).
iii. Computing the relevant weight: the relative weights for each matrix are given by the right eigenvector (w) corresponding to the largest eigenvalue (λ_{max}). Thus, $A_w = \lambda_{max} w$, where: λ_{max} is the maximum eigenvalue of A and the unit matrix; and w the eigenvector.
iv. Consistency ratio: the consistency ratio (CR) of the matrices is checked to ensure that the judgment of decision-makers is consistent. CR=CI/RI, where: CI is the consistency index, denoted by CI = $(\lambda_{max} - n)/(n-1)$, and the value of the random consistency index (RI) depends on (n). The value of CR should be ≤ 0.10 to be consistent (Luthra *et al.,* 2016).

3.3 Target respondents

To achieve the objectives of this study and address the research gaps, it is essential to collect relevant empirical data from the case study. This makes supply chain strategic decision-makers at NLNG the target respondents for empirical data collection. However, a researcher needs to think carefully regarding the impact of the judgement when deciding whether to include or exclude cases (Saunders, *et al.,* 2016). Purposive sampling intentionally samples a group of participants that best inform the researcher about the research problem under investigation was utilised in this study (Creswell and Poth, 2018). When selecting the respondents, the researcher

worked meticulously with two highly experienced LNG professionals and identified the key divisions that are involved with SCS that affect financial performance, and pinpointed the specialists that carry out decision-making responsibilities with financial implications for NLNG networks. Heterogeneous or maximum variation sampling strategies was used as a strategy for purposive sampling. Most of the participants for this study were identified from four key divisions, including Finance, Production, Managing Director, and Shipping divisions, due to their involvement in SCS. Heterogeneous sampling enabled the collection of data from any division where relevant specialist is identified to describe and explain the key constructs observed (Saunders *et al.* 2016). In the process of data collection, 23 out of the identified 32 professionals who are involved in SCS decision-making at NLNG completed the AHP survey and 15 participated in the interviews. All responses were considered for group decision analysis.

4. Analysis and findings

4.1 Evaluation of supply chain strategies in LNG networks

To substantiate and validate whether the identified SCS established from extant literature improve financial performance in LNG networks, a scoping study was conducted with supply chain experts at NLNG. The scoping study corroborates the theoretical template findings that sourcing strategy (A_1); IT and automation (A_2); integration and collaboration (A_3); and sustainability (A_4) strategies drive financial performance in LNG networks. Experts further upheld that financial performance in LNG networks are measured using revenue (C_1); cost (C_2); working capital (C_3); and assets utilisation (C_4). Consequently, to achieve the second objective of this study, the proposed framework was evaluated empirically using data collected from NLNG supply chain specialists to determine the relative importance of the identified SCS using AHP technique.

4.1.1 Evaluation of the supply chain strategies to determine their relative importance

A hierarchical structure for evaluation of the SCS in LNG networks is formed, consisting of objective, criteria, and alternatives. AHP process makes it possible to incorporate LNG supply chain expert's judgements regarding SCS using pairwise comparisons between criteria and between alternatives. AHP group decision-making technique using geometric mean was utilised to synthesise the individual judgements and develop single matrix each for criteria and alternatives. The advantage of using the geometric mean method for generating the elements of the matrix is that it considers the compounding that occurs from one decision-maker to another (Saaty, 1989). Many organisations employ groups in decision-making problems, because it is difficult for individual decision-makers to consider all the relevant aspects of a given problem (Ahn, 2000).

The group pairwise comparison matrix of one SCS measurement criterion over another is conducted and their relative weights established. AHP findings revealed revenue growth as the most important factor for consideration when measuring SCS in LNG networks. Cost reduction is the second most important criteria. The third ranked criteria is assets utilisation. Working capital efficiency was considered as the least important (Table I).

Table I: Pairwise matrix for supply chain strategies measurement criteria in LNG networks

Criteria	C_1	C_2	C_3	C_4	Weight	Rank
C_1	1.00	1.30	1.80	1.32	0.3206	1st
C_2	0.77	1.00	1.61	1.92	0.3013	2nd
C_3	0.56	0.62	1.00	0.83	0.1756	4th
C_4	0.76	0.52	1.21	1.00	0.2025	3rd

λ_{max} = 4.0362; CI = 0.0121; RI = 0.9; CR = 0.0134

The paired comparison matrix of SCS with respect to measuring criteria were analysed and their relative weights is established. Paired comparison of alternatives with respect to criteria revealed the group ranking for SCS drivers in LNG networks as follows: first, integration and

collaboration; second, sourcing strategy; third, IT and automation; and last, sustainability (Table II).

Table II: Evaluation of identified supply chain strategies in LNG networks

Alternatives	C_1	C_2	C_3	C_4	Weight	Priority
A_1	0.2705	0.2901	0.2992	0.2282	0.2729	2nd
A_2	0.1906	0.2174	0.2258	0.2916	0.2253	3rd
A_3	0.3142	0.3155	0.2605	0.2352	0.2892	1st
A_4	0.2247	0.1770	0.2145	0.2451	0.2127	4th

4.2 Identification and analysis of tacit factors that influence SCS in LNG networks

To achieve the third objective of this study, semi-structured interviews were conducted individually with 15 supply chain experts and key decision-makers to identify and analyse tacit factors that influence financial performance of SCS in LNG networks. The interviews assisted in acquiring tacit information relevant to SCS in LNG networks, which were analysed using template analysis and validated some earlier findings and identified other latent factors specific to the impact of SCS on LNG networks' financial performance.

4.2.1 Template presentation

During template analysis, categories of themes are presented at different order levels depending on nature and objective of study (Brooks *et al.,* 2015). In this study, categories span from two to five levels depending on the breadth of a group. The order signifies the relative importance of the categories; the first level identifies the higher-order themes representing the most important drivers and measures, respectively.

4.2.2 Initial coding template

Themes for the initial template were derived from a set of SCS that drive financial performance identified from existing literature and expert inputs. Initial higher-order themes for SCS included sourcing strategy, IT and automation, integration and collaboration and sustainability. These factors have influence on financial performance measures, consisting revenue, cost, working capital and assets utilisation. Shi and Yu's (2013) interpretation of supply chain financial performance was employed to analyse texts: as the ability to optimise sourcing strategy, IT infrastructure, integration and collaboration and external relationships to realise full financial benefits of SCS.

4.2.3 Development of final template

After identifying a base definition from the initial template, further SCS data items from interview transcripts were applied to develop the final template. Iteratively modifications were applied where weaknesses appeared relating to how well data was captured, relevant and potentially important (King and Brooks, 2017). The final template confirmed extant literature findings revealing sourcing strategy, IT and automation, integration and collaboration, and sustainability as higher-order themes. The template further validated AHP findings confirming supply chain integration and collaboration as a dominant driver of financial performance in LNG networks. The final template further identified investment strategy and capacity development as new higher-order themes, specific to LNG networks. Investment and capacity development are new higher-order themes which developed as further data appeared from interview analysis. Investment strategy entails purposive planning to attract investment into LNG networks, which will enhance production capacity, competitiveness, and financial outcomes. Capacity development includes implementation of clearly defined policies and procedures for recruitment, training, and retention of manpower with relevant skills across LNG networks. Capacity development improves employee productivity and competitiveness

and financial results. Identification and analysis of additional higher-order themes specific to LNG networks enabled this study to achieve its final objective.

5. Discussion

5.1 Supply chain financial performance measuring criteria

A framework of SCS comprises four key financial performance measures, revenue, cost, working capital and assets utilisation, all of which are directly and indirectly affected by SCS (Figure 1). Template analysis of interviews validated the framework by establishing influence of SCS on the four performance measures. Considering the importance of supply chain management to business survival and growth, performance measurement is essential in evaluating the efficiency of SCS. Findings presented in Table I revealed revenue growth as the most important factor for consideration when measuring SCS. Cost reduction was the second most important criteria for measuring SCS. Cumulatively, revenue and cost efficiency represented over 62% of the SCS measuring criteria in LNG networks. Revenue and cost remained key objectives of SCS, as companies view supply chain management as a strategy to increase shareholders value and improve competitiveness (Christopher, 2011). The third ranked criteria for measuring SCS was assets utilisation. Working capital efficiency was ranked as the fourth and considered the least important SCS measurement criteria for by LNG experts. Assets utilisation is a major medium-term strategy for increasing shareholders value (Hahn and Kuhn, 2012). SCS can improve network performance by facilitating longer payment terms for buyers and better access to financing for suppliers (Wuttke *et al.,* 2016). Payment delays increase working capital employed and decrease total operational cost (Zhong, *et al*., 2018). Similarly, accounts receivable and inventory significantly influence supply chain cost reduction (Wang *et al*., 2020).

5.2 Supply chain strategies that drive financial performance

The framework identified four SCS as drivers of financial performance (Figure1). Furthermore, the empirical analysis of interview data confirmed the applicability of these four strategies in LNG supply chains and revealed two additional constructs, investment and capacity development, as additional SCS synonymous to LNG networks. Investments in supply chains are linked to shareholder value (Gomm, 2010).

5.2.1 Integration and collaboration

Template analysis revealed that the extensive vertical integration of LNG supply chains has made integration and collaboration effective in improving financial performance. AHP established integration and collaboration as the highest ranked SCS in LNG networks. The highest preference given to integration and collaboration arose from its strong priority against top ranking measures, revenue growth and cost reduction. This means that improving supply chain financial performance in LNG networks is impossible without integrative and collaborative strategies. This is consistent with literature findings where integration and collaboration is the dominant SCS theme. Supply chain integrative capabilities are associated with corporate financial performance (Stevens and Johnson, 2016); profitability is related to firm's connectedness and market share (Seiler *et al*. 2020). Both internal and external supply chain integration and collaboration impact on supply chain performance (Seo *et al.,* 2014). Similarly, integration and collaboration in LNG networks encompass internal integration between divisions, departments and units, and external integration with suppliers and customers. Collaboration strategies in LNG networks include working with customers under long-term contracts to divert cargos to locations where revenues could be optimised. An integrated network increases a company's capability to coordinate all business processes to achieve financial benefits (Shi and Yu, 2013). Supply chain glitches affect trade credit, risk

and profitability, and financing to support growth (Gibilaro and Mattarocci, 2019). Integration enhances flexibility, which helps in addressing uncertainties and glitches (Germain *et al.,* 2008). Empirical analysis established that integration and collaboration initiatives enhance financial performance in LNG networks by facilitating supplier partnerships, which enhance *flexibility in gas supply*. An LNG supply chain specialist stated that *"…greater partnering with suppliers including operations integration using information technology"* is a strategy that enhances financial performance in LNG networks. Integration in LNG networks is associated with lead time reduction, demand management, service delivery, spot sales opportunities *…especially in periods of demand or supplies uncertainties*. However, it is established that top management support, trust, and IT infrastructure are the most important collaborative drivers considered by financial service providers (Ma *et al.,* 2020).

5.2.2 Sourcing strategy

Findings revealed that sourcing strategy in LNG networks consist of decisions regarding cost-efficient and reliable supply of assets, consumables, manpower and most importantly feedgas supply. AHP results established sourcing strategy as the second ranked SCS in LNG networks. Weighing 0.2729, sourcing strategy is just 1.63% lower than integration and collaboration in the overall ranking. Similar to integration and collaboration, the high preference given to sourcing strategy resulted from its strong impact on revenue and cost. Interview analysis upheld that cost effectiveness and reliability of delivery has a major influence on sourcing strategy and financial results in LNG networks. This conforms with extant studies that established a relationship between sourcing strategy and financial performance (Oke and Kach, 2012). Sourcing strategy allows networks to focus on key competitive advantages, which result in win-win situations for all the supply chain participants (Shi and Yi, 2013). There are links between strategic purchasing and cost efficiency (Montgomery *et al.,* 2018), and supplier

selection/evaluation and purchase value (Lee, *et al.,* 2017). The high rank given to sourcing strategy is largely associated to the challenges facing NLNG feedgas supply, especially reported cases of pipeline sabotage by third parties, which pose a serious threat to security of gas supply and declining LNG export capacity from NLNG (Clarksons, 2016). This suggests that the importance given to sourcing strategy is country specific. An interview respondent argued that *"...poor security situation leads to higher cost of procurement of goods and services as well as feed stock. Suppliers are limited in number due to high security costs, such as insurance. This leads to frequent outages of logistics services, with its attendant impact on ability to meet demand".* Other studies established conflicting findings regarding impact of outsourcing as a sourcing strategy. Outsourcing can produce positive, negative, mixed, moderated, or no significant impact on performance (Lahiri, 2016). Financial productivity differs, depending on a sourcing decision between offshore and re-shore sourcing (Yu and Kim, 2018). To sustain financial benefits, costs of implementing a certain sourcing strategy should not outweigh its benefits and supply chains must constantly weigh the costs of a make-or-buy decision (Shi and Yu, 2013).

5.2.3 Information technology and automation

LNG supply chains are characterised by a high level of automation and digitisation with state-of-the-art technologies embedded across its value streams (Andersson *et al.,* 2016). Table II depicts IT and automation as the third ranking SCS in LNG networks. Although IT and automation ranked third, it was still higher than sustainability, largely due to its highest impact on assets utilisation. Additionally, results established that IT and automation was ranked third in terms of its influence on cost and working capital efficiency. Technology-based supply chains make positive contributions to financial performance (Dehning *et al.,* 2007). E-commerce, advanced technologies, and emerging production techniques have increased supply

chains' efficiency and value-added (Kırılmaz and Erol, 2017). There is a positive relationship between technology integration and supply chain integration, which is an enabler for customer service and, in turn, directly influences financial outcomes (Vickery *et al.,* 2003). Availability of technology such as electronic ordering systems for customers is an important strategy in cost-containment (Lee *et al.,* 2007). Investments in supply chain technology such as ERP can help to reduce the frequency and intensity of supply chain glitches, thereby improving financial performance (Hendricks and Singhal, 2005). Technology improves trust by minimising concerns for secure data with legal integrity (Mei and Dinwoodie, 2005). Empirical analysis conformed with literature that partnering with supplies using IT enhances financial performance in LNG networks. However, the performance implications of supply chain technology and automation strategies revealed scepticism that certain technologies can be imitated by competitors which may erode the competitive advantages of investment (Shi and Yu, 2013); and the ability to realise these benefits are influenced by a company's position within the supply chain and exogenous economic forces (Blankley, 2008). Findings also established that the performance of IT and automation is heavily influenced by investment, integration, and knowledge base across LNG networks.

5.2.4 Sustainability

Sustainable supply chain finance enhances competitive advantages (Tseng *et al.,* 2019). Although sustainability is synonymous with LNG participants mission and vision statements, amongst the SCS that drive financial performance, sustainability was given the least priority by respondents. The lowest preference accorded to sustainability was because it has the least positive impact on cost and working capital as financial performance measures in LNG networks. Sustainability practices such as social responsibility, health and safety, and green practices have associated costs in LNG networks. A key challenge with sustainability strategy

for oil and gas companies is to balance the often-conflicting pressures created by economic performance versus environmental degradation and social disruption (Matos and Hall, 2007). However, further findings revealed that sustainability was ranked second by experts concerning its relationship with assets utilisation, which is only bettered by integration and collaboration. Increasing interest in sustainability reflects community concerns, climate change and ecosystems and necessitates environmentally friendly practices as a competitive SCS for financial performance (Bastas and Liyanage, 2018). Sustainability concerns in LNG networks go beyond production and includes sustainable development of maritime operations consisting of environmental and social concerns in relation to terminal operations and transportation. Implementation of both social and environmental supply chain practices significantly affects financial performance (Wang and Sarkis, 2013). However, the financial benefits of sustainable networks vary between regions, industries, and products. Additionally, economic challenges such as a financial crunch could affect the financial performance of sustainable supply chain practices (Ortas *et al.*, 2014). LNG supply chain executives are committed towards a sustainable socio-economic development of host communities. Sustainability in networks is more effective when there is top management support (Dou *et al.,* 2018) and when it is implemented jointly by all participants (Zubairu *et al.,* 2018). Appropriate government policies and support are necessary in adopting sustainability in supply chains (Luthra *et al.,* 2016).

5.2.5 Investment strategy

The framework for SCS does not categorise investment as a SCS (Figure. 1). However, investment emerged from template analysis of interviews as a major driver of financial performance in LNG networks, largely attributed to the capital-intensive nature of the industry and country peculiarities specific to NLNG supply chains. In addition, investment is a dominant higher-order theme in the final empirical template because of its influence on other higher-

order SCS, including IT and automation, sourcing, capacity development and sustainability. Investment decisions in LNG networks involve a substantial trade-off between risk and returns by investors (Furlonge, 2011). LNG project feasibility, including market conditions, long-term supply contracts and access to feedstock is a determinant for investment into LNG networks (Nikhalat-Jahromi, *et al.,* 2017). Rise in gas production and fast growth in LNG liquefaction capacity continues to exert pressure on LNG price and investment (Clarksons, 2016). This study confirmed that low crude oil prices, global oversupply of LNG and alternative energies are major factors that limit LNG production and export capacity. The take or-pay arrangement in long-term contracts offers a platform for improved operational and cash planning which enhances financial outcomes in LNG networks. However, long-term contracts do not provide much flexibility and arbitrage opportunities like spot contracts (Pirrong, 2017). The liquefaction component of LNG supply chain which is at the core of the LNG value chain is the most capital-intensive, with key challenges facing liquefaction projects including completion, supply, market, pricing and political risks (Berle *et al.,* 2011). Socioeconomic factors such as political stability, policies and regulatory requirements should be considered when developing an investment strategy to improve financial results in LNG networks. It was established that access and financing cost as well as marketing strategy also have influence on LNG investment (Clarksons, 2016). The goal of LNG investment is to minimize assets investment and operating costs (Koza *et al.,* 2017).

5.2.6 Capacity development

Prior studies established that efficient supply chain knowledge and competencies include general knowledge, specific knowledge, and competencies (Mangan and Christopher, 2005). However, literature analysis does not categorise capacity development as a higher-order theme for SCS. The emergence of capacity development from interviews as a key SCS theme that

drives financial outcomes in LNG networks was not surprising due to the relevant knowhow required to operate in such a complex, extended and sophisticated automated supply chain. The levels of investment, technology implementation, integration intensity, environmental conditions and availability of skilled labour facilitate capacity development and retention in LNG networks. Financial performance from supply chain IT investments are derived from improvements in knowledge-intensive capabilities, which result in improved operational capabilities (Blankley, 2008). Findings revealed that capacity development enables other LNG SCS such as investment, integration, technology implementation and utilisation, and sustainability. LNG networks involve complex and risky operations such as management and manning of liquefaction trains, terminal operations and ship handling, which all need a certain level of expertise to operate safely and efficiently to improve financial performance across LNG networks. Capacity development and retention facilitate internal integration as well as external integration with suppliers and customers, which enhances flow of information, material, and finance within and across LNG networks. However, security challenges threaten capacity development by making it difficult to attract expatriates with the required skills needed to improve financial performance in LNG networks. This paper concludes with implications of the study and directions for further research.

6. Conclusions

SCS contributes significantly to corporate performance, including financial performance. This study proposes an explicit framework and a model of supply chain financial performance based on literature study and expert data analyses undertaken using template analysis and AHP methods. Empirical results conclude that effective SCS that drive financial performance in LNG networks involves investment strategy and capacity development in addition to the established SCS including sourcing strategy, integration and collaboration, IT and automation,

and sustainability. To fully optimise financial performance, all the six strategies should be implemented across LNG networks as none of the SCS is a standalone driver of financial outcomes. The level of performance by these SCS depends on the extent of the interconnectivity between each strategy, explaining why integration and collaboration is essential to improving financial results in LNG networks. These intangible SCS have impact on tangible financial performance measures, including revenue, cost, working capital and assets utilisation.

6.1 Implications of the study

6.1.1 Managerial/practical implications

This work confirmed that SCS make positive contributions to financial performance and provided a more extended strategies that drive financial results in the context of LNG networks. The paper recommends that for LNG practitioners to fully optimise financial performance, all the six SCS should be implemented across LNG networks. It is suggested LNG supply chain participants should measure the performance of these SCS based on their influence on conventional financial measures, consisting of revenue, cost, working capital and assets utilisation. Quantitative AHP modelling suggests that more priority should be given to integration and collaboration, followed by sourcing strategy due to their strong influence on revenue growth and cost as key financial measures in LNG networks. The strong impact of integration and collaboration could be associated with the vertically integrated nature of LNG networks, and the influence of sourcing strategy may perhaps be country-specific due to geographical and socio-political challenges affecting NLNG procurement and supply networks.

Although this is a case study, all the major LNG exporting networks shared relatively similar characteristics and objectives. The findings from this work may provide guidelines to other

major LNG exporting networks like Qatar, Australia, Malaysia, Indonesia, or the United States, to implement SCS and improve financial results. This study may serve as a catalyst for similar studies in any of the major energy exporting networks and other emerging energy sources including fuel cells, hydrogen, and lithium-air batteries. However, some variations may be required due to differences in geography and socio-economic set-up. Careful implementation of SCS proposed by this study is important for affordable, profitable, and reliable delivery of LNG as an energy source to the international market.

6.1.2 Theoretical/scientific implications

This paper contributes to supply chain finance literature by establishing links between SCS and financial performance. The study provides an updated framework/taxonomy for SCS, grounded in an extensive empirical research, offering an understanding of how SCS make positive contributions to financial performance in LNG systems. The study divulges two methodologies, template analysis and AHP, that were applied across three stages to achieve qualitative and quantitative results. Template analysis enabled this research to achieve varied objectives ranging from hypothetical to empirical applications of SCS. Template analysis of extant literature successfully captured the high variation of outcomes often reported and identified common and shared themes. In addition, template analysis of empirical interviews enabled this research to extract tacit information from practitioners, consisting of investment strategy and capacity development to propose the first theoretical construct that link SCS and financial results in LNG networks. These factors have important implications for financial performance and require key strategic decisions and implementation.

The work revealed how AHP as a multi-criteria decision-making technique is important in measuring the relative weight of various SCS to prioritise their financial implications in a specialised network. AHP ranks SCS according to their impact on business survival and growth

and value creation for investors. The AHP model does not only determine the relative importance of SCS but also enables supply chains to implement SCS efficiently. Synthesising AHP and template analysis improved the nobility of this study as the first that combined these two methods in the field of energy supply chain finance.

6.2 Directions for future research

The research framework emerged following rigorous review and analysis of SCS related articles, which is evaluated in NLNG supply chain context. There could be some limitations regarding the application of some of the research findings, beyond the case study. Future work is required to examine these SCS in different sectors, locations, economies, and across various supply chain dimensions, to establish systematic similarities and differences in supply chain finance strategies.

Practical implementation of the research outcome on the case study was not feasible in this study; to maximise impact, it is desirable that an application of the framework is conducted in LNG networks. Future researchers with access to LNG operations should consider collecting operational and financial data to investigate the impact of implementing the proposed SCS on financial results, which will facilitate informed decision-making. In addition, traditional financial measures have their own limitations and caution should be taken accordingly. Creative efforts are needed to design balanced systems for assessing supply chain financial performance for individual value chains and networks.

Results are grounded on clearly defined theoretical and methodological foundations, including template analysis and AHP methods to propose a theoretical construct for SCS in LNG networks. Like any other method, these methods have their associated limitations, template analysis is not linked to any specific philosophy, and discards prescribed procedures which can generate varied interpretations. Template analysis produces fragmented accounts, potentially

confounding researchers who are sought to understand experiences of the whole person (King and Brooks, 2017). Similarly, AHP has drawbacks such as vagueness, uncertainty, and bias (Mangla *et al.,* 2015). Future study should consider using a different combination of methods of data collection and analysis. Qualitative researchers with extended access to LNG networks should consider research strategies such as action research or ethnography to immerse themselves with relevant tacit information. Quantitative researchers may consider a more holistic approach where a study will be conducted from a distance to cover the entire networks using instruments such as surveys, which can be analysed using other quantitative methods. Applications of diverse methods will analyse and measure SCS in LNG networks differently and add to the debate in this exciting subject in a fast-growing industry. Such studies will contribute towards proposing SCS that will enhance financial innovation and excellence.

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