



James Vickery

***Visualising Volatility, Uncertainty, Complexity, and Ambiguity
(VUCA)***

Centre for Design Engineering
Cranfield University

PhD Thesis
Academic Year: 2024

Supervisor: Leon Williams
Associate Supervisors: Matt Collins, Enes Unal

This thesis is submitted in partial fulfilment of the requirements for
the degree of Doctor of Philosophy

© Cranfield University 2024. All rights reserved. No part of this
publication may be reproduced without the written permission of the
copyright owner.

Academic integrity declaration

I declare that:

- the thesis submitted has been written by me alone.
- the thesis submitted has not been previously submitted to this university or any other.
- that all content, including primary and/or secondary data, is true to the best of my knowledge.
- that all quotations and references have been duly acknowledged according to the requirements of academic research.

I understand that to knowingly submit work in violation of the above statement will be considered by examiners as academic misconduct.

Abstract

Organisations continue to face a range of existential threats from increasing turbulence in their operating environment. The nature of the turbulence is multifaceted, from global pandemics and financial crashes to military conflicts and climate changes, requiring strategic decision makers to craft tailored responses to ensure not just survival, but ideally to take advantage of the emerging situation for competitive advantage. Achieving these aims however is not straightforward, for in order to respond, data and insight is required, along with new decision-making tools, to enable improved understanding and visualisation.

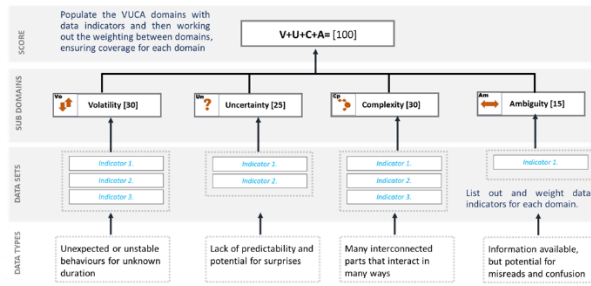
VUCA, an acronym for volatility, uncertainty, complexity, and ambiguity, has emerged as a way to frame this turbulent environment helping make sense of it. VUCA events, such as the COVID-19 pandemic, can form quickly and have far reaching impacts across organisations and whole economies. A growing body of research continues to examine how organisations improve, adapt and change internally to respond to VUCA and the capabilities they need to survive and thrive.

This thesis examines the other side of the equation, seeking to make sense of VUCA events forming in the turbulent environment. Crafting a response would be greatly aided by a more robust understanding of the VUCA events themselves, an area under researched as of today, with VUCA often used as shorthand to encapsulate challenging operating conditions, but with little exploration to understand what signals it provides.

In particular, this research aims to show VUCA visualised for arguably the first time. Through hundreds of individual surveys generating thousands of data points, this research explored how VUCA was experienced, its epistemological roots, and developed a visual decision-making toolset (Figure 1) to understand when external turbulence is occurring, disseminating this to hundreds of peers through lectures and industry presentations.

VUCA Scorecard Template

This template can be used to sense and understand VUCA events in the external environment. Identify data indicators for each of the VUCA domains to build a data driven picture of the external landscape and its turbulence. The data indicators can capture social, economic, governmental, public, and private trends/patterns. Weighting of domain can be tailored based on the quality and number of data indicators in each VUCA domain.



VUCA BreachMap Template

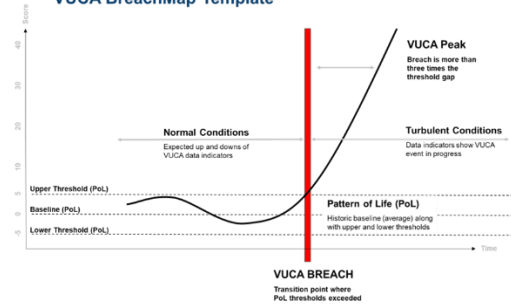


Figure 1 – VUCA Scorecard and BreachMap

Keywords:

Visualising VUCA, Strategic decision making, Turbulent environment, VUCA Scorecard, Pattern of Life analysis

Acknowledgements

This thesis would not have been possible without the support of many people. The first words of appreciation are for my supervisors who have helped me through the years, Leon Williams and Enes Unal from Cranfield University's Centre for Design Engineering. Their patience and guidance have been invaluable on this journey.

I'm also grateful for the love and support my family and friends have shown on this journey, in particular my wife Michelle, and daughter, Raissa.

I also owe a debt to those who have taken the time out to discuss ideas and concepts, helping me refine my ideas and test my thinking.

Table of Contents

Academic integrity declaration.....	i
Abstract	ii
Acknowledgements	iv
List of Figures.....	vii
List of Abbreviations	ix
1 Introduction.....	10
1.1 Setting the Stage: A VUCA World.....	10
1.2 Problem Statement	11
1.3 State of the Art.....	12
1.4 Research Purpose and Research Questions	15
1.4.1 Aims, Objectives and Questions	16
1.5 Contribution to Knowledge Summarised.....	17
1.6 Thesis Structure.....	17
1.6.1 Reflection	18
1.7 Literature Review Update	19
1.8 List of Research Papers.....	20
2 Research Paper 1 - Literature Review	21
3 Research Approach & Methodology	47
3.1 Gap in Defining and Sensing VUCA Events	47
3.2 Overall Research Design	48
3.2.1 Research Strategies.....	48
3.2.2 Rationale for Mixed Methods Approach	48
3.2.3 Rationale for Case Study Approach	49
3.2.4 Rationale for Abductive Approach.....	50
3.2.5 Research Process Flow	50
3.3 Defining and Baselining VUCA	51
3.4 Data Collection	52
3.4.1 Data Acquisition and Use	52
3.4.2 Data Velocity, Volume, and Variety	53
3.5 Research Hypotheses.....	54
3.5.1 Experimental Planning	55
3.5.2 Research Concerns.....	55
3.6 Research Design for Individual Papers.....	56
3.7 Ethical Consideration	57
4 Research Paper 2 - Sensing VUCA Survey	58
5 Research Paper 3 - VUCA Decision-Making Tool	87
6 Research Paper 4 - VUCA Data Indicators	125
7 Research Paper 5 - Visualising VUCA: A Case Study	171
8 Results	202
8.1 Mapping of RQ's to Results	203

8.2 VUCA Discovery Summary.....	204
8.3 Synthesis of The Results	205
8.4 Research Hypotheses Revisited	205
9 Discussion	207
9.1 VUCA Events Can be Experienced.....	207
9.2 VUCA as Part of Strategy	207
9.3 VUCA Research Today.....	209
9.4 VUCA can be Visualised	212
9.5 Aiding Strategic Decision Makers	212
9.6 Teaching and Disseminating VUCA.....	213
9.7 Implications for Researchers	218
9.8 Implications for Practitioners.....	219
9.9 Potential Weaknesses in VUCA Model	220
9.10 Limitations of Research	222
9.11 Recommendations for Future Research	223
10 Conclusion.....	225
10.1 Reflection on Research Aims, Objectives and Questions	225
10.2 Contribution to Knowledge	228
10.2.1 Additional Findings	230
11 References	232
Appendices.....	300
Appendix A – Ethical approval letter	300
Appendix B – Data Sets.....	301
Appendix C – Decision Making Artefact.....	306
Appendix D – Step-by-Step	307
Appendix E – Teaching Collateral.....	314

List of Figures

Figure 1 – VUCA Scorecard and BreachMap.....	iii
Figure 2 - Strategy Inputs & Outputs	11
Figure 3 - VUCA Definitions	12
Figure 4 - Conceptual analysis of volatility (Taskan et al 2022).....	13
Figure 5 - VUCA Map (Maheshkar et al 2024)	13
Figure 6 - Graphical VUCA project scores (Fridgeirsson et al 2021).....	14
Figure 7 - Structure of the Thesis	18
Figure 8 - Reflection Model	19
Figure 9 - Research Papers	20
Figure 10 - Research Process Flow	51
Figure 11 - Data & Baseline Feedback Loop.....	53
Figure 12 - Research Methods	56
Figure 13 - Link to Research Papers.....	174
Figure 14 - Data Sources	178
Figure 15 - VUCA Scorecard Populated.....	178
Figure 16 - VUCA Baseline generated in Normal Conditions	180
Figure 17 - VUCA Event Visualised.....	181
Figure 18 - Data Sample	182
Figure 19 - WHO Key Initial COVID-19 Events	183
Figure 20 - Volatility Visualisation.....	183
Figure 21 - Volatility and VUCA Mark Up	184
Figure 22 - Uncertainty Visualisation.....	185
Figure 23 - Uncertainty and VUCA Mark Up.....	186
Figure 24 - Complexity Visualisation	187
Figure 25 - Complexity and VUCA Mark Up.....	187
Figure 26 - Ambiguity Visualisation	188
Figure 27 - Ambiguity and VUCA Mark Up.....	189
Figure 28 - Ambiguity Worldwide Visualisation.....	190

Figure 29 - Ambiguity Worldwide and VUCA Mark Up	190
Figure 30 - VUCA Scorecard Multiple Entries	191
Figure 31 - VUCA Scorecard Weighting.....	192
Figure 32 - Combined VUCA Visualisation.....	193
Figure 33 - VUCA in Action	196
Figure 34 - VUCA Event Deck Guidance	197
Figure 35 - Overall Mapping of RQ's to Results	204
Figure 36 - Correlation Between the Papers and Research Questions	204
Figure 37 - VUCA Searches.....	210
Figure 38 - Human Resources Focused Papers 2024	211
Figure 39 - Lectures 2020 to 2023	214
Figure 40 - Completing VUCA Scorecard.....	215
Figure 41 - Completed VUCA Scorecards.....	216
Figure 42 - Industry Workshops	217
Figure 43 - VUCA Weakness and Mitigations	221
Figure 44 - VUCA Inputs to Strategy Development.....	222
Figure 45 - Reflection	227
Figure 46 - VUCA Event Deck.....	229

List of Abbreviations

AI	Artificial Intelligence
BaU	Business as Usual
COVID -19	Coronavirus Disease 19 / severe acute respiratory syndrome coronavirus 2
CURE	Cranfield University Research Ethics System
IMF	International Monetary Fund
IT	Information Technology
LLM	Large Language Model
LSE	London Stock Exchange
ML	Machine Learning
PoL	Pattern of Life
SME	Small and Medium Enterprise
RQ	Research Question
UK	United Kingdom
UN	United Nations
VUCA	Volatility, uncertainty, complexity, and ambiguity
WHO	World Health Organisation

1 Introduction

1.1 Setting the Stage: A VUCA World

We live in turbulent times. The frequency of unpredictable, chaotic, discontinuous crisis events with global impact and enormous long-term consequences is increasing (Schuh et al 2022, IMF 2020), ranging from financial crashes and global pandemics to geopolitical instabilities and climate change. Thought leaders and strategic decision makers are faced with a bewildering array of challenges on multiple fronts as they seek to sustain their organisations, innovate, and create value. As this ever-shifting series of existential threats continues to emerge and the pace of change becomes ever quicker, thought leaders are seeking to better understand the turbulent external environmental factors that can impact the longevity and sustainability of their organisations, and potentially its very survival. Making sense of these factors or even being able to detect the changes taking place, can offer a competitive advantage to decision makers (Porter 1985) if they can plot a strategy through them (Mintzberg 1994).

But organisations risk sleepwalking into a strategic quagmire for reasons of intellectual negligence. If they fail to define, design, and manage their various strategic initiatives to build adaptive and agile capabilities against these events, then they risk the very existence of their organisations. In order to build as detailed a picture as possible of the turbulent business environment and receive the signals required to inform strategic decision making, particularly those related to innovation and building resilience, organisations need data driven insights from the business environment and better strategic decision-making tools to help them navigate a path through avoiding inherent risks and ideally helping them prosper.

Against this backdrop VUCA (Bennett and Lemoine 2014), which is an acronym for volatility, uncertainty, complexity, and ambiguity, has emerged as a leading way to frame this dynamic, turbulent world in which organisations operate. VUCA provides much needed structure to the turbulent business environment organisations face, with the potential to aid strategic leaders in categorising and defining these 'VUCA events', such as Coronavirus Disease 19 (COVID-19). It

has the potential to help decision makers sense and visualise when VUCA events are happening, helping decompose and break them down into their constituent parts, which will enable the formulation of more precise and tailored strategic responses.

1.2 Problem Statement

Current research into VUCA has primarily focused on internal organisational capabilities and how these need to change to respond to VUCA events. Yet to craft a meaningful response thought leaders need intelligence on what is happening, signals they can decode and take informed decisions against. This ability to sense has historically been underserved, and to its discredit, VUCA at times has become little more than shorthand or catch all term to allow researchers to say its hard out there and here are the things we need to change internally to respond. Addressing these turbulent VUCA events requires a comprehensive understanding of their drivers, effects, and implications on organisational strategies, operations, and performance. Thus, the need arises for effective detection techniques and strategic decision-making tools to add to the thought leader's repertoire so that they can navigate and thrive amidst such dynamic business environments, ensuring sustained growth, resilience, and success.

This thesis faces into this challenge and researches the composition of VUCA events. It is focused on the inputs side of the equation, as shown in Figure 2, to complement and build on existing research that is looking for external VUCA signals to inform data driven strategic decision making.

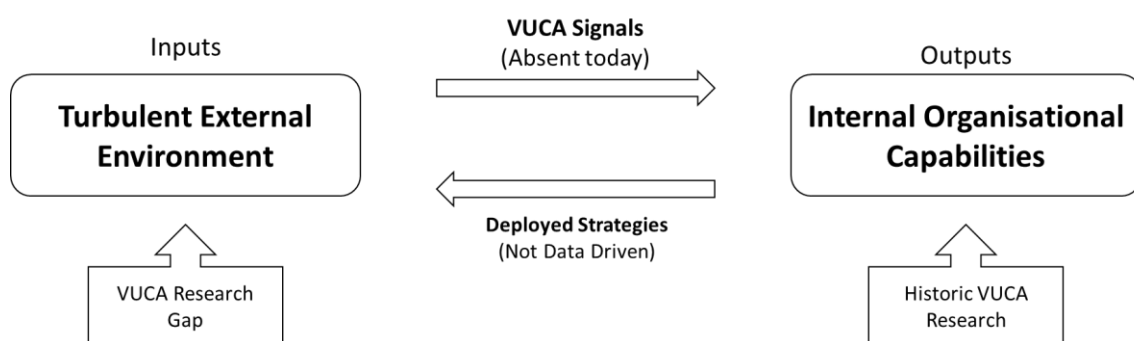


Figure 2 - Strategy Inputs & Outputs

Previous attempts to characterise VUCA in any detail at all, such as that by Kail (2010) do so at an extremely high level of abstraction. Thus, alongside the challenge of sensing VUCA events there is not a single agreed definition in the community for each of the VUCA domains (volatility, uncertainty, complexity, and ambiguity) with different researchers proposing different definitions and terminology, although conceptually they all overlap to some extent. This thesis therefore used the following definitions as shown in Figure 3 which were developed by the author and derived from literature throughout.

	Definition	Example
Volatility	Unexpected or unstable behaviours for unknown duration	Stock market and share prices, shares trade over a large range
Uncertainty	Lack of predictability and potential for surprises	How much of a new product will you sell?
Complexity	Many interconnected parts that interact in many ways	Supply chain with multiple tiers of suppliers and sub-suppliers
Ambiguity	Information available, but potential for misreads and confusion	Airport is closed – Is this due to bad weather or something more fundamental like IT system failure?

Figure 3 - VUCA Definitions

1.3 State of the Art

It is useful at the start to understand the state-of-the-art in current research to help ground and position the contribution this research makes to the field. To date, no one has set out to visualise VUCA as it is occurring. The visuals that do exist tend to fall into one of two camps. The first is graphs or word clouds that map the meaning of VUCA, or each domain, as shown below Figure 4. In this example, Taskan et al (2022) set out to research a conceptual map of the components of VUCA and their relationships to other words in order to highlight some avenues for future research. For Volatility, they discovered nine other closely associated words, with the thick line in the visual denoting the most common word, and small icons on the outside representing the number of times each word was identified in their review.

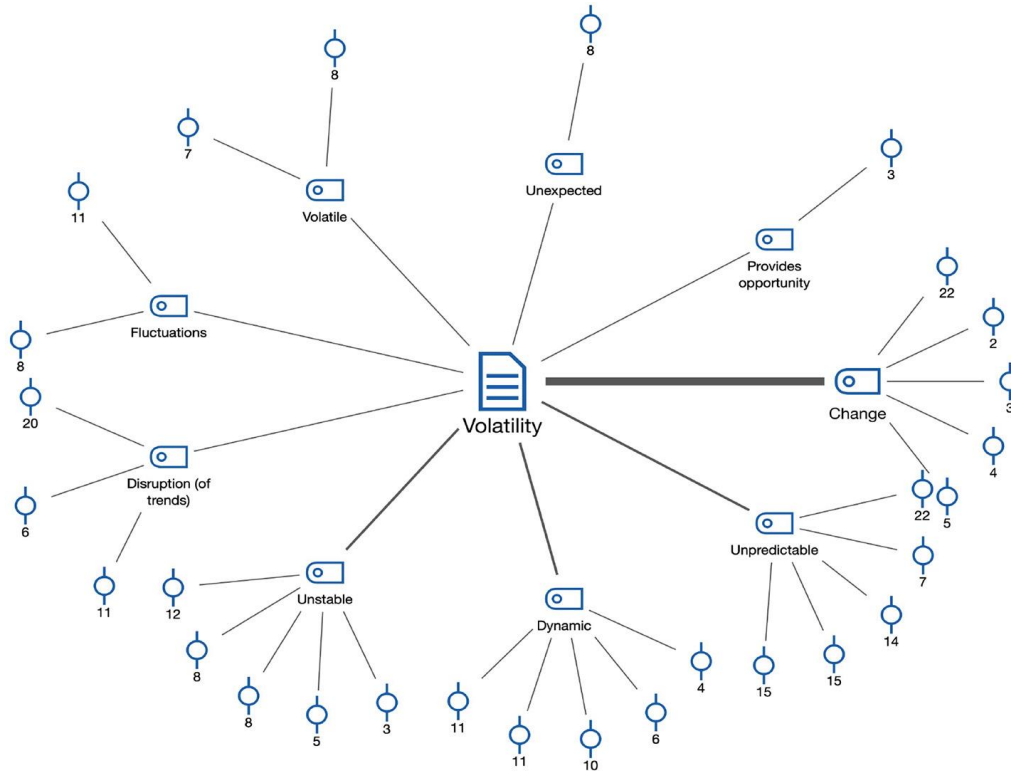


Figure 4 - Conceptual analysis of volatility (Taskan et al 2022)

The second type of VUCA visual is used to represent a framework or construct that has been developed to help frame and understand VUCA. These tend to be static, i.e. there is no data going through them, and they act more as a visual aid to help researchers and practitioners make sense of VUCA. Figure 5 below from Maheshkar et al (2024) is a typical example of one of these.

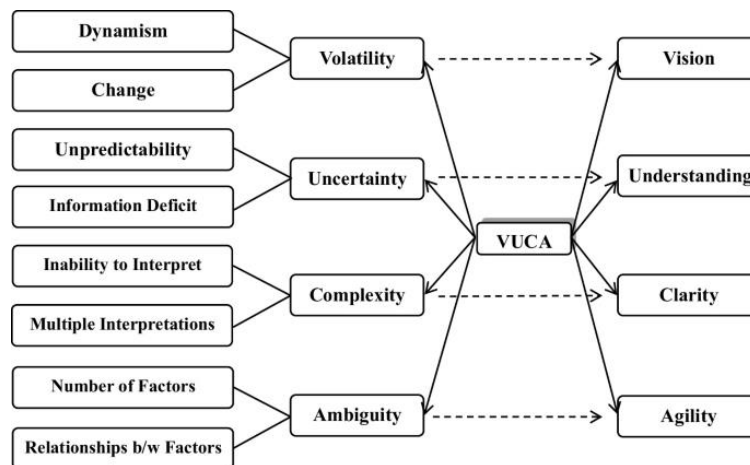


Figure 5 - VUCA Map (Maheshkar et al 2024)

The VUCA map by Maheshkar et al (2024) frames what input might be useful to help respond to VUCA through ‘Vision, Understanding, Clarity and Agility’. The switching of the VUCA acronym to have a different, more positive set of words focused on responding is a common approach in literature, with ‘Velocity, Unorthodoxy, Co-Creation, Abundance’ (Leonhard 2014) and ‘Vision, Understanding, Courage and Adaptability’ (George 2017) being other examples.

It should be noted that a range of internally focused visuals exist as well, but these are positioned to help frame the internal response. An example of this would be the work of Fridgeirsson et al (2021) (Figure 6), who use an assessment approach to evaluate internal organisational projects against VUCA to produce project radar charts. This allows projects to be grouped by common themes: are they more volatile or complex? This approach therefore supports organisations in deciding on internal resource allocation to address them.

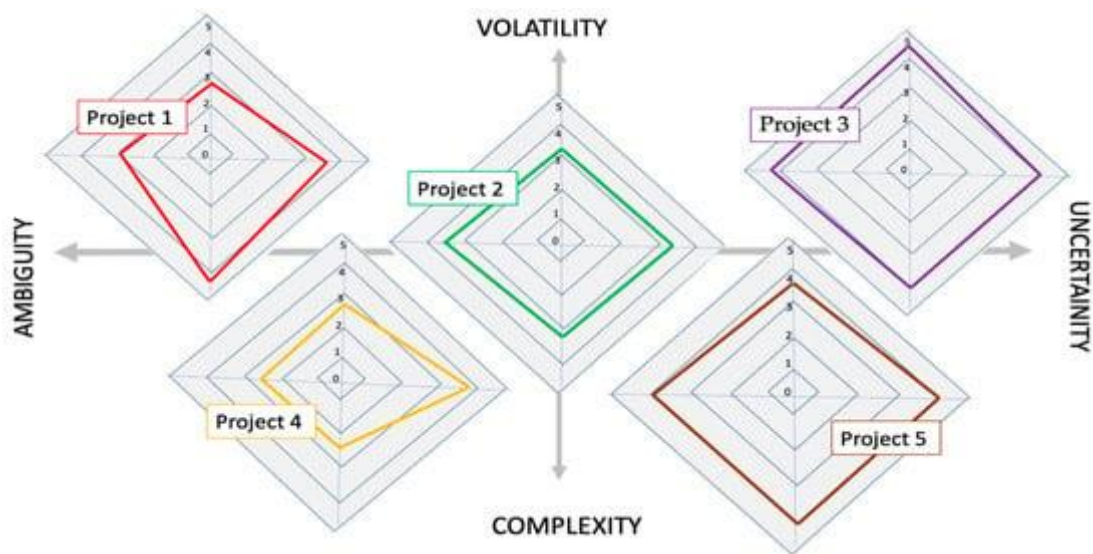


Figure 6 - Graphical VUCA project scores (Fridgeirsson et al 2021)

The state-of-the-art examples in this section show that using visualisations to help explain VUCA is a common approach, but to date no one has developed visuals focusing on detecting when a VUCA event is happening and helping to understand the characteristics of that event, which is the focus of this research.

1.4 Research Purpose and Research Questions

The overall purpose of the research being undertaken was to provide an ability to visualise VUCA events for the first time, thereby providing a capability to sense, examine, and understand what is happening, passing these VUCA signals to the internal organisation.

Armed with the right strategic decision-making tools, leaders will be able to interpret the VUCA events taking place and make more informed decisions. If such a phenomenon were able to be visualised - this would be a breakthrough for the design-science and design-thinking scholarly community and decision making practitioners in strategic and innovation management that base their strategies on responding to VUCA events, potentially allowing them to develop new products and services in response to VUCA events, thereby capturing new markets and opportunities in the process.

This research is scoped to examining the impact VUCA has on an individual organisation, such as a private company, and helping it identify and understand a VUCA event so that it can respond appropriately and in an informed manner through data driven insights. The earlier an organisation senses and understands the shape and nature of a VUCA event, the more opportunities and options there will be to respond. The research is not seeking to identify macro trends or changes to the operating environment that lead to a VUCA event. Understanding what conditions lead to these types of macro events and what causes the formation of VUCA events is outside the scope of this research and would constitute a research undertaking in its own right.

The aim is to measure and build a baseline of the normal conditions in an organisations operating environment to identify as early as possible VUCA events impacting it.

1.4.1 Aims, Objectives and Questions

This study is structured as follows:

- **Overall Aim:** The goal of this research is to develop a set of visual tools that aid strategic decision makers in identifying turbulent events as they form and understand the volatility, uncertainty, complexity, and ambiguity characteristics that underpin them. This will be achieved through the completion of a number of objectives. In short, the aim is to understand if VUCA can be visualised.

To achieve this, the following research objectives were developed:

- **Research Objective 1** – To synthesise available literature and conduct a critical literature review to understand existing research into VUCA, particularly the ‘input’ stage in the external environment and confirm the research gap.
- **Research Objective 2** – To conduct primary quantitative research to better understand VUCA events and their different states.
- **Research Objective 3** – To explore what decision-making tools could be developed, baselined, and populated with data to aid strategic leaders.
- **Research Objective 4** – To evaluate existing evidence and theory to test if data indicators can be validated within existing research.

A standard process was followed throughout to answer the research objectives in a structured and repeatable way: Step 1 - Undertake review of existing theory and literature, Step 2 – Define the method used, Step 3 – Collect data and/or build artefacts, Step 4 – Analysis and results.

The research objectives are answered through three research questions (RQs):

- **Research Question 1:** Can VUCA events be classified as an experience that can be tracked?
- **Research Question 2:** Can a strategic tool be developed to reveal the phenomenon of VUCA events, as they occur?
- **Research Question 3:** Is there a rigorous theoretical underpinning for the data sources for VUCA?

1.5 Contribution to Knowledge Summarised

The aim of this research, and its primary contribution to knowledge, was to prove that VUCA can be visualised for arguably the first time for the design-science and design-thinking scholarly community and practitioners in the strategic and innovation management community. The VUCA Visualisations showed that Pattern of Life (PoL) is applicable for organisations as an analytical method for VUCA detection. The research defined a method to obtain robust data to populate the VUCA Visualisations and PoL. It developed a number of artefacts to support peers in their own research and ensure transferability of key principles and knowledge, primarily through a decision support making tool that is useable in the real world. This research, and the artefacts it produces, could support Thought Leaders, Chief Strategy Officers, Product Owners, and Board members in identifying VUCA events and responding to them in the real world.

A key component of all this is finding, and then defining, the data indicators required to make PoL work for organisations. The expectation is that each organisation would have different data sets, but the research could provide guidance on what these data sets look like and where to find them.

1.6 Thesis Structure

An overview of the thesis structure is provided in Figure 7 on the next page.

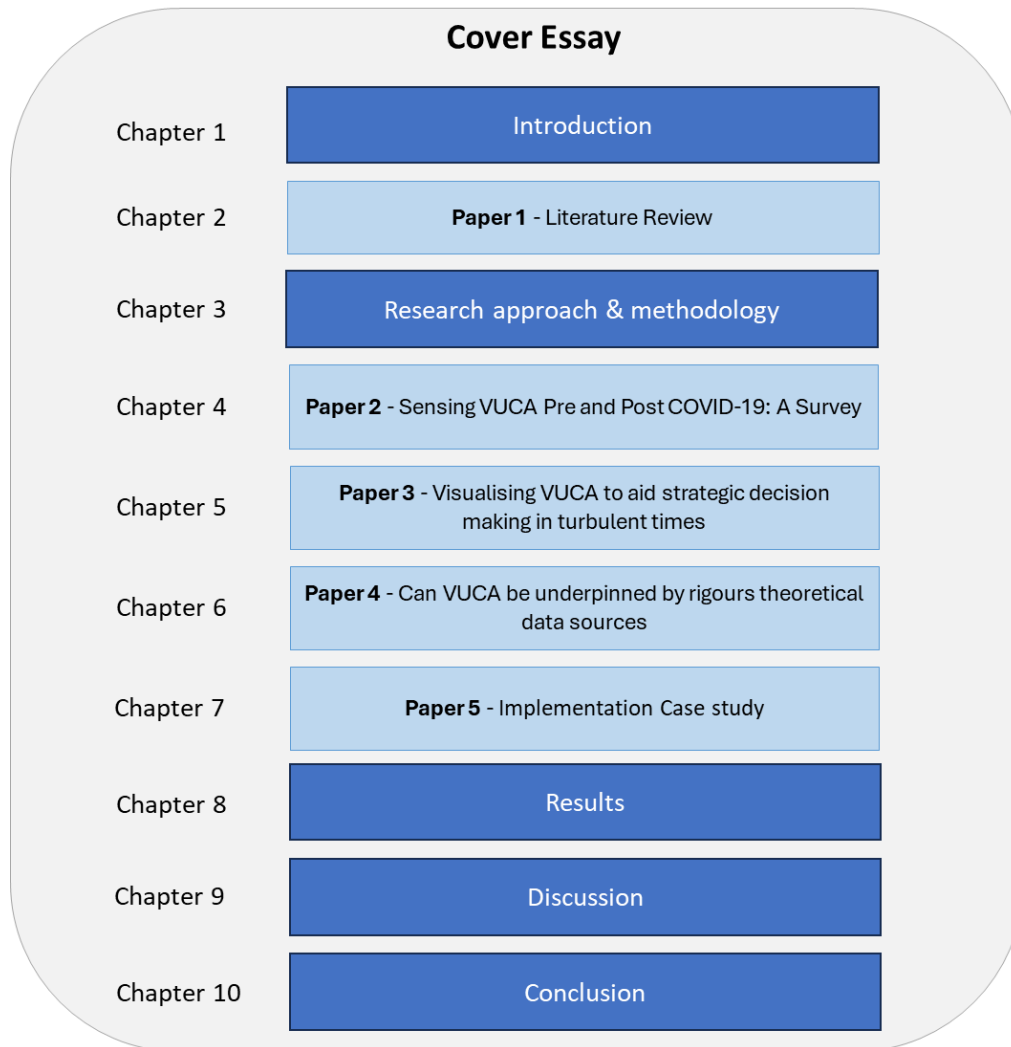


Figure 7 - Structure of the Thesis

The thesis is developed using a “paper-format” basis and follows the guidelines provided by Cranfield University. It primarily delivers the intellectual contribution through interlinked Research Papers, found in Chapters 4 to 7. The Research Papers act as self-contained packages of work as shown above in Figure 7. The implementation Case Study in Chapter 7 consolidates the work from each of the preceding Research Papers and directly answers the overall research aim.

1.6.1 Reflection

The structure of this thesis enables a cohesive and rigorous means of concept development as shown in Figure 8.

