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Unpacking critical success factors to improve supply chain effectiveness, efficiency and performance: a 7Vs framework for consideration

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ABSTRACT

This paper seeks to guide supply chain managers regarding critical success factors (CSFs) by examining decision-making themes associated with effectiveness. It builds on previous theoretical and operational perspectives relating to CSFs for supply chain management. The research uses a quantitative survey instrument informed by responses from 303 supply chain decision makers. This enabled the identification of 7 key clusters from 48 variables which are directly linked to supply chain efficiency by applying Principal Component Analysis. CSFs are somewhat neglected in the supply chain literature and to address this, an evidence-based 7Vs framework is proposed, incorporating CSFs to aid the successful operation of supply chain performance. The results suggest that managing CSFs improves supply chain efficiency and performance, whilst assisting organisations in attaining a competitive advantage. This research takes a holistic view of organisations' operational efficiency and contributes to the evidence base for successful operation of supply chains utilising CSFs.

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Supply chain management; critical success factors; efficiency framework

1. Introduction

There is evidence to suggest that success factors attributed to efficiency and performance of supply chains are not being fully addressed (Anjomshoae, Hassan, and Wong 2019; Garcia-Buendia et al. 2021; Sehnem et al. 2019). This is of strategic and operational concern for organisations as they seek to create value for customers and reduce costs, whilst striving to maximise competitive advantage (Min, Zacharia, and Smith 2019; Kotzab et al. 2015; Chiappetta Jabbour, Mauricio, and Jabbour 2017) and to address the continued challenges within the external environment of Brexit (Roscoe et al. 2020) and the COVID-19 Pandemic (Handfield, Graham, and Burns 2020). These challenges highlight the need for organisations to focus on the efficiency of their supply chains. In justifying this research there are some important aspects to acknowledge. Firstly, the importance of supply chains is clearly highlighted in the literature, especially in helping them to gain a competitive advantage (Fawcett, Magnan, and McCarter 2008; Kalaitzi, Matopoulos, and Clegg 2019). The efficient way organisations set-up a supply chain in conjunction with the speed that they implement changes to it have never been more critical. However, the planning and subsequent management must be responsive to the customer's needs, across strategic, tactical, and operational levels (Bhagwat, Chan, and Sharma 2008; Gunasekaran, Patel, and McGaughey 2004). This is not only of interest to supply chain scholars to know how, when and why supply chains fail, but also to the practitioners who have to manage the daily tasks associated with them (Fawcett, Magnan, and McCarter 2008). Secondly, although supply chain management (SCM) literature relating to critical success factors (CSFs) has increased in recent years and core studies such as Cullen and Taylor (2009) have enhanced our understanding, the literature still falls short of offering a framework to address specific CSFs within supply chains. Furthermore, Wieland (2021) criticised the static view on supply chains and building on panarchy theory, reinterpreting them as a socio-ecological system. They indicated that to date supply chains have been viewed deterministically by managers as static, like a machine to be designed and be controlled, rather than as a dynamic system. Wieland (2021) argued that two assumptions have led to the discipline's failure (i) considering stability in certain sets of conditions in SCM theories; (ii) supply chain isolation from the rest of the world.

Therefore, an underlying issue with current SCM research is the narrow functional areas from which it draws its knowledge. Although a broader organisational perspective has been sought, SCM research is rather eclectic with little in the way of consensus in relation to its conceptualisation (Burgess, Singh, and Koroglu 2006). Unfortunately, with such varied research into CSFs there is a lack of generalisability; very few studies have taken a holistic view of supply chains when identifying CSFs in terms of improving performance. This offers an opportunity for new research which this study seeks to engage with. Therefore, this study sets out to add

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clarity to a research area that does not take a holistic view of all supply chains and the critical factors associated with them. As such, five research objectives are: (i) identification of CSFs influencing supply chain effectiveness; (ii) validating identified CSFs; (iii) incorporating CSFs into 7Vs conceptual framework; (iv) reconceptualising how supply chain can be more effective; (v) evaluating implications for supply chain managers. Through this, the 7Vs framework from Hines (2004) (value; volume/volatility; velocity; variety; virtuality; variability; and visibility) is repositioned to develop the understanding of CSFs that are key to enhance supply chain performance. This paper scopes the impact of the 7Vs themes and confirms critical factors that need to be addressed. In doing so, a deeper exploration of the factors relating to effective supply chains in terms of performance and effectiveness is presented. The contributions of this research are summarised as follows:

i. The themes within the 7Vs framework have been conceptualised from the literature and validated through the empirical research. These identified themes can help develop case study research which will result in a theoretical framework for further empirical research.
ii. The identification of CSFs attributed to the successful delivery of supply chains has been achieved. Through the research process, 48 defined CSFs were assessed across specific themes within the 7Vs framework that were directly attributed to enhancing supply chain performance.
iii. The research is able to draw implications for the practice of SCM. Practitioners and supply chain managers can assess and then improve their supply chain performance by applying critical pain points and success factors suggested in the 7Vs models as benchmark indicators in their specific business context.

The rest of this paper is organised as follows. The literature review, research gaps, background models, and critical success factors within seven themes are discussed in Section 2. The research methodology and data collection are illustrated in Section 3. Results and analysis are discussed in Section 4. The implications and conclusions, Section 5, summarises the paper and discusses the theoretical and managerial implications, limitations and future research directions.

2. Literature review

2.1. Unwrapping critical success factors (CSFs)

The importance of gaining a competitive advantage through supply chains is highlighted throughout the literature as being key to delivering organisational strategy (Reichhart and Holweg 2007), enhanced competitiveness (Gunasekaran, Patel, and Tirtiroglu 2001) and social advantage (Nayak, Bhattacharyya, and Krishnamoorthy 2022). Tatham and Christopher (2018) stated that historically suppliers were kept at a distance, which minimised the opportunities for competitive advantage through innovation. Organisations tended to focus their efforts on making internal business functions as effective and efficient as possible (Shepherd and Günter 2010) rather than focus externally on the supply chain, failing to realise the need to compete not only through products, but also through efficacy within their supply chains (Christopher and Towill 2002). There is now an understanding of the clear relationship between efficiency and the attainment of a competitive advantage gained through supply chains (Jeong and Phillips 2001; Kalaitzi, Matopoulos, and Clegg 2019; Lambert and Cooper 2000; Li and Liu 2006; Patnayakuni, Rai, and Seth 2006; Power 2005; Sengupta, Heiser, and Cook 2006).

Discussions surrounding SCM often bring the terms 'efficiency' and 'effectiveness' together, when highlighting factors that focus on supply chain operations. In this section, the models and frameworks in traditional supply chains for providing a general structure and frame to understand, assess and improve CSFs in relation to the efficiency and performance enhancement of the whole processes in supply chains are reviewed. The discussed models are general enough to be applied in any supply chain.

Various frameworks have focused on 'Customer and Supplier Relationship Management'. For example, Cooper, Lambert, and Pagh (1997) conceptual model offered six further business-related processes of: (i) customer service management: (ii) demand management; (iii) order fulfilment; (iv) manufacturing flow management; (v) product development and commercialisation; and (vi) returns management which provided guidance for future supply chain decision-making. Cooper, Lambert, and Pagh (1997) model has also been reconceptualised by integrating key business processes across the supply chain (Lambert 2008). In terms of enhancing the supply chain operations, the much-regarded supply chain operations reference model (SCOR) developed by the Supply Chain Council (Harrison and van Hoek 2008) consists of six overlapping management processes of 'Plan, Source, Make, Deliver, Return and Enable'. The SCOR model focused specifically on three process levels, the model offers support to various supply chains across industries (Harrison and van Hoek 2008). Interestingly, Rotaru, Wilkin, and Ceglowski (2014) analysed SCOR's approach to supply chain risk management and found that there are issues in integrating risk management processes within supply chain processes considering discrepancies in how supply chain risk management has been embedded into SCOR.

The SCOR model is widely accepted as a tool to inform the decision-making problems related to supply chain performance (Ntabe et al. 2015). However, there is concern of the inherent supply chain performance evaluation, since it is isolated and case specific, qualitative in nature and often lacking in substantial supporting data (Zanon et al. 2020). Even though supply chain risk is well documented within the literature (Gunessee and Subramanian 2020) it does not offer much to the discussion or identification and classification of the CSFs.

In order to examine how CSFs are perceived in the context of supply chain management performance, the original

work by Hines (2004) is revisited. Hines (2004) focused on seven attributes (7Vs) that organisations can use to examine their ability to meet the challenges of devising a suitable supply chain strategy. Hines (2004) contextualised the concept of the 7Vs themes through a theoretical framework from which organisations can examine their ability to meet the challenges of fashioning suitable supply chain strategies. However, the framework focuses predominantly on the business challenges and neglects the influences of the supply chain factor. Therefore, an adapted version of the Hines (2004) contribution is presented in Figure 1.

Of course, there are numerous difficulties associated with formalising CSFs (Belhadi, Touriki, and Elfezazi 2019) because they can be different from industry to industry, project to project and in the context of this research, supply chain to supply chain. Research undertaken within SCM directly attributed to CSFs is seen as constantly developing (Chowdhury et al. 2020) so for the purpose of this study, a CSF is defined as a variable that if not managed will affect the outcome of an event or process within a supply chain.

In order to contextualise the scope of CSFs with the 7 V model, 70 possible CSFs were identified from the literature in the context of supply chain strategies, using manual thematic coding principles developed by Fereday and Muir-Cochrane (2006). From these we populated the CSFs within the context of the 7Vs: Value (6); Volume (9); Velocity (8); Variety (10); Virtuality (11); Variability (9); and Visibility (17), with a specific focus on supply chain performance. The identified CSFs from the literature were then examined from an operational perspective before moving to the data collection phase of the research via round table meetings where CSFs were adapted, and new ones identified. Following three round-table discussions with members of the Chartered Institute of Procurement and Supply (CIPS), 106 CSFs were deemed valid for the collection of data; these CSFs are summarised in Table 1.

Given the dimensions of CSFs and the centralisation around the 7Vs themes, specific operational and organisational areas include: medical technology supply chain (García-Villarreal, Bhamra, and Schoenheit 2019); synchromodal logistics (Giusti et al. 2019); Circular Economy (CE) (Sehnem et al. 2019); humanitarian aid (Pettit and Beresford 2009); sustainable foods (Grimm, Hofstetter, and Sarkis 2014); National health service (NHS) (Cullen and Taylor 2009); enterprise implementation (Koh, Gunasekaran, and Goodman 2011); sustainable supply chains (Jabbour et al. 2015; Kim and Rhee 2012; Wittstruck and Teuteberg 2012); sustainable supply chain integration with blockchain technology (Yadav and Singh 2020); manufacturing (Ai et al. 2011; K. Patil and Kant 2014; Routroy and Pradhan 2013); fashion and clothing (Castelli and Sianesi 2015; Thomassey 2010) and green supply chain management (Chiappetta Jabbour, Mauricio, and Jabbour 2017).

Some studies do offer a focus in addressing CSFs within SCM literature, such as when discussing sustainability strategies and green supply chains (Jabbour et al. 2018; Gopal and Thakker 2016; Luthra et al. 2018) as shown in Table 2.

The literature review has synthesised the CSF constructs and the need for a conceptual framework for supply chain CSFs, this is presented in Figure 2 and demonstrates how supply chain effectiveness and efficiency has a continual influence on: the 7Vs identified, supply chain challenges, understanding of critical success factors and interaction with suppliers in supply chain performance. Additionally, there is a logical flow in terms of the 7Vs potentially providing useful definitions and highlighting potential challenges which could then inform/influence CSFs and thereby have an impact on potential disruption/challenges regarding suppliers and supply chain performance.

By investigating CSFs more precisely and effectively, the authors believe that an applied 7 V-CSF framework has the potential to enhance supply chain performance and efficiency, and to prevent disruptions when supply chains are encouraged to examine their overall effectiveness. The literature presented here has examined CSFs and questions the influence of the 7Vs. The next section presents the research aim and objectives, and the design of the survey instrument.

3. Research methodology

From the manual thematic coding of the literature, it was identified that CSFs have been widely accepted throughout the operational domain to help describe key variables crucial to the outcome of an event (Naveed et al. 2019). This study utilised a quantitative data collection tool in the form of a survey instrument, which was designed with the assistance of key supply chain experts. These included group and individual discussions, as well as the literature review, to gather information regarding CSFs. The information collected assisted in designing the questionnaire for the quantitative data collection phase. This collection and analysis of the data were carried out over four distinct phases (Figure 3).

3.1. Data collection

The primary data collection was conducted via a survey, and it was crucial that the responses produced meaningful data in relation to the aim and objectives of the study. Using closed questions offered the opportunity to present questions quickly and clearly to participants, allowed for the comparison of responses and provided an opportunity to assess the representativeness of the findings to a wider population. In order to maximise the efficiency of the use of closed questions the survey instrument utilised a 7-point Likert-Scale (1 = strongly disagree; 2 = disagree; 3 = slightly disagree; 4 = neither agree nor disagree; 5 = slightly agree; 6 = agree; 7 = strongly agree). A codebook was created from the 106 possible CSFs confirmed at the completion of phase 1 to include a narrative that made operational sense, ensuring that respondents would understand what was being asked. To accomplish this before each question was asked, a short definition was given prior to the main questions, confirming the operational meaning of the theme being investigated.

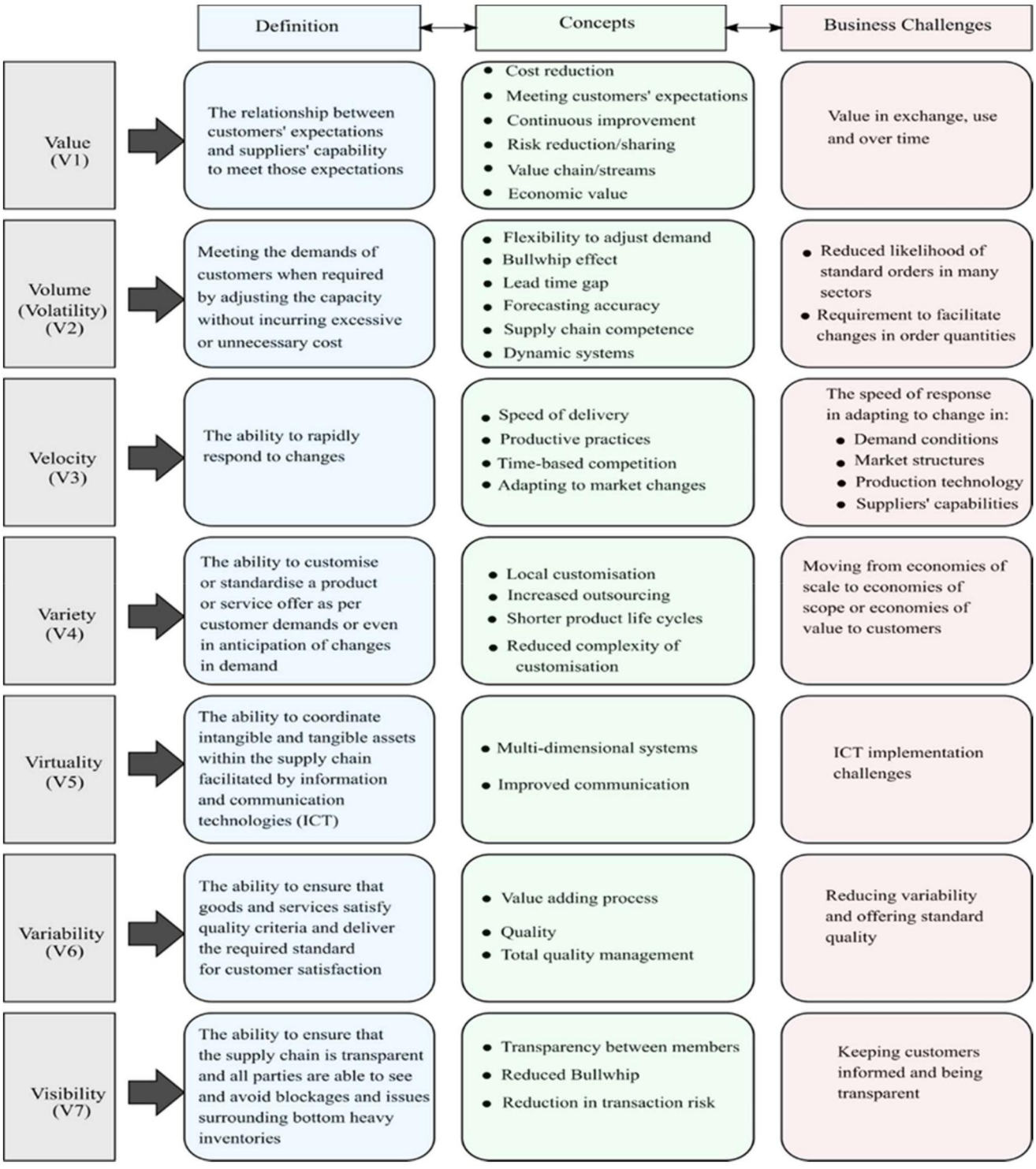

Figure 1. The 7Vs themes - Definitions, concepts and business challenges (adapted from Hines 2004).

3.2. Pilot testing

The first phase constituted an initial draft of the questionnaire with questions drawn from the codebook. This draft was used to inform discussions with supply chain experts, who were members of the professional body: The Chartered Institute of Procurement and Supply (CIPS), a professional body of 64,000 active practitioners. The draft was also discussed in depth with senior academics with extensive knowledge of both the area of research and this method of collecting data. The second phase of the pilot testing encompassed face-to-face round-table meetings with 8 members from CIPS. During this phase, the focus was around each individual question and the language used. The third phase of pilot testing involved utilising the supply chain network built up during the life cycle of the study. All members of the sample group (30 members) were considered to be experts who operated within operational supply chains. Having identified 70 possible CSFs from the literature review

Table 1. Sample CSFs identified from literature.

Author(s)	CSFs-Value (V1)
Coman and Ronen (2010)	Delays do in product development does not slows time to market.
Mentzer et al. (2001)	The product/service delivered has no unnecessary feature, is reliable and defect free and aligns to customers satisfaction.
Giunipero and Brand (1996)	The product/ service supplied has stand-alone uniqueness.
Heikkilä (2002)	Suppliers are able to offer flexibility regarding client requirements.
Author(s)	**CSFs-Volume (Volatility) (V2)**
Reichhart and Holweg (2007)	The supply chain has the ability to alter pre-determined delivery dates and is flexible enough to deal with sudden changes in demand
Power, Sohal, and Rahman (2001)	Suppliers understand the customers' market conditions.
Prahinski and Benton (2004)	Suppliers are able to anticipate changes in demand.
Feldmann and Müller (2003)	Data being used throughout the chain is accurate.
Author(s)	**CSFs-Velocity (V3)**
Tyndall (1998), Elmuti (2002)	Realistic time frames are agreed.
Handfield and Nicholas Jr (1999)	Suppliers have the ability to operate in a manner that assists in speed of delivery.
Bowersox and Calantone (1998)	Levels of inventory are at a practical level for such operations.
Kilgore, Joseph, and Metersky (2007)	There is no complication in cost for the increased speed of delivery and intermediaries work with the same urgency as supply chain.
Author(s)	**CSFs-Variety (V4)**
Hines (2004)	The supply chain can change or introduce new product without starting a new chain.
Reichhart and Holweg (2007)	The quality of the product is not compromised.
Mentzer et al. (2001)	Inventories are kept as low as possible.
Malik, Niemeyer, and Ruwadi (2011)	Communication across the supply chain is good.
Author(s)	**CSFs-Virtuality (V5)**
Tatham and Christopher (2018)	Supply chain members have compatible information technology capabilities.
Lancioni, Smith, and Schau (2003)	Relationships between supply chain members are constantly managed.
Williamson, Harrison, and Jordan (2004)	The risk of infrastructure mismatch between suppliers and yourself has been assessed and IT security risks are evaluated and managed.
Gunasekaran, Patel, and Tirtiroglu (2001)	IT capabilities of the supply chain new members are comprehensively evaluated before joining the supply chain and then integrated.
Author(s)	**CSFs-Variability (V6)**
Jraisat and Sawalha (2013)	There is a focus on planning and design of the supply chain.
Forker, Mendez, and Hershauer (1997)	There is procurement of a defect free product.
Feigenbaum (1956)	The initial design of the product is of good quality.
Jraisat and Sawalha (2013)	Products meet customer specifications and achieve consistent quality.
Author(s)	**CSFs-Visibility (V7)**
Mentzer et al. (2001)	You are open with your suppliers and have a close working relationship.
Chen, Lin, and Huang (2006)	Suppliers are fully integrated with the supply chain.
Patnayakuni, Rai, and Seth (2006)	There is the availability of real time information.
Chen, Lin, and Huang (2006)	There are conflict resolution procedures.

Table 2. Key literature on critical success factors reported in the journal of PPC.

No	Author(s)	Key Contributions
1	Luthra et al. (2018)	Incorporated framework to identify relevant CSFs in supply chains, examining influential and influenced interactions among sustainability-oriented CSFs. Identified 11 CSFs requiring managerial attention to attain sustainable initiatives.
2	Jabbour, Mauricio, and Jabbour (2015)	Applied a resources-based view (RBV) in relation to CSFs and green supply chain management (GSCM), arguing that improved green human resource management (GHRM) is linked to the increase effectiveness of CSFs for GSCM strategies.
3	Luthra, Garg and Halem (2015)	Identified CSFs and performance measures of green supply chain management (GSCM)
4	García-Villarreal, Bhamra and Schoenheit (2019)	Identified six CSFs for Medical Technology supply chains, suggesting practitioner aligned strategy of re-prioritising CSFs will improve operational performance.
5	Gopal and Thakker (2016)	Analysed CSFs in achieving the successful implementation of sustainable supply chain practices. Identified twenty- five CSFs to assist in the implementation of sustainable supply chain practices.
6	Botchie, Damoah, and Tingbani (2021)	Explored the CSF of operational excellence in post-disaster operations, identified eight themed factors.

as shown in Table 2, after the round-table discussions with members of CIPS, 36 additional CSFs, were identified across the themes of: Value (20); Velocity (4); Variability (9); and Visibility (3). A sample of these are highlighted in Table 3 and when added to those from the literature created 106 possible CSFs.

3.3. Population, sampling, response rate

The population of the study shared a similar set of traits and experience within the area being researched. This study utilised probability sampling (simple random sampling) which was derived from a database containing key decision makers

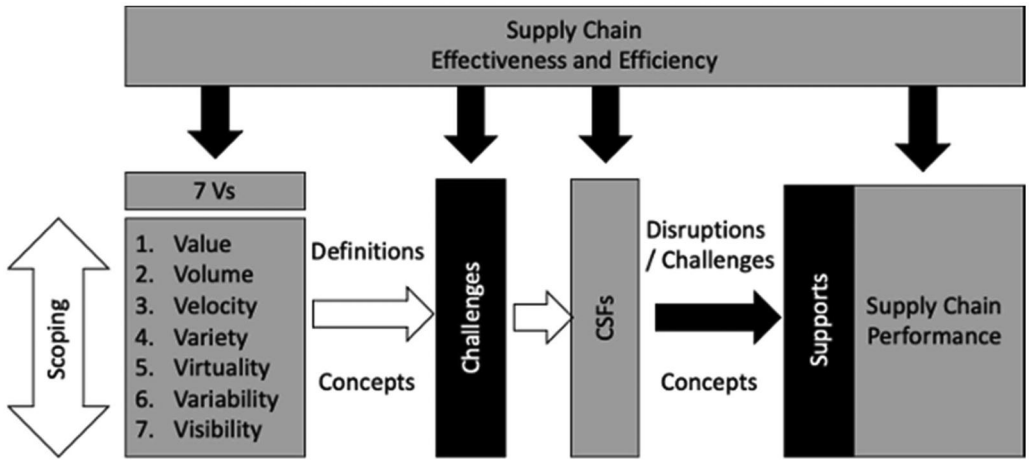

Figure 2. A conceptual model for 7 V-CSFs for supply chain management.

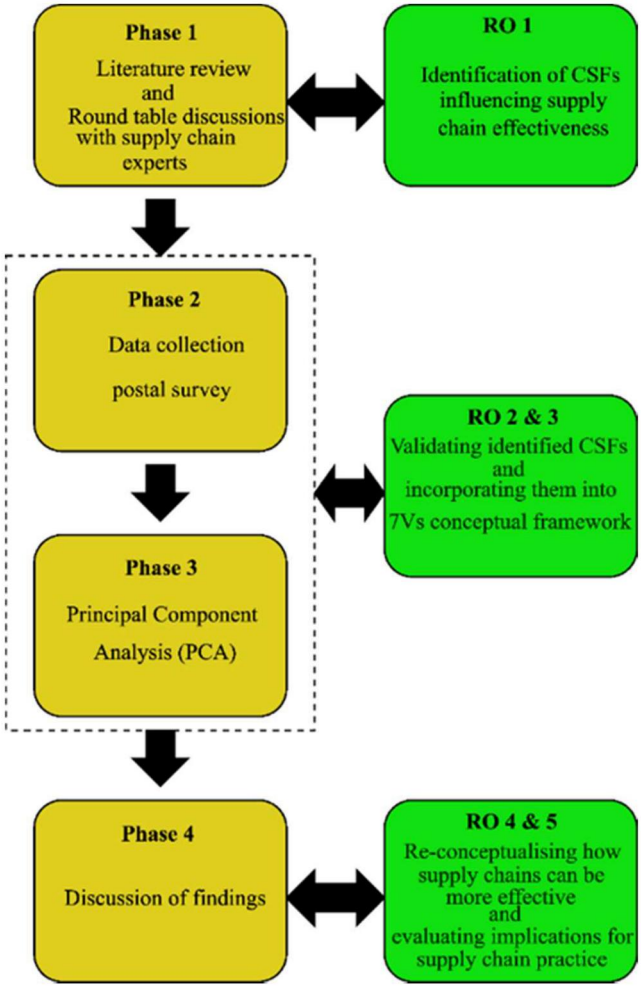

Figure 3. The four phases of the research and linked research objectives.

within operational supply chains located within the United Kingdom. To gain direct access to a sample of the population, the study utilised the 'Data Partnership Ltd' to purchase a contact list of 3050 contacts within organisational supply chains in the United Kingdom. This is an acceptable practice in SCM research (Kannan and Choon Tan 2007; Li et al. 2006). Within these organisations, experienced decision makers were targeted such as supply chain directors, managers and buyers. 34 different organisational job titles within the 3050 sample were utilised. From the sample of 303 participants, 197 classified themselves as managers, 60 as buyers and 46 as directors. The response rate was 303 completed questionnaires from 3050 distributed. The overall response rate from the postal survey was 10.3%.

4. Analysis and discussion

Within research focusing on CSFs, Principal Component Analysis (PCA - a data/variable reduction technique which extracts principal components by reducing a larger set of variables into a smaller set of variables) is a common methodological approach in key studies (Luthra, Garg, and Haleem 2015; Mazhar, Kara, and Kaebernick 2007). The technique allowed the researcher to ascertain how each variable/item (i.e., CSF) was attributed to the dimensions/components/themes (individual Vs). Thus, a PCA with varimax rotation was carried out to validate the 106 possible CSFs highlighted during phase 1 of the research. In the study, Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity were also used to test sampling adequacy of the study. KMO measurement of sampling adequacy highlights a 0.898, which is classed as great and above the commonly recommended measurement of 0.6. Bartlett's Test of Sphericity revealed significant strong relationships between the variables. In addition to both KMO and Bartlett's it was also found that the commonalities were all above 0.3, this lends weight to the assumption that each item shares in part some common variance with other items. The scree plot revealed that after component seven the rest of the components start to plateau, suggesting seven factors. It highlights 48 items loading onto the 7 principal components each named after their relevant themes. In order to test reliability and convergent validity, Cronbach's Alpha $= \alpha$ and Composite Reliability (CR) were applied to each individual component to determine the interrelatedness between items. For Cronbach's Alpha, Field (2013) suggests lower scores below 0.6 are considered heterogeneous with little correlation to other items. Options have been known to differ in relation to an ideal score, however, according to Tavakol and Dennick (2011) a score

between 0.70 and 0.95 is acceptable with a value closer to 1.0 highlighting a more reliable result. The obtained $\alpha = [0.69, 0.92]$ for all 7 components, therefore the reliability was considered good. The lowest CR value among 7 components is 0.72 which is above 0.70 and shows the internal consistency reliability (Nunnally and Bernstein 1994)

4.1. Component 1: Visibility (V7)

The first component which explains 27.01% of variance is that of visibility. The Cronbach's Alpha score of $\alpha = 0.918$ highlights clear interrelatedness between items and is close enough to 1.0 to confirm a reliable result. The CSF 'culture of integration within the supply chain' as being key to visibility. The significance of this item is supported by the highest factor loading of 0.822, a mean of 6.19 and a standard deviation of 0.829. This suggests that the respondents strongly agree with the importance of this item in relation to visibility.

Table 4, suggests that key-factors related to the attainment of the theme visibility, are linked to integration, cooperation, joint planning, information sharing and compatibility between organisations. The highest loaded CSF is that of 'culture of integration' (Mentzer et al. 2001), whilst the other highest loaded factor of closer relationships between suppliers (Huang and Mak 2000) along with the other top loaded CSFs highlight that integration and cooperation between supply chain members are key to assuring the attainment of visibility. This would enable all parts of the supply chain to be transparent and avoid blockages, 'iceberg' inventories and hidden costs; keeping the customer informed and address the dreaded 'bullwhip effect', which the importance of cannot be underestimated in industries such as car manufacturing, where integration and cooperation between suppliers is well evidenced (Bennett and Klug 2012). It is important for supply chains to be able to cooperate and integrate with other entities and actors beyond their immediate environment in the political (Grover and Dresner 2022) and ecological (Wieland 2021) domains in which they operate.

Table 3. Sample CSFs identified by supply chain decision makers.

CSFs-Value (V1)
• The supply chain offers customer service that meets clients' requirements.
• Non-value-added activities must be removed from the supply chain to be efficient.
• Flexible prices are applied to ensure that service costs add value.
CSFs-Velocity (V3)
• Distance to delivery point is factored into timeframe.
• Lead times must be planned for carefully.
• Blockages need to be identified quickly and removed.
CSFs-Variability (V6)
• Quality standards are unambiguous and specified in processes.
• Quality standards are maintained.
• Continuous improvement is embedded in the supply chain processes.
CSFs-Visibility (V7)
• To measure inventories regularly.
• Staff have skills and technology to identify potential delays as soon as possible.
• Standardised practices are implemented where feasible.

4.2. Component 2: Virtuality (V5)

Component 2-Virtuality, which accounts for 7.76% of variance and combines with component 1 Visibility, to highlight a combined variance of 34.78%. The Cronbach's Alpha score of $\alpha = 0.890$ highlights a reliable interrelatedness between items. The PCA reduced items from an initial 11 to 7. With virtuality addressing the ability to manage and coordinate supply chains using IT (Williamson, Harrison, and Jordan 2004), the item 'infrastructure mismatches have to be addressed between suppliers' with a high factor loading of 0.799. This item has a mean of 5.50 suggesting that the experts agreed with its importance. With a standard deviation of 1.196, the spread of opinions from the mean is within an acceptable level of agreement (Table 5).

Williamson, Harrison, and Jordan (2004) also proposed the item 3 'different processes between supply chain members are identified' as the third heaviest loaded CSF from the

Table 4. Analysis findings-component 1: Visibility (V7).

Item	CSF	Factor loading	SD	Mean	N
1	There is a culture of integration within the supply chain.	0.822	0.829	6.19	303
2	Suppliers are fully integrated within the supply chain.	0.797	1.007	5.84	303
3	There is close cooperation between managers throughout the supply chain.	0.677	0.950	5.96	303
4	The processes within the supply chain are integrated.	0.676	1.183	5.63	303
5	There is joint planning of the initial supply chain between suppliers and yourself.	0.673	1.147	5.90	303
6	There is cooperation and collaboration between all members of the supply chain.	0.663	0.996	5.91	303
7	Supply chain members openly share information.	0.662	1.235	5.61	303
8	You are open with your suppliers and have a close working relationship.	0.647	0.829	6.19	303
9	There are organisational compatibility/ working practices between supply chain members.	0.614	1.233	5.46	303
Eigenvalues 13.23	% **of Variance explained** 27.01%	$\alpha =$ 0.918 CR = 0.89		**Cumulative** % **of variance** 27.01%	

analysis. The earlier works by Webster, Sugden, and Tayles (2004) laid the foundations of our understanding of virtuality within manufacturing organisations. The findings of this study allow for organisations to focus on the practices when focusing externally on virtuality when working with or setting up supply chain partners.

4.3. Component 3: Variability (V6)

The third component variability accounts for 6.75% of variance and with two previous components (i.e., visibility and virtuality) highlight a combined variance of 41.53%. The Cronbach's Alpha score of $\alpha = 0.864$ confirms a reliable result. The PCA has seen the component virtuality items reduce from the initial 18 to 8. The PCA shows that the first item 'quality standards are maintained' has the highest factor loading of 0.783. Although this was not a direct CSF taken from one individual source within the literature, it was seen as an underlying theme and furthermore, through discussions with supply chain decision makers it stood out as an ongoing concern, therefore it was included within the study. With a mean of 6.50, it can be ascertained that experts strongly agree on its importance. The second item of 'products meet customer specifications and achieve consistent quality' has a factor loading of 0.749 and a mean score of 6.52 (Table 6).

There is always the issue of addressing quality and the subjective nature of what it actually is and means (Brah, Li Wong, and Madhu Rao 2000), the idea of quality not being ambiguous but specified was confirmed as a CSF through the analysis carried out. The CSF of 'supply chain managers understand the importance of quality standards' was widely seen as a crucial factor (Crosby 1979; Feigenbaum 1956; Fotopoulos and Psomas 2009; Jraisat and Sawalha 2013). The findings have shown that supply chain decision makers agree on its importance as a CSF in delivering variability. The study has also been able to confirm that the CSF 'procurement of a defect free product' is key as first highlighted by Forker, Mendez, and Hershauer (1997). In addition, this study agrees and offers clear evidence that the 'initial design of the product is of good quality' is also a CSF as previously discussed by Jraisat and Sawalha (2013).

4.4. Component 4: Value (V1)

The fourth component of value accounts for 4.26% with combined variance of 45.80%. The Cronbach's Alpha score of $\alpha = 0.793$ indicates a reliable result. The PCA significantly reduced the initial 26 items identified to 9. The PCA identifies item 1, which was first highlighted by Heikkilä (2002) as ensuring that 'suppliers are able to offer flexibility regarding client requirements' has a factor loading of 0.625 as the highest loaded item in relation to value. With a mean of 6.01, the experts see this as being very important in achieving value. In comparison to the items from other components, the items attributed to value have a lower loading with only one item above 0.600. However, all but one of the items have a mean higher than 6.00 highlighting their individual importance in attaining value (Table 7).

Sengupta, Heiser, and Cook (2006) stated that customers are continuing to demand value and it is essential that organisations ensure it is delivered. The challenge for suppliers is how they can achieve this value for their customers and what the CSFs are that must be considered to attain this. These findings offer 9 CSFs as highlighted in Table 6 that if addressed can assist in delivering value.

4.5. Component 5: Variety (V4)

The fifth component value accounts for 3.96% of variance and combines with components 1-4 to highlight a combined variance of 49.76%. The Cronbach's Alpha value is $\alpha = 0.806$. The PCA reduced items from the initial 10 to 6. There is this requirement that for variety to be achieved, there must be the ability to customise or standardise a product as per consumer demands or even in anticipation of changes in demand. However, in order for that to happen, the PCA highlights that the heaviest loaded factor on component 5 is 'changes to product are not complex' (Tatham and Christopher 2018) with a loading of 0.787. In relation to the mean score of 5.11, it suggests that experts agree on its importance (Table 8). They follow this up with the closely linked CSFs of 'products are not complex', suggesting that the less complex the product the more variety that can be offered and, similar to item 1, it resonated with the supply chain experts.

The CSF 'ability to customise products locally' (item 3) was not attributed to a single academic source and was created through discussions with the supply chain experts. Although, Hines (2004) did suggest the need for the ability to switch to varied or new products when the market dictates, with changes made closer to the end user. Ensuring that 'over specification is reduced' as highlighted by Coman and Ronen (2010) has also now been confirmed as a CSF, along with 'design of products adaptable for differing markets', previously suggested in the research of Elmuti (2002), that needs to be addressed in order to achieve variety.

4.6. Component 6: Velocity (V3)

The sixth component velocity accounts for 3.42% of variance and combines with components 1-5 highlights a combined variance of 53.23%. A Cronbach's Alpha score of $\alpha = 0.831$. The PCA reduced initial items from 12 to 5. With velocity seeking the ability for customers to utilise speed through their supply chain as a competitive advantage, the first item that is loaded heaviest against this component, which was highlighted by supply chain experts is that 'potential delays must be identified early to minimise risks', which focuses on communication of information and links closely back to visibility in that the transparency of the supply chain can be an issue that needs to be addressed. This item has a factor loading of 0.734. It also has a mean of 6.42, which highlights that experts strongly agree that this is an important item when it comes to attaining velocity. Further to this the standard

Table 5. Analysis findings-component 2: Virtuality (V5).

Item	CSF	Factor loading	SD	Mean	N
1	The risk of infrastructure mismatch between suppliers and yourself has been assessed.	0.799	1.196	5.50	303
2	IT capabilities of the supply chain new members are comprehensively evaluated before joining the supply chain.	0.756	1.545	5.01	303
3	Differing processes between supply chain members are highlighted and managed.	0.726	1.152	5.56	303
4	Standard IT platforms are agreed between supply chain members to exchange data and information efficiently.	0.704	1.453	5.32	303
5	IT systems integration between key supply chain members has taken place.	0.696	1.592	5.05	303
6	IT security risks are evaluated and managed.	0.648	1.046	5.95	303
7	Supply chain members have compatible IT capabilities.	0.604	1.356	5.47	303
Eigenvalues 3.80	% **of Variance explained** 7.76%	**α =** 0.890 CR = 0.87	**Cumulative** % **of variance** 34.78%		

Table 6. Analysis findings-component 3: Variability (V6).

Item	CSF	Factor loading	SD	Mean	N
1	Quality standards are maintained.	0.783	0.650	6.50	303
2	Products meet customer specifications and achieve consistent quality.	0.749	0.704	6.52	303
3	Quality standards are unambiguous and specified in processes.	0.748	0.937	6.28	303
4	All supply chain managers understand the importance of quality standards.	0.691	0.695	6.39	303
5	New suppliers are subject to vetting procedures and understand quality standards.	0.656	0.901	6.30	303
6	Component and lower tier suppliers all work to agreed quality standards.	0.600	0.809	6.17	303
7	There is procurement of a defect free product.	0.590	0.917	6.17	303
8	The initial design of the product is of good quality.	0.485	0.844	6.28	303
Eigenvalues 3.31	% **of Variance explained** 6.75%	**α =** 0.864 CR = 0.86	**Cumulative** % **of variance** 41.53%		

Table 7. Analysis findings-component 4: Value (V1).

Item	CSF	Factor loading	SD	Mean	N
1	Suppliers are able to offer flexibility regarding client requirements.	0.625	0.952	6.01	303
2	Suppliers have the necessary skills and equipment to add value and reduce costs.	0.575	0.927	6.08	303
3	The supply chain offers customer service that meets client requirements.	0.571	0.665	6.38	303
4	Assets are fully utilised.	0.562	1.258	5.62	303
5	Reducing costs/adding value through continuous learning.	0.560	0.895	6.06	303
6	The supply chain represents value for money to all parties including the final customer.	0.533	0.797	6.01	303
7	Costs are minimised.	0.522	0.893	6.01	303
8	The product/service offers customer satisfaction.	0.496	0.865	6.36	303
9	The supply chain is profitable for each partner in the chain.	0.471	0.898	6.16	303
Eigenvalues 2.09	% **of Variance explained** 4.26%	**α =** 0.793 CR = 0.79	**Cumulative** % **of variance** 45.80%		

deviation score of 0.641, suggests that experts' opinions are closely spread (Table 9). They also identified 'blockages need to be identified quickly and removed' as a CSF that must be addressed.

Reichhart and Holweg (2007) suggestion that 'suppliers respond in a timely manner' and Elmuti (2002) identification that 'realistic time frames are agreed' are also seen as crucial to the attainment of velocity. Whilst the supply chain expert's indication that 'lead times must be planned for carefully' can reduce the impact of CSFs associated with velocity, which links into Tyndall (1998) suggesting that 'practical timeframes are agreed between supply chain members' as shown in item 4. The CSFs confirmed through the analysis in relation to velocity could be set into two simple subthemes of proactive and reactive strategies for decision makers to consider. Proactive focuses on putting in place realistic timeframes and planning careful lead times, whilst reactive strategies incorporate the identification of blockages and delays as well as suppliers being able to respond to them.

4.7. Component 7: Volume (Volatility) (V2)

The seventh and final component is volume and accounts for 2.87% of variance and combines with components 1-6 to highlight a combined variance of 56.10%. A Cronbach's Alpha score of $\alpha = 0.694$. The PCA reduced items from 9 to 4. With Volume (Volatility) seeking to ensure that customers have the flexibility to increase/decrease volume as their demands dictate. Within operation management literature, this is outlined by Reichhart and Holweg (2007) as a concept of supply chain responsiveness (SCR), pointing out that although SCR focuses on customisation, build-to-order and also includes lean and agility, there is a lack of comprehensive definition as well as a defined relationship between 'responsiveness' and 'flexibility'. The first item with the heaviest factor loading from component 7 is 'suppliers are able to anticipate changes in demand' and has a loading of 0.721, which was previously discussed by Prahinski and Benton (2004). The mean for item 1 is 5.65 which on the scale utilised highlights that the experts agree that this is an

Table 8. Analysis findings-component 5: Variety (V4).

Item	CSF	Factor loading	SD	Mean	N
1	Changes to product are not complex.	0.787	1.558	5.11	303
2	Products are not complex.	0.772	1.785	4.39	303
3	There is an ability to customise products locally close to the point of final delivery.	0.702	1.670	4.75	303
4	Over specification is reduced.	0.626	1.249	5.55	303
5	Products are designed in a way that they are easily adaptable to different markets.	0.586	1.313	5.56	303
6	The supply chain has the ability to change or introduce new product without starting a new chain.	0.543	1.254	5.46	303
Eigenvalues 1.94	% **of Variance explained** 3.96%	$\alpha =$ 0.806 CR = 0.83	**Cumulative** % **of variance** 49.76%		

Table 9. Analysis findings-component 6: Velocity (V3).

Item	CSF	Factor loading	SD	Mean	N
1	Potential delays must be identified early to minimise risks.	0.734	0.641	6.42	303
2	Lead times must be planned for carefully.	0.724	0.750	6.32	303
3	Blockages need to be identified quickly and removed.	0.718	0.621	6.43	303
4	Realistic time frames are agreed.	0.653	0.782	6.35	303
5	Suppliers respond in a timely manner.	0.635	0.615	6.37	303
Eigenvalues 1.69	% **of Variance explained** 3.42%	$\alpha =$ 0.831 CR = 0.82	**Cumulative** % **of variance** 53.23%		

Table 10. Analysis findings-component 7: Volume (Volatility) (V2).

Item	CSF	Factor Loading	SD	Mean	N
1	Suppliers are able to anticipate changes in demand	0.721	1.194	5.65	303
2	Forecasting is accurate.	0.606	1.220	5.85	303
3	The supply chain is flexible enough to deal with sudden changes in demand.	0.585	0.931	6.01	303
4	The behaviour of everyone in the supply chain is integrated.	0.576	0.776	6.24	303
Eigenvalues 1.40	% **of Variance explained** 2.87%	$\alpha =$ 0.694 CR = 0.72	**Cumulative** % **of variance** 56.10%		

important item, it is noted that this is the lowest mean within this component (Table 10).

Initially this study identified 13 possible items that could be considered as CSFs. However, through the piloting process these were reduced to 9. These CSFs were further reduced to 4 confirmed CSFs associated with the attainment of volume and are highlighted in Table 8. The need for 'forecasting to be accurate' as first highlighted by Fisher (1997) suggests that there are restrictions on how much flexibility suppliers would have in ensuring it when looking at downstream supplies. CSFs highlighted by Elmuti (2002) that 'the behaviour of everyone in the supply chain is integrated' and Prahinski and Benton (2004) where 'the suppliers are able to anticipate changes in demand' in order attain this flexibility. An interesting observation is the possible link to the suggestion of Mentzer et al. (2001) regarding CSFs with visibility. It suggests that through supply chain integration, visibility can be achieved and flexibility attained.

5. Implications and conclusions

The aim of this research was to gain a greater understanding of key factors related to the effective delivery of supply chains. Specific CSFs associated with the successful delivery of supply chains are identified and evidence of the suitability of the revised 7Vs framework as an organisational tool for better understanding and managing CSFs is offered.

5.1. Theoretical implications

The research contributes to a deeper understanding of CSFs associated with supply chain management. Previously, the SCOR and Cooper, Lambert, and Pagh (1997) models were highlighted as having been considered for the attainment of the aim and objectives of this study. Although neither was deemed suitable for the identification of CSFs in SCM, it is believed that through its validation, the 7Vs framework could now be utilised in conjunction with the SCOR model. It may therefore be possible, in what SCOR calls a process of 'Enable', where SCOR 'Manages Supply Chain Risk', our contribution is that the 7 themed areas and 48 CSFs offer specific guidance to supply chain decision makers that could assist in the area of risk identification. As this area is non prescriptive within the SCOR Model, the 7Vs framework could be utilised by supply chain decision makers to assist organisations in what SCOR process highlights as designing and maintaining supply chains.

In relation to the Cooper, Lambert, and Pagh (1997) model there are specific areas that do overlap and would add more depth of understanding. These include what Cooper, Lambert, and Pagh (1997) calls 'Demand Management' where forecasting and supply chain capabilities are considered. However, unlike the SCOR model it does not offer a specific area in which the CSFs associated with the supply chain could be considered. Additionally, due to the Cooper, Lambert, and Pagh (1997) model's prescriptive structure it would be problematic for the 7Vs framework to be added or used in conjunction with it.

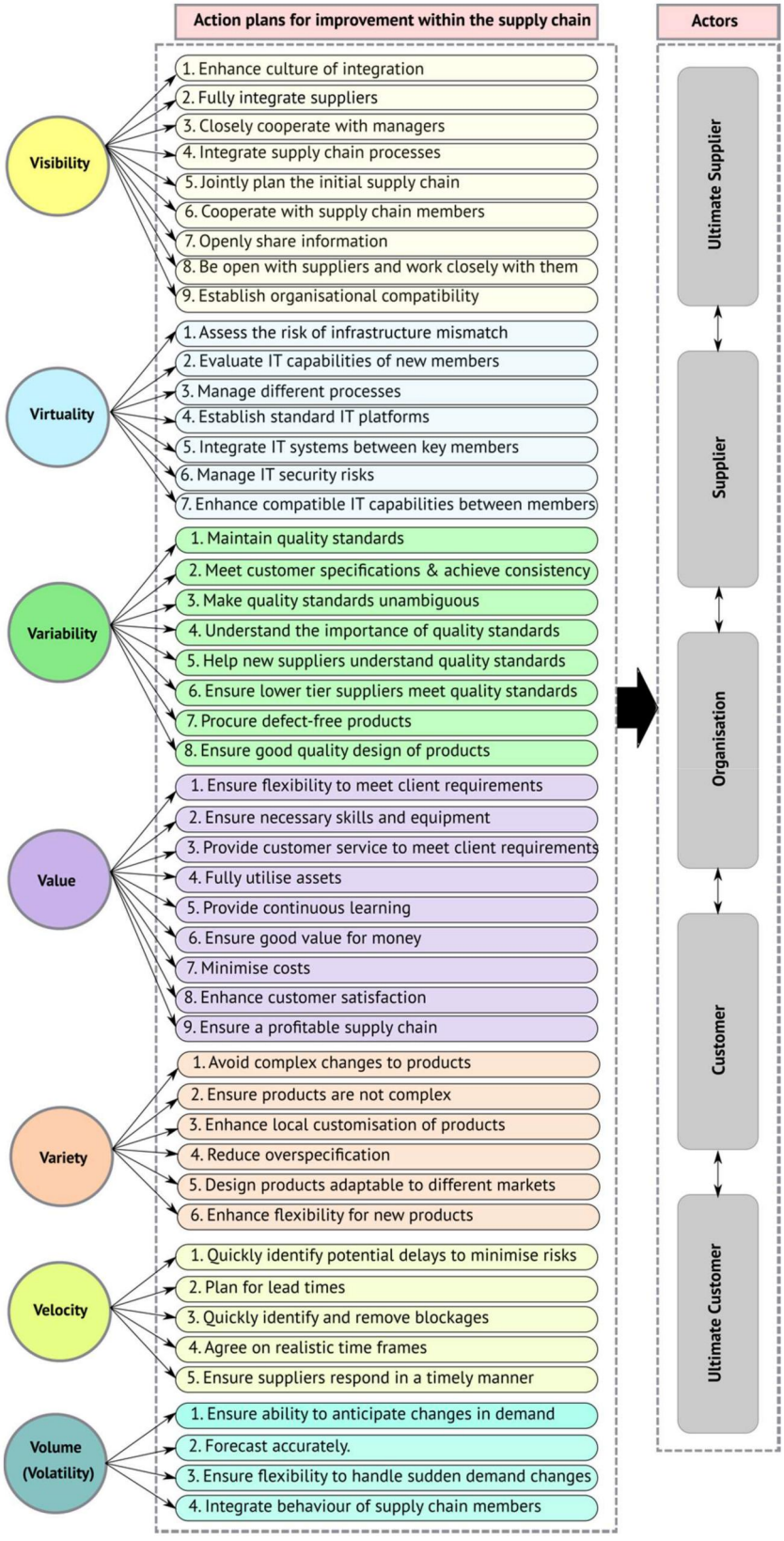

Figure 4. Action plans and actors in the 7Vs framework.

5.2. Managerial implications

This study makes a direct contribution to practice in the validation and development of the 7Vs framework which practitioners can use to identify and address CSFs at key points throughout the supply chain life cycle. Unlike previous research into CFSs, this framework is not focused on individual industries or organisations but offers a more holistic view so it can be applied to diverse sectors and organisations. Practitioners can easily adapt the framework and in turn

create checklists more aligned with their own. The summarised action plans along with actors within the supply chain in the 7Vs framework are illustrated in Figure 4.

5.3. Reflections, limitations and future research

On reflection, the study set out to offer a guide to support the operational management of critical success factors (CSFs), to enhance the effectiveness of supply chains. It is noted that the extant literature associated with CSFs is growing as this research area develops. As supply chains continually evolve, they create new factors for consideration. The results suggest that CSFs are crucial to the outcome of an event which allows for a direct link to the 7Vs framework. This research has confirmed CSFs as being associated with each theme and allowed for clarity in a research area that is still developing. To date, no other SCM research has been identified that gives such focus to CSFs in relation to the collective amount confirmed within this study. The confirmation of 48 CSFs from a possible 106 original analysed, assisted in the attainment of research objective 2 (See RO 2 in Figure 3). The 48 CSFs confirmed through the PCA reflects a direct contribution to theory.

It is noted that the scope of the study does have some limitations, specifically in relation to the findings, in which the span of the 7Vs framework focused on specific areas related to supply chain effectiveness. However, it is acknowledged that these areas take a holistic view of all supply chains. Therefore, in its attempt to be non-prescriptive, the model cannot cover issues related to all supply chains. For example, if a supply chain has a focus on sustainability, then the model would need to be adapted to include a theme that could identify CSFs in that area. Furthermore, the scope of this study made the possibility of acquiring a representative sample of supply chain experts difficult, given the number of people operating in supply chains. However, the sample size of 303 did offer a diverse range of opinions from key informants.

The findings of the current study offer a framework that can be utilised to assist in the management of supply chains. This should be seen as a starting point as the framework can and will be developed further. The extent to which the identified CSFs impact supply chain management has not been measured and could be a potential avenue for future research. It is envisaged that the next stage of this research is to take the 7Vs framework out into industry and assess its practical implementation within supply chains. For example, this could be in the growing research area of sustainability. As no causality between the themes or CSFs was sought during this study, future research could also focus on the strengths of relationships between the themes. Additionally, with current political and economic challenges surrounding the Ukraine war and the recession in the UK economy, having organisations with supply chain issues creates new avenues for research into CSFs.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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