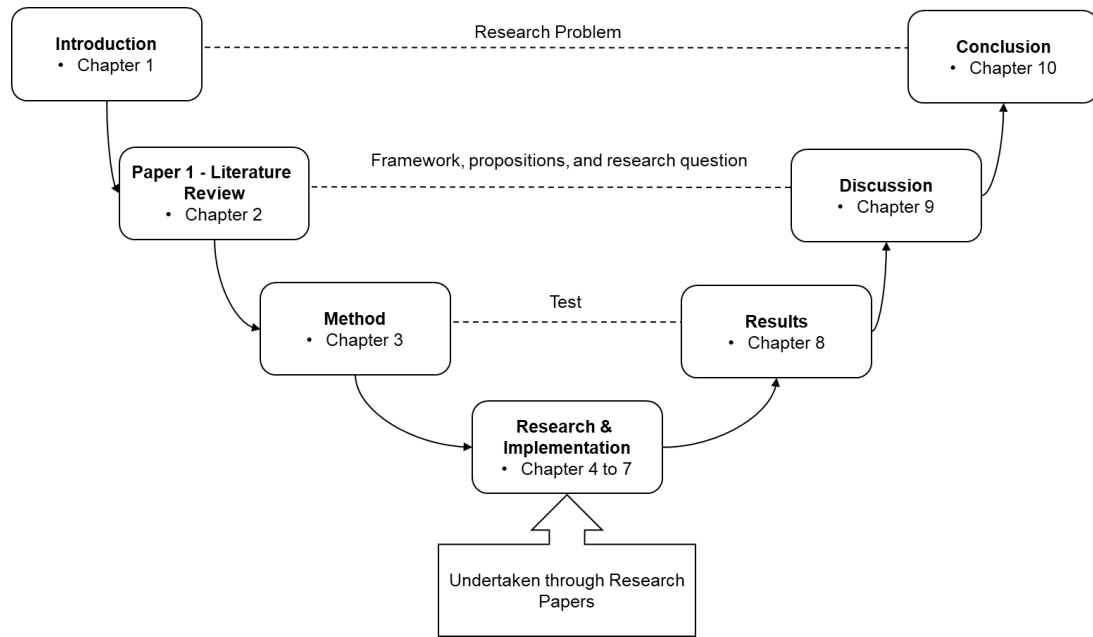


Figure 8 - Reflection Model

The symmetry above mirrors the introduction with the conclusions, the literature review with the discussion, and the method with the results. The different stages reflect the Chapters in this report and are considered both in terms of a sequential project path and as a means of reflecting on earlier ‘opposite’ stages. With the core research, covered in the Research Papers and Case Study, positioned in the middle, the structure enables the researcher to develop a clearer sense of the project as a whole, with deeper conceptual insights.

1.7 Literature Review Update

A systematic literature review was conducted in March 2016. During the period of research contained within this thesis a significant number of new papers have been published, the latest of which are covered in Chapter 9. Published research undertaken since the literature review has only strengthened the conclusions drawn from the original review, namely that the focus continues to be on internal organisation capability development to respond to a VUCA event, and there is little focus on understanding the shape and nature of VUCA events as they form. New VUCA research has continually been reviewed as it has been produced and is referenced in the Research Papers and the cover essay where relevant.

1.8 List of Research Papers

This thesis contains five Research Papers as shown below (Figure 9). Each paper starts with a short introduction explaining how it links to the preceding Research Paper, enabling a coherent story and narrative throughout the thesis.

Paper	Title	Authors	Location
Paper 1	How can VUCA better help 'thought leaders' with strategic change: a systematic literature review	Vickery, J., Unal, E., and Williams, L.	Chapter 2
Paper 2	Sensing VUCA Pre and Post COVID-19: A Survey	Vickery, J., Unal, E., and Williams, L.	Chapter 4
Paper 3	Visualising VUCA to aid strategic decision making in turbulent times	Vickery, J., Unal, E., and Williams, L.	Chapter 5
Paper 4	Can VUCA be underpinned by rigorous theoretical data sources	Vickery, J., Unal, E., and Williams, L.	Chapter 6
Paper 5	Visualising VUCA: A Case Study	Vickery, J., Unal, E., and Williams, L.	Chapter 7

Figure 9 - Research Papers

2 Research Paper 1 - Literature Review

Introduction to Paper

Research Paper 1, a Literature Review, seeks to synthesise all the available literature and conduct a critical review. The aim is to undertake a complete analysis of the VUCA landscape and the current thinking to confirm the research gap and distil any insights enabling further research to build on the work of other researchers.

How can VUCA better help ‘thought leaders’ with strategic change: a systematic literature review

James Vickery

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK, and

Enes Unal

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Dr. Leon Williams

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Abstract

Key Finding – The ‘Input’ stage is underserviced in literature and presents a clear research gap. Researchers discuss VUCA events happening, but no research or insight into this exists. The focus is on the ‘output’ stage, what does an organisation do to respond to VUCA.

Purpose – To understand the existing research into VUCA, in particular focusing on how it helps organisations understand their external operating environment. Organisations risk sleepwalking into a strategic quagmire for reasons of intellectual negligence. If they fail to define, map, and manage their various strategic initiatives, such as change programmes or new product development, against a backdrop of increasing volatility, uncertainty, complexity, and ambiguity (VUCA), then they risk the longevity and sustainability of their organisation, and potentially its very survival.

Design/methodology/approach – A systematic approach has been taken to the literature review, which ensures it is both fully repeatable and auditable. The selected methods were used because the selection criteria for papers to review aligned clearly with the overall research question, thereby ensuring all literature relevant to the question was identified and reviewed. Information deemed relevant was extracted and synthesised into a set of hypotheses.

Additional Findings – This literature review covered the core journal texts available and identified the leaders in the field, and a set of attributes that were common across the literature. It also identified that while VUCA is a growing field there is presently a gap in the availability of high-quality journal entries. In particular, there is a complete lack of information or research on how to apply VUCA to the organisations external operating environment. The main themes covered in literature were internally focused and centred on Strategy and Leadership, Human Resources, and General Business Management.

This paper also identified the leading authors in VUCA at this time. There were four of these that fell in to two different camps. The first two, Johnson (2007) and Kali (2010) published short articles that in part led to the promotion and adoption of VUCA as a concept. The second set of authors, Bennett and Lemoine (2014), and Bartscht (2015) published peer reviewed papers in journals, with Bennett and Lemoine (2014) in particular being notable as they are now likely to be the most cited authors in this space.

Research limitations/implications – While the hypotheses remain theoretical, it is now possible to test them and understand the relative significance for thought leaders.

Practical implications – This study helps thought leaders make sense of what VUCA can offer today to address the challenge of a fast-changing world and provides avenues to explore in the future to help address that need.

Originality/value – Detailed review of all the literature on VUCA across all functional domains such as leadership, innovation, strategy, human resource, and general business management. The study clearly shows where the current research in this field stands.

Contribution to the thesis – The literature review identified the leaders in the field, key papers published up to 2016 and articulated the need to better understand and sense VUCA events so that strategic decision makers could formulate responses.

Keywords: VUCA, Volatility, Uncertainty, Complexity, Ambiguity, Foresight, Horizon scanning, Decision making, Strategic change, Strategy development, Thought leaders,

Paper type - Literature review

1. Introduction

Thought leaders are faced with a bewildering array of challenges on multiple fronts as they seek to sustain their organisations, innovate, and create value. As the pace of change increases at an ever-quicker rate, thought leaders seek to better understand the external environmental factors that can impact their organisations very existence. Making sense of these factors, or even being able to detect the changes taking place, can offer a competitive advantage to decision makers (Porter 1985) if they can plot a strategy through them (Mintzberg 1994). This position has broad consensus, particularly in an environment where globalisation has created opportunities with one hand, while introducing threats with the other (Bennett and Lemoine 2014).

The challenges thought leaders face in setting their strategies are varied. They are dealing with *Volatility*, the unstable and unpredictable (Bennett and Lemoine 2014) nature, speed, volume, and magnitude of change (Sullivan 2012). Organisations see volatility all around, from stock markets to fuel prices, which impact how they operate and the decisions they make to address the volatile situation. Being able to absorb shocks from volatility can actually be a competitive advantage and lead to an organisation becoming anti-fragile (Taleb 2012). This approach allows us to 'conquer the unseen, the opaque, and the inexplicable', and build a capability to not just survive, but blossom. However, to do so, calls for anti-fragile organisations to be exposed continuously to volatility in order to build up resistance (Taleb 2012). They need to also be flexible and adaptable to deal with the challenge.

Leaders are faced with the prospect of surprise events happening, such as a 'Black Swan' (Taleb 2010), in their ecosystem, brought about by a lack of knowledge about what is taking place. This *Uncertainty* highlights the limits of awareness and understanding of issues and events, and similar to the Heisenburg Uncertainty Principle (Hilgevoord and Uffink 2001), it is unlikely in a complex world that a leader will know everything with certainty. Faced with uncertainty, leaders often rely on gut instinct to make decisions (Gigerenzer 2007). Uncertainty is a recognised problem domain, often linked with risk (Knight 1921) and there are a number of programmes attempting to improve our understanding such as the Winton Programme at the University of Cambridge and Strategic Engineering for an Uncertain Future at MIT. The primary route to understanding uncertainty is through information acquisition to plug the gaps in a leader's knowledge to offer greater precision and deeper insight (Spiegelhalter et al 2011).

Complexity prevents easy analysis. While there is no 'unique definition of complexity' (Johnson 2009), its generally accepted to involve many interconnected parts that interact in many ways. It is human nature to look for simple answers to complex problems. Our brains are wired to take the easiest path, rather than face into, and understand, complexity (Kahneman 2011). We substitute the simple answer to the one that requires thought without thinking. Our ability to model complex problem tangles with volatile requirements (Hall 2013), thereby understanding the web of interlocking issues and factors that impact a strategy, is immature and relatively unsystematic (Kaminski and Hall 2015). Dealing with complexity can also be stressful (Coates 2009), and in times of stress, a leader can abandon their espoused values (Argyris 1994), react to strong emotions and behave in ways that drift significantly away from their original strategically expressed values (Coates 2009). When applied to an organisation that is global in nature, with extensive supply chains, and trying to compete on multiple fronts it's easy to see how hard it would be to have a complete picture of the complex operating environment.

The final part of the puzzle is *Ambiguity*. This denotes situations where there is a lack of clarity (Caron, 2009) or doubt about the nature of cause-and-effect relationships (Bennett and Lemoine 2014) making it hard to ascertain why things are unfolding in a certain way (Sullivan 2012) or to conceptualise threats and opportunities before they happen (Kail, 2010). Ambiguity also influences how Leaders lead when it happens. Wilkinson (2006) found a strong correlation between the mode of leadership adopted and their reaction to ambiguous situations.

Taken together these four elements, *volatility, uncertainty, complexity, and ambiguity*, created the acronym VUCA. The term 'VUCA' traces its heritage back to the U.S. Military who coined the term in the late 1980's to reflect an increasingly chaotic, unstable, and rapidly changing world (Whiteman 1998, Kinsinger & Walch, 2012) presenting problems for situational awareness. This acronym was adopted by thought leaders in the late 2000s (Johansen 2007, Kail 2010) to describe a world where the pace of change was becoming quicker, and it was harder to plot a course through the macro environment for organisations (Lawrence 2013). The global financial collapse in the late 2000's potentially saw the use of term increase further as thought leaders linked VUCA with financial loss and shortening lifespan of organisations (Leonhard 2014), and also to the fact that the new post-crash world some organisations were operating in was nothing like what they had seen before (Bennett and Lemoine 2014).

Understanding the external VUCA landscape and what it is telling us allows leaders to set strategic visions (Mintzberg 1994) in response to the coming changes and new information as it exposes itself to analysis. These visions enable greater value creation and strategic advantage (Porter, 1985), in whatever form that takes for their stakeholders. Strategic planning (strategic programming through the elaboration and articulation of the vision) to move from point A to point B, already has mechanisms through the management of emergent strategy (Mintzberg and Waters 1985) to handle what VUCA throws at it, and allows organisations to adapt or pivot (Ries, 2011) at a strategic level. That is not to underestimate the challenge faced however in implementing a programme of

‘change’ or ‘transformation’ to achieve the defined strategy vision. It is also likely that multiple programmes will be taking place at once, leading to a portfolio of strategic change (Sanwal, 2007) that will need co-ordination to deliver. The VUCA environment is now a permanent condition (Hernandez & Allen 2013) and thought leaders do not have one lever to pull to create and sustain organisational success (Horney et al 2010). Beckers and Bsai (2002) state that the quality of a decision depends on how well the decision maker is able to acquire information, analyse the information, and evaluate and interpret that information so as to discriminate between relevant and irrelevant bits of data. The need the tools and frameworks to identify VUCA and react to it to ensure survival has never been greater.

Of the literature available on VUCA, little of it contains rigorous review, or referencing of existing knowledge. What is there is fragmented and dispersed in nature. The available literature on VUCA would benefit from a systematic literature review (SLR) allowing this author to conduct a cross-functional analysis of the papers published so far and make sense of what has been produced (Starbuck 2006, Kelley and Thibaut 1954) to aid in the understanding of VUCA. Through an SLR this paper aims to identify what aspects of VUCA may be of use to thought leaders and support the development of hypotheses that can be tested in due course. Through the SLR, the paper aims to answer two crucial questions:

1. What, if any, common themes can be distilled from the current VUCA literature?
2. Can these be used to inform how VUCA can help thought leaders?

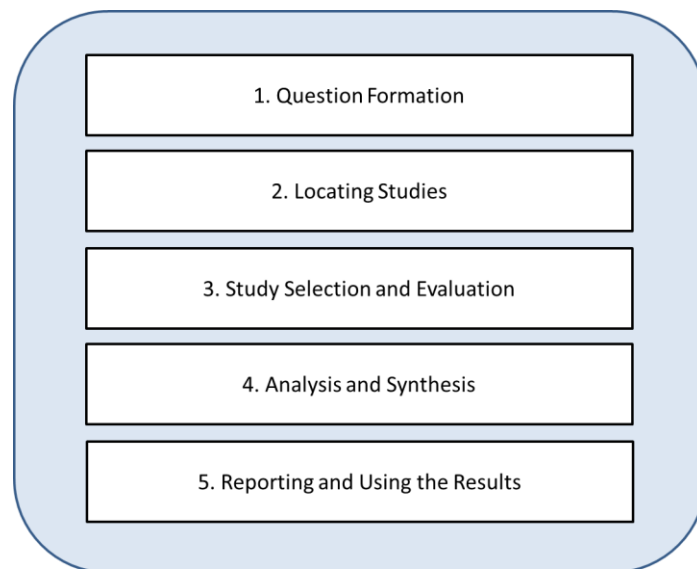
Answers to these questions will contribute to our knowledge and understanding of VUCA and allow others to build on the repeatable SLR undertaken in this paper.

2. Method (Justification for Systematic Review)

This paper starts with a description of the SLR methodology used in this study to synthesise the findings of literature retrieved from searches of online databases,

followed by a descriptive analysis of the papers selected for review. Once the literature has been reviewed in depth, the emerging themes are identified and discussed, including opportunities for further study. Finally, the implications and limitations of this paper are discussed in the conclusions.

This study adopted a systematic or evidence-informed approach based on the five-step approach outlined by Denyer and Tranfield (2009) and adapted by Wong et al (2012). The five steps as illustrated in Figure 1 include: question formulation, locating studies, study selection and evaluation, analysis and synthesis, and finally reporting and using the results.



Adapted by Wong et al (2012) from Denyer and Tranfield (2009)

Figure 1 – Five Step Process

2.1 Question formulation

Any systematic literature review (SLR) is underpinned by a clear research question. The role of the question is critical to narrow the research and provide a laser beam focus on the area of interest, in the hope of distilling that grain of unique knowledge. The questions were formed around two key aims of

understanding what was out there and how this could help (thought) leaders. The questions this study aims to address are set out below:

1. What, if any, common themes can be distilled from the current VUCA literature?
2. Can these be used to inform how VUCA can help thought leaders?

There is a risk that the current literature on VUCA may be too varied across different disciplines (HR, Supply Chains, Leadership, Strategy, etc) to allow common themes to be identified. This is the rationale behind the construction of the first sentence, and its possible negative connotations through the use of 'if any'. However, the second question is positive in nature, assuming themes will be found and asks how these could be used.

2.2 Locating studies (search string and databases)

Because the term 'VUCA' is unique in itself, this was used as the search term. It was deemed to be highly unlikely that authors would use VUCA by mistake or unintentionally. This theory was borne out by the results, where only a few articles fell outside the scope of this paper (for example, one was linked to plant genetics and DNA, and another to a person's surname).

As this literature review was looking broadly across VUCA, and recognised it was a relatively new term, there was an expectation that the total number of results returned would be manageable. If the number of results was too high, then the plan was to extend the search string to include terms like 'leadership' and / or 'thought leader'.

Crafting a search string involving two of the words making up VUCA (for example, complexity and uncertainty) was discounted early on as it was felt these were too generic and likely to result in an unmanageable number of search returns. If the string had been extended to include all four elements of VUCA, it would defeat

the purpose of developing the search string, and likely bring back the same set of results as just using the VUCA acronym.

Two databases were chosen to ensure strong coverage. The primary database was SearchPoint, located in Cranfield University Library, as this has access to a wide range of journals and articles, and amalgamates input from sources such as ABI Inform ProQuest and EBSCO host. The search process in this database was rigorous, and critically, fully repeatable. Google Scholar was used as the back-up secondary database in the hope that its coverage and structure would be different, ensuring a broad-spectrum search across all available literature sources. The process used on Google Scholar was more subjective, and involved reviewing the first five pages of results (50 articles) to ensure no key documents were missed or major gaps were appearing. The search term used was also 'VUCA' for consistency and the search was configured not to include patents or citations. It should be noted that the use of Google Scholar took place after the evaluation of material found on SearchPoint. The rationale for this was that the author would have experience with the core VUCA material and quickly be able to identify novel or new entries.

The use of VUCA search string on SearchPoint generated 165 results when used on the 7th of March 2016.

2.3 Study selection and evaluation (which sources and why)

Initial scanning of the literature had shown that while there were VUCA results, the returns were of a highly mixed nature and quality. The aim of this paper is to review journal papers, and therefore the following process was used to reduce the number of returns down to a number that could be analysed in full, while ensuring quality was present:

- Remove any duplicates
- Remove any papers not written in English
- Remove any papers not focused on VUCA (as the term is used within this paper)

- Apply a quality criterion (see below)
- Remove any papers not of a general 'business' focus (i.e. military documents)

The SearchPoint tool sought to remove exact duplicates, reducing the number from 165 to 121. However, when manually scanning each of these documents there were still a relatively high number of duplicates present that needed removal by hand. Along with the removal of any articles not written in English or not about VUCA, the impact of which was extremely low, the resulting number of articles left was 76.

The quality criteria that had to be met for inclusion in the literature review stated that any journal paper selected for inclusion in the literature review must have been published in a recognised journal, contain more than 3 references, and be more than one-page long.

The use of a recognised Quality Assessment Criteria, such as Cranfield University's systematic literature review protocol was considered. However, due to the limited number of articles available, it was felt the threshold would have to be set too low to allow a suitable volume through for analysis, and therefore it would not act as a good filter.

The author recognises that the area of VUCA is relatively new, and therefore there was not an expectation of extensive literature to review. The proposed criteria were felt to be balanced enough to let in original research, although noting that the articles may not be extensive in length. The addition of a minimum number of references ensured some level of academic rigour had taken place in producing the article, and three references were felt to be an eminently reasonable expectation. This criterion had the biggest impact on reducing the number of articles to review, leaving only 18 papers of the required quality.

The role of this paper is to look at the impact of VUCA on thought leaders and what it means for them, primarily in a business context. The term VUCA arose

from the US military and certainly the majority of papers pre-2007 are generated from military sources. However, their focus is predominantly on the subject of warfare, including battlefield logistics, which is beyond the scope of this paper. In fact, analysing the military's use of the term and what can be synthesised for wider use is probably a paper in its own right. The impact of this final step was the removal of 1 paper, leaving a total of 17 papers for the literature review.

Google Scholar was now accessed and the term 'VUCA' searched for. The majority of articles were duplicates of those found with SearchPoint, or were not relevant. In total 2 papers were identified that met the above criteria and were added for in-depth review. While the initial scope of the search on Google Scholar was 5 web pages / 50 articles, this was subjective and would have been extended in significant results were found.

The total number of papers left for review was 19.

2.4 Analysis and synthesis including descriptive results (commentary on the literature)

There is no doubting the rise of the term VUCA and what it means, from captains of industry at GSK, Tata and Tesco, to TED talks (Raghu Raman 2015), organisations structuring their strategy and annual events around VUCA (CIPD 2014 and 2015), through world class management consultancies describing how to be 'Fit 4 VUCA' (Deloitte 2014) or lead in VUCA times (McKinsey & Company 2015), and finally thought leadership pieces in leading publications, such as Kail's (2011) often quoted piece in the Harvard Business Review. The usage of the term is growing, and across the board.

Yet this growth would seem to be at odds with the results of this SLR, which has found few high quality journal articles. A lot of the articles returned in the database searches were in fact either opinion pieces, letters, editorials or articles without any referencing. While there was still value and insight to be found in these, and they did in the majority appear in journals, they were not what one would think of as traditional, peer reviewed, high quality, journal articles. Perhaps this outcome

is not surprising as the term VUCA first started to appear in the business press from the mid to late 2000's, and even the references in the paragraphs above are, in the majority, only a few years old. The wave of academic interest, and in particular meaningful research, can take time to appear through the normal channels and be pulled through. The first appearance in an academic journal this author found in database searches was in the Business Renaissance Quarterly in 2009. While most authors recognise the origin of VUCA from the US Military in the 1980's, it is Johansen's (2007) book 'Get There Early' that is cited as the crossover point to business literature, a point in time still not that long ago.

Figure 2 provides a breakdown of journal articles reviewed by year, and it tells its own story in that more than half of the articles reviewed were published in the last three years, evidencing the growth of VUCA as an academic term.

	2009	2010	2011	2012	2013	2014	2015	2016
Journals	2	3	0	0	2	8	3	1

Figure 2 - Journal Articles by Year

2.5 Using the resulting (role of this paper)

This paper would appear to be the first formal review of academic journal entries on VUCA and the presentation of those results. What is clear is that there is a gap in VUCA knowledge, with an array of areas demanding research to aid thinking in this important and emerging area. The remainder of this paper is dedicated to reporting the results of the SLR thematically and their possible application to both academia and practice.

3. Thematic Results (what was found, various sub sections expected)

A number of the journal authors (Coates 2009, Anitha and Aruna 2014, Ajith 2015) use VUCA as a given to describe the world in which organisations operate,

and their papers focus on solutions to it, rather than describing or expanding on what VUCA actually is beyond the words that make the acronym.

While there are some high-quality papers that address VUCA in depth (Bennett and Lemoine 2014, Bartscht 2015) the majority only have tentative links to VUCA at the start as a way of referencing a complex changing world with little meaningful analysis of VUCA itself.

The papers broadly break down into three groups: 1 Strategy and Leadership, 2 Human Resources, and 3. General Business Management.

3.1 Journal Results

The journals review uncovered three clear functional areas. These were Strategy and Leadership, Human Resources, and General Business Management. The 19 VUCA journals are noted in **bold** below.

Group 1: Strategy and Leadership

Coates (2009) puts forward a position that to survive in a VUCA world, the leader needs to be an Arya leader (meaning 'noble' leader from ancient Vedic and Socratic texts). This noble leader must have strong morals and values, put duty above personal gain, be self-aware, think critically and act ethically. The leader, using these traits, acts as the bedrock that provides an organisation with its direction while the VUCA world swirls around it. Coates focuses in part on introspection and self-awareness as large building blocks for the noble leader, such as being aware of one's own 'moral vision and code of ethics'. The work of Hass (1992) Coates (2009), Gouldner (1959) and Merton (1957) that is referenced is of particular interest, in that it puts forward a position of 'Strategic Goal Drift to Displacement' whereby people and companies fail if their moral code is not upheld in trying times. Leaders are tempted to act less noble, and substitute less ethically sound solutions, as they suffer strategic drift. Coates also examines emotional intelligence and how actors perform during moments of blackness (the

dark moments before implementation of a great decision— such as the decision for war by military leader). Goleman (1998) Hersey and Blanchard (2000), and Follett (1926) recognised that ‘emotionally intelligent leaders are situationally aware’ and are analytical when wrestling with a number of rival courses of action.

The profoundly challenging demands placed on corporate boards in a rapidly changing global world led to four distinctly perplexing conditions: volatility, uncertainty, complexity, and ambiguity (Bennet and Lemoine 2014). These demands seem to be increasing at a rate that significantly outstrips the rate at which the individual capability of leaders is growing (Bennet and Lemoine 2014), bringing about a ‘complexity gap’ (**Rich-Tolsma and Oliver 2016**), a concept which builds on the work of Jaques (1976) and Habermas (1975). While some believe that corporate boards and leaders perform an essentially ornamental function in the face of the increasingly complex and competitive landscapes (Drucker 1974 and Mace 1971) and are perpetually “in over their heads” (Kegan 1994), Rich-Tolsma and Oliver (2016) believe that core developmental skills that support more complex ways of working, coupled with an understanding of the variability within individual performances and the fact that people may perform very differently under a range of different conditions, allow us to select corporate boards that can lead in demanding times. This thinking is underpinned by empirical psychological science of constructive development, leveraging and building on genetic epistemology (Baldwin 1904 and Piaget 1932) to understand the hard stages of development that each individual progresses through hierarchically at variable rates (Fischer and Bidell 2006) through an iterative process of cycles of learning (Dawson and Stein 2011). Examples of this insight into board selection include Stamp’s work (1993) which shows that only 6% of people have the capacity for modelling complex systems, and only 3% have the capacity for weaving; the ability to describe and integrate a range of abstract principles, potentially over time spans of 20 years into the future. Identifying and selecting these people for corporate board roles ensures companies have the right skills to lead them through VUCA.

Rodriguez and Rodriguez (2013) set out a position to evidence the scenarios any leader is currently facing in front of three specific situations: a volatile, uncertain, complex and ambiguous world (VUCA). They reference the work of Johansen (2012) in laying out how it is the Millennials generation that is changing the way to form relationships, work and knowledge transfer; and the possibility for a “Cloud Leadership” to overcome today’s reality of constant change, redirection, new frontiers and formatting.

Within the context of this paper, the features of VUCA are applied to the resources a leader has to manage, so that Volatility is related to employees job tenure and loyalty to a company (Bauman, 2008), Uncertainty identifies that globalisation, new technologies, education, travel and immigration are dissolving many of the bonds that held societies together, Complexity is found everywhere from social structure through to data overload, and Ambiguity drills down on wide range of options for any decision, with a particular focus on the ethics and values underpinning it.

‘Cloud’ in this context refers to a metaphorical description of an interconnected and converged set of thinking, disciplines and principles for leadership today (Rodriguez and Rodriguez 2013). Millennials (Howe and Strauss 1991), also known as Generation Y (DeVaney 2015), have a strong presence in the VUCA world (Rodriguez and Rodriguez 2013), with different cognitive processes than other generations that leaders will have to interact with (Rodriguez and Rodriguez 2013). These processes include being tech-savvy (Stein, 2013), multitasking (Bauerlein, 2011) lightning speed (Immerwahr, 2015) and autonomy (Howe and Strauss, 2000).

By mirroring some of the traits of Millennials, the authors propose Cloud Leadership as an acceptable way to understand and lead Millennials in a VUCA world.

Businesses have always had limited life spans (**Murthy and Murthy 2014**), which in turn call for renewal to stave off existential challenges, and thereby ensure longevity for all stakeholders (Murthy and Murthy 2014). This position is further exacerbated by the prevailing volatile, uncertain, complex and ambiguous (VUCA) environment in the first decade of the new millennium ((Horney et al., 2010). Murthy and Murthy (2014) therefore lay out in their paper a case that businesses need 'Adaptive Leadership' to be sustainable, and, based on two previous neo-classical grounded theory research studies (Murthy and McKie 2009), theorise an augmented leadership repertoires for VUCA worlds. This ensemble leadership repertoire (ELR) uses a classification schema of Enactments (Locke 2001 and Weick 2009), Practices (Glaser 1978) and Virtues (Peterson and Seligman 2004). The subject of 'a moral and ethical core' is raised again under practices (Kouzes and Posner 2002) and reinforced by the requirement for good leaders to display positive virtues, referencing work as far back, and drawing comparison with, Aristotle's *Nicomachean Ethic*.

Bartscht's paper (2015) is one of the few papers that continuously comes back to the subject of VUCA, reinforcing its position and intent against the challenges VUCA brings. He builds on the work of March (1991), Ackoff (1998 and 2006) and Kotter (2001) amongst others to look at the difference between exploration (leadership) and exploitation (management) activities, arguing that not enough exploration is taking place and companies are over managed. Organisations are highly optimised to 'manage' today, yet vulnerable and unprepared for future changes (Rowe, 2010). So, when the unexpected happens, these 'efficient yet fragile organisations' face crisis, or worse, organisational collapse (Hoverstadt 2008). A leader must consistently reposition the organisation correctly to sustain it (Lichtenstein 2006, Marion 2008). Bartscht (2015) hypothesises that a leader must; 1) continuously "explore" their environment (increased exploration activity), which leads to 2) improved situational understanding, thereby allowing a leader to 3) better position the organisation in a VUCA landscape to reap rewards (Tetenbaum and Laurence, 2011).

Bartscht (2015) believes that an organisation must open itself up to exploration beyond its current known world to understand the variables that affect it (the system). The organisation must then consume this new information, integrate its meaning, and change its behaviour accordingly (its identity). Bartscht (2015) proposes that 'the willingness of a system to be influenced by new learning can be called "the epistemic stance" of the system'. He goes on to state that 'the epistemic stance of an organisation to play a key role in its ability to innovate as innovation often requires large scale identity re-organisation as the system pivots to a new competitive position'.

Bennett and Lemoine (2014) in their often-referenced VUCA paper, open by putting forward a number of well-made statements about how the acronym VUCA is mistreated, something this author has seen in reviewing the available literature. They list out three core problems in the use of VUCA; 1), VUCA has become a trendy byword for saying 'unpredictable change' with all the words being used interchangeably with pundits and leaders often being insensitive to the differences in meaning, 2) there is a lack of information regarding just what to do to address VUCA, they (leaders) quickly move on to simpler items without offering solutions, and where solutions are offered, it is in high level general terms such as 'innovate, be creative, be flexible, or listen more' (Bennett and Lemoine 2014), and 3) because there is a lack of actionable advice leaders bury their heads in the sand and give up - obsolete ideas such as strategy and marketing are now 'dead' (Draycott 2012).

Bennett and Lemoine (2014) proceed to deconstruct VUCA down to each of its constituent parts, arguing that each has to be understood in isolation, as what works for one element will not work for another, and assess what this means for solution development (i.e. each element needs its own solution). Volatility therefore equals relatively unstable change that is addressed through agility, Uncertainty is a lack of knowledge tackled through the acquisition of information, Complexity is denoted through its many interconnected parts forming an elaborate network that requires internal restructuring to match the external

environment, and finally Ambiguity captures doubt about the nature of cause-and-effect relationships, and is addressed through experimentation, controlled risk taking, and option development.

A VUCA world, **Horney et al (2010)** believe, calls for 'Leader Agility'. Their 2010 paper characterises this as 'the capability to sense and respond to changes in the business environment with actions that are focused, fast and flexible'. Specifically, agile leaders must provide guidance, take more risks moving talent, information and knowledge around the organisation, have a laser like focus on employee engagement, and finally pursue collaboration at every opportunity. Ideally, these four things need to be done everywhere a business operates across the globe, regardless of cultures, time zones, geography or organisational barriers. The paper looks at the qualities agile leaders need (Anticipating Change, Generating Confidence, Liberating Thinking, and Evaluating Results) and the talent management tools and methods for identifying and developing these skills.

Group 2: Human Resources

Ajith (2015) states that 'organisations in VUCA world need to be agile and innovative, constantly redefining the way they do business in order to maximize stakeholder value and build a profitable and sustainable business model', believing the recruitment of the right type of resources can ensure the organisation has what it takes to operate in a VUCA world.

Ajith (2015) work proposes a framework called KESHAVA (Knowledge, Emotional Intelligence, Skill, Hardwork, Attitude, Values and Ambition) to be used during recruitment to ensure prospective resources have the required skills needed to thrive in a VUCA world. Those without these skills should not be employed. Interestingly, this work, while not referencing Coates (2009) directly, calls for two of the same attributes Coates believed a leader needed, namely emotional intelligence and strong values.

‘Curbing Career Fears’ by **Lindborg (2010)** advocates using VUCA as a ‘strategic model’ for career development. Previously people may have used SWOT (Humphrey 2005) or PEST (Aguilar 1967, and Johnson, Scholes et al 2008) to conduct a strategic analysis of their own career, whereas Lindborg (2010) advocates VUCA for its deeper interrogation of threats. In a simple matrix, the model cross references each of the VUCA domains against an individual’s view, an organisation’s view, and trends. Of note is that while the first two columns (individual and organisation) are subjective, the trends column requires objective, referenceable, outside information, thereby providing a systematic understanding of what is affecting now and the future (Lindborg 2010). The model calls on people to think about dynamic and complex systems (Simon 1962) where cause and effect can be subtle, and the outcome of intervention is not always clear (Senge 2006).

Sturmberg (2010) in his paper on healthcare leadership makes the case that VUCA serves as a ‘handy reminder how to enhance leadership through insight and foresight, and an understanding of individual and group behaviours’. The author believes volatility, uncertainty, complexity and ambiguity perfectly describe the nature of the consultation, and the interactions within health care organizations (Malterud 2001, Polanyi 1958, and Hjortdahl 1992) and draws parallels to the Institute for the Future (Pang 2007) statement that ‘increasingly we are moving from a world of problems – which demand speed, analysis and elimination of uncertainty to solve – to a world of dilemmas – which demand patience, sense-making and an engagement with uncertainty. Dilemmas span disciplines and frustrate attempts to craft elegant and final solutions. Dilemmas require a different orientation, decision process and set of skills’. Leadership is about facilitating the adaptive work that needs to be done (Heifetz 1994) in complex adaptive systems and Sturmberg (2010) elegantly sums this up by proposing Caron (2009) alternative use of the VUCA acronym to guide leadership action in a VUCA world through Vision, Understanding, Clarity and Agility.

Anitha and Aruna have produced two papers (2014 and 2015) examining different facets of HR to address VUCA challenges. The first (**Anitha and Aruna 2014**) is through the use of a Human Resource Information System (HRIS) (Kavanagh et al. 1990) to codify and be competitive (Beckers and Bsat, 2002) in business. The paper focuses on four major groups that it puts forward as the key influences for the adoption of HRIS. These are technological factors (DePietro et al 1990, Yang et al 2007, Seyal et al 2007, Alberto and Fernando, 2007, Lymer, 1997, and Alshawi, 2010) organisational factors (DeLone 1981, Cragg and King 1993, Cavaye and Hussain 2007, Mirchandani and Motwani, 2001, Ahuja et al. 2009), environmental factors (Docherty 2004, Todd and Javalgi, 2007, Mendo and Fitzgerald, 2005) and psychological factors (McAfee 2003, Haines and Petit 1997, Greenwood 2002).

Their second paper (**Anitha and Aruna 2015**) looks at the retention of Generation Y workforce in a VUCA environment. They put forward a position that Generation Y is significantly different, for example, by not being loyal to a company, and see retaining and leveraging their different mind-set as 'a phenomenal task for the organisations in this VUCA scenario'. Through the authors review of Generation Y's expectations and enablers, they have used the paper to propose a 'conceptual model' depicting six variables that influence the employee retention of this generation'. The six variables are mentoring (Munde 2010 including reverse mentoring Bloomquist, 2014 and Koster, 2013), career development (Sayers 2007, Burmeister 2009 and Shaw 2008), job satisfaction (Beck and Wade 2004, and Henon, 2006), inclusive style of management (Weyland 2011, Rai 2012, and Pinkess 2008), work environment (Rai 2012, and Raman et al., 2011), and the nature of working style (Baruch 2004, Elkins et al., 2007, and Martin 2005).

These factors are then tested through a study involving real world data collection and analysis. Of the original six proposed influencing variables, mentoring and work environment are shown to be statistically significant by the authors. One

possible criticism of the research was that it was limited to one city in India, so its global implications need to be tested further.

While there would appear to be no direct link between this research on retention and Ajith (2015) KESHAVA framework for recruitment in a VUCA world, some of the themes from the different papers correlate. For example, 'Knowledge' in KESHAVA looks at continual development, and aligns with 'Career Development', while 'Ambition' aligns with 'Job Satisfaction'. Cone (2006) and McElhaney (2008) have described Generation Y as friendly, open minded, socially minded, informed, intelligent, responsible, and civic minded. Weyland (2011) also identifies 'Values' as important to Generation Y. These attributes read across to the KESHAVA work as well, suggesting there may be a link in the literature between Generation Y's make up and their ability to respond to VUCA, a position also put forward in Rodriguez and Rodriguez (2013) paper on 'Metaphors for Today's Leadership'.

Group 3: General Business Management

Packowski et al (2014) released a series of **five papers**, the first three of which directly examine the impact of a VUCA world on Lean Supply Chain Management (SCM). The authors focus primarily on the pharmaceutical sector and put forward a case that in an environment with ever widening market fluctuations, greater frequency of change, and the high levels of complexity involved in globally dispersed production processes, organisations are confronted with hitherto unknown problems and challenges. The case is not helped by rigid production process and IT, such as enterprise resource planning (ERP) systems that require exact schedules 12 months in advance. To address the VUCA challenge, the authors propose LEAN SCM, which is designed to enable production and replenishment planning across the entire supply chain through cyclic planning with a "Rhythm Wheel", end-to-end synchronisation along the supply chain, and variability management on the capacity and inventory side.

Hernandez and Allen (2013) recognise and examine how the VUCA world is negatively impacting the Pathology profession. Traditional methods and practices that served so well, no longer suffice against the frenetic pace of environmental change, leading to increased workload, time pressures and stress (Seamon 2012). Hernandez and Allen (2013) believe that for pathologists to prepare for VUCA, they require a better understanding of the challenges and possible coping mechanisms for volatility, uncertainty, complexity, and ambiguity. They proceed to take apart each element of VUCA describing its characteristics and exploring ways to deal with them. For example, they see volatility as a state of dynamic instability brought about by drastic, violent, and rapid shifts (Kail 2010), which can be addressed through effective leadership, intelligent use of information, and clear communication of their intent. With clear intent, volatility gives way to vision (Pang 2007).

Interesting points of note that have wider applicability include 1) In an ambiguous world, leaders must be ready for surprises, ensuring they remain agile to flex and respond appropriately to rapidly unfolding situations (Pang 2007), 2) using the VUCA acronym to mean Vision, Understanding, Clarity and Agility, as per Sturmberg (2010), and 3) the position that with complexity "confusion and chaos become the norm. . . . This means there are no obvious 'low hanging fruit' solutions that [one] can quickly implement. Instead, [one must] learn new ways to think critically and creatively to solve the dilemmas". This focus on the use of the term 'dilemmas' instead of problems reinforces the suggestion that VUCA cannot be solved like a traditional problem with a clear set solution.

Bodenhausen and Peery (2009) examine how historically we have used social norms (race, nationality, etc.) as identifiers to categorise people, and the perceptions, judgements, and behaviour this brings (see Allport 1954, Sherif 1948, Tajfel 1974, Goldberg 1968 and Kasof 1993). However, the real social environment is much messier, an idea embodied in VUCA (Johansen 2007). To explore the complicating realities of real-world social perception that VUCA brings, they focus first on complexity. The bulk of the paper is therefore a detailed

study of social and psychological work on how people build perceptions, and how crossed-categorisation effects (Crisp & Hewstone 1999), emergent properties impact on parent categories (Kunda et al 1990), and context and situation, amongst others, inform our thinking. The authors conclude by looking at how social categorisation will change as it is faced with richly multifaceted, dynamically changing, and at least partially ambiguous or unknown information.

4. Key Findings

This Literature Review has identified the following key findings:

- Identified the core journal texts in this area, the core audience of VUCA specialists, and provided an overview of existing research. Few of the texts offer any detailed analysis of VUCA itself, and it is really only Bennett and Lemoine (2014) paper that stands out as deconstructing VUCA and seeking to understand its constituent parts. Most of the other authors are applying solutions to a VUCA world, and there is a gap in understanding about the VUCA events themselves.
- Identified common threads and theories across the literature and allowed these to be pulled into a unified set of attributes.
- Systematically reinforced the early perception that there was not an extensive number of high-quality journal articles available, clearly demonstrating a gap in knowledge.
- Helped shape the research question and demonstrate how it adds value to the field.

5. Hypotheses for Further Research

For the majority of the papers reviewed, the following four attributes, and their supporting sub points, were consistently present, albeit with different nomenclature, and could in theory be extrapolated out to form the basis of a framework to guide thought leaders through the marrying of responses directly to

insight about the VUCA events. Research should be undertaken in the first instance to understand if these points resonate with thought leaders, before developing practical applications (frameworks, tools, etc.,) that can be tested. The four attributes were:

- **Values:** Moral and ethical base to guide decisions
- **Style:** Authenticate leadership to manage through VUCA, holding true to a vision
- **Extend:** Explore, sense and respond, learn about the environment
- **Approach:** Be adaptive and agile, flexibility to adapt, willingness to change identity

Of a more critical nature was the call to action by Bartscht (2015) and Bennett and Lemoine (2014) to gain a better understanding of VUCA events and their constituent parts (the VUCA domains of volatility, uncertainty, complexity, and ambiguity). There is an underlying assumption that VUCA events exist and can be dissected, but this has not been subjected to rigorous testing or analysis in the literature reviewed.

More data, particularly quantitative primary data that can be subjected to statistical analysis, is clearly required across the board in the area of VUCA to understand how VUCA can help thought leaders and what it means for them. The first step in seeking to understand VUCA in the external environment is to be able to examine if organisations through their people can clearly articulate that they are experiencing a VUCA situation; is it real, and if so, is it significant? Going a step further, there is a need for clarity about what they are experiencing; is it volatility, uncertainty, complexity, or ambiguity, a combination of these domains, or all of the VUCA domains at once? Do they experience them evenly, or are there differences between each of the VUCA domains?

Understanding more about VUCA events and their make-up will help researchers, such as those covered in the literature review, to tailor research to address the multifaceted nature of the VUCA event. A number of researchers identified in their work, such as Bartscht (2015), that a model for sensing outside

an organisation and the feedback loops it provides would be useful. This is the research gap that needs to be addressed, the input of insight and data driven signals about the VUCA event to enable a response, leading potentially to feedback loops.

6. Conclusions

As a shorthand for the challenges thought leaders and organisations face in their external environment, VUCA provides a powerful rallying point, an easy to remember and use acronym that everyone can understand and appreciate.

Based on a systematic literature review of publications across a range of functional domains, this paper identifies four core clusters of behaviours (Values, Style, Extend and Approach) that could be used to help thought leaders sustain their organisations in a VUCA world. But this requires insight into the VUCA events to achieve this, and the sophisticated feedback loops envisioned. This is the clear research gap called out in the literature by researchers in the field, the need for a greater understanding about the VUCA event itself.

The main contribution of this systematic literature review is that it brings together the findings and theoretical arguments from a diverse set of literature and synthesises them into a hypothesis based on a clear research gap, a need for a greater understanding of VUCA events, that could potentially help shape ways for thought leaders to deal with VUCA. Being able to 'see' VUCA events as they form and understand their make-up would represent a new and novel contributions to the field and aid the community in developing responses.

While the proposed hypotheses remain theoretical, they now opens up possible avenues to test through data collection and experimentation to understand if they resonate and work. Therefore, the research questions coming of the literature review is: Can VUCA be visualised?

3 Research Approach & Methodology

3.1 Gap in Defining and Sensing VUCA Events

It becomes clear very quickly after undertaking a literature review (Chapter 2) in the domain of VUCA that while there are papers and research on how to ‘respond’ to VUCA, and what internal skills and capabilities an organisation may need to be able to cope with VUCA, there is little to no coverage on how to ‘detect’ or ‘sense’ VUCA events.

In order for a thought leader to respond to VUCA, they need to first know it is happening and then collect as much data about it as possible to understand the shape and nature of it to formulate an enduring response. It is well documented that an understanding of the issue is needed to be able to strategically respond (Slatter et al 2006, Day and Lichtenstein 2006, Marion 2008).

This thesis therefore focuses on sensing and defining VUCA events in an organisation’s external environment, as this was the gap identified from the literature review and the author’s own experiences. Four key research approaches have been identified to support this:

- Surveys – Investigation with different organisations to understand how they perceive and experience VUCA events, in essence, can VUCA be detected.
- Focus Groups – Used with leaders to test conceptual designs of decision-making tools.
- Primary Data Collection – Use of open-source data to build a picture of the external environment.
- Case Study - Detailed implementation consolidating all the research and analysis of a worked example of a real organisation with real data to understand the usefulness of a VUCA decision making tool.

It is recognised that while in-depth discussions with the focus groups might lead to the identification of useful internal and proprietary data sets to populate VUCA

Visualisations, the overhead to do this is potentially significant. It begins to look like a mini consulting engagement, mapping out parts of their business model and its touch points with the external world, and is therefore, due to time and cost constraints, potentially outside the scope of the research.

3.2 Overall Research Design

Research aim: "Can VUCA be visualised?"

3.2.1 Research Strategies

Research strategies focused on finding an appropriate fit between the research objectives and the wide range of methodological options available. In selecting a suitable research strategy, the initial questions were whether to focus on quantitative, qualitative or mixed research methods, and which research approach to select (Abductive, Deductive, or Inductive). In order to understand VUCA events, it is important to study experiences, events, and facts (Neuman 2014) in a natural, social setting with sensitivity to researcher influence on the observation and analysis of data (Locke 2001; Neuman 2014). Therefore, an abductive, mixed research methodology cap stoned with a Case Study consolidating all the research from the preceding and interrelated Research Papers was selected as the overall strategy. Data is to be gathered through both primary and secondary means, including surveys and semi-structured interviews for the primary data collection. For the Case Study, this approach will use open source publicly available data and provide an in-depth investigation of the impact and identification of VUCA events correlated against an organisation's experiences.

3.2.2 Rationale for Mixed Methods Approach

The thesis uses a paper-format basis, where research is undertaken through a series of academic papers rather than producing a single, monolithic thesis to conduct the research. Each paper is standalone with its own distinct research method selected in order to address the research questions it is seeking to answer. There is no single research method approach that would address all the

research questions, and the blended approach selected allows the best research methods to be deployed as required.

As an example, the literature review (Research Paper 1 in Chapter 2) provided a thematic synthesis of work to date and highlighted both the internal impacts of VUCA on an organisation and its people, and the lack of awareness of the external factors causing the impact. The usefulness of any solution to identify external VUCA events, even if these are based on quantitative data, requires the output to be viewed through the organisation's people (its thought leaders) and their perception and experience (Smircich 1983). The need to interrogate the organisations people to validate the conceptual design of a VUCA decision making tool through focus groups requires a qualitative approach, particularly to tease out the key learnings and insights (e.g. semi-structured interviews).

3.2.3 Rationale for Case Study Approach

The paucity of research to identify external VUCA events, as evidenced in the literature review, is a key issue this research project is seeking to address. Being able to apply the research undertaken in the subsequent Research Papers through an actual Case Study with a real company and real VUCA event is critical to validating the results of research questions one to three and providing an answer to the overall research aim (Can VUCA be visualised?). There are three aspects of the Case Study approach, as identified by Eisenhardt (1989) that make it suitable for explanation building (also referred to as theory building), namely:

- Constant juxtaposition of conflicting evidence reduces influence of researcher preconceptions and increases probability of generating novel theory.
- Developed theory is likely to be testable and falsifiable.
- Developed theory is likely to be empirically grounded because theory development is closely linked with data gathering and analysis.

Yin (2009) also identifies that a Case Study approach is useful to allow individual, institutional and cultural contextual factors to be taken into account as part of the analysis. Therefore, a Case Study approach, focused on confirming the ability of

this research project to add value to thought leaders was selected as an appropriate method (Yin 2009) to cap stone the overall research. It should be noted that while the overall thesis is abductive in nature, the Case Study will be primarily inductive, as it is making an inference based on the observations of the VUCA decision making tools in use with real data.

3.2.4 Rationale for Abductive Approach

The lack of an established way to sense VUCA events in the external environment was clearly spelt out in the literature review. While it was an identified problem space in some of the literature, it was an emergent area with a lack of both consensus and ideas on how to address it. There is therefore a need to start with observation, and then seek the simplest and most likely reason for the outcome using logical inference. An abductive approach structured this way and as outlined by Kelle (2005) provides the researcher with a way to examine emergent and unexpected findings while still incorporating existing theories and knowledge. Remaining theoretically agnostic is required of the researcher using an abductive approach, as outlined by Henwood & Pidgeon (2006). This approach seeks to select the 'best' or 'most likely' explanation and does not force the outcome to artificially 'fit' existing theory.

3.2.5 Research Process Flow

The diagram on the next page (Figure 10) shows the thesis's overall structured process flow for the research projects and the steps it will go through to produce the Case Study to support the later analysis and discussion Chapters.

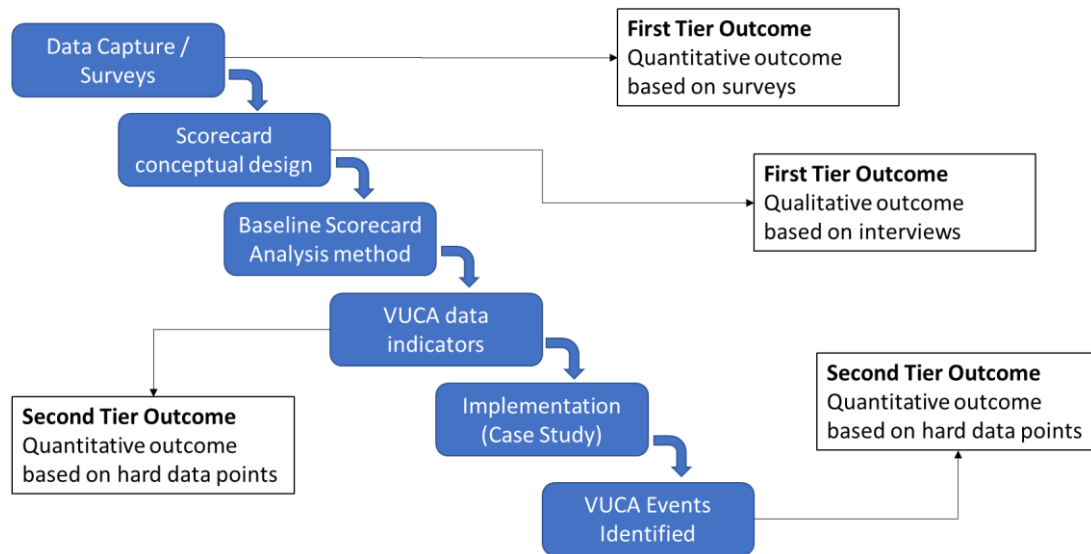


Figure 10 - Research Process Flow

3.3 Defining and Baselining VUCA

The aim of this research is to detect and measure VUCA events. In order to do this, we must first define VUCA events fully. The combination of volatility, uncertainty, complexity and ambiguity taken together, along with their internal interaction, is what makes VUCA a unique term. For the purpose of this research, VUCA is structured as follows:

1. An event that happens
2. An event that contains volatility, uncertainty, complexity and ambiguity together
3. An event that impacts an organisation or collection of organisations
4. An event whose temporal proximity is very close (i.e. VUCA event happens, and the organisation is impacted within weeks, possibly days and even hours or minutes)
5. An event that is significant in scale, and in extreme cases directly impacts the organisation's ability to operate or survive.

The term 'VUCA event' is used to encapsulate all the points above. A VUCA event, by its very nature, also requires a timely response from those impacted. This is in contrast to say, Strategic Change, where strategic planning can be developed over a much longer time horizon.

There is of course subtlety in this definition. A VUCA event does not always have to be a large global impact with headline news and everything that comes with it. In fact, it could be far smaller and nuanced for a Small or Medium sized Enterprise (SME) organisation, not even appearing in the public consciousness, but still contain all the characteristics of the VUCA event as defined above from the perspective of that organisation. What may appear as a VUCA event to one organisation, may not even register for another. So, living through a VUCA event is from the viewpoint of those organisations experiencing it.

Whether VUCA events can form over long periods, and possibly even remain hidden during the start, is out of scope of this research due to time considerations. The focus of the research is on sensing and visualising VUCA, not decoding why the VUCA events happen as that would be a research project in its own right.

3.4 Data Collection

It has been argued that major breakthroughs in Machine Learning (ML) and Artificial Intelligence (AI) have been constrained by access to robust data sets rather than algorithmic advances (Wissner-Gross 2016). Without any doubt, data sets, and access to them, will be critical¹ to this research. The hardest part will be identifying and accessing valid data sets to support the VUCA decision making tool and enable the sought visualisation of VUCA. Once a decision-making tool has been conceptually designed, then the intention is to undertake secondary research via published journal papers to identify candidate data to feed the decision-making tool, supported by theoretical evidence and peer review. At the moment, this is a blank canvas and is addressed in Research Paper 4 - VUCA Data Mapping (see Chapter 6).

3.4.1 Data Acquisition and Use

The initial approach to data acquisition for Research Paper 4 and to use in the Case Study will be to gather primary data through publicly available and open-

¹ The Academic Afterlife of Enron E-Mails – Spam filters and some types of AI struggled to advance without strong data sets to train them against, the public release of hundreds of thousands of emails as part of the Enron scandal and collapse lead to a large, untainted data set being publicly available for use.

source means, covering as wide a gamut as possible. This avoids pay walls and promotes the research being repeatable, although clearly there can be no guarantee that any public or open-source data will be available in perpetuity.

Alternative data is a growing field in investment and finance domain, and generally refers to any non-financial data that is used to provide insight into a company's performance. While the data sets tend to be clean, un-processed, raw data, which is useful, access to these institutional investment data sets will be considered but can be challenging due to the use and trading of them by hedge funds as they can incur significant acquisition costs.

The model below (Figure 11) is used to underpin the VUCA decision making tool design, as it is expected that users will seek to optimise the VUCA Visualisations through learning what works in the real world (i.e. what data best powers the models) and thereby providing a feedback loop. The more an organisation consumes data, refines the PoL and its algorithms, the better baselines they will produce.

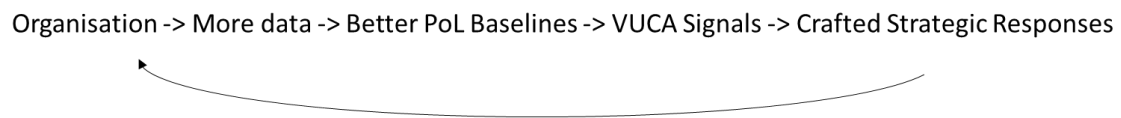


Figure 11 - Data & Baseline Feedback Loop

As part of the acquisition strategy there is a need to consider data retention. How much data needs to be held to allow a VUCA decision making tool to be built is unknown at this stage. There will be some trial and error (e.g., configuration of the data) required to optimise the output and understand how much historic data is required to build a PoL and the VUCA Visualisation.

3.4.2 Data Velocity, Volume, and Variety

It is recognised that different data sets will move at different speeds. Lots of big data sets (UN global birth rates for example) are slow moving. Twitter data is almost instant. Both have value, and blending the two types together will require a level of analysis. In data science systems a jitter engine would perform this task.

The jitter engine would both manage sequencing of data with different clock speeds, and also deal with wrong temporal or geolocational stamps, which could potentially lead to wrong conclusions.

While out of scope for this research, it may be possible to enhance the data further by including some pre-existing data sets. This may support machine learning to better understand the historic baseline (deep learning, pattern recognition, etc.), thereby helping detection of anomalies in the present. The biggest issue though presented by these are the fact the data sets are large, and how you would import and process them has cost implications, both in the purchase of the data sets, and the design and running of a compute platform to handle them, confirming that while considered, this is out of scope for this research.

3.5 Research Hypotheses

An organisation that has a VUCA decision making tool can measure through various data indicators taken from various data sets both what normal operation looks like, but also help identify when VUCA events happen.

Two hypotheses are proposed to be addressed in this research:

1. Primary Hypotheses: Directional hypotheses – Events are time based and will change over time. This would be shown through the VUCA decision making tool, once you have data over time you can visualise the pattern and see changes to it.
2. Secondary Hypotheses: Complex hypothesis "... a change in variable 1 will influence variables 2 & 3 etc..." where variable 1 is the VUCA event, variable 2 will be the VUCA decision making tool, and variable 3 would be the organisations strategic response.

The implementation Case Study will test a range of supporting hypotheses to help answer the overall research question.

There is a further possible Hypothesis that could be proven if the experiment fails (i.e. VUCA decision making tool can't be applied to organisations), and that is a Null hypothesis (HO) "...there will be no correlations between variable 1 and 2 ..."

3.5.1 Experimental Planning

The three key priorities of the research are to:

- Prove the Directional hypotheses – Events are time based and will change over time
- Demonstrate that the VUCA decision making tool can be applied to organisations to see VUCA events
- Show that through the identification of a VUCA event, the research question (*Can VUCA be visualised?*) can be answered.

Chapter 7 contains Research Paper 5 - Visualising VUCA: A Case Study which deals with the practicalities of undertaking the experiment to address these.

3.5.2 Research Concerns

The conceptual design and application of a VUCA decision making tool to aid organisations has not been done before. It is therefore hard to know what data and over what periods are required in order to both find 'normal' and to experience a VUCA event. If no anomaly (VUCA event) is picked up, is this because of a flaw in the conceptual design and application of a VUCA decision making tool, the data sets, the fact a VUCA event cannot be experienced, or just that no VUCA event actually took place?

There is also a possible time lag implication, meaning that there could be a delay between when a VUCA event happens and when it is represented in the data. If it is genuinely believed that no VUCA events have happened over an extended period, the research project will seek to simulate events through the use of inserted synthetic data. Due to the classic project management 'Iron Triangle', there will be trade-offs during the research between time, cost and quality, with quality being given the highest protection .

There is also a risk of outliers and false alarms that will need to be considered. As more is learnt about VUCA decision making tool for organisations and the data sets required to populate them, the expectation is that the impact from these would be reduced.

3.6 Research Design for Individual Papers

While each Research Paper defines the methods and approaches used, Figure 12 contains a summary of the research methods used throughout the individual papers.

	Paper 1	Paper 2	Paper 3	Paper 4
Paper Title	How can VUCA better help 'thought leaders' with strategic change: a systematic literature review	Sensing VUCA Pre and Post COVID-19: A Survey	Visualising VUCA to aid strategic decision making in turbulent times	Can VUCA be underpinned by rigorous theoretical data sources
Topic	Review of existing VUCA Literature to understand the landscape	Can VUCA events be experienced, is there a before and after?	Examines the place of VUCA in the field of Strategy, where decision making tools fit in, and how one could be constructed	Builds a link between theory and practices for potential data sets that could be used in a VUCA decision-making tool
Specific Research Methods	Structured and systematic literature review, Secondary research of published Journal papers	Quantitative, empirical research using primary data collection	Conceptual Theory Building, Qualitative research through Semi-structured interviews with focus groups	Structured and systematic literature review, empirical research using primary data collection
Research Approach	Deductive	Inductive	Inductive	Deductive
RQ's Addressed	Overall Research Aim	RQ 1	RQ 2	RQ 3

Figure 12 - Research Methods

3.7 Ethical Consideration

There are no ethical issues with the research methodology proposed. In particular the data set being collected for Research Papers 4 and 5 are all in the public domain and no personal data is being used or retained. The CURE will be used throughout for any surveys, studies, or interviews.

4 Research Paper 2 - Sensing VUCA Survey

Introduction to Paper

The first Research Paper, a Literature Review located in Chapter 2, was able to synthesise all the available literature and conduct a critical review. This provided a complete overview of the landscape and the current thinking at the time which identified that VUCA was a relatively new field of study. Researchers discussed VUCA events happening, but there was no research or insight into this, the focus was on the 'output' stage, what does an organisation do to respond to VUCA. The 'Input' stage is underserved in literature and presents a clear research gap. Research Paper 2 in this Chapter undertakes quantitative research to address this gap. In particular, existing research identified the external turbulent environment and called for it to be better understood. This helped with the crafting of the survey in Research Paper 2 and in targeting the area to focus on.

Sensing VUCA Pre and Post COVID-19: A Survey

James Vickery

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK, and

Enes Unal

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Dr. Leon Williams

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Abstract

Key Finding – Statistically significant quantitative research showed VUCA events are experienced, with a clear before and after. It also showed that the VUCA domains are experienced differently.

Purpose – The purpose of this paper was to see if VUCA events could actually be experienced. The researcher wanted to analyse both VUCA events as a single entity, and also the different VUCA domains, volatility, uncertainty, complexity, and ambiguity, to understand if these were experienced in a uniform way or not.

Methodology – 153 participants from mid to senior levels within a range of organisations were surveyed as groups in controlled conditions through 2021 and 2022. The survey design went through an iterative process of testing, seeking to leverage different methods of responses such as a sliding scale to elicit the best possible engagement and response levels, before it was used to ensure its rigour. For the core COVID-19 focused questions, a Likert scale was used by respondents to rate the degree to which they agree or disagree with a statement. Qualtrics was used as the tool to run the surveys as this is Cranfield University's official solution. The survey collected three thousand and seventy-six unique data points across the testing and operational stages of the survey. The collected primary data allowed for empirical research to be undertaken to produce quantitative results.

Additional Findings – The results, both through the statistical analysis and through the visual representations, provide a clear picture to enable the research questions to be answered. The research definitively shows a clear before and after state during a VUCA event, in this case COVID-19, and proves that a VUCA event can be sensed and experienced. Further it shows the individual domains of VUCA, namely volatility, uncertainty, complexity, and ambiguity, are experienced separately and organisations can delineate between the component parts of VUCA. The participant answers are uniform in experiencing VUCA events across all cohorts and all time periods, though there are subtle differences due to cultural and temporal factors. The data was subject to a range of analyses to ensure statistical significance including the production of a standard error to measure the significance difference and the use of Cohen's *d* analysis on the effect size, to help measure how meaningful the relationship between variables is, any differences between cohorts, and most importantly the size of the impact.

Research implications – The research moves the conversation on from using VUCA as a catch-all term to express that the world is hard and challenging, to quantifying the distinct domains that make up VUCA. Understanding the distinct domains of a VUCA event helps inform how organisations can start to formulate and fine-tune targeted responses utilising the internal capabilities they have been building or providing them with clear signposting of where they need to strengthen to endure VUCA events. The research contributes to a fundamentally better understanding of how a VUCA event is sensed and experienced in the external environment.

Originality/value – To the best knowledge of the researcher, this is the first time VUCA events have been measured in this way. The paper provided a rare empirical example of the statistical significance of VUCA events and how they can be sensed.

Contribution to the thesis – The paper contributed to the understanding of how VUCA events are experienced and also that each domain (Volatility, Uncertainty, etc.) has its own measure. It also demonstrated that COVID-19 could be used in the Case Study as a recognised VUCA event.

Keywords:

VUCA, COVID-19, Strategy, Business environment change, Survey

Paper type – Original Research

Research into the field of VUCA (volatility, uncertainty, complexity, and ambiguity) has grown significantly in recent years. The vast majority of research focuses on how an organisation responds to VUCA, as well as the leadership and internal capabilities that are required to sustain an organisation through a VUCA event. This paper presents the results of a series of surveys through 2021 and 2022 with 153 participants from a range of organisations and is one of the first attempts to show the external nature of VUCA events that happen in an organisations external operating environment and can impact those organisations to various degrees. The research definitively shows a clear before and after state during a VUCA event, in this case COVID-19, and proves that a VUCA event can be sensed and experienced. Further, it shows the individual elements of VUCA, namely volatility, uncertainty, complexity, and ambiguity, are experienced separately and organisations can delineate between the component parts of VUCA. The research moves the conversation on from using VUCA as a unidimensional construct, a catch-all term if you will, to express the world is hard and challenging, to quantifying the distinct elements that make up VUCA. Understanding the distinct elements of a VUCA event helps inform how organisations can start to formulate and fine-tune targeted responses utilising the internal capabilities they have been building or providing them with clear signposting on where they need to strengthen to endure VUCA events. The research contributes to a fundamentally better understanding of how a VUCA event is sensed and experienced in the external environment. For practitioners, an improved understanding of the VUCA event taking place and the constituent parts that make it up enables them to develop informed responses. The paper closes by identifying a range of areas for further research to better understand VUCA events.

1. INTRODUCTION

Organisations of all shapes and sizes are impacted by the events that take place in their dynamic external business environment; the landscape and ecosystem in which they operate. Making sense of these factors, or even being able to detect the changes taking place, can offer a competitive advantage to decision makers (Porter 1985) if they can plot a strategy through them (Mintzberg 1994). Strategic decision makers navigating their organisations through this world are not without challenge, for they are continuously ‘bombarded from all sides’ (Grzybowska & Tubis 2022) in a ‘world with rapid and unexpected changes to their business environment that are often difficult to understand’ (Minciu et al 2020). Organisations are highly optimised to manage today, yet vulnerable and unprepared for future changes (Rowe, 2010). Against this backdrop, VUCA (Bennett and Lemoine 2014, Fridgeirsson et al 2021, Nishimoto 2021, Putro et al 2022, Lilja et al 2022) has emerged as a way to frame this dynamic world, evidenced by the growing number of publications in recent years (Major and Clarke 2022, Griffith et al 2023, Zhang-Zhang et al 2022, Fernandes and Afonso 2021, Nikseresht et al 2022, and Ciolacu et al 2023).

VUCA research has grown quickly but primarily focuses on helping organisations respond to VUCA events by improving internal capabilities. There is little research on sensing and then visualising VUCA to help decision makers make sense of their external business environment. To generate an optimal response, they need to understand what is happening. To address this gap, this research explores if VUCA can be experienced in the external environment. It seeks to answer the following overall aim ‘Can VUCA events be classified as an experience that can be tracked?’. It does this through two research questions to examine the untested to this point argument that VUCA is happening in the real world. It seeks clarity on whether the different constituent parts (domains) of VUCA, the volatility, uncertainty, complexity, and ambiguity, can be clearly separated out and whether VUCA is not just a large amorphous blob. The two research questions are:

RQ1. Can people delineate between the different parts of VUCA, do they experience each part (volatility, uncertainty, complexity, and ambiguity) as a discrete entity in its own right?

RQ2. Do people experience a before and after state for VUCA?

In this respect, the contribution with this study is tangential and complementary to existing VUCA research which has addressed a wide gamut of improvements to internal organisational functions to enable them to respond to VUCA. Anything that helps colour the 'input' stage of VUCA will enable the development of richer outputs, the response within an organisation to VUCA. We specifically investigate both the before and after of VUCA events, and the discrete constituent parts of VUCA as this provides insight from different viewpoints on how, if at all, VUCA is experienced.

Overall, the results from this research will provide a contribution to knowledge by enriching our understanding of how VUCA is experienced and provide quantifiable evidence for the first time that VUCA takes place and is experienced by people within organisations. The research delivers a series of clear indications for how sensing and detecting VUCA could be taken forward.

Practitioner points

- VUCA events are not just amorphous blobs used as a catch-all to express the world as hard, dynamic, and unpredictable, but have distinct elements that can be quantified. VUCA events are not random noise, and the size of their impact can be measured.
- Organisations must develop ways to sense VUCA events taking place in their external operating environment. Doing so allows them to understand when a VUCA event is happening, as there is clear before and after states.
- By understanding the shape and characteristics of a VUCA event and its different dimensions, organisations will be better placed to align the internal capabilities they are building to maximise the potential benefits of their work and increase their chances of surviving a VUCA event.

2. THEORY

VUCA refers to volatility, uncertainty, complexity, and ambiguity and traces its heritage back to the U.S. Military who coined the term in the late 1980's to reflect an increasingly unstable and rapidly changing world (Whiteman 1998, Kinsinger & Walch, 2012) presenting problems for situational awareness, where threats are both diffuse and uncertain, where conflict is inherent yet unpredictable (Roderick 1998). This acronym was adopted by thought leaders in the late 2000s (Johansen 2007, Kail 2010) to describe a world where the pace of change was becoming quicker, and it was harder to plot a course through the macro environment for organisations (Lawrence 2013) looking to succeed. The global financial collapse in the late 2000's potentially saw the use of the term increase further as thought leaders linked VUCA with financial loss and the shortening lifespan of organisations (Leonhard 2014).

VUCA as a term therefore became a catch-all acronym for all that was challenging in the external world in which organisations operate in, a shorthand to say 'it's really hard out there', and a 'litmus test for recognising unpredictable external environments' (Fletcher and Griffiths, 2020). VUCA research, led perhaps by the work of Bennett and Lemoine (2014) in their often-referenced VUCA paper, has become focused on the internal organisation and how to help leaders build the capability and capacity to respond to VUCA.

Almost exclusively though the majority of published papers on VUCA, while providing new research on internal organisational practices, do little to address how to detect and sense VUCA. They frame VUCA almost as an input to which they are building outputs (responses) through the development of new capabilities. Proposed solutions to build these new internal capabilities are varied and include 'Leader Agility' (Horney et al 2010), 'Performance Measurement Systems' (Bourne 2021), 'Decision-making skills training for engineers' (Rouvrais et al 2020), 'Marketing mix' (Lubowiecki-Vikuk et al 2023) and 'Service delivery tools' (Barbier and Tenengeh 2022) to name a few. These works, taken together, provide an emerging view into how an organisation could shape itself to respond to VUCA events in the world.

Bartscht (2015) calls this out explicitly in their paper on VUCA and notes that organisations must open themselves up to exploration beyond their current known world to understand the variables that affect them (the system). The organisation must then consume this new information, integrate its meaning, and change its behaviour accordingly. Dombrowski and Henningsen (2019) state that lean enterprises 'need to derive new requirements from the VUCA world' to inform the design of systems of objectives and techniques for meeting them, making the hard link between the external business environment and an organisations internal functions, its people, processes, technology and systems. The position that current research related to the concept of VUCA focuses on internal factors, such as its implications for leadership and managers to respond, is also directly highlighted by Lubowiecki-Vikuk et al (2023).

Even the originators of the VUCA terminology, the US Army, in their Strategic Leadership Primer (Gerra et al 2010) stated that 'on a holistic level, the interpretation of environmental scanning in a VUCA world ought to lead to the creation of a vision that is aligned with a best estimate of the future environment', recognising the need to sense and detect what was happening to enable a strategic response internally. It also goes on to state that being in a VUCA world 'does little to excuse irresponsibility, carelessness, or a lack of rigor when attempting to understand the environment, anticipate change, and manage risk'. Strategic leaders and strategists must therefore attempt to understand, interpret, and master the VUCA environment (Gerra et al 2010).

The first step in seeking to understand VUCA in the external environment is to be able to examine if organisations through their people can clearly articulate that they are experiencing a VUCA situation. Going a step further, there is a need for clarity about what they are experiencing; is it volatility, uncertainty, complexity, and ambiguity, or is it just 'hard', in which case VUCA would have little meaning beyond being a shorthand or a trendy buzz word for dynamic change in the external environment, likely to fall from grace once the next term appears. Bennett and Lemoine (2014) noted that VUCA has also become a catchword for saying 'unpredictable change' with all the words being used interchangeably with

pundits and leaders being insensitive to the differences in meaning. There is an urgent need in the research to qualify this point with certainty. Taskan et al. (2022) thought it possible that the domains of the four VUCA areas overlap while Schick et al. (2017) showed that the VUCA conditions are closely related.

3. METHODOLOGY

The objective of this research article, to understand if VUCA events can be experienced, is addressed through the use of a survey to capture primary data directly from participants. A number of recently published papers on VUCA (Ciolacu et al 2023, Wereda et al 2023, and Ullrich et al 2021) used surveys as the primary means to capture data for their research, although their focus was different which meant their results were not suitable to answer the research questions posed in this paper.

The research was conducted between July 2020 and September 2022. Clearly during this period, the world was living through the COVID-19 pandemic, a disruptive event of global proportion that should, following the existing literature, represent a VUCA event that would show up in the collected data. Ochoa and Revilla (2022) in their research of in-the-moment surveys invitation approaches noted that respondents might not properly recall the requested information about past events, while surveying participants right when an event of interest occurs should reduce these recall errors (Ochoa et al 2016). Undertaking the VUCA surveys during the time period outlined had the benefit of being in-the-moment and ensuring participants' experience of VUCA was occurring then and there.

A number of tools were considered for undertaking the survey, such as Survey Monkey and Amazon Mechanical Turk (MTurk) which are commonly used tools to perform survey type tasks in various academic and business settings (Miller 2020). There has been growing criticism of some of these tools, with MTurk in particular attracting professional survey takers who skew results (Peer et al 2017). The selected tool though was the Qualtrics platform, specifically the Qualtrics Core XM, a popular, flexible and trusted online survey tool that is used under license by many academic institutions (Cui et al 2022, Cushman et al 2021)

and has become near ubiquitous now in academic and professional surveys (Rogers 2017). The survey was issued via a link and could be accessed through a smartphone or browser, an approach which has been shown to be less expensive, require less time to complete and more readily provide access to unique populations compared to traditional methods such as telephone, mail, and SMS (Miller 2020).

Using Qualtrics to undertake COVID-19 related surveys has also been conducted extensively, for example Johnson (2021) uses the tool to explore material hardship during COVID-19 via a cross-sectional Qualtrics survey. The Qualtrics tool was hosted by Cranfield University and all data collected was in line with the universities ethical, hosting, storage policies, ensuring robust collection, preservation, and integrity of the data.

3.2 Survey specification and methodology

The survey design set out to answer the core research questions by constructing a question set that addressed the root of the challenge. As a design principle the survey also tried to embrace different methods of response, such as a sliding scale, to make the interactions for the participants more visually varied and engaging, rather than repetitive text fields to complete. The survey was broken into four distinct parts:

- Part One – Core Survey Features
- Part Two – Participant Information
- Part Three – Ecosystem Measurement
- Part Four – VUCA Measurement

Part One of the survey captured a number of data points and metrics about the survey without the respondent having to complete any questions. The key data captured included the date, start and finish times, total time to complete, and a unique ID. This information helped with structuring and analysing the responses. The IP address was used to help ensure each response was unique at the point of submission but was not stored or retained.

Part Two set out a number of questions to enable the researcher to better understand the makeup of the participants. This included capturing their age range, location, job title, and the organisation they worked for.

Part Three sought to understand how well participants understood their organisations external ecosystem, the environment in which they operate.

Part Four was the core question set focused on VUCA; the previous three parts were laying the required groundwork. Part Four was designed to test the main research questions in this paper and two key hypotheses, namely respondents could delineate between the different parts of VUCA and there was a clear before and after for VUCA events that participants experienced. As the core of the research, significant effort went into examining and identifying the best approach to use in the survey to capture the required information for Part Four. It was decided to use a Likert scale (Landaluce-Calvo 2024), a reliable way to measure perceptions by asking participants to state how much they agreed or disagreed with a statement. Using a Likert scale allowed the researcher to capture a greater range of opinions and detect nuances in the responses, as opposed to a blanket yes and no. The questions contained a verbal survey scale as part of a closed-ended question that covered a range of options. It was decided to use a five-point satisfaction scale that ranged from one extreme of the spectrum 'Negligible' impact to the other 'Extreme' impact with a neutral point 'Moderate' impact in the middle. Using the Likert scale, provided a structured way to quantify the answers and transpose them to numerical values for further analysis. It also provided the benefit of constraining participants' responses to a narrow field while also providing them with a time efficient response method.

To aid with making the VUCA part of the survey efficient a design decision was taken by the researcher to craft the VUCA elements of the survey into one question with a series of radio buttons for submission as shown below in Figure 1. The question they were asked was "When looking at the business environment in which your organisation is operating, please provide from your perspective the view before and after COVID-19".

Volatility, Uncertainty, Complexity and Ambiguity (VUCA) Rating

When looking at the business environment in which your organisation is operating, please provide from your perspective the view before and after COVID

	Before COVID					During COVID				
	Negligible	Some	Moderate	High	Extreme	Negligible	Some	Moderate	High	Extreme
Volatility - Unexpected or unstable behaviours for unknown duration (e.g. price changes in supply chain)	☒	☐	☐	☐	☐	☐	☐	☒	☐	☐
Uncertainty - Lack of predictability and potential for surprises (e.g. ability to trade impacted)	☐	☒	☐	☐	☐	☐	☐	☐	☒	☐
Complexity - Many interconnected parts that interact in many ways (e.g. extra activities to deliver a service or product)	☒	☐	☐	☐	☐	☐	☐	☐	☐	☒
Ambiguity - Information available, but potential for misreads and confusion (e.g. incomplete sales information)	☒	☐	☐	☐	☐	☐	☐	☐	☒	☐

Figure 1 – VUCA Survey Question Response Example

A participant could only select one radio button for each part, giving a total of 8 radio button selections in total. There was also a clear visual pattern they could observe to sense check their own response, ensuring a high-quality answer.

The target participants to complete the survey were mid to senior managers who could speak with authority on how their organisations had experienced COVID-19. There were no constraints on geography, organisation type (public, private, Not for Profit, etc) or sector (Information Technology, Civil Engineering, Travel and Hospitality, etc). A decision was made at the outset not to use metered survey solutions. This decision was made for two key reasons. The first was to remove any cost barriers from someone trying to emulate the work in this research, as the metered survey providers charge a fee to find respondents. Second, the researcher wanted to avoid professional survey takers and have some control over the target groups.

The only technical constraints were that participants did require access to a smartphone or device with a browser along with internet access in order to complete the survey. They were sent a link to the Qualtrics tool which hosted the survey.

3.3 Survey Evolution

The survey went through two distinct series of iterations and testing before a finalised version was locked down. The first iteration saw four drafts of the survey and questions produced by the researcher. Some of this was to gain familiarity with the Qualtrics tool and the features on offer from it, particularly with regard to different interactive elements that could be used to achieve the design aims of the survey as listed above.

The second series of iterations focused on testing the survey with participants. This process allowed the researcher to optimise the survey to ensure a high level of quality responses. It became clear that the initial drafts of the survey contained far too many questions that deterred participants from either responding or completing the survey. At the outset there were valid reasons for the inclusion of an extended set of questions, namely trying to understand the external operating environment better and, with an eye to future research, examining what data sources they had access to for understanding their external environment. While these questions undoubtedly could add value, they significantly increased the time required to complete the survey, negatively impacted the purity of what was being asked, and distracted the participant. As part of the second series of iterations, a judicious review by the researcher saw the number of questions aggressively reduced to the core area of research, increasing responses and dramatically reducing the time to complete.

During two distinct series of iterations and testing external quality assurance was used through Cranfield University to assess the survey and provide guidance on its design and optimisation.

As part of the testing stage, the research sought to target different groups of participants to understand the completion rate and also how easy it was to engage quality candidates from the different sources, particularly as no fee or reward was offered to take part. Each version of the survey had its own unique link, meaning no cross contamination of different participant groups, and the surveys were set to expire after a short period. The researcher approached the following groups:

- An aerospace industry working group (20+ leading companies): The researcher had access to this forum through Cranfield University and they were collectively struggling to respond to COVID-19, with a particular focus on resilience building as they believed the future would see more pandemics like CVOID that threaten their industry. The survey was issued to the group via a link in an email. The link included a short paragraph explaining the objective of the survey. The survey issued was the first version, so it was the longest one ever tested which likely impacted the response rate.
- An executive education group (26 Members): The researcher had access to this forum through Cranfield University School of Management. The participants represented a broad mix of industries and mainly commercial organisations. The survey was issued to the group via a link in an email. The link included a short paragraph explaining the objective of the survey. The survey issued was the second version, so while it had been reduced considerably in size via a reduction in questions, the time to complete was still fairly long at circa 10mins and the question set included questions which were more open ended in nature, and therefore required more cognitive processing by the participant. Considering the delivery mechanism, an email link, and the length of the survey, the response rate was positive.
- LinkedIn business group (50 Members): The researcher sought to identify relevant professional working groups on LinkedIn, a professional networking site. The researcher looked at a sample of profiles of people within a group, joined relevant groups, and then issued a link to the survey with a short paragraph explaining the ask. While the groups often had tens of thousands of members, it was hard to gauge how active most of these actually were and whether the survey link was ever seen. For this reason, the research messaged fifty people within the different groups directly through LinkedIn focusing on members that had posted recently as evidenced of engagement with that group and posted on the

challenges of dealing with COVID-19. The version of the test survey used was version four, which was close to the final version with an optimised set of six questions and short response time. Even so, the respondent rate was disappointingly low.

- A senior leaders forum: The final set of participants comprised two senior leaders in large well-known organisations and were drawn from an online Senior Leader Forum. These individuals were used as a final test point with what was believed to be at the time a final version of the survey. They were followed up with direct face to face contact via Zoom or Teams video conferencing solutions to seek feedback on the survey. These follow up interviews sought to identify any improvements that would make the survey easier to complete for busy senior leaders and more likely to lead to higher levels of engagement as well as a sense check that when received could the overall objective of the survey and its constituent parts made sense and was easy to understand.

The table below, Figure 2, capture the key data points from the testing.

Metrics	Survey Test Stage				
	Version 1	Version 2	Version 3	Version 4	Version 5
Date	Jul-20	Sep-20	Dec-20	Jan-21	Jan-21
Target	Air Exec	Exec Ed	Senior Leader	LinkedIn	Senior Leader
Participants Invited	24	26	1	50	1
Participants Responded	4	9	1	11	1
Completed Surveys	4	9	1	9	1
Invalid Responses	0	0	0	2	0
Response Rate	17%	35%	100%	22%	100%
Questions	31	9	6	6	6
Est. Time to Complete	30 mins	10 minutes	3-5 mins	3-5 mins	3-5 mins

Figure 2 – VUCA Survey Testing Metrics

3.4 Control Variables

After the two distinct series of iterations and testing, a final survey was ready for use. The final version (VUCAv1) contained 6 questions, the first four of these were focused on collecting some basic demographic information (Unique Identifier, Age, Location, and Company). The fifth question asked participants “How well do you think your organisation understands what is happening in its

business ecosystem (suppliers, customers, partners, etc.) during large shocks like COVID-19?” with a visual scoring scale ranging from A+ to F. The scoring scale used a visually interactive feature that allowed participants to adjust a slider to the score they wanted to give. The alphabetic values mapped to a 13 point to support analysis. It should be noted that while the question set was reduced and the language was refined across the whole survey, the core VUCA question in Part Four – VUCA Measurement remained largely unchanged except for minor changes to the questions itself.

Reflecting on learnings from the testing groups and in order to produce the highest quality set of data possible, a research design decision was made to run the actual surveys in a classroom as part of an executive education course at Cranfield University School of Management. This produced a number of benefits. The first was a very high level of consistency in the profile of the participants. They were predominantly of the same age range (25 to 44) as can be seen in Figure 3 and typically funded by their companies to undertake the executive education programme part time indicating a certain level of seniority, ability, and potential. The participant companies leaned towards major well-known organisations such as Microsoft, AXA, BP, and KPMG. The second benefit was that all the students completed the survey in the same conditions, a classroom setting, with the same amount of time made available as part of the programme.

Age Range	Particpate Count
No Age	1
16 - 24	5
25 - 34	83
35 - 44	51
45 - 54	24
55 - 64	2
64 & Above	0
Total	166

Figure 3 – Age Ranges

It became apparent during the testing phase that participants needed a clear definition of VUCA to enable a meaningful response as without this they struggled to separate volatility, uncertainty, complexity, and ambiguity in a consistent way. This phenomenon of participants seeing the different aspects of VUCA as being closely related and therefore difficult to understand was also observed by Schick et al. (2017). They noted however that after having the concept of VUCA introduced most participants were able to better be equipped to deal with the tasks presented. To address this concern and take advantage of the classroom-based survey, every participant was introduced to VUCA before taking the survey. This introduction included defining the different aspects of VUCA as shown in Figure 4. As there are no standard definitions for VUCA in literature, the definitions were synthesised by the author based on commonality of VUCA research that already existed in literature.

	Definition	Example
Volatility	Unexpected or unstable behaviours for unknown duration	Stock market and share prices, shares trade over a large range
Uncertainty	Lack of predictability and potential for surprises	How much of a new product will you sell?
Complexity	Many interconnected parts that interact in many ways	Supply chain with multiple tiers of suppliers and sub-suppliers
Ambiguity	Information available, but potential for misreads and confusion	Airport is closed – Is this due to bad weather or something more fundamental like IT system failure?

Figure 4 – VUCA Standard Definitions

Spending time ensuring all the participants had an understanding at a high level of VUCA and a clear definition of each aspect fully prepared them for the survey.

With a robustly tested and refined survey in place, the Qualtrics tool ready to collect and store the data, a clear definition of VUCA set out, and a means to source consistent sets of participants, the survey process was undertaken. The survey was completed by six cohorts of participants between Feb 2021 and Sept 2022. The survey began with informed consent, which outlined the anticipated

length of time it would take to complete the survey (three to five minutes), as well as the purpose of the study and explanation of VUCA. The informed consent also indicated that participation was voluntary and that responses (particularly participant names) were anonymous. To ensure participant anonymity, documentation of consent was waived, and participation was taken as acceptance. None of the analysis directly linked back to participants organisations to further protect anonymity, the focus was overall trends.

The key metrics from the survey process are presented below in Figure 5:

Metrics	Survey Stage						Totals
	Cohort 1	Cohort 2	Cohort 3	Cohort 4	Cohort 5	Cohort 6	
Date	Feb-21	Mar-21	Sep-21	Feb-22	Mar-22	Sep-22	
Source	Exec Ed	Exec Ed	Exec Ed	Exec Ed	Exec Ed	Exec Ed	
Participants Location	Oman	UK	UK	Oman	UK	UK	
Participants Invited	20	30	33	4	45	34	166
Participants Responded	20	30	33	4	45	34	166
Completed VUCA Questions	18	27	29	3	42	34	153
Spoiled Surveys	2	3	4	1	3	0	13
Response Rate	100%	100%	100%	100%	100%	100%	100%
VUCA Completion Rate	90%	90%	88%	75%	93%	100%	92%
Survey Version	VUCA v1	VUCA v1	VUCA v1	VUCA v1	VUCA v1	VUCA v1	
Questions	6	6	6	6	6	6	
Est. Time to Complete	3-5 mins	3-5 mins	3-5 mins	3-5 mins	3-5 mins	3-5 mins	

Figure 5 – Survey Metrics

4. RESULTS

The survey collected three thousand and seventy-six unique data points across the testing and operational stages of the survey (Figure 6). The shaded boxes in Figure 6 indicate a data point was captured with a value.

relationship between variables is, any difference between cohorts, and most importantly the size of the impact.

While the statistical results were generated for all the forty-eight subsets of data, for ease of consumption and brevity in this paper, Figure 7 below just shows the summary results for a single subset. It focuses just on the volatility scores from before the VUCA event of COVID-19 for Cohort 2 in Feb 2021 and included 27 responses from participants. Within the analysis, *f* records the number of responses from participants for that score, *fx* was used to calculate the mean.

		Cohort 2 Volatility Before					
Participants in Group		27					
VUCA Impact	Linkert Scale	<i>f</i>	<i>fx</i>	<i>Mean</i>	<i>Mode</i>		
Negligible	1	3	3				
Some	2	8	16				
Moderate	3	13	39				
High	4	3	12				
Extreme	5		0				
		27	70	2.59	3	0.71	0.84
				<i>Mean</i>	<i>Mode</i>	<i>Variance</i>	<i>SD</i>

Figure 7 – Statistical Analysis

The results presented in Figure 7 are typical of the results throughout the survey and all forty-eight subsets and of particular note, the standard deviation (SD) for all responses is typically between 0.80 and 0.95 which indicates the distribution and spread of results are close to the average.

The next step in the analysis was to work out the standard error and confidence intervals. Again, while the values were calculated for all forty-eight subsets of data, Figure 8 calculates the standard error for only four sets of data. Again, the results presented in Figure 8 are indicative of the results throughout, which gives a low standard error and allows us to construct a 95% confidence interval (CI) to estimate the population mean for each data set. The CI low and high points demonstrate there is low uncertainty around the mean.

			Mean	Mode	Standard Deviation	Standard Error	CI Low	CI High
Cohort Data Sub Set								
Cohort 2 Volatility Before			2.59	3	0.84	0.16	2.2764	2.9036
Cohort 2 Volatility After			3.52	4	0.84	0.16	3.2064	3.8336
Cohort 5 Volatility Before			2.76	2	0.95	0.14	2.4856	3.0344
Cohort 5 Volatility After			3.76	4	0.90	0.13	3.5052	4.0148

Figure 8 - Standard Error

The next set of analyses was to look at the effect size, as we now know the results above the difference is real, but is it important? While some of this is done through the readers own interpretation of what is important, an effect size is a proven way to assert it quantitatively. To do this we compare the size of the effect we saw (the difference in means between two subset of data) against the amount of deviation in the data, i.e. it is harder to detect smaller effects in noisier data. We pool the SD between the two cohorts and use this along with the means to calculate the Cohen's *d*. We use the Cohens own scale to assess the impact with over 0.2 being small, over 0.5 being medium, and over 0.8 being large. Figure 9 below shows the results for the selected subsets.

						Pooled SD	Effect Size	Cohen's <i>d</i> Score
Cohort Data Sub Set								
Cohort 2 Volatility Before vs Cohort 2 Volatility After						0.85	-1.09	Large
Cohort 5 Volatility Before vs Cohort 5 Volatility After						0.93	-1.07	Large

Figure 9 – Effect Size

We can see clearly from the results that statistically the impact of a VUCA event is large. Taken together the analysis shows there is statistical significance. Using standard error, we can see the results are not random or that the difference in means from before and after is not happenstance. The potential error in our mean gets smaller as the amount of data gets larger due to the "Central Limit Theorem". The effect size analysis showed us that the difference is not just real, but it is also important.

Alongside the statistical analysis it is useful to look at the raw numbers and visuals as these tell a clear qualitative story as well. For each of the six cohorts the mean score was worked out for their responses against each of the VUCA elements, both before and after, so twenty-four pairs giving us a total of forty-eight sets of data. To explain further a linked pair is two data points, the before and after for either volatility, uncertainty, complexity, and ambiguity within a cohort. The calculated mean scores can be seen in the table below (Figure 10) along with a percentage change from before to the after state. The percentage change shows that in every case there was a positive increase between the two states of before and after. The lowest change was eleven percent, and the highest was eighty-three percent. The overall mean for the percentage of change shows between twenty-seven percent and thirty-five percent. There is no question that a change was experienced by participants for VUCA, but the results also show the individual elements of VUCA experience the change differently as well. If this was not the case, and VUCA was just an amorphous blob, the average means would have been the same.

	Before					After					% Change			
	V	U	C	A		V	U	C	A		V	U	C	A
Cohort 1	2.44	2.44	2.44	2.72		3.22	3.39	3.39	3.44		32%	39%	39%	27%
Cohort 2	2.59	2.56	3.26	2.56		3.52	3.59	4.00	3.22		36%	41%	23%	26%
Cohort 3	2.72	2.86	3.07	2.97		3.66	3.93	3.79	3.52		34%	37%	24%	19%
Cohort 4	2.67	3.00	1.67	2.00		3.33	3.33	3.00	3.67		25%	11%	80%	83%
Cohort 5	2.76	2.79	3.17	2.83		3.76	3.57	3.55	3.29		36%	28%	12%	16%
Cohort 6	2.59	2.65	3.32	2.82		3.74	3.91	3.71	3.62		44%	48%	12%	28%
Cohort Mean	2.63	2.72	2.82	2.65		3.54	3.62	3.57	3.46		35%	33%	27%	31%

Figure 10 – Cohort Means and % Change

When we map out the before and after visually on a scatter chart (Figure 11), clearly linking the twenty-four pairs to show the relationship between the before and after states we can see that in every case there is a marked difference. Except in a few instances, the cluster of after dots appear above the totality of before dots and visually show a clear step change across the twenty-four pairs. It is also interesting to note that where a data point looks out of alignment with the rest of the before or after data points, in most instances the corresponding

pair shows the same behaviour, meaning that the participants still experience the same scale of change between the before and after.

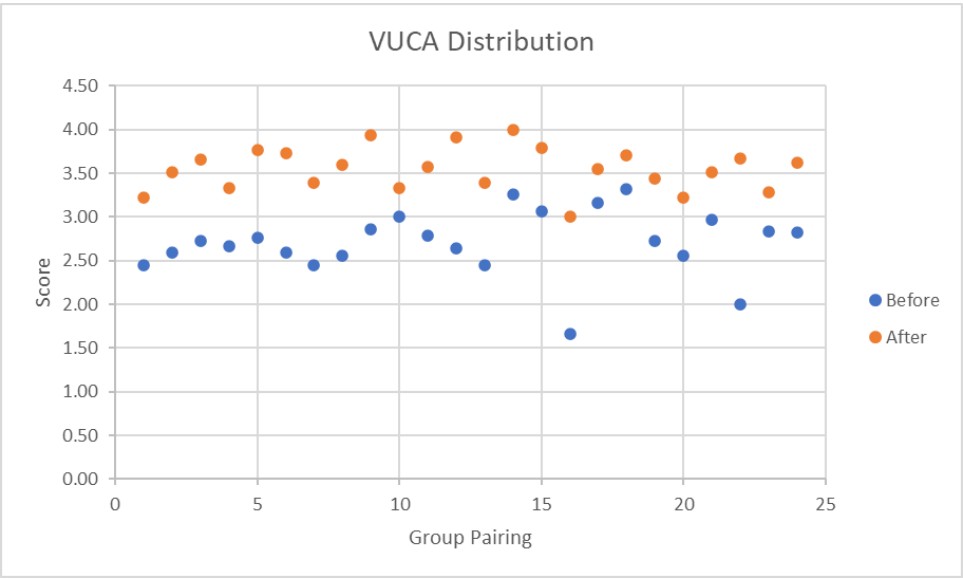


Figure 11 – Group pairs and related change

The final visual (Figure 12) is a bar chart that shows an overview of all the before and after data across all six cohorts. It shows the percentage change for the two highest points on the Likert scale used, namely those that selected ‘High’ or ‘Extreme’. The bar chart shows how dramatic the scale of the change is between the before and after states when looking collectively at all participant responses.

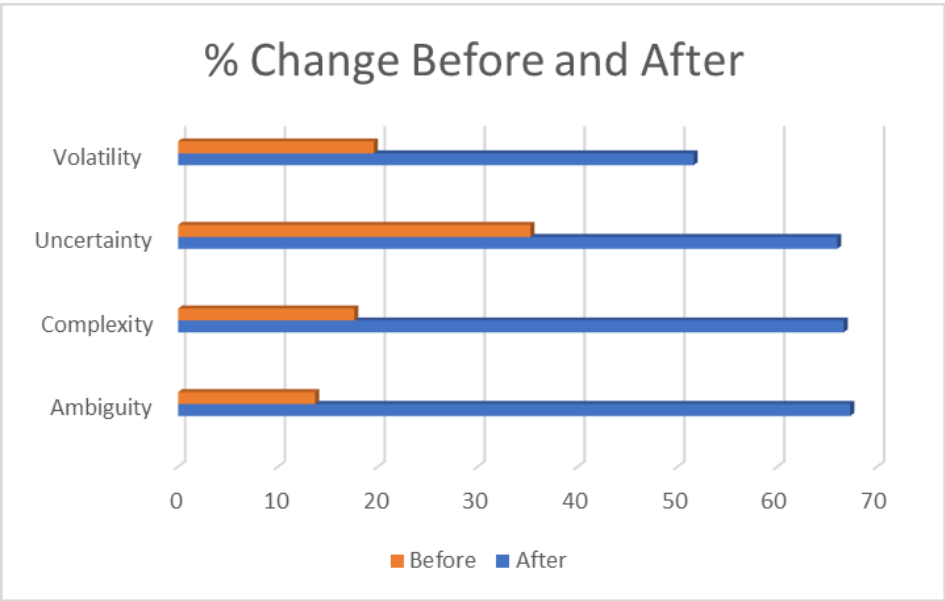


Figure 12 – Cohort percentage change

5. DISCUSSION AND CONCLUSION

The VUCA literature review showed that a number of authors (Johansen 2007, Kail 2010, and Leonhard 2014) recognised VUCA as a catch-all for change in the external world and used it as a rally cry for the internal change organisations needed to go through to improve leadership (Bennett and Lemoine 2014) or become more agile (Horney et al 2010). Some (Bartscht 2015, and Dombrowski and Henningsen 2019) drew a clear line to the need to better understand VUCA events so they could act as an input against which to respond. The research in this paper extends and builds on the existing research by focusing exclusively on the external operating environment to better understand and quantify VUCA events, enabling organisations to sense them and craft the right responses.

The results, both through the statistical analysis and through the visual representations, provide a clear picture to enable the research questions to be answered. For RQ1, ‘Can people delineate between the different parts of VUCA, do they experience each dimension (volatility, uncertainty, complexity, and ambiguity) as a discrete entity in its own right?’, the evidence from the survey shows that the participants could. There was a clear pattern and discernibly different scores across the four VUCA domains of volatility, uncertainty, complexity, and ambiguity as shown in Figure 10.

For RQ2, ‘Do people experience a before and after state for VUCA?’ again the evidence from the surveys supports the position that participants do. The results are unambiguous in this and shows a clear before and after state for VUCA with a distinct boundary.

The answers to RQ1 and RQ2 are uniform across all cohorts and all time periods. While not included with the results published here, the results from the testing phases, which were even more in the moment (Ochoa and Revilla 2022), revealed the same results and patterns.

Within the results however there are some subtle differences that it is worth elaborating on to provide further context. In particular, there was an opportunity to discuss results post the survey completion with the cohorts undertaking them.

The Qualtrics tool enabled some real time results to be calculated and there was therefore an opportunity to discuss initial results with a cohort.

The first of these relates to Figure 13 below which shows the different results between a cohort from Oman (Set 1 February 2021) and a cohort from the United Kingdom (Set 6 September 2022).

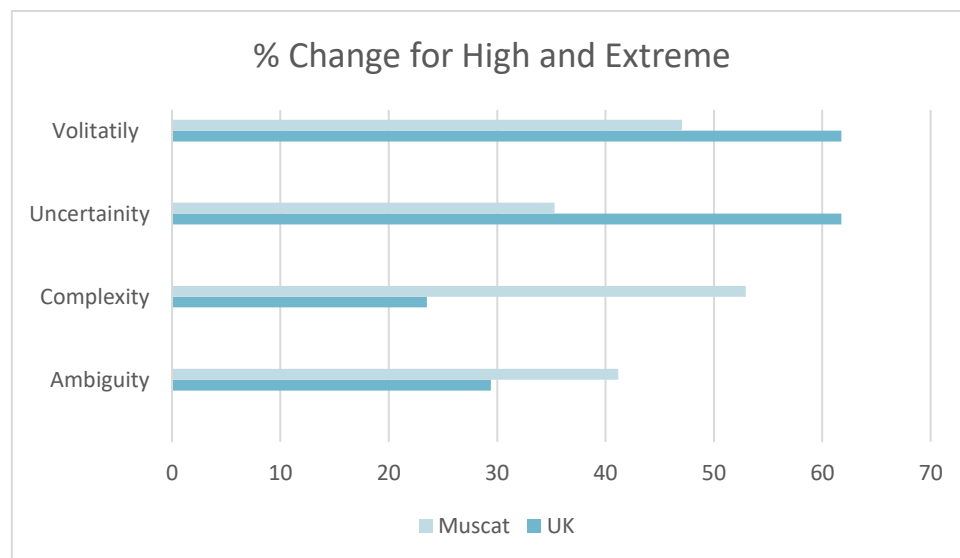


Figure 13 – Oman and UK

Figure 13 shows the percentage change between the before and after scores in the high and extreme boxes for the Oman and UK cohorts. The results show a clear split between how the two countries viewed where they most felt the impact. When exploring the scores with the cohorts in follow up sessions it became clear that Oman had more complex business processes within an organisation that employees had to follow, and it was ambiguous how these might change, while the cohort from the United Kingdom experienced more volatility and uncertainty around employee roles and job security, in essence they had different concerns. The ability to explore this through a follow up conversation provided insight into the scores, noting with interest that the scores were generated by individual participants from those countries in a controlled setting, yet showed a clear split in response.

The second insight published in this paper relates to Figure 14 which examines the different results between two cohorts from the United Kingdom, one in March 2021 and the second in September 2021

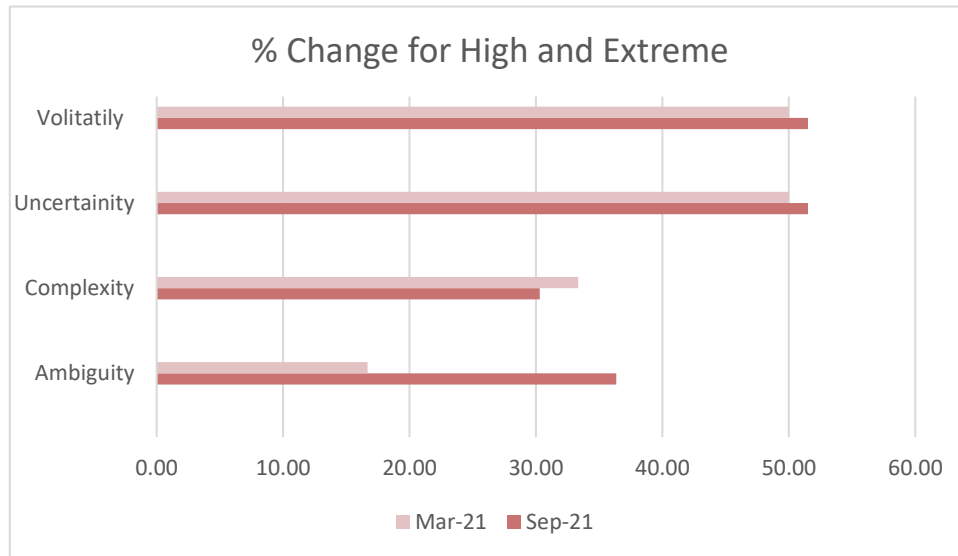


Figure 14 – Oman and UK

The opportunity was taken to discuss the results with the cohort in an attempt to elicit insight into what was driving the scores. The belief was that as COVID-19 was becoming more understood and organisations adapted better to operating in the environment with clear guidance from the government, the scores in the later cohorts would mirror the earlier ones, and perhaps even reduce due to COVID-19 becoming the norm. This proved not to be the case, and in particular, Ambiguity stood out as increasing in impact which was unexpected. When discussing the results with the cohort participants it became clear that while the external operating environment was settling and organisations had more clarity on what operating in it might look like, the organisations themselves internally were in a state of flux developing responses and policies. It was for example highly ambiguous what future work patterns would look like, how many staff would work from home, and how future products and services would be designed, built, and delivered in this new world.

From both of these examples, these visual results and the supporting follow up conversations show both how different cohorts, and potential countries and

cultures, experience VUCA events differently, while also supporting RQ1 in evidencing the different aspects of VUCA are experienced differently.

The original design of VUCA back in the 1980's was not produced on a whim; it was in direct response to an increasingly unstable and rapidly changing world (Whiteman 1998). It was constructed to allow different dimensions of a situation to be analysed as one, providing a holistic overview to an evolving situation or crisis. The different VUCA domains, as defined in Figure 4, capture discretely different dimensions by design, and therefore the results from this survey when viewed through that lens, re-enforce the strength of the VUCA model. They also help explain, as shown in Figure 10, why there is a clear difference in scores and experience between the different VUCA domains. This is critical for those crafting responses to VUCA as it enables them to key the response to specific features of the VUCA event taking place, they can focus on the granular characteristics of the VUCA event to highly tailor their actions.

The survey also took the opportunity to ask, 'Is there a relationship between the impact VUCA of the perception of the business ecosystem?' to understand if this might offer insight into the impact of a VUCA event. It was hypothesised that if an organisation did not understand their business ecosystem particularly well, then the impact of VUCA events might be more keenly felt. All six cohorts were asked to score how well their organisation understood their business ecosystem system on an alphabetical Likert scale, ranging from an A+ to F. The mean for all responses was a D+, which would suggest that almost universally the participants felt their organisation failed to understand the business ecosystem in which they operated. The alphabetical Likert scale was converted to a numeral Likert scale to aid analysis, and Figure 15 below shows the spread of results, with the higher the score, the less the organisation understands their business ecosystem. The chart shows how densely packed the 153 responses were with negative scores. Further research is required to fully understand the link with the VUCA score, but initial indicators are that there could be a link between the impact factor of VUCA and how poorly understood business ecosystems are.

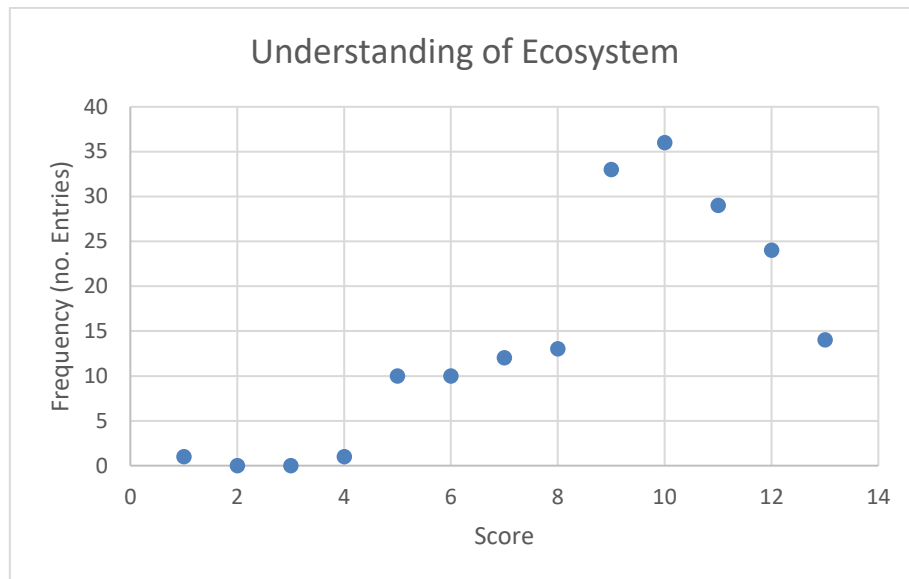


Figure 15 – Ecosystem Understanding

Taken together the research questions addressed the overall research aim and confirmed that VUCA events can be classified as an experience that can be tracked.

6. IMPLICATIONS

This research has a number of implications for both researchers and practitioners in the field of Strategy. It is one of the first pieces of research that explicitly demonstrates that VUCA has a before and after, that organisations live through it, and can sense its impact in their external operating environment as it evolves. For those designing strategic responses to VUCA, they can now quantify VUCA as an input to which their outputs respond. Alongside this is the awareness that VUCA is not just a blob but has discrete parts, the volatility, uncertainty, complexity, and ambiguity, that are experienced individually from each other and in quite different ways, depending on the context. Strategic leaders seeking to respond to VUCA can tailor the design of these outputs to the shape of VUCA impacting them, allowing them to increase the activities against one discrete element more than another based on the input signals received, thereby using resources more effectively and efficiently. Furthermore, it may be possible to get some sense of the impact weighting of the VUCA event taking place. The

research in this paper opens up a whole new arena for researchers by exploring how to sense VUCA in the external environment and configure tailored responses

7. LIMITATIONS & FUTURE RESEARCH

This research is clearly not devoid of limitations, which provide interesting avenues for future research. While the cohorts surveyed provided consistency, a strength to enable like for like analysis, there is a need to survey a wider field with different participant make ups. The research also focused on COVID-19, which is without question a seismic macro event that only comes along every so often, it was bound to leave a significant (large) impact. There is a need to focus on, and research more, smaller scale micro events, possibly at a regional or country level to see how easy it is to detect these; do they have a clear before and after that organisations can detect? And while some of the participants were from public sector and not for profit organisations, the bulk were from commercial organisations, therefore there is a need to research further the differences between these. Finally, the linkage between how well organisations understood their business ecosystems and VUCA was only lightly addressed in this research and warrants further investigation to understand what is really happening here.

The research showed there was a clear lack of understanding by organisations of their business ecosystems. Theoretical and empirical investigations on the different ways ecosystems, with their multifaceted characteristics, may interact with VUCA could greatly increase our comprehension of how to not just respond to VUCA, but potentially mitigate it before it happens in the near future.

Conflict of Interest

The author declares no conflict of interest.

Ethics Statement

The author has read and agreed to the Committee on Publication Ethics (COPE) international standards for authors. All data was collected and stored in line with Cranfield University standards and policies.

5 Research Paper 3 - VUCA Decision-Making Tool

Introduction to Paper

Research Paper 2, located in Chapter 4, undertook statistically significant quantitative research that showed VUCA events are experienced, with a clear before and after state. It also showed that each VUCA domain is experienced differently and provided a sound foundational understanding of how VUCA events are observed. The research undertaken in the following paper (Research Paper 3) builds on this by seeking to understand what function a decision-making tool could play, where in the lifecycle it could focus (VUCA event detection), and how it might be constructed.

Visualising VUCA to aid strategic decision making in turbulent times

James Vickery

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK, and

Enes Unal

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Dr. Leon Williams

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Abstract

Key Finding – Proposes new and original novel ideas and artefacts to aid researchers and practitioners in visualising VUCA through the development of the VUCA Scorecard, data indicators to populate it, and the use of Pattern of Life analysis as a method to baseline the data.

Purpose – The purpose of this paper was the development of a strategic decision-making tool to help strategic leaders collect and understand data to enable them to make informed decisions in response to VUCA events, thereby seeking to answer the research question ‘Can a strategic decision-making tool be developed to inform the understanding of VUCA events’. In order to do this, VUCA’s place within existing research had to be researched to understand the design and role of the decision-making tool. Once a decision-making tool was developed, further research was required to find a way to populate it and then assess if it was fit for purpose.

Methodology – A number of approaches were used to answer the research question posed by the paper. Literature was reviewed to understand VUCA’s place in existing theory, explicitly for Strategic Management, environmental operating conditions, the role of decision-making tools, and a way to populate them. In order to develop a decision-making tool, conceptual theory building was the method used. Finally, qualitative research methods, namely semi-structured

interviews with focus groups, were used to assess whether the proposed decision-making tool was fit for purpose.

Additional Findings – Strategic decision makers need to be armed with the right tools to enable them to sense VUCA events taking place and develop the correct responses to ensure survival and competitiveness. This research centres VUCA within strategy and strategic decision making, identifies a new tool, the VUCA Scorecard, to aid strategic decision makers sense VUCA events, and proposes a way to populate the scorecard using Pattern of Life analysis. It identified how a VUCA Scorecard could help identify when an organisation moved from ‘Normal Conditions’ to ‘Turbulent Conditions’, terms clearly defined in literature from luminaries in the field. The VUCA Scorecard also helped structure data to avoid information overload. The qualitative research showed that participants could use the VUCA Scorecard and generate ideas for data sources to populate it.

Research implications – This research has a number of implications for both researchers and practitioners in the field of Strategy and strategic decision making. The first is that VUCA provides a valid and structured way to understand a turbulent business environment. Strategy leaders and decision makers that do not have a way to understand VUCA and detect what is happening are missing a tool from their strategic armoury.

In order to sense and detect VUCA events forming, organisations will need data to build a Pattern of Life. For practitioners, example data sets, almost like a starter pack, will aid users in populating a VUCA Scorecard.

Originality/value – This paper developed a number of unique outputs to this field of research. This included the VUCA Scorecard and the use of Pattern of Life as a method to visualise VUCA. In addition, to the best knowledge of this research, it is one of the first times a link has been drawn between Strategic Management, environmental turbulence, and VUCA, all underpinned with theoretical rigour.

Contribution to the thesis – The research started to build out the artefacts required to sense and visualise VUCA events, and defined how a tool could be populated. It also grounded VUCA in existing theory and research.

Keywords:

VUCA, turbulent business environment, Scorecard, Strategic decision making, Pattern of Life, PoL,

Paper type – Original Research

Strategic leaders and decision makers within organisations face a bewildering and growing array of external challenges that threaten their organisation's ability to not just operate, but even exist. The number of external crises events has grown in recent years to include the 2008 financial crash, the global COVID-19 pandemic, military conflicts, climate changes, and political tensions, presenting a complex and ever shifting series existential threats to leaders.

VUCA has emerged as a way to frame this turbulent business environment, but to decompose and understand it, strategic decision makers need to be armed with the right tools to enable them to sense VUCA events taking place and develop the correct responses to ensure survival and competitiveness. This research centres VUCA within strategy and strategic decision making, proposes a new tool, the VUCA Scorecard, to aid strategic decision makers sense VUCA events, and defines a way to populate the scorecard using Pattern of Life analysis. The VUCA Scorecard is then subjected to testing with focus groups.

1. INTRODUCTION

Organisations of all shapes and sizes are under enormous continuous stress from all sides by major external events such as the global COVID-19 pandemic, military conflicts, stagnation, and an intensification of severe natural events. Organisations environments are changing ever more rapidly and abruptly, and with ever greater consequences due to the influence of external factors (Niehaus et al 2023) and organisations must constantly adapt to these new conditions (Munteanu et al 2020). The world is now changing so quickly that no business can plan for every eventuality (Mankins and Gottfredson 2022).

Against a backdrop of a growing number of unpredictable, discontinuous crisis events with global impact and enormous long-term consequences such as the COVID19 pandemic, the war in Ukraine, and the global semiconductor crisis (Schuh et al 2022) organisations need to sense these changes with greater precision in order to understand the external environment. These external events place enormous stress on strategic leaders to chart a path through, adjusting their internal competencies as needed in response to the external stimuli (Hamel and Prahalad, 1990), thereby ensuring their organisation does not just maintain its competitive advantage, but actually survives.

As a result of various influences such as globalisation, digitalisation, and industry convergence, companies are confronted with an increased level of volatility, uncertainty, complexity and ambiguity (VUCA) in their corporate environment (Schuh et al 2019). Existing research has focused primarily on developing internal capabilities to respond to VUCA, yet organisations need a way to detect VUCA events as they form, understand what is happening, and use this insight to aid strategic decision makers in charting a course through the turbulent external business environment.

Practitioner points

- A VUCA framework as laid out in this research can help structure a turbulent external business environment, providing organisations and senior decision makers with data driven insight into what is happening, enabling a measured and informed strategic response.
- The VUCA Scorecard, which has been tested with focus groups, provides a structured way for organisations to identify and group data indicators that can help them understand and sense changes to their external business environment.
- Practitioners will need to consider how far they want to go in scaling up the collection of data, and therefore the tooling to achieve this, noting both the complexity and potential rewards this brings.

2. THEORY

Strategy and Strategic Management have been researched extensively and continue to be so. Strategy traces its roots back through time, from its use by the early Greeks (circa 500 BC) to describe the art of leadership by generals (van Aartsengel and Kurtoglu 2013) to Sun Tzu's 'The Art of War' (circa 500BC) which focused on military strategy and tactics (Shih and Hwang, 2018). That The Art of War in particular has stood the test of time (Stokking and R. Strijkers 2012) and is often quoted in the strategic decision making of a company (Hlavatý and Ližbetin 2021). Thus, in this original sense, "strategy" is "the art of leading the army".

Business focused strategy originated as a distinct discipline in the 1950's and 1960's (Kiechel 2010). A number of seminal works that defined strategic management were produced from this period onwards that still shape modern thinking. Alfred Chandler, a professor of business history at Harvard Business School and Johns Hopkins University, researched the relationship between organisational structure and strategy in the 1960's stressing the importance of taking a long-term perspective (Chandler 1962) and 'The visible Hand' of the managerial class (Chandler 1977).

Chandler's work was built on by Igor Ansoff, a manager and mathematician, who is recognised as one of the fathers of strategic management (The Economist 2008, Strategic Change 2002). Ansoff developed strategy tools such as the Growth Grid (Ansoff 1957) that underpinned product market growth strategies (Pleshko and Heiens 2007). Ansoff also developed gap analysis, the comparison of actual performance with potential or desired performance in his widely cited book, Corporate Strategy (Ansoff 1965) and was recognised for majoring on strategic management that focused on control and detailed strategic planning.

Henry Mintzberg, a remarkable (Hernández-Betancur et al 2020) and distinguished management professor (Feldman 2005) who has made—and continues to make—fundamental contributions to various areas of strategic management research (Azevedo and Gates 2018), pioneered a move away from strategic planning and researched adaptation and emergent strategy (Foss et al

2022, Johnson, Scholes, and Whittington 2010, Mintzberg and Waters 1985, Mintzberg 1978). The core idea of emergent strategy was that strategies are contingent on circumstances that change from time to time, often very rapidly (Hashim et al 2022), in a volatile and turbulent world, and therefore prediction is difficult and long-range planning of limited value (Hamel 2009).

More recently, the work of Michael Porter and his theories on business strategy have made a number of contributions to the field. His theory of competitive advantage (Porter 1985, Porter 1990) focuses on competitive responses in a given business context, which is responsible for how various firms react in the face of competition (Ahiabenu 2023), and Porters tools, such as the Porter's "five forces" (Dias et al 2023, Putri et al 2023) and diamond firm strategy (Butt and Katuse 2023) are still used today for competitive advantage analysis of a nation and its industries (Moreland et al 2023). The building of competitive advantage is a relative, evolving, and still important concept in strategy formulation (Hashim et al 2022). Porter's Value Chain (Porter 1985) allows an organisation to see the potential value of separate functions in obtaining competitive advantage (Di Vita et al 2023).

While the leaders in the field of strategy mentioned above are not exhaustive and provide only a short introduction, standing back reveals a pattern that tracks strategy from being a scientific top-down approach, to one that recognises strategies emerge and need to be aware of their turbulent and unpredictable environment, how they derive value, and how they compete. The debates about the right approach to strategy continue today and all leaders in the field have faced criticism, for example, that Mintzberg's 'five Ps for strategy' needs a product recall (Khalifa 2023) and Porter's 5 forces model fails to define how to sustain competitive advantage (Goyal 2020).

2.1 Strategy and the Business Environment

Understanding the business environment is critical to organisations being able to compete and sustain their operation and thereby ensure their viability (Baldzhy et al 2023). In today's rapidly changing global business landscape (Abbas et al 2024), where organisations are faced with a multitude of simultaneous changes

and multidimensional dynamics as the business environment transforms (Schuh et al 2023), strategic leaders need a way to develop strategies to compete in this uncertain business environment (Armanious and Padgett 2021)

Since business focused strategy evolved in the 1950's and 1960, the discourse on the impact of the external business operating environment on strategic management has grown (Murphy and Seriki 2021). A variety of terms have been used to categorise a changing business environment, such as Environmental Dynamism (AlMulhim 2023), Environmental Volatility (Schuh et al 2022), and the Chaotic Business Environment (Hapenciuc and Aurel 2014).

Against this backdrop the term 'turbulent business environment' has become one of the most dominant with a significant and growing body of research associated with it (Rajala and Hautala-Kankaanpää (2023), Wu et al (2023), Li (2022), Zhang et al (2022), Yiyi et al (2022), Turulja and Bajgoric (2019)) and has seen an increase of interest in recent years (Gemici and Zehir 2023). Emery and Trist (1965) were the first to classify the concept of environmental turbulence (Kiple et al 2012). Ansoff (1979) followed this by producing a rating for environmental turbulence to measure change, predictability and instability. The term turbulent environment was then picked up by leading researchers in the field of strategy such as Johnson and Scholes (1989) Prahalad and Hamel (1990) and Grant (2003) leading to widespread use.

While the term 'turbulent business environment' is used extensively to encapsulate the external challenge organisations face, there is no agreed definition. Rather it is a catch all to describe a changing external environment fraught with peril. When describing the turbulence, research often characterises it using terminology like 'uncertainty, unpredictability, volatility, and complexity' (Murphy and Serikl 2001); 'Chaotic' (Kotler and Caslione, 2009); 'dynamism, complexity and predictability, or lack therefor' (Kiple et al 2012); and 'volatility, uncertainty, and ambiguity' (Schuh et al 2022).

VUCA (Bennett and Lemoine 2014, Fridgeirsson et al 2021, Nishimoto 2021, Putro et al 2022, Lilja et al 2022), is an acronym for volatility, uncertainty, complexity, and ambiguity, and has emerged as a leading way to frame this

dynamic, turbulent world in which organisations operate, evidenced by the growing number of publications in recent years (Major and Clarke 2022, Griffith et al 2023, Zhang-Zhang et al 2022, Fernandes and Afonso 2021, Nikseresht et al 2022, and Ciolacu et al 2023). VUCA events, such as COVID19, have forced companies to change the way they operate and even think (David and Dragomir 2021). VUCA therefore provides structure to the turbulent business environments, aiding strategic leaders to categorise the events happening, helping them unpack them and break down the events into their constituent parts, thereby enabling the formulation of a strategic response. The external environment is the primary stimulus of firm innovativeness (Gemici and Zehir 2023) and helping strategic leaders characterise it will drive innovation and growth.

2.2 Strategic Decision Making

Within a turbulent environment, those organisations that can take advantage of the situation through the mobilisation of their internal systems and innovativeness can grasp an opportunity for growth (Gemici and Zehir 2023). This position resonates with the research of Bennett and Lemoine (2014) in the field of VUCA who define the need for the internal organisation and leaders to build the capability and capacity to respond to the external business environment. Strategic decision making has been researched extensively and prior work has introduced a wide range of different approaches, paradigms, and processes (Curnin et al 2023, Tabesh and Vera 2020) to define the field. The nature of strategic decision-making changes as well based on the external operating environment and pressures placed on an organisation, for example in times of crisis such as a VUCA event taking place. To succeed in this 'dynamic, complicated and competitive business environment businesses need to develop strategic decisions by exploring all the available information' (Alghamdi et al 2022). There is a widespread stated desire amongst both public and private organisations worldwide to engage in more significant "evidence-based reasoning" and to be more "data-driven" when taking strategic decisions in

complex and/or volatile environments (Pratt et al 2023). The speed and the quality of a decision made today will have an impact on future business opportunities that will either be seized or missed (Galli 2018), and using data driven insight to make decisions on innovation or resilience building will therefore have long term impacts for the organisation.

2.3 Strategic Decision-making Tools

Research (Alghamdi et al 2022) shows that those organisations that use strategic decision-making tools find these to be effective and generate positive results towards business decision making. Strategy as a discipline has a long history of using management tools to help frame the strategic context to aid decision making and strategy tools are extensively used by businesses (Knott 2006). Some of the most used range from, but are not limited to, Ansoff's growth grid (Ansoff 1957, DuCoin and Kuo 2023), Porter Five Forces (Porter 1979, Dias et al 2023), the McKinsey 7S framework (Peters and Waterman, 1982, Parmer et al 2023), value chain analysis (Porter 1985, Macit and Abaci 2023), VRIO Framework (Barney, J. B. 1991, Okorie et al 2023), and more recently the Business Model Canvas (Osterwalder 2005, Lopes et al 2023).

Particularly in the context of crises, it is critical for practicing managers to understand the value offered, and take advantage of, all the strategic decision-making tools available to them, as part of the decision-making process, in order to make rapid and quality decisions (Tabesh and Vera 2020). By adding structure to the information about a VUCA event unfolding in a strategic decision-making tool, leaders would be better able to interpret what is happening and therefore make better informed decisions. This approach fits with the work of Mintzberg et al (1998) who describe how the technique or organising tool used to structure information influences the insights and decisions that arise from that information. The use of tools also helps leaders evaluate the volume of information being presented for assimilation, thereby reducing 'information overload' - an excessive amount of information beyond an individual's ability to process (Nugapitiya 2023). Modern technology systems integrate coherently all available sources of

information to compose an operational picture that is as complete as possible. While in the past organisations have suffered from a lack of data, current technology transformed the problem into one of an overabundance of information (Braca 2022). Failure to design collection systems correctly can create avalanches of data that clog information networks and overwhelm decision makers (Braca 2022), distorting what should be a helpful solution into information overload. So, while a decision-making tool has a key role to play, it needs to structure the capture of the underpinning data to avoid information overload.

With regard to terminology and use of the term 'tool', this research adopts the work of Dellantonio et al (2013) to categorise an artefact as a man made, and thereby artificial object. Tools are artefacts produced to undertake a specific task, in this case strategic decision making. Lesnikova et al (2023) state that 'regardless of the name, all strategic management tools, which includes tools and techniques that are also known as methods, analyses, frameworks, planning tools, strategic toolkits, strategic toolsets, models, and decision tools, serve the same purpose'. Knott (2006) defines strategy tools as "the full range of concepts, ideas, techniques and approaches that structure or influence the strategic thinking, strategic decision-making, and strategy implementation activity".

Strategic leaders select the decision-making tools they use carefully, which has seen an increase in their overall satisfaction with the selected tools, and an increase in the benefits they bring, be that better performance, greater profits, or progress for the organisation (Lesnikova et al 2023) through the formulation of strategic responses.

2.4 Theory Summary

Organisations are faced with an unprecedented array of challenges from their external business environment. This environmental turbulence is hard for strategic leaders to navigate and make sense of. VUCA offers a way to frame the challenges strategic leaders face enabling them to recognise VUCA events early and formulate strategic responses. Research has also clearly shown that within

the field of Strategic Management and environmental turbulence, strategic decision making is critical to success. Further, decision making is aided greatly by decision making tools that present information in a way that allows leaders to digest it, using the data driven insight to unlock and develop the appropriate response to a VUCA event. The rest of this research focuses on what a VUCA strategic decision-making tool would look like.

3. METHODOLOGY

This research sets out to answer the following the research question 'Can a strategic tool be developed to reveal the phenomenon of VUCA events?'. A structured methodology, Conceptual Theory Building, was employed to answer this question and develop a strategic tool for VUCA.

'Theoretical concepts are the foundation of theory development and scientific progress' (Solinger et al 2024), where the use of conceptual methods are employed to undertake theory-building, rather than theory-testing (Meredith 1993). This research uses Conceptual Theory Building as a method (Solinger et al 2024) to develop through abstraction and generalisation a theoretical framework to detect VUCA. It synthesises existing knowledge, empirical evidence, and conceptualising relationships between variables or constructs to create a coherent and explanatory framework that can be 'used as principles of explanation and understanding'(Meredith 1993).

In using Conceptual Theory Building this paper therefore starts by identifying the research gap (Can a strategic tool be developed to reveal the phenomenon of VUCA events?), reviews relevant existing literature to understand the current state of knowledge and position the research (Strategic Management, environmental turbulence, and decision-making tools) to then formulate concepts and propositions that help explain the phenomenon of interest (VUCA). The research draws on existing theoretical perspectives (existing models, frameworks and tools) to refine and revise the conceptual framework under development based on feedback, empirical evidence, and further analysis. The method builds on the literature research in this paper to formulate a proposition for a strategic

tool which not only explains the observed phenomena but also provides insights for future research and practical applications.

The use of this structured process to develop the strategic tool provides transparency, empirical validation, and qualitative testing, while providing an opportunity for critical reflection against the initial literature research. The Conceptual Theory Building method follows the steps outlined below:

1. Reflect on the theory to ensure thorough understanding of the role a strategic decision-making tool plays, the required outcomes, and any design considerations, such as the structuring of data to avoid information overload.
2. Development of assessment criteria to test the short-listed tools against to ensure fit and to justify selection. The scoring of the criteria was undertaken by the researcher.
3. A shortlist of suitable tools was be produced and scored using the selection criteria. Non-suitable tools were discounted at the outset to produce the short list. The research to review all possible tools was too extensive to be included within this paper and is unlikely to be exhaustive due to the sheer volume of tools produced over time. The focus was therefore bounded to mainstream tools in widespread use today (for example, benchmarking).
4. A review point to check the validity of the chosen tool against the theory to ensure the tool is suitable for the purpose intended.
5. Research has shown that data driven decisions are valued, and the tool needs to consume data about the external operating environment. A method to populate the tool was researched as part of the methodology as a way to perform this task in a structured and repeatable way.
6. A conceptual tool was designed based on the steps above and tested for fit.
7. The final outcome was tested in the real world with user groups to assess if it met the desired outcomes. Iteration and revisions were identified based on feedback.

4. VUCA STRATEGIC DECISION-MAKING TOOL DEVELOPMENT

In order to detect VUCA events in the external business world during environmental turbulence strategic leaders need to sense and detect them, only

then can they respond. Organisations need to live in real time, with better situational awareness of their operating environment (Braca 2022) and see emerging pictures early as they start to coalesce. Modern advances in data collection, data platforms, AI, and information management mean the historic approach to simply use past events and templates to predict future patterns can be replaced with real time actuals. Organisations that can live in the now, take the right decisions, and formulate strategic responses will not only strive, but potentially reap bigger benefits over the long term. Strategic leaders therefore need a strategic decision-making tool to help them detect and understand VUCA in real time, based on real data, and develop responses grounded in data driven insights.

4.1 Key Principle for Tool Design

A number of scholars have baked their research into proprietary software, such as ArcGIS by Esri UK, a geographic information system company (Alghamdi et al (2022)) and Microsoft® Excel® workbooks (Pretzel 2023). While there may be valid reasons for this, such as leveraging inbuilt capabilities within the software, this approach puts an overhead on the use of the tool and potentially limits its application due to cost and complexity of the proprietary software. The VUCA tool needs to be technology and platform agnostic. It is a tool that anyone can adopt and use in its generic state. During implementation, organisations may choose to build out a solution based on the tool using open source or proprietary software to achieve scales of economy and to deal with data ingest, but this is not a prerequisite, nor a part of this research.

4.2 Data to Drive Insights

The development of a VUCA Tool to aid strategic decision making needs to provide strategic leaders with meaningful data on what is unfolding in the external environment in which they operate. A wealth of such data is now accessible from the many digital platforms that exist (Mulvenna, 2016). Strategic Decision making “through data mining and machine learning using open-source digital platforms” (Chaudhari and Damle, 2023) is growing rapidly, spurred on it part by the rush to adopt AI to achieve a competitive advantage. Social media, data, text mining, and

geo-spatial analysis are all used to enhance competitive intelligence of an organisation in the modern world (Alghamdi et al 2022).

However, while there is more data, the volume and potential unstructured nature of it leads to a situation where leaders are “data-rich, but insight-poor” (Chaudhari and Damle, 2023), a position that is no longer desirable. Zhu and Li (2023) advocate the use of targeted data collection for deep, robust and rich data driven insights, i.e. the ability to acquire knowledge, identify and predict opportunities, and determine solutions using large sets of current and historical data, that drive actions and strategic decision makings. Zhu and Li (2023) also make valid, research driven arguments that strategic decisions taken in consensus and based on data generate better results than individuals making intuitive leaps that may ignore relevant facts. Tabesh and Vera (2020) define this as a shift in power from experienced and judgmental decision-making to intelligent and comprehensive decision-making. The VUCA strategic decision-making tool helps address these concerns by structuring the data against its four key domains (volatility, uncertainty, complexity, and ambiguity) and by ensuring the data collection for each of them is used to measure what is happening in the external operating environment in real time, providing an up to date and living view of a VUCA Event.

4.3 Tool Design

A method was developed to structure and guide the tool design selection stage adapting the widely used and referenced multi-criteria decision-making (MCDM) method (Dagci Yuksel and Ersoz 2024) which is ‘useful when multi-criteria need to be considered simultaneously’ (Jahan et al 2016). The method used identifies multiple key criteria, shortlists a range of potential tools, and then undertook scoring and decision making against the tools while considering trade-offs.

The selection criteria were based on the outcome of the theory findings and in conjunction with what could practically be developed to aid strategic leaders. This covered the key areas of focus for deploying a tool. All criteria, shown below in Figure 1, were measured on a scale of 1 to 5, with 1 being a poor fit and 5 being an excellent fit.

ID	Name	Description	Rationale
C1	Visual	A visual interface to the tool, rather than a set of numbers in a spreadsheet, so it is easy to see the pattern.	VUCA has not been 'seen' before. The tool needs to be able to visualise the external environment and any VUCA events happening.
C2	Layered	The individual VUCA domains feed into an overall view of what is happening.	Decision makers need to be able to see both what is happening in each VUCA domain and the overall picture. The VUCA domains provide an input to the overall view.
C3	Repeatable	The tool can be populated in a consistent way, allowing anyone to use it.	Some tools are very bespoke requiring significant effort to tailor to an organisation. The VUCA tool needs to be simple to understand and repeatable.
C4	Standalone	The tool can be used independently without recourse to internal or partner systems.	Organisations are not required to use data from either other organisations (such as their peers) or internal systems (such as an ERP). Both of these add an unwarranted overhead to populating the tool.
C5	Ease of Use	An individual can identify and take external data feeds to start populating the tool.	The tool needs to look at the external world only, there does not need to be any linkage to internal stakeholders, processes, or capabilities as this would drive up both the complexity of the tool and time to develop it.

Figure 1 - Selection Criteria

A number of tool options were researched and considered such as the Kano Model (Kano et al, 1984), and discounted. For example, the Kano Model is designed as an analysis tool to explore and measure customer needs, this is conceptually quite different to what a VUCA tool would require. Hoshin Kanri (Yacoubi et al 2022), a planning and deployment process that focuses on aligning the organisation's strategy with daily operations, and the Performance Prism (Goharshenasan et al 2022), which focuses on stakeholders, processes, and capabilities, are further examples that would also fail to be included due to the internally focused nature of the tool rather than looking out to the external environment. For these reasons, a number of management tools could be ruled out at the initial stage.

The following six tool types, presented alphabetically in Figure 2, were identified as candidates for investigation.

ID	Type	Description
T1	Benchmarking	Benchmarking involves comparing an organisation's performance metrics with those of other similar organisations or industry standards.
T2	Canvas	A Canvas is a central diagnostic tool and an action framework that plots business factors (e.g. customer service) for building a compelling strategy.
T3	Dashboard	Dashboards convey different, but related information and metrics, often integrated from different sources, such as a business process, together.
T4	Framework	A framework is a broader and more comprehensive system or structure that guides an organisation's approach to performance management and strategic planning.

T5	Scorecard	A scorecard is typically a tool or document used to track and display key performance indicators (KPIs) and their associated metrics.
T6	Strategy Maps	Strategy maps are graphical representations of an organisation's strategy, showing the cause-and-effect relationships between strategic objectives.

Figure 2 - Possible Tools

Each of the candidate tools was assessed against the selection criteria and scored out of five to identify the one with the best fit (Figure 3). The scoring was conducted by a panel of three, the author of this paper along with two peers from industry to check, challenge, and bring real world perspectives, thereby ensuring real world application while being underpinned with a robust process incorporating independence.

		Selection Criteria						
ID	Type	C1	C2	C3	C4	C5	Total	Comment
T1	Benchmarking	4	5	3	1	4	17	Requires peer company data
T2	Canvas	5	4	1	4	4	18	Too flexible and board in nature
T3	Dashboard	5	1	3	3	3	15	Lacks layering, needs internal data
T4	Framework	4	5	1	5	4	19	Too flexible and board in nature
T5	Scorecard	5	5	5	5	4	24	Strong coverage
T6	Strategy Maps	5	4	2	3	1	15	Too flexible and board in nature

Figure 3 - Tool Scoring

The processes of scoring the candidate tools against the set selection criteria led to the selection of a Scorecard as the best fit to underpin the development of a VUCA strategic decision-making tool, hereon called the VUCA Scorecard.

Scorecards have a long history of use in strategy development with probably the most famous being the Balanced Scorecard that was promoted by Robert Kaplan and David Norton (1992) and is still being used and researched today (Khanmohammadi et al 2024, Junior and Alves 2023, Hugle and Grek 2023). The Balanced Scorecard enables the selected company to understand which key performance indicators (KPIs) should be measured in relation to the company's set goals. The name "Balanced Scorecard" comes from the idea of looking at strategic measures in addition to traditional financial measures to get a more "balanced" view of performance (Stalmachova et al 2022).

While it is possibly the most famous, Scorecards are not though limited to just the Balance Scorecard. Graaff et al (2023) use a scorecard as a tool for countries to track preventable stillbirths in high and upper middle income countries, The Chartered Institute of Management Accountants (CIMA) developed the CIMA Strategic Scorecard to provide a simple, effective process that helps management boards to focus on strategic issues, ask the right questions, and exercise strategic oversight (Lees 2004), and various researchers have developed their own novel and bespoke scorecards to solve challenges in various field such as applying ethics to Artificial Intelligence (Cebulla et al 2021).

Scorecards also address the selection criteria of layering, as they can be considered as a chain of information in which each aspect provides the input of another (Nikolaou and Tsalis 2013). Furthermore, Nikolaou and Tsalis (2013) have suggested a scoring/rating system by using two sub-indexes, namely the Accountability Index and the Performance Index. This approach to feeding a scorecard with data from various indexes mirrors how the VUCA Scorecard would work, pulling in external data feeds to understand what is happening for each of the VUCA domains, and provides a proven patterns for development that is underpinned by pre-existing research.

The review of literature also supports the selection of a scorecard as the selecting tool, particularly noting its ability to layer and consume external data sets evidenced in research. The VUCA Scorecard will enable senior leaders to absorb distributed information and develop responses that come from data-driven insights about what is taking place in the external operating environment.

4.4 Pattern of Life

In order to populate the VUCA Scorecard a method needed to be found to identify VUCA events that stood out from the normal routine of operation an organisation has. Much like how VUCA was conceived by the military to address an unstable and rapidly changing world (Whiteman 1998), the proposed analysis technique to help populate the VUCA Scorecard, which is known as Pattern of Life (Chen et al 2022), traces its origin back to the military and intelligence communities (Flynn et al 2008) where it has been used extensively for over five decades (Molnar et al 1963, Kitson 1971). Pattern of Life (Spence et al 2016, Craddock et al 2016) has helped the military achieve a greater understanding of how their opponent operates by building detailed persistent analysis that connects relationships and activities over extended time periods (Flynn et al 2008). In recent years the analysis technique of Pattern of Life has moved to the business world and covers a diverse range of applications such as insurance sales (Ellis 1974), truck movements at construction sites (Draayer et al 2022), smart home and the Internet of Things (IOT) security (Beyer et al 2018), and tourist behaviour (Mikhailov et al 2020). Tesco, a supermarket chain in the UK, used “pattern-of-life analysis to save £100m over a five-year period by reducing wasted stock through the merging of its own customer data with information on weather forecasts to determine likely demand” (Bell 2013) demonstrating the financial impact this analysis technique can have.

Pattern of Life analysis seeks to build a model of the normal repeatable observable rhythms of activity (Gao et al 2013) associated with a particular entity over time (Drawer et al 2022) and then looks to detect unusual or anomalous behaviour against the normal pattern (Lane and Copsey 2012, Gao et al 2013, Spence et al 2016). As a simple example, when applied to a shopping mall it

might identify that the most popular time for people to shop is every Wednesday afternoon. It builds the picture up over months, and potentially years depending on the use case, based on observations to generate and understand the baseline. The baseline can be built from a combination of all types of data, for example car density in the car park, revenue in food courts, or air conditioning peak loads. Abnormal behaviours would be the sudden disappearance of all shoppers on a Wednesday afternoon, coupled perhaps with a significant rise on a different day. Using this data the shopping mall owner could see something major has changed that could impact deliveries, stock levels, revenue, and customer satisfaction if the shopping mall had optimised its operations to cater for the weekly Wednesday peak. Understanding and identifying changes to Pattern of Life enables responses to be implemented, and ideally the earlier the abnormal signal is detected the more time it gives to consider options and pivot. Gao et al (2013) noted that Pattern of Life can have short term attributes (a door opens) or long-term attributes (the mall is open every Monday to Friday from 8am until 6pm). This is similar in concept to Lim et al (2019) who noted that Pattern of Life can have micro (recent fine-grained trends) and macro (features designed to summarise the long-term history in a compact yet meaningful manner) attributes. In both these examples the attributes could be combined to produce a rich overall picture of the entity of interest.

Pattern of Life builds the essential baseline of what normal looks like to enable a user to see the anomalies. The process of producing Pattern of Life 'utilises the full range of heterogeneous data available to the user to produce knowledge about an entity's behaviour and habits over time' (Craddock et al 2016), but it could supplement this by using data with different attributes (the finely grained micro and coarsely grained macro trends) to provide further insight (Gao et al 2013, Lim et al 2019).

When examining organisations against typical patterns, interesting normal and anomalous behaviour can often be detected in relation to their environmental patterns. For example, organisations tend to open for business at set hours, their customers and employees come and go at set times, stock markets open and

close at set times, customers transact in predictable patterns, suppliers deliver and invoice with regularity, companies file accounts at set periods, and so on. All of this forms a Pattern of Life for the organisations that can be baselined. The list of external phenomena an organisation interacts with is almost endless, and it is not always instantly obvious which ones it has a dependency on (Mikhailov et al 2020). A conflict, environmental disaster, or pandemic in a far-off place may not at first look like it will impact the organisation, but the downstream consequences can, as COVID-19 has shown, and a VUCA event can quickly spiral to impact every organisation and person in every corner of the earth, radically changing its Pattern of Life (Stalmachova et al 2022).

Seeking anomalies across data streams from each of volatility, uncertainty, complexity, and ambiguity alongside error checking helps protect against false positives (Liu et al 2023), outcomes or results that incorrectly indicate the presence of a particular condition, attribute, or event when it is actually absent, by seeking a signal in multiple interconnected threads (Mikhailov et al 2020). Research by this author has shown that VUCA events have statistical significance, particularly in impact, through Cohen's *d* analysis. This combination of multiple signals with high impact ratings is what triggers an awareness that a VUCA event may be taking place that requires a response. This approach enables a user to manage false positives as well, if a signal is only in one domain of volatility, uncertainty, complexity, and ambiguity and only just outside normal impact bounds, then it could be discounted, reducing the unwanted use of resources by an organisation in developing or enacting a pre-planned response to address false positives. Organisations want to understand when something significant is happening in their external operating environment so they can apply the appropriate level of resources and leadership to deal with the unravelling situation. Just saying the world is hard without applying structure and rigour to quantifying this could lead to notification fatigue (Zhou et al 2021) which causes the actual, and potentially existential, VUCA events to go unnoticed or ignored until it is too late.

It does take time to build a baseline though for Pattern of Life analysis (Franz 2016, Dogancay et al 2021), be that a human or automated system it needs to learn over time what normal looks like across various sets of data. Craddock et al (2016) proposed an approach to automate the collection and processing of 'priori and historical information' to produce Pattern of Life from observations, with a practical focus on answering questions like 'what is happening currently?' and 'is it something to react to?'. The advent of the Fourth Industrial Revolution (Schwab 2016) brings with it a wealth of new technological advances that should help automate and analyse Pattern of Life information (Franz 2016), particularly those that fuse a variety of data sets (Lim et al 2019), use artificial intelligence (AI), Bayesian networks (Dogancay et al 2021), unsupervised machine learning methods (Draayer et al 2022), and combine different but complementary techniques (mathematical and logical approaches) together to form cloud based automated scaled solutions (Gross et al 2015).

As the theory above outlines, Pattern of Life analysis makes an excellent candidate approach to build a baseline of events happening in an organisation's external environment from the various data indicators available to enable the identification of changes or abnormal behaviour that might indicate a VUCA event of significance is unfolding requiring organisations to make an intervention to protect their position, or in extreme cases, existence. It should be noted that while this research is focused on identifying VUCA events as they happen, Pattern of Life analysis is also used to aid prediction (Lim et al 2019, Mikhailov et al 2020, Draayer et al 2022). Prediction is beyond the scope of this research but may be an interesting avenue for future research once a baseline Pattern of Life has been established.

4.5 Putting the VUCA Tool Together

Now that a scorecard has been selected as the appropriate tool and Pattern of Life provides a way to use data to populate the tool, it can be built out. This process was done through iteration, with initial rough sketches and then more formal higher resolution diagrams as the concept crystallised. The artefacts were designed to offer guidance to participants completing them, which also helped

ensure the process was repeatable. This section captures the key output from the process, starting with Figure 4 shown below.

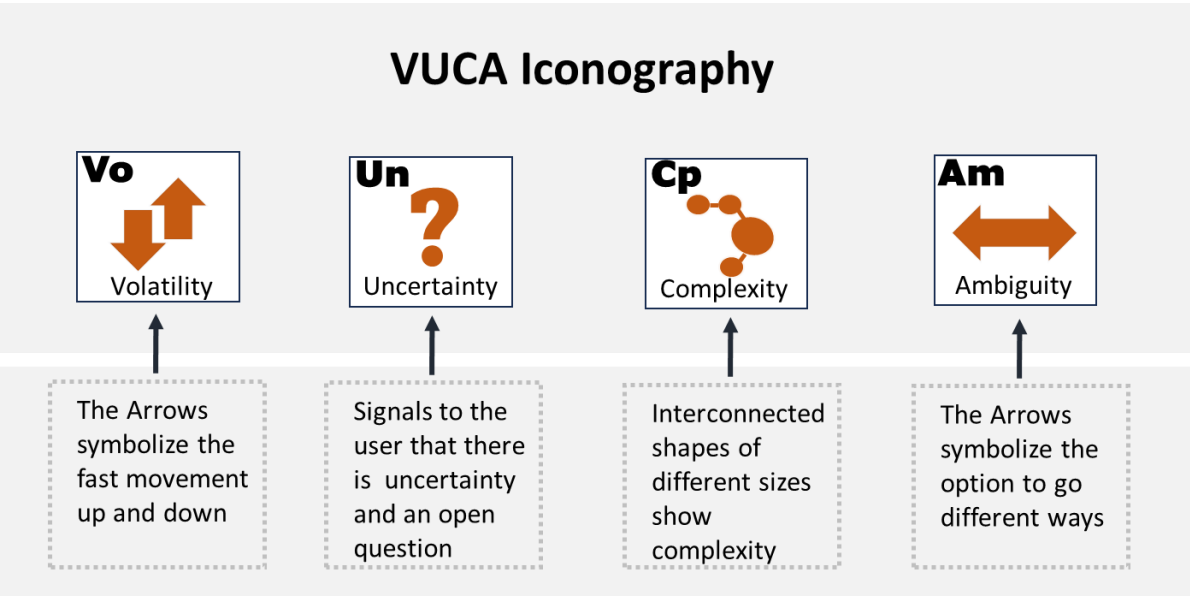


Figure 4 - VUCA Icons

The initial focus was on developing a set of icons for each of the VUCA domains as shown in Figure 4. This would help participants distinguish between them more easily, as well as offer a visual representation to aid recall on the focus of the domain.

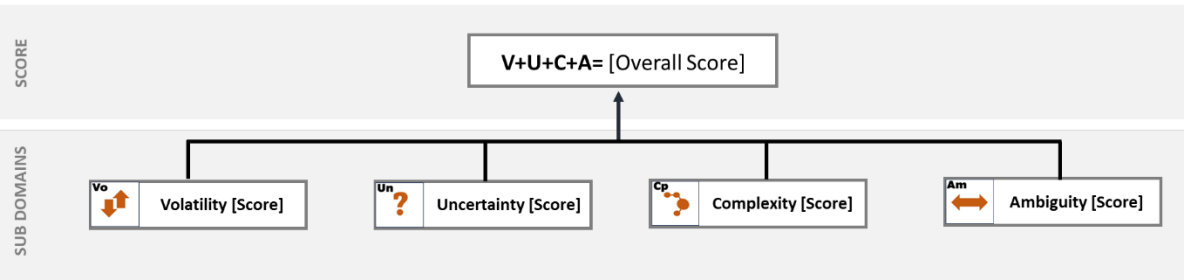


Figure 5 - VUCA Domains

The next step was building out all the VUCA domains and adding the icons to give an overall structure to the VUCA Scorecard at the top level. This is shown above in Figure 5.

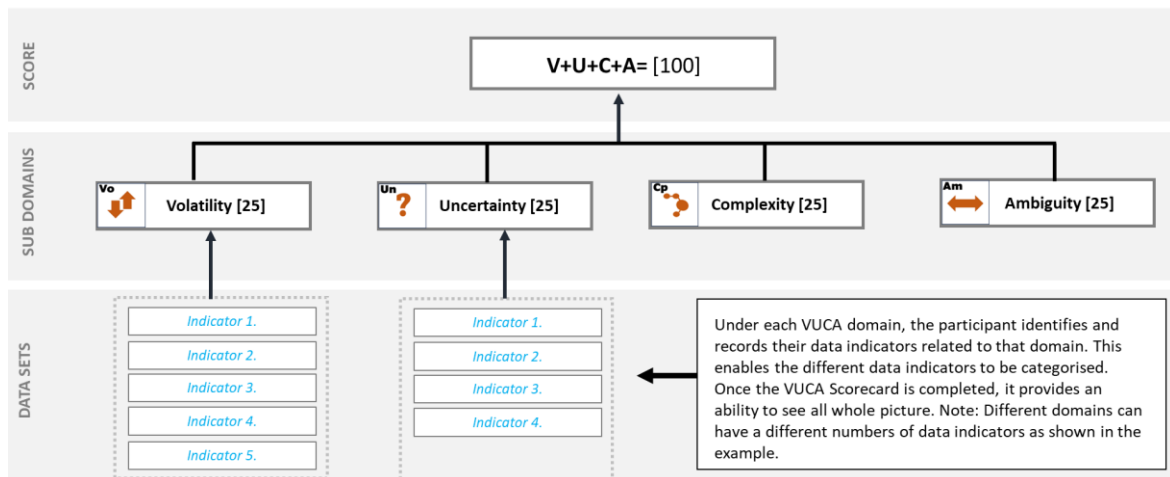


Figure 6- VUCA Data Indicators

Now that the top layer is in place, the VUCA Scorecard was extended downwards to provide space for data indicators to be inserted against the VUCA domains. At this stage guidance was added to the artefacts to enable participants, future researchers, and practitioners to follow the steps in order to repeat the process. This is shown above in Figure 6.

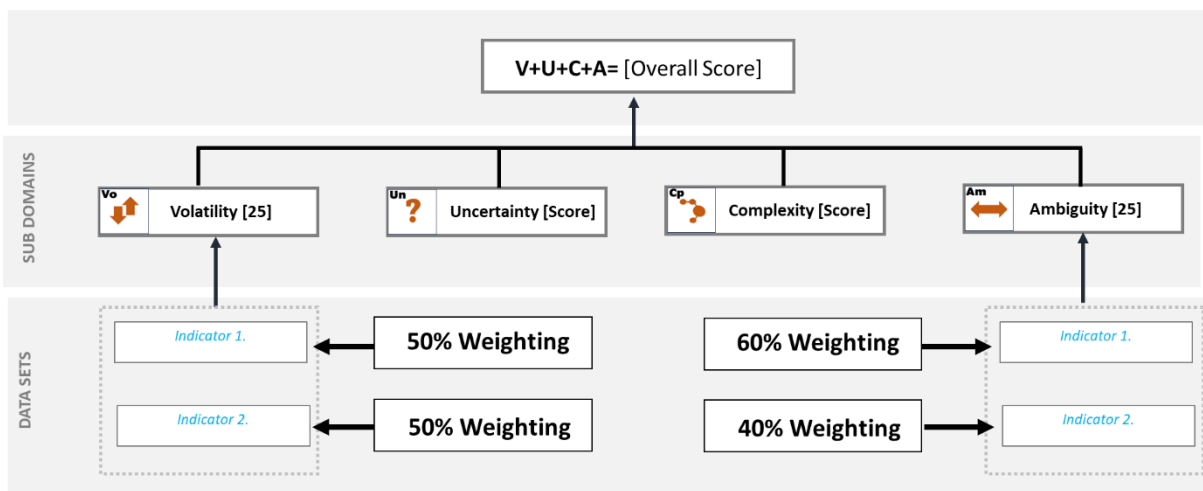


Figure 7- Data Weighting

At this stage the flexibility of the VUCA Scorecard is introduced. The VUCA Scorecard baseline assumes all data indicators and VUCA domains are equal. But the inbuilt flexibility allows a participant to weight both the data indicators and VUCA domains based on the level of trust they place in each of the data

indicators. Figure 7 above shows how the individual data indicators in different domains could be weighted. Practically speaking, the user should put their highly reliable, accurate, and authoritative data indicators, herein referred to as gold standard data sources (Tissera and Weerasinghe 2019), at the top of each VUCA domain. This helps prioritise the capturing of high value data and further ensures the robustness of the overall VUCA Scorecard. It would also support the ability to run the VUCA Scorecard in different modes, for example using only gold standard data. This could provide greater certainty in the results being seen, but conversely may miss early signals that appear in non-mainstream data that could possibly be more helpful. It is expected that users will need to adjust the data inputs as they learn from experience using the VUCA Scorecard.

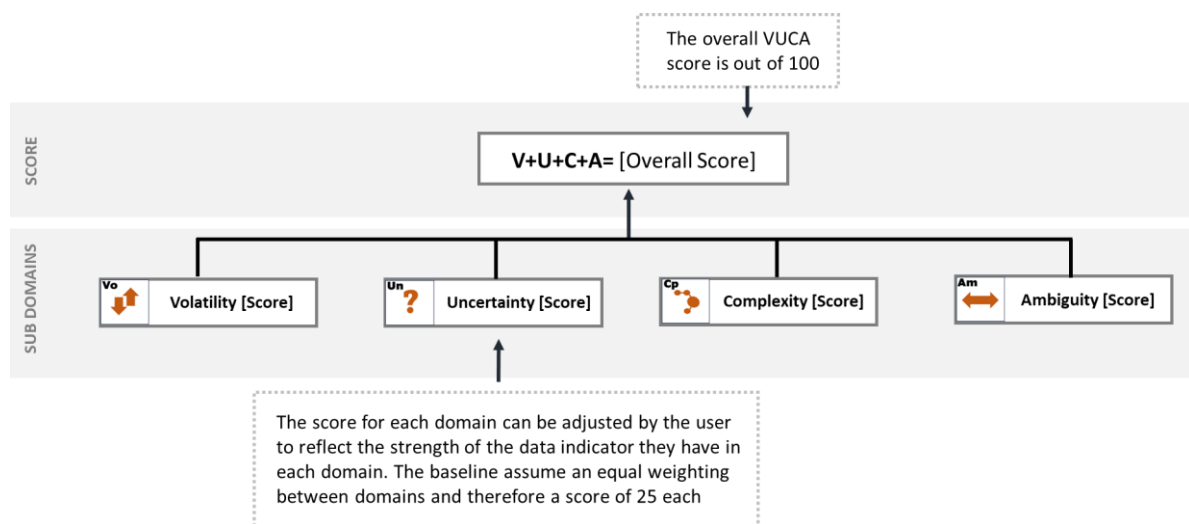


Figure 8 - Domain Weighting

The next example (Figure 8) above provides guidance for the VUCA Domains. At the outset the individual VUCA domains are weighted equally, with each making up 25% of the overall VUCA score. However, the weighting of each domain can be adjusted by the user developing the VUCA Scorecard based on a number of user defined variables. For example, perhaps they have more data feeds in one domain versus another, the quality of data is higher as it comes from a gold standard source, the data is published more frequently, or the user, and therefore their organisation, values a certain type of data over another (i.e. social media).

So, while the baseline assumes equal weighting of each domain, there are a range of possible reasons a user might weight the domains differently and fine tune the configuration of the VUCA Scorecard to their needs.

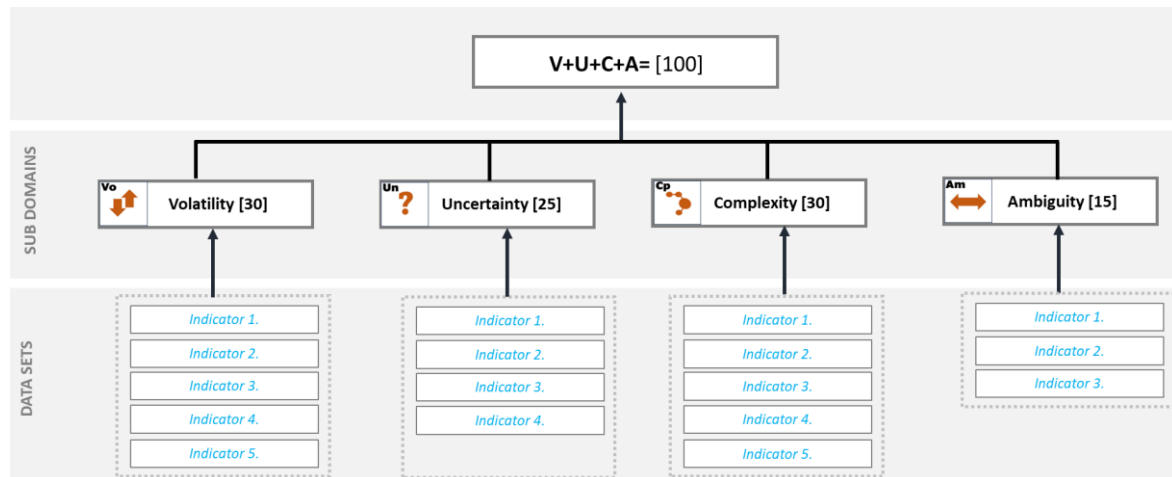


Figure 9 - Weighting Example

Figure 9 above shows how an overall VUCA Scorecard could be tailored. The initial baseline assumes all data indicators are weighted equally, but a user can adjust the weighting of each indicator based on a number of factors related to the underpinning data and its source. For example, a user could choose to weight gold standard data much higher than other data within a domain. This ability to adjust the weighting at both the indicator and domain level provides the user with flexibility to promote certain data they value more highly based on the relative importance they assign to each. The example above shows how this impacts the score for each VUCA domain, based on there being a different number of data indicators for each VUCA domain.

When first issued, a VUCA Scorecard requires participants to focus on generating ideas for the data indicators. This task should be open-ended with the aim of generating lots of different ideas for the data indicators. The next step is to then think through how the data could be sourced and collected. Ideally the data should be open source and publicly available which makes it repeatable by anyone and potentially at lower cost. Doing this provides a low barrier to entry and enables the participants to begin with populating the VUCA Scorecard. Over

time, a participant or their organisation can add proprietary or paid for data sets to enhance the VUCA Scorecard. It may also be the case that while some of the data indicator ideas are great concepts, obtaining data is just impractical or it does not exist in an easy to capture or consume format. Once a set of data indicators are identified for all the VUCA domains, the participant can start to collect the data and apply the Pattern of Life method to understand the baseline, and then look for data that deviates from the baselines, signalling turbulence and a possible VUCA event.

VUCA Scorecard Template

This template can be used to sense and understand VUCA events in the external environment. Identify data indicates for each of the VUCA domains to build a data driven picture of the external landscape and its turbulence. The data indications can capture social, economic, governmental, public, and private trends/patterns. Weighting of domain can be tailored based on the quality and number of data indicators in each VUCA domain.

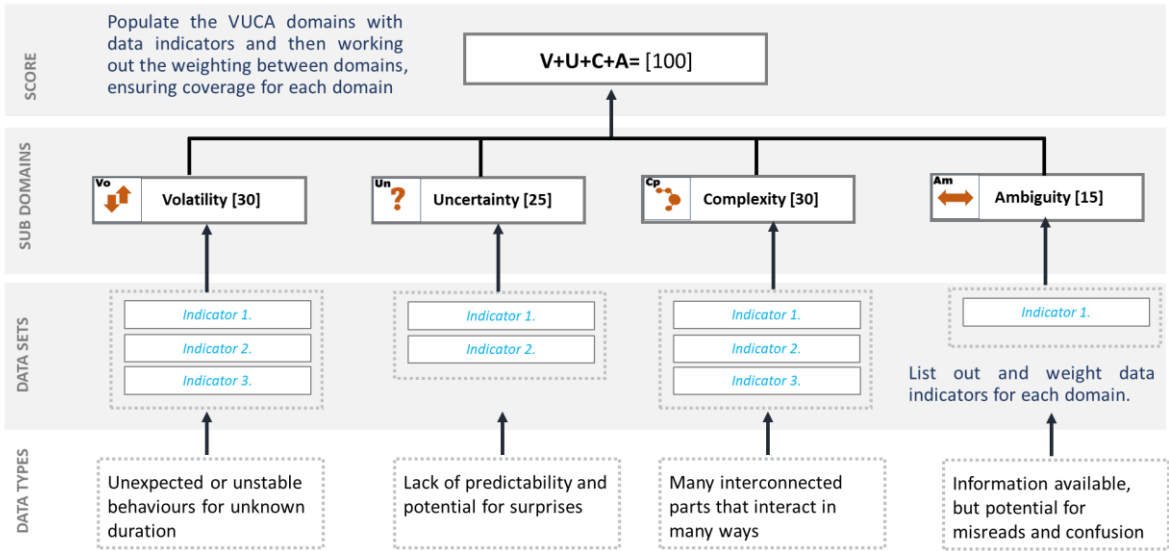


Figure 10 - VUCA Scorecard Template

The final example (Figure 10) seeks to provide a single VUCA Scorecard Template that has an example of how the data indicator population could look, along with instructions and suggested weighting. Under each domain a prompt is provided to help remind the user of the domain being populated and the data indicator being sought.

4.6 Decision Making Support

Decision makers within an organisation trying to determine from the information they receive whether a VUCA event is happening are often asked to perform the analysis under stress. Decision making under stress with varied information is known to introduce or enforce bias (Kahneman and Tversky 1979, Comes 2016). To mitigate against bias and support decision making under stress (Comes 2016), decision support structures and models (Beveridge et al 1997) can be used to frame (Huizenga et al 2023) the choices into clearly discernible options and discrete courses of action to reduce the magnitude of the effect.

To aid strategic leaders in understanding the potential magnitude of a VUCA event taking place, and the urgency with which they need to respond, the following decision support artefact, Figure 11, has been developed. This artefact, the VUCA Impact Scale, provides organisations with the foundations on which to take decisions, helping them contextualise the level of their own interventions and what may be required.

VUCA Impact Scale		
Impact ↑ Low ↓ High	VUCA Domains Breached	Condition and Response
	0	Normal operating environment and conditions
	1	One VUCA domain breached, likely to be self-contained and addressed as business as usual
	2	Two VUCA domains breached and possible early signal that VUCA event maybe inbound with the environment becoming turbulent
	3	Three VUCA domains breached and a VUCA Event is now in progress, action required to navigate turbulent conditions
	4	All VUCA domains breached and serve VUCA Event in progress, immediate action required to ensure survival

Figure 11 - Decision Making Artefact

The VUCA Impact Scale measures the significance of what is being identified in the VUCA Scorecard to aid decision making. A VUCA event requires at least three of the four VUCA domains (volatility, uncertainty, complexity, and ambiguity) to have been breached (i.e. the Pattern of Life baseline has been exceeded) for a VUCA event to be declared as underway, at which point it is

recommended strategic leaders engage early to formulate a response. At the lower end of the scale, one domain being breached is likely to be akin to the normal day to day operation within an organisation, action is required to manage it, but it is not likely to be an existential crisis event. Once a VUCA Scorecard is built out and Pattern of Life is used to review the data collected, a decision maker is alerted when a VUCA domain is breached, and based on the number of domains breached, uses the VUCA Impact Scale to help assess the severity of the situation and level of response required. The colour coding further helps quickly assess the impact of the event unfolding, with green indicating normal conditions and red indicating turbulent conditions (i.e. a VUCA event is taking place). In short, the VUCA Impact Scale seeks to understand the significance of any impact, i.e. has the Pattern of Life baseline been broken, and then asks for how many of the VUCA domains has this occurred.

5. TESTING THE SCORECARD

A qualitative research method was selected, namely focus groups, to evaluate the proposed VUCA Scorecard tool. The qualitative research followed the guidelines proposed for 'Business Research Projects' by Jankowicz (2004). The findings showed positive results towards using the tool and it exhibits the potential to be effective with respect to business decision-making.

In order to produce the highest quality output from the qualitative research, a research design decision was made to test the VUCA Scorecard in a classroom setting as part of an executive education course at Cranfield University School of Management between 2021 and 2022. This produced a number of benefits. The first was a very high level of consistency in the profile of the participants in each cohort. They were predominantly of the same age range (25 to 44) as can be seen in Figure 12 and predominantly funded by their companies to undertake the executive education programme part time indicating a certain level of seniority, ability, and potential. The participant companies leaned towards major well-known organisations such as Microsoft, AXA, BP, and KPMG, and no fees or payment were exchanged for taking part in the testing. The second benefit was

that all the participants in the cohort completed the testing in the same conditions, with the same introduction and background material, and the same amount of time made available.

Age Range	Participate Count
No Age	1
16 - 24	5
25 - 34	83
35 - 44	51
45 - 54	24
55 - 64	2
64 & Above	0
Total	166

Figure 12 - Age Ranges

A structured testing process was designed for use with the cohorts. This ensured consistency in testing approach and supported the comparison of results from cohort to cohort. This process involved four distinct stages: 1) setting the context and providing the required materials, 2) completing the VUCA Scorecard, 3) playing back the results from completing the VUCA Scorecard, and 4) reflecting on both the individual cohorts findings and the overall findings across all the cohorts as whole.

Setting the context involved a short overview of VUCA and the VUCA Scorecard, how it functioned and how it needed to be completed. This steering step in elicitation ensured the respondents knew how they were meant to tackle the task, how to answer, and the time available. As part of the material provided, alongside a blank VUCA Scorecard, as shown in Figure 6, the participants were presented with the VUCA definitions, as presented in Figure 13 below as an aide-mémoire. This both provided them with a reference point and also ensured consistency in the definition applied. The qualitative research method thereby provided in-depth explanations to help reduce participant uncertainty regarding the required task.

Vo  Volatility	Volatility Definition: Unexpected or unstable behaviours for unknown duration Example: Stock market and share prices, shares trade over a large range
Un  Uncertainty	Uncertainty Definition: Lack of predictability and potential for surprises Example: How much of a new product will you sell?
Cp  Complexity	Complexity Definition: Many interconnected parts that interact in many ways Example: Supply chain with multiple tiers of suppliers and sub-suppliers
Am  Ambiguity	Ambiguity Definition: Information available, but potential for misreads and confusion Example: Airport is closed – Is this due to bad weather or IT system failure?

Figure 13 - VUCA Standard Definitions

Cohort participants had been split into pre-assigned groups, with 4 to 5 people in each group. The group approach was useful as it allowed participants to use brainstorming as a collaborative problem-solving technique, which is the established gold standard in generating new creative and innovative ideas (Cabanès 2023). Further, completing the VUCA Scorecard made the best use of the available time, as for every individual to provide feedback separately would have required an unreasonable amount of time. Each group was given 30 minutes to complete a single VUCA Scorecard, with the same business scenario (development of a new IoT product) being used by all groups. Each group had its own unique VUCA Scorecard to complete and their own private work area to undertake the task in, meaning no cross contamination of different participant groups.

Once the allotted 30 minutes were up, each group was asked to playback their completed VUCA Scorecard to the wider group, outlining what data indicators they had identified, and their experiences completing the VUCA Scorecard. Semi-structured questioning was used as a relatively open-ended data gathering technique to elicit feedback, and while remaining centred on the core topic, this

allowed the exploration of unique points that were raised by any groups or cohorts.

Metric	Response
Period Covered	2021- 2022
Total Number of Focus Groups	33
Total Number of responses	33
Completed VUCA Scorecards	100%
Data Indicator provides for all VUCA domains	100%

Table 1 – VUCA Scorecard Results

All of the 33 focus groups were able to complete the task within the allotted 30 minutes and provide a data indicator for each VUCA domain (volatility, uncertainty, complexity, and ambiguity) as shown in Table 1 above. While at least one data indicator for each VUCA domain was always provided, the depth of the responses varied, with some groups providing between 1 and 3 data indicators per domain, while others provided between 3 and 5 data indicators for some of the VUCA domains. While the depth varied, all groups were able to complete the task though as required.

The reflections stage allowed the researcher to pan back and reflect on the work of each group and across cohorts to look for patterns or trends, referring to the submitted VUCA Scorecards from each group and notes taken as the playback took place. For example, one group was looking at developing an IoT product linked to energy, the data indicators they identified included weather, pricing, occupancy rates, government policy and funding, and climate change. When compared to other groups, it was possible to start to see how different data indicators appeared multiple times across the groups, even though the products were different, and also coalesced in the same VUCA domains.

5.2 Testing Reflection

While a robust qualitative research method was followed to test the VUCA Scorecard, the main objective of this stage was to see if the tool had merit at all to practitioners and if there were major issues with its design. All groups were

able to understand the task and complete the VUCA Scorecard without issue which satisfied the success criteria for the testing. A number of the groups commented that the use of the VUCA Scorecard helped them think more about the external environment in a way they had not before, and how the use of data driven insights into what is taking place could help inform strategy and product development. Table 2 below captures the key data indicators from the testing.

	Focus Groups Key Information						Totals
Metrics	Cohort 1	Cohort 2	Cohort 3	Cohort 4	Cohort 5	Cohort 6	
Date	Feb-21	Mar-21	Sep-21	Feb-22	Mar-22	Sep-22	
Source	Exec Ed	Exec Ed	Exec Ed	Exec Ed	Exec Ed	Exec Ed	
Participants Location	Oman	UK	UK	Oman	UK	UK	
Participants Involved	20	30	33	4	45	34	166
Participants Groups	4	6	7	1	9	7	33
Group Responses	4	6	7	1	9	7	33
Spoiled Responses	0	0	0	0	0	0	0
Response Rate	100%	100%	100%	100%	100%	100%	100%
Completion Rate	100%	100%	100%	100%	100%	100%	100%
VUCA Scorecard Version	VUCA SC v1	VUCA SC v1	VUCA SC v1	VUCA SC v1	VUCA SC v1	VUCA SC v1	
Questions	1	1	1	1	1	1	
Time to Complete	30 Mins	30 Mins	30 Mins	30 Mins	30 Mins	30 Mins	

Table 2 - VUCA Scorecard Testing Metrics

While there were no fundamental issues with the VUCA Scorecard itself there were opportunities for improvement. The first key area for future development concerned more guidance on how to apply weighting of both the individual data indicators vis-à-vis each other, and also the weighting of each VUCA domain against each other. The groups that had previous affinity with working with data driven frameworks or were quick to grasp the concept quickly wanted to tailor the VUCA Scorecard further to reflect the relative merit they placed on each data indicator, something the design of the VUCA Scorecard supported. For example, one group weighted much more highly data indicators they could access every minute verses ones that are released once a quarter or once a year. The second key area for future development centred on some groups asking for a worked example of the VUCA Scorecard that was pre-populated with some example data indicators so they could better understand the types of data indicators being sought. This was not initially provided to prevent bias and to promote free thinking and brainstorming within the group, but with hindsight, time was then lost without the structure this provided as they debated how to use the VUCA Scorecard.

While all the groups were able to complete the VUCA Scorecard it was felt for some that the worked example would have helped them join the dots quicker on what was required, giving them more time to brainstorm their own data indicators.

A further key insight from the VUCA Scorecard results was the ability of the focus groups to generate an extremely broad and diverse range of data indicators well beyond those initially considered by the author. This is perhaps not surprising given there were 166 participants from a diverse set of backgrounds and organisations. Researchers and practitioners looking to generate data indicators to populate their own VUCA Scorecards would be advised to leverage focus groups to brainstorm and crowd source initial data indicator candidates. These will likely require validation but would provide a useful starting point for investigation.

6. DISCUSSION AND CONCLUSION

The purpose of the study was to explore if a strategic tool could be developed to reveal the phenomenon of VUCA events. The tool would inform and aid strategic decision makers in understanding VUCA events in their turbulent business environments. In order to achieve the aims of the research it utilised a structured approach employing Conceptual Theory Building (Meredith 1993, Solinger et al 2024) as a method. A number of theoretical contributions were produced during this process.

The research first reviewed existing literature to understand VUCA's place in different fields of research and exploited existing knowledge on strategy, decision making and strategic tools. The literature review clearly showed a link through the field of strategy, from Strategic Management as an overarching discipline (Chandler 1962, Ansoff 1965, Mintzberg 1978), through environmental turbulence (Johnson and Scholes 1989, Prahalad and Hamel 1990, Grant 2003), to strategic decision making (Curnin et al 2023, Tabesh and Vera 2020) and tools to support this (Knott 2006). VUCA's (Bennett and Lemoine 2014) place in Strategic Management resolved itself to demonstrate how VUCA adds structure as a way to unpack and decode environmental turbulence. This positioning of

VUCA as part of Strategic Management is a natural fit as it integrates seamlessly with existing theory and literature when viewed through this lens.

The research then sought to formulate concepts and propositions that helped explain the phenomenon of interest (VUCA). The work drew on existing theoretical perspectives and assessed a variety of proven options in the field of Strategic Management for a tool to help visualise and see VUCA in action. This research identified a scorecard through a rigorous selection process, and a VUCA Scorecard was developed. It was conceptually theorised that to bring the scorecard to life it would need to be able to analyse the data indicators it was receiving, a position backed up in literature (Zhu and Li 2023). Pattern of Life (Craddock et al 2016) was therefore researched and combined with the scorecard to achieve this aim.

Finally, as part of the Conceptual Theory Building method, the conceptual framework (VUCA Scorecard) was then tested using a qualitative approach of focus groups, which identified enhancements to the supporting narrative of weighting and a worked example with pre-populated data indicators thereby enabling easier completion of the scorecard. This focus-group method and the use of semi-structured questioning captured in-depth insights into individual and group dynamics in the production of a tailored VUCA Scorecard to a set business problem scenario in an open but structured manner, proving the tool could aid strategic leaders and practitioners. The practical use of qualitative methods and a clear process for conducting qualitative research in a scientific manner allowed for theoretical development and also generated practitioner-oriented insights to promote take up and use of the VUCA Scorecard.

Taken together, the process provided a structured and rigorous approach to address the research aim and demonstrate that the phenomenon of VUCA events could be revealed through the development of a strategic tool, one that reflected on existing literature and was subjected to qualitative assessment by peers.

To the best of the knowledge of this researcher, this is one of the first attempts where a tool has been produced and tested to help organisation visualise VUCA

in action and collect data to support data driven insights into VUCA, providing a novel contribution to knowledge.

7. IMPLICATIONS

This research has a number of implications for both researchers and practitioners in the field of Strategy and strategic decision making. The first is that VUCA (Bennett and Lemoine 2014) is a way to understand a turbulent business environment. Strategy leaders and decision makers that do not have a way to understand VUCA and detect what is happening are missing a tool from the strategy armoury.

In order to sense and detect VUCA events forming, organisations will need data to build a Pattern of Life. For practitioners, example data sets, almost like a starter pack, will be of aid to users populating a VUCE Scorecard.

8. LIMITATIONS & FUTURE RESEARCH

This research focuses on sensing and understanding what is taking place in the external business environment to aid strategy formulation. How the insights are then implemented is not within the scope of this research. This aligns with the long-standing view in the literature that typically distinguishes strategy formulation from implementation (Mirabeau and Maguire 2014).

Pattern of Life, and in fact VUCA, are just approaches to help organisations understand their external environment and read the signals that are out there. It is highly unlikely that any single solution will provide complete coverage of what is happening in an organisations external operating environment, and it is likely a number of tools and approaches will be required to build an armoury over time. The VUCA Scorecard is just one of these, albeit an important one. Going forward it should be possible to build and automate these types of solutions so that an organisation has continuous protection and early alerting, but at a minimum cost or human effort overhead.

It is recommended that a human needs to be in the loop to analyse the emerging signals and indications that a VUCA event is happening. While the VUCA Scorecard scores will give early warning and pointers to where the main impacts are, it is likely the outputs will be too imprecise and require human input to distil fully and obtain fine-grained interpretation. This position may change as AI and similar technologies advance, or trust is built up in the system. The VUCA Scorecard is never meant to be a silver bullet, rather it is an indicator of an emerging VUCA event that likely requires a response, and the shape of the response needs to be constructed by senior leaders based on what is taking place.

It is also beyond the scope of this research to design or build a data ingest engine to deal with the data indicators that are collected to populate a VUCA Scorecard. Data ingest includes aspects such as imputation of missing data, jitter, normalisation, sensitivity analysis, and weighting. While a simple VUCA Scorecard can be developed with pen and paper to help an organisation think about and capture its key data indicators to understand the external environment, as it scales up and the collection process is industrialised it is likely to become a more sophisticated tool with real time tracking and data fusion requirements. Artificial Intelligence, through machine learning, neural networks and deep learning, is also likely to have a profound impact in the future and help with the identification of patterns within the data and will need to be researched to understand how these tools can be used and what benefits they bring.

Conflict of Interest

The author declares no conflict of interest.

Ethics Statement

The author has read and agreed to the Committee on Publication Ethics (COPE) international standards for authors. All data was collected and stored in line with Cranfield University standards and policies.

6 Research Paper 4 - VUCA Data Indicators

Introduction to Paper

Research Paper 3, located in Chapter 5, proposed new and original novel ideas and artefacts to aid researchers and practitioners in visualising VUCA through the development of the VUCA Scorecard, the concept of data indicators to populate the scorecard, and the use of Pattern of Life as a method to baseline the data to produce a decision-making tool. The research showed participants could generate a wide range of data indicators across the VUCA domains. However, the validity of these, and exactly which domain they belonged to, needed to be addressed. Paper 4 was designed to achieve this aim by researching if data indicators could be underpinned by existing peer reviewed research to validate their robustness and thereby warrant their inclusion for use.

Can VUCA be underpinned by rigorous theoretical data sources

James Vickery

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK, and

Enes Unal

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Dr. Leon Williams

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Abstract

Key Finding – This research proves that the data indicators used to populate a VUCA Scorecard could be underpinned by rigorous theoretical research published in peer reviewed journals, thereby further validating their use.

Purpose – The purpose of this paper was to map proposed data sources that could be used as candidates to populate a VUCA Scorecard to existing peer reviewed research to validate their robustness. This research developed a hard link between the candidate data sets and academic research, thereby justifying their potential inclusion. The research also ensured that a physical implementation of the data set existed to provide primary data to feed into the VUCA Scorecard.

Methodology – A structured search was undertaken against a journal database. Unlike a literature review which is bounded, this process was unbounded by design. The primary database was SearchPoint, located in Cranfield University Library, as this has access to a wide range of journals and articles, and amalgamates input from sources such as ABI Inform ProQuest and EBSCO host. The search process in this database was rigorous, and critically, all the steps laid out in the paper are fully repeatable. Once a data set was identified, it was researched to ensure there was a physical implementation of it with the detail of this provided in the paper.

Additional Findings – The research successfully identified data sets with rigorous theoretical underpinning in literature, four for each VUCA domain of volatility, uncertainty, complexity, and ambiguity. Each data set can provide a data indicator in the VUCA Scorecard. The research demonstrates how further robust data sets could be sourced to fully populate a VUCA Scorecard based on an organisation's own drivers and circumstances. For each data set the main supporting journal paper and implementation source is shown, rolled up together in a VUCA Scorecard as an overarching framework.

Research implications – The research provides a repeatable way to source data sets. The research also provides an initial collection of sixteen data sets that act as an eclectic library of validated candidate options organisations could use.

Originality/value – To the best knowledge of the researcher, the findings in this paper are the first time data sets used to understand VUCA and each of its domains have been linked back to, and underpinned by, peer reviewed journal papers in literature.

Contribution to the thesis – In order to bring the VUCA Scorecard to life, it needs to be populated with data. This research provides data sets that could be used as data indicators in the Case Study to visualise VUCA.

Keywords:

VUCA, VUCA Scorecard, volatility, uncertainty, complexity, ambiguity, Data Indicators

Paper type – Original Research

In order to respond to an increasingly turbulent and fast-moving business environment strategic leaders and decision makers need data driven insights to enable them to craft strategic responses to the challenges their organisations face.

The VUCA Scorecard provides leaders and decision makers with a new strategic decision-making tool in their armoury to achieve this. VUCA, an acronym for volatility, uncertainty, complexity, and ambiguity has emerged as a way to help frame, structure, and understand what is taking place in the external operating environment.

In order to bring the VUCA Scorecard to life, it needs to be populated with data. This research for the first time seeks to identify rigorous theoretical data sources underpinned in literature that can be used to build out the VUCA Scorecard, while at the same time acting as eclectic library of validated candidate options organisations could use.

Introduction

It has long been understood that organisations need to understand the ‘relevant dimensions’ (Duncan 1972) of their business operating environments to endure and thrive (Lawrence & Lorsch 1967, Thompson 1967, Cannon and Caron 2007). VUCA, an acronym for volatility, uncertainty, complexity, and ambiguity (Kail EG 2010, Bennett and Lemoine 2014, Fridgeirsson et al 2021, Nishimoto 2021, Putro et al 2022, Lilja et al 2022), has emerged as a way to help frame this turbulent business environment (Ansoff 1979, Johnson and Scholes 1989, Prahalad and Hamel 1990, and Grant 2003). The proposed VUCA Scorecard seeks to understand and visualise this turbulent VUCA world by enabling organisations to build a Pattern of Life (Craddock et al 2016, Mikhailov et al 2020), brought to life through data indicators (measures of the environment). These data indicators are the lifeblood (Palshikar 2001, Ramakrishnan 2016) of an organisation and the ‘New Oil of the Digital Economy’ (The Economist 2017, Bhageshpur 2019).

In order to build as detailed a picture as possible of the turbulent business environment and receive the signals required to inform strategic decisions, particularly those for data driven innovation and building resilience, organisations need to understand the macro and micro elements of their external operating environment. Within the context of this research, for macro, this means data

indicators on the wider overall economic conditions. For micro, this means data indicators relevant to the organisations themselves or their specific vertical, such as sports equipment or farm machinery.

The proposed VUCA Scorecard assumes the existence and validity of data indicators on which to build a Pattern of Life model. This research tests that assumption by applying academic rigour to analyse journal articles to look for explicit evidence that a certain type of data can act as a signal for Volatility, Uncertainty, Complexity or Ambiguity. This research project does not mandate the use of any identified data indicator however, more that those underpinned with sound academic rigour act as an eclectic library of validated candidate options for external data indicators that a researcher or practitioner within an organisation could use to populate its VUCA Scorecard.

1. Methodology

The aim of the research is to understand and validate that VUCA can be underpinned by rigorous theoretical data sources. The research uses a mixed methods approach to achieve this. The first step is through the use of a structured and repeatable systematic literature review method to identify, analyse, and synthesise existing literature relevant to the VUCA domain. The exact process is detailed below (Section 1.2 Identifying Data Indicators) and follows accepted norms and best practices to play a crucial role in providing a foundation based on existing knowledge.

Once a data indicator has been identified in literature, the second step builds on this by validating that the data point is real and exists through a physical manifestation. In the most part this is straightforward, as the research in literature was often undertaken to support the production of an actual data service, often hosted by, or in conjunction with, a university or research institute. Where this is not possible, mainstream services, for example a national stock exchange or government run entity, are used. The data indicator validation process follows the methodology for data validation 1.0 as defined by Zio et al (2016) to ensure 'data validation assesses the plausibility of data' (Zio et al 2016). For each of the

sixteen data indicators, the key paper from literature is identified, along with the physical source where it was validated (its real-world location).

1.1 Data Indicator Types

VUCA inherently encompasses different domains (volatility, uncertainty, complexity, and ambiguity) and therefore by its very nature the types of identified data indicators will vary greatly to provide as rich a picture as possible about what is taking place outside an organisation and to help avoid a myopic view developing by only looking at one type of data (i.e. stock price). The structure, dynamics and interconnected nature of an organisations external networks mean they include data from social, epidemiological, financial, and economic systems (Morrison et al, Boccaletti et al 2006, Sekera et al 2016, Xie et al 2011, Pastor-Satorras et al 2015, Colizza et al 2008, Battiston et al 2012, Vitali et al 2011, Hidalgo et al 2007, Foschi et al 2014). Different data types will also be more important to different organisational types and their stakeholders. For example, one organisation may be more concerned with its public image, social media profile and adverse publicity, while another is more concerned with the price of the raw materials it requires. The VUCA Scorecard is designed to flex and handle these different concerns and data types, enabling an organisation to assemble the external data indicators that make the most sense for its mission. The VUCA Scorecard can grow over time with more data sets added as required and to adapt to any changing mission or priorities by adjusting the mix of data indicators.

1.2 Identifying Data Indicators

A structured search was undertaken against a journal database. The primary database was SearchPoint, located in Cranfield University Library, as this has access to a wide range of journals and articles, and amalgamates input from sources such as ABI Inform ProQuest and EBSCO host. The search process in this database was rigorous following the steps below, and critically, is fully repeatable.

Search strings were semi-structured, in that they began with the VUCA word, such as volatility, and followed this with 'data'. In some cases, variations of the

VUCA word were used, for example ambiguous for ambiguity, and the search was extended by adding one of the following terms to the search string end: 'point', 'index', 'framework', 'measure', 'indicator'. 'business' or 'external environment'.

Unlike a literature review which is bounded, this process is unbounded by design. It is unknown what the upper limit of VUCA data indicators might be, and there are lots of avenues of potential discovery in academic literature. Therefore, in order to bound this project and prove that academically rigorous data indicators exist, the project set out to see if sixteen data indicators could be identified, four for each of the four domains of volatility, uncertainty, complexity, and ambiguity.

In order to test whether there was coverage for all of VUCA, the decision was made to follow an iterative process to first identify a single data indicator for each part of volatility, uncertainty, complexity, and ambiguity. Once this test had been passed, then the focus shifted from coverage across VUCA to depth within each domain, and the process worked back through each part of volatility, uncertainty, complexity, and ambiguity to seek a further three data indicators for each area, achieving the required four in total, before moving on to the next domain until complete.

It is also noted that an identified data indicator may fit multiple dimensions within VUCA, however, the strength of the arguments in literature will act as the primary justification for where it is grouped.

1.3 Data Indicator Prioritisation Process

It is recognised that within the process to identify data points different types of data are likely to emerge. The following prioritisation is applied to focus the research and ensure the widest use and applicability of any identified VUCA data indicators:

- **Macro over Micro** – While a micro data indicator might be massively valuable for an individual company, its wider relevance could be fairly limited. For example, an index that tracks the volatility of a unique material used by a handful of organisations will have very limited wider appeal. For

this reason, data that looks at the macro is favoured for the purposes of this research and also helps demonstrate the wider applicability of the VUCA Scorecard.

- Global over national, national over regional – To support the reuse of the research in this project, ideally data sets should have coverage as follows, global, then national, then regional.
- English first – This research is conducted in western countries using English as the main language. The data indicators must be explained in English and, where applicable, be available in English if they exist. This allows this research to interrogate and understand the underlying theory, logic and design of the data indicator.
- Prioritise live data feeds over theoretical models - Ideally any data sets will have moved from being a theoretical concept to an actual working state that can be accessed and used live.

This is not to say a small local micro data set will not feature in the research, but the priority will be given to data indicators supporting the widest set of use cases. It should also be noted that the order in which data indicators appear in has no bearing on their importance, the importance of any data indicator is decided by the researcher or practitioner implementing it.

1.4 Research Framework

The data indicators identified in this research will be used to populate the following VUCA Scorecard (Figure 1), which adds guidance and structure to the process being followed. Each of the next sections within this Research Paper is seeking to identify and populate four data indicators for each domain of VUCA.

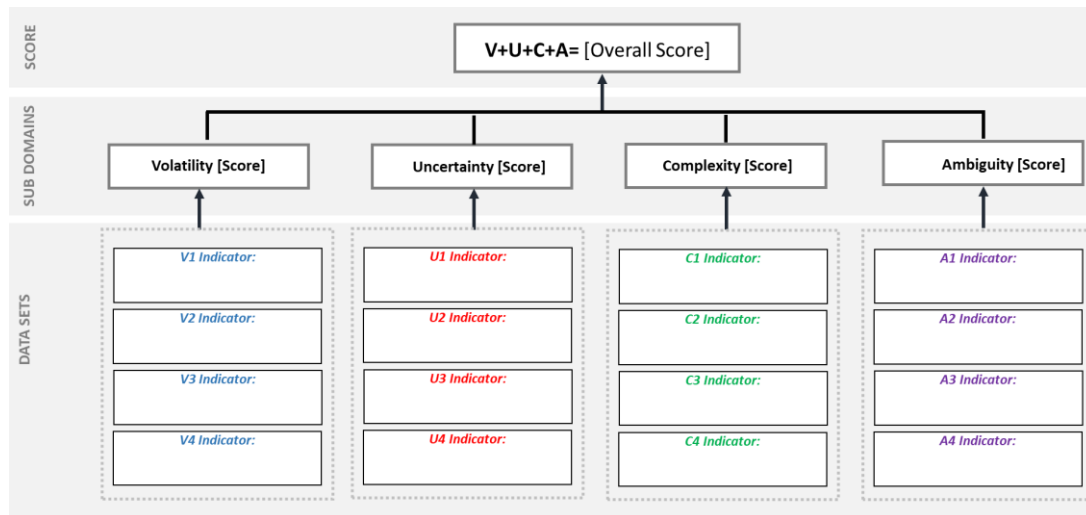


Figure 1 - VUCA Scorecard

2. Volatility

The definition of Volatility used within this research is that of ‘unexpected or unstable behaviours for unknown duration’. Business volatility can present both risks and opportunities for companies and what leaders want is early indicators that volatility is increasing. While high volatility can make it challenging to plan, forecast or react, it can also create opportunities for agile businesses to capitalise on market fluctuations, adapt to changing conditions to gain a competitive advantage, particularly those attuned to market dynamics and external conditions. Within financial markets volatility, or how fast prices change, is seen as a way to gauge the degree of fear among market participants and has long held a fascination with economists as it reflects the arrival rate of information. The following data indicators uncovered in research help to identify volatility as part of a VUCA Scorecard.

CBOE Volatility Index

Chicago Board Options Exchange (CBOE) has produced the CBOE Volatility Index (VIX) since 1993 (Fernandes et al 2014), a real-time index that measures the volatility of the Standard and Poor's (S&P) index, with increases in the CBOE Volatility Index corresponding to declines in the Standard and Poor's index (Gökgöz and Kayahan 2023, Fernandes et al 2014). The CBOE Volatility Index, which follows the methodology of Whaley (1993), captures investors' fear related to their investments, for when the CBOE Volatility Index increases, the stock

market tends to adjust downward due to the high turbulence in the market (Vuong et al 2022, Whaley 2000). The CBOE Volatility Index generates a 30-day market-determined, forward-looking (Hentschel, 2003) projection of volatility and is often used as a predictor in research (Xu et al 2023).

Volatility, or the speed at which prices change, can be seen as a way to gauge market sentiment, and in particular the degree of fear among market participants. For these reasons the media refer to the CBOE Volatility Index as the ‘Fear Gauge’ (Darrons 2023, FT 2023). On a global basis, it is one of the most recognised and popular measures (Kyung and Kye 2020) of volatility widely reported by financial media and closely followed by a variety of market participants as a daily market indicator. Put simply, the higher the score, the more volatility. Research, such as that by Batten et al (2023), Das and Gangopadhyay (2023), and Apergis et al (2023) shows a correlation between the higher CBOE Volatility Index scores and global events, such as COVID-19, Swine Flu and Zika virus epidemics, further enhancing the CBOE Volatility Index credentials as a data indicator for VUCA.

The CBOE Volatility Index has current and in-depth robust research coverage (Gökgöz and Kayahan 2023, Xu et al 2023, Zhang et al 2023, Cooray et al 2023, Yue et al 2023) and its design is well in line with the strong empirical evidence in the literature (Fernandes et al 2014). Critically, it also provides a useful real time data feed. For these reasons and its place as a globally recognised measure of volatility, the CBOE Volatility Index is the first data indicator for volatility.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
V1	CBOE Volatility Index	Macro	Chicago Board Options Exchange	The Investor Fear Gauge - Whaley, R. E. (2000)

Figure 2 - First Volatility Data Indicator

Energy Prices

All organisations consume energy, be that to power manufacturing machinery, operate high tech data centres, or just to keep lights and heating on, and are therefore impacted, often significantly, by sudden changes to energy costs.

Spyrou (2020) notes that 'energy prices are an important factor that affects economic growth, industrial production, production costs, transportation costs, firm profitability, and consumer prices, among others.' Energy costs can impact downstream activities that depend on energy, for example impacting food security and increasing the volatility of beef and lamb prices (Bozma et al 2023).

The connectedness of price volatility for natural resources such as oil and coal, and the enhancement of economic growth has long been an area of central attention for academicians and researchers (Phan 2023). Oil prices and the prices of other energy products show strong linkages and studies generally find a long-term relationship between them (Miller 2023). A number of researchers, such as Ghosh (2022), also explore the links between alternative clean energies, such as renewables, and the impact of major shocks, such as the Russian invasion of Ukraine, and the unarguable volatility imposed on the sector.

There is clear evidence in research of the impact of major VUCA events, such as COVID-19, climate change, recessions, and geopolitical instability on the volatility of energy prices (Sarker et al 2023, Dhifaoui et al 2023, Prisecaru and Calanter 2022). Even simple changes like new power cables that transit and distribute power to cities and regions can lead to price volatility spillovers (Sapio and Spagnolo 2020) demonstrating the factors impacting energy price volatility can initially be fairly innocuous.

Research by Prisecaru and Calanter (2022) showed that energy prices are generally more volatile than the prices of other commodities due to how energy demand responds more quickly to the impact of economic growth making energy prices a strong leading indicator that strongly detects volatility. Sudden, volatile changes in energy prices will have material impacts on businesses of all shapes and sizes, from local stores to multinationals, as no business is immune from instability in energy markets. Like wages, energy prices affect overall production costs, which in turn, influences output for a business (Aminu 2019).

The volatility of energy prices has been researched extensively over the years with a raft of current published papers in the field (Cunado et al 2024, Berrisch et al 2023, Cevik and Ninomiya 2023, Qingyan et al 2022, and Ren et al 2022). In

order to track the volatility of energy prices, the Wholesale Day Ahead Contracts Price Trends for Gas and Electricity are proposed as one source from this type of data. In the United Kingdom (UK) these are available from The Office of Gas and Electricity Markets (Ofgem), Great Britain's independent energy regulator (Yang et al 2020). This data is published monthly and available as a free CSV download. Other countries have similar data sources, for example, the US has sources such as the Federal Reserve Economic Data (FRED). Wholesale energy prices are therefore the second data indicator for volatility.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
V2	Gas and Electricity Wholesale Energy Prices (UK)	Macro	The Office of Gas and Electricity Markets (Ofgem)	Intensification of the Prices Volatility for Oil and Natural Gas - Prisecaru and Calanter 2022

Figure 3 - Second Volatility Data Indicator

Share Price

A company with a share price that fluctuates wildly between new highs and lows or moves erratically is classified as highly volatile. Increased levels of volatility imply a greater degree of risk and therefore will impact the behaviour and returns of investments (Yu et al 2023). Numerous research studies provide strong evidence that extreme events, such as those VUCA wants to detect, affect the volatility of stock prices (Zhang et al 2023, Fasanya et al 2023) and therefore sudden changes in share price either up or down can signal a VUCA event that needs intervention from leadership. The short squeeze led by the Reddit forum r/Wallstreetbets on GameStop's stock showed that it is not just decreases to be concerned about, increases in share price can also have unwanted impacts (Kerckhoven and O'Dubhghaill 2021).

A range of macro factors can influence stock price volatility, including extreme natural disasters, such as floods, landslides, volcanic eruptions, earthquakes and forest fires (Montero et al 2024, Zhang et al 2023), exchange rate changes (Hussain et al 2023), pandemics such as COVID-19 (Mushunj et al 2023, Fasanya et al 2023), and armed conflicts (Ngwakwe 2022).

Even fairly straightforward business activities such as public disclosure of hours spent auditing financial statements (Lim and Mali 2023), paying dividend yields (Kengatharan and Ford 2021), undertaking a digital transformation in the enterprise (Liu et al 2023) and the setting of R&D strategies (Xu 2006) have the potential to exacerbate stock price volatility.

A wide number of providers give access to individual stock price information, ranging from the indices themselves such as the London Stock Exchange and the Dow Jones, through to third party providers such as tech companies like Apple and traditional media companies such as CNBC. Google Finance (<https://www.google.com/finance/>) has operated since 2006 and provides a reliable and straightforward means to access individual stocks from a wide number of countries. For the purpose of this research the London Stock Exchange (Banerjee 2023, Pietraszewski et al 2023) itself is used as the main point to directly access stock information electronically, as it provides access to all UK listed individual stocks.

Share price volatility continues to be studied in recent literature (Liu et al 2024, Bu et al 2023, Jin et al 2023, Nottar et al 2023, Wang and Zhou 2022) and the London Stock Exchange provides a reliable source to access individual stock prices. For these reasons stock prices are the third data indicator for volatility.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
V3	Individual Share Price	Micro	London Stock Exchange	On the effects of Covid-19 pandemic on stock prices: an imminent global threat - Fasanya et al 2023

Figure 4 - Third Volatility Data Indicator

Fiscal Policy Volatility

The relationship between macroeconomic volatility and economic growth is a well-established and important issue, both from a theoretical and an empirical standpoint (Brzozowski and Siwinska-Gorzela 2010, Rodriguez 2014). Fiscal policy is the use of government spending and taxation to influence economic conditions, especially macroeconomic conditions. Volatility of both government expenditures and revenues is detrimental to growth (Afonso and Jalles 2012) and

government policy makers therefore typically use fiscal policy to promote strong and sustainable growth, and thereby reduce volatility.

Properly used, fiscal policy can help governments alleviate the effects of a crisis, such as the global COVID-19 pandemic, cushioning the blows and helping achieve recovery (Sheiner et al 2021, Calmotti and Caba 2022, Apeti et al 2024), but it is also right to worry about the detrimental effect it can have when used incorrectly. Yong and Lin (2023) found that harmful effect of financial instability on fiscal policy conduct would be magnified during expansionary, recessionary and, critically for this research, crisis periods. An increase in volatility can stem from the injudicious use of policy discretion by elected political representatives to respond to unexpected shocks resulting over time in a loss of policy credibility (Kuncoro 2014). Incorrect use of fiscal policy will necessitate additional discretionary action to achieve the previously set policy goal, further amplifying the volatility of fiscal policy indicators (Tagkalakis 2012). Volatility can lead to a range of further negative consequences, such as a rise in inflation (Munir and Riaz 2020). These procyclical measures by policy makers are therefore a likely source of business cycle fluctuations and exacerbate (undesirably) macroeconomic volatility (Afonso and Jalles 2012).

There are a number of ways to track fiscal policy and its volatility. The International Monetary Fund (IMF) has a Fiscal Monitor as part of its monitoring and surveillance activities, which themselves can move markets (Breen and Doak 2023) and thereby cause volatility. The IMF fiscal monitoring is a data set of eight indicators, and it requires a certain level of capability to utilise these to understand the position. A preferred indicator is the Hutchins Centre on Fiscal and Monetary Policy's Fiscal Impact Measure (FIM), which is hosted by The Brookings Institution, a nonprofit research organisation. This indicator leverages the work of Cashin et al (2017) at the US Federal Reserve in its design and provides a measure of the contribution of federal, state, and local fiscal policy to near-term changes in the gross domestic product, the tally of all the goods and services produced in the economy (Sheiner et al 2021). The FIM shows a clear correlation

between policy decisions and recessions over the last twenty years, indicating early when a recession, or similar crisis event, is forming.

Fiscal policy and its impact on economic volatility continues to be researched extensively (Kiarsi 2021, Reuter et al 2022, Stojanovikj 2022, Grauwe and Foresti 2023, Fang et al 2023) and the Fiscal Impact Measure provides a free access indicator, for these reasons making it the fourth data indicator for volatility.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
V4	Fiscal Impact Measure	Macro	The Hutchins Center Fiscal Impact Measure	Fiscal volatility, financial crises and growth - Afonsoa and Jalles 2012

Figure 5 - Fourth Volatility Data Indicator

Volatility – Potential Areas of Further Research

Technology disruption, including the rapid advances in technology such as artificial intelligence, is causing significant volatility in the business environment and changes to how organisations operate. In the face of technology advances and intense competition creating new hybrid business models, adopting digitisation can help business survive as consumers adopt new technology platforms (Barquissau et al 2024). While technology disruption appeared extensively in literature, there was no clear data indicator that was easy to consume. Providers like Gartner produced hype cycles (Kondo et al 2022) and analysts notes, but these need identification (which technology to track) and interpretation (does it impact an organisation), both areas further research could address.

Volatility Summary

Business volatility is a widely researched and active area of investigation, as any variability or fluctuations in the external operating environment can quickly impact an organisations operations and financial performance. The research into potential candidate data indicators for volatility successfully identified four different sources, all underpinned with robust theoretical grounding in academic literature.

3. Uncertainty

The definition of Uncertainty used within this research is a ‘lack of predictability and potential for surprises’. The International Monetary Fund (Ahir et al 2020) state that ‘It is well-known that uncertainty reduces the willingness of firms to hire and invest and of consumers to spend. Yet it is a nebulous concept, because it reflects uncertainty in the minds of consumers, managers, and policymakers about future events (that may or may not happen). It is also a broad concept since it relates to macro phenomena like GDP growth and micro phenomena like the growth rate of firms—as well as other events like elections, wars, and climate change.’

In a VUCA world, the data indicators for uncertainty are focused on helping organisations measure and reduce the opaqueness of uncertainty in the business operating environment. The data indicators use proven measures to provide certainty and to identify where uncertainty is increasing.

Economic Policy Uncertainty Index

Economic policy uncertainty is an important factor in increasing the turbulence and risk premium within an organisations external operating environment, influencing behaviours and expectations, and impacting an organisations performance (Baker et al 2016, Iqbal et al 2020, Xi et al 2023). Concerns about economic policy uncertainty have intensified in the wake of the global financial crisis in 2008 and a series of crises across the globe (Baker et al 2016), with the International Monetary Fund research also showing that global uncertainty has increased significantly in synchronisation with advanced economies since 2012 (Ahir et al 2020). A number of studies have shown evidence that increased economic policy uncertainty can negatively impact stock market performance and returns in G7 and BRIC economies (Guo et al 2018), link to the asymmetric effects of economic policy uncertainty on G7 stock returns (Huang and Liu 2021), and the impact of economic policy uncertainty on green financial markets (Xi et al 2023).

Baker et al (2016) in their research proposed a new index of economic policy uncertainty based on the frequency of keywords in newspaper coverage. The Economic Policy Uncertainty Index was then developed as a live data indicator and has since been researched extensively since its inception (Dai et al 2019, Alola and Uzuner 2020, Isik et al 2020, Hazgui et al 2022, Miranda-Belmonte et al 2023) where it is now recognised as a leading index for uncertainty. The index is hosted live online and the team behind it from Northwestern University, Kellogg School of Management, Stanford University, and University of Chicago, Booth School of Business regularly publish new research behind the underlying theory. The methodology used has also evolved, and alongside newspaper coverage it now also incorporates inputs from the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters and reports from the United States Congressional Budget Office that compile lists of temporary federal tax code provisions, adding to its robustness.

As one of the recognised leading measures and a key index for understanding uncertainty in economic policy, the Economic Policy Uncertainty Index is the first data indicator for uncertainty.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
U1	Economic Policy Uncertainty Index	Macro	Economic Policy Uncertainty Index	Measuring Economic Policy Uncertainty - Baker et al 2016

Figure 6 - First Uncertainty Data Indicator

The World Uncertainty Index

A recent Harvard Business Review article (Bloom et al 2022) stated that over ‘the last six years, companies have had to grapple with five major “uncertainty shocks”’: First it was Brexit in 2016, followed by the U.S. presidential election, China-U.S. trade-tensions, the Covid-19 pandemic, and in 2022 the Ukraine war’. These major shocks reflect the environmental turbulence (Emery and Trist 1965, Ansoff 1979, Johnson and Scholes 1989, Prahalad and Hamel 1990, and Grant 2003) that organisations can face when determining their strategy and have real consequences, driven in the view of Bloom et al (2022) by domestic and

international political fragmentation which can disrupt economies, energy and food supplies.

To help identify uncertainty and understand when shocks are taking place, there is a need to look across a broad range of actors including geopolitical, conflict tensions, economics, and pandemics, such as COVID19.

To help respond to this challenge, Ahir et al (2022) through their work with International Monetary Fund and the U.K.'s Foreign, Commonwealth and Development Office (FCDO), developed the World Uncertainty Index. The index counts the use of the word “uncertainty” (and its variants) in the Economist Intelligence Units standardised monthly reports for over 140 countries. The result is adjusted for word count in each report and weighted by each country’s GDP to then create a measure of uncertainty across the global economy, with a higher number meaning higher uncertainty and vice versa. The text-based approach also captures words that appear alongside uncertainty, so the drivers of uncertainty can be analysed. For example, in June 2016 Brexit appeared significantly in the results, and then in 2020 the Covid-19 pandemic surged as a key driver.

The World Uncertainty Index is actively researched in journals (Liu and Gao 2022, Nguyen et al 2022, Chatterjee2023, Demir et al 2023, and Yu 2023) where for example Yao and Liu (2023) showed that it outperformed other indexes in forecasting crude oil pricing while Tolga Er et al (2023) showed a link between increases in the World Uncertainty Index and suicide rates across 141 countries and especially those in high-income economies. The World Uncertainty Index is therefore the second data indicator for uncertainty.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
U2	World Uncertainty Index	Macro	World Uncertainty Index	World Uncertainty Index. NBER Working Paper - Ahir et al 2022

Figure 7 - Second Uncertainty Data Indicator

Index of Economic Freedom

Organisations want certainty about the environment they operate in. The more uncertainty there is, the more risk to operations. This is true for countries an organisation already operates in, helping them understand if it is becoming more or less certain, but it is also useful to provide an indication of new countries (markets) they are considering entering (how much uncertainty does it contain). Greater transparency of economic freedom, which is defined as the extent to which a country's policies and institutions protect the rights of individuals and organisations to pursue their economic goals, can help mitigate the uncertainty (Islam 2018, Shah et al 2023), and research has shown that greater economic freedom leads to greater growth (Gropper et al 2015, Cebula et al 2016, Gomez-Gallego et al 2022)

The Index of Economic Freedom was created in 1995 by The Heritage Foundation and The Wall Street Journal to measure and provide an annual ranking of the level of economic freedom in the world's nations and has been cited extensively in research over the years (Susjan and Redek 2008, Nica 2020, Dialga and Vallee 2021, Gomez-Gallego et al 2022, Isik et al 2023).

The index is based on 12 factors, from property rights to financial freedom, which are then grouped under four key domains: government size, market openness, regulatory efficiency and rule of law (Kim 2023). The index tracks these for 181 separate countries, which can move up and down the ranking to reflect their current posture and provides both individual scores for each of the 12 factors and an overall ranking, with Singapore leading in 2023 with a score of 83.9, while North Korea with a score of 2.9 is ranked last. The index was developed and is maintained by The Heritage Foundation, and while its main aim is to highlight the lack of economic freedom that condemns some individuals to poverty and deprivation, it also provides a detailed picture of the certainty around the operating environment for an organisation, be that market openness or the rule of law (Cebula et al 2016). Where there is a lack of transparency for the four key domains, then there is increased uncertainty. For this reason, the Index of Economic Freedom is the third data indicator for uncertainty.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
U3	Index of Economic Freedom	Macro	The Heritage Foundation	The impact of higher quality government regulation of business and greater economic freedom on living standards - Cebula et al 2016

Figure 8 - Third Uncertainty Data Indicator

Unemployment Rates

Labour markets are affected by uncertainty (International Labour Organization 2022). A key insight into labour market dynamics is the unemployment rate which measures the percentage of the labour force that is unemployed and out of work. It is a key indicator of the health of an economy and the availability of jobs. The unemployment rate is calculated by dividing the number of unemployed individuals by the total labour force and then multiplying by 100 to express it as a percentage. That the unemployment rate has been used as a proxy to measure uncertainty in research is well established (Claveria and Soric 2023) and van der Wielen and Barrios (2021) showed that internet searches on unemployment could be a useful real time indicator for 'sudden, surprise developments like the COVID-19 crisis'.

Researchers and economists looking at uncertainty and unemployment rates have 'emphasised the crucial role of uncertainty in shaping labour market outcomes' where 'rises in uncertainty can have persistent effects, by affecting expectations that drive long-term commitments, such as hiring decisions, and thus, unemployment dynamics' (Kandoussi and Langot 2022). 'Empirical studies generally conclude that elevated uncertainty leads to a decline in economic activity' and therefore 'more uncertainty leads to a higher expected future unemployment rate' (Freund and Rendahl 2020). The empirically evidenced theoretical framework of Leduc and Liu (2016) showed that post the Great Recession of 2008–2009 'an increase in uncertainty raises unemployment'. Other authors have focused on specific issues such as Thompson (2013) who noted in their 'States of Uncertainty' research that for the European Union the 'outlook for youth unemployment is more uncertain' than adults.

A number of authors, such as Gheorghe and Roman (2024), have undertaken nation level studies that have shown that post COVID-19 there was uncertainty

in the market, especially in 2021, which led to a significant increase in the unemployment rate within those nations. Reached by Dajcman et al (2022) also found that ‘following an uncertainty shock, the youth unemployment rate increases significantly more than the adult unemployment rate’ in a number of markets including France, Italy and Spain. High unemployment rates and ‘employment uncertainty’ also tend to delay parenthood among both men and women (Miettinen and Jalovaara 2023). The link between uncertainty and unemployment is heavily researched and well established in literature making it an ideal data indicator.

The Office for National Statistics (ONS) is part of the UK Statistics Authority, a non-ministerial department that is directly accountable to the UK Parliament. It provides a free monthly UK Statistical Bulletin that includes an overview of the UK Labour market, providing estimates of employment, economic inactivity, and other employment-related statistics for the UK. The unemployment rate is included and is provided as a monthly percentage. The percentage estimates the number of unemployed people in the UK as measured by the Labour Force Survey (LFS) which includes people who meet the international definition of unemployment specified by the International Labour Organisation (ILO). For this reason, this is used as the data indicator for unemployment rate as it is free and provided by a government body. Similar examples exist in most countries, for example The United States Department of Labor, and from sources such as the Organisation for Economic Co-operation and Development (OCED). The ability to access a reliable government provided data indicator coupled with the wealth of research in unemployment rates (Barbuscia et al 2023, Davidescu et al 2021, Nieto-Chaupis 2021) makes this the fourth and final data indicator for uncertainty.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
U4	Unemployment Rate	Macro	The Office for National Statistics (ONS)	Economic sentiment during the COVID pandemic: evidence from search behaviour in the EU - van der Wielen and Barrios 2021

Figure 9 - Fourth Uncertainty Data Indicator

Uncertainty – Potential Areas of Further Research

The growing global political uncertainty gives cause for concern for organisations, increasing turbulence in their external operating environment. Political uncertainty is a crucial disadvantage to the internationalisation of enterprises in developing countries and requires innovative behaviour of export enterprises to balance the impact (Zhou and Lee 2023) and uncertainty before national elections is associated with a higher cost of capital (Kwabi et al 2024). There is also evidence that organisations defer merger and acquisition activities and alter investment projects to mitigate exposure to political uncertainty (Chen et al 2022). Political uncertainty offers a field rich for further research to identify data that could support a VUCA Scorecard.

Uncertainty Summary

There are some limitations with a number of the data indicators listed above in that they typically are limited to more advanced economies that have robust data available to allow indexes to be measured (Ahir et al 2020), particularly economic indicators. There is also a growth in research around the use of machine learning and neural networks with the aim of better capturing semantic and syntactic information of articles and removing some of the noise from keyword-based matching methods used extensively today to construct indices (Chen et al 2024) which is likely to add new and more robust indices in the future. Overall though, the research into potential candidate data indicators to act as a proxy for uncertainty successfully indicated four different sources, all of which were referenced in academic literature

4. Complexity

The definition of Complexity used within this research is ‘many interconnected parts that interact in many ways’. In a world of growing complexity (Ivanova et al 2019) researchers, such as Emery and Trist (1965), Lawrence and Lorsch (1967), Thompson (1967) and Duncan (1972) have long sought to understand organisations’ operating environments, the complexity within them, and the

impact they have on performance. The following data indicators uncovered in research help to shed light on that complexity, allowing organisations to better understand the complexity as part of a VUCA Scorecard.

Economic Complexity Index

Economic complexity has emerged in recent years as an important metric to measure nations' inherent capabilities embodied in the structure of economic production (Mishra 2020, Saraceno 2020). The economic growth and income a region or country can expect is intrinsically linked to its product diversity (Cadot et al., 2011, 2013). As far back as 'The Wealth of Nations' in 1776 Adam Smith identified the division of labour; that is people and firms specialise in different activities, drove increases in economic efficiency. Hidalgo and Hausmann, (2009) used this logic as a key tenet in their paper 'The building blocks of economic complexity' when outlining the Economic Complexity Index, which is recognised as a key measure of an economy's complexity (Ivanova et al 2017). The Economic Complexity Index is built on well-founded existing literature to underpin its design (Bonacich, P (1987) and Francesche, M (2011)). The Harvard University Kennedy School of Government states "The Economic Complexity Index (ECI) has been shown to explain income differences across countries and predict future growth better than any other single measure". While Ivanova et al (2017) goes further proposing the Triple Helix Complexity Index as a new method for measuring complexity building on the Economic Complexity Index, the Economic Complexity Index, which is a live functioning data service and analysed through further research from Albeaik et al (2017), Mealy et al (2018), Breitenbach et al (2021), and Dzotsenidze (2021), is the first data indicator for complexity.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
C1	Economic Complexity Index	Macro	The Observatory of Economic Complexity (MIT)	Economic and technological complexity: A model study of indicators of knowledge-based innovation systems - Hidalgo and Hausmann 2009

Figure 10 - First Complexity Data Indicator

It is noted that within the literature on the Economic Complexity Index, the Fitness-Complexity (FC) algorithm is also discussed extensively. Alongside traditional product and manufacturing complexity measures, such as those identified by Hidalgo et al. (2007) and Hidalgo and Hausmann (2009), the growing importance of services and technology innovations in global trade (Tachella et al. 2012, Cristelli et al. 2013), needs to be considered, particularly in light of the current trends in globalisation and emerging technologies (Mishra et al, 2020). The International Monetary Fund (IMF) believe services to be worth over 60 percent of global GDP (Loungani et al. 2018). To address this, the Fitness-Complexity (FC) algorithm was developed to capture the level of competitiveness and advancement by a country via a single number called 'Fitness', and the level of technology and advancement required to export a product (or service) by its associated 'Complexity' (Cristelli et al 2013, Tachella et al 2013, Pugliese et al 2015, Mishra et al 2020). The World Bank uses the Fitness-Complexity algorithm as the method to underpin its Universal Economic Fitness (UEF) metric, which is one of the data sources it provides to measure the global economy and competitiveness of nations. The Fitness-Complexity (FC) metric therefore offers further insight into the complexity of an organisation's external environment. The Economic Complexity Index work of Hidalgo and Hausmann (2009) is often called the Method of Reflection (MR) in literature and defines competitiveness through a linear algorithm. Conversely, the Fitness-Complexity (FC) is a highly non-linear algorithm that usually reveals nested structure (Cristelli et al. 2013). The merits of each of these approaches have been widely discussed in many studies and Research Papers (Pugliese et al. 2014; Mariani, 2015) and practitioners will need to decide which data indicator or combination is right for them, it may well be both. For simplicity, the long-standing Economic Complexity Index is used as the data indicator in this research.

Innovation Ecosystem

Innovation ecosystems are viewed as dynamic adaptive organisms that create, consume, and transform knowledge and ideas into innovative products (Munroe, 2012). The concept of the ecosystem to promote innovation can also be seen

through Porters (1998) work on networked clusters of organisations linked and working together, Etzkowitz & Leydesdorff (1995) research on the Triple Helix Model which refers to the interactive network of cooperation between private sector (companies), knowledge sector (research universities) and public sector (authorities); and Smorodinskaya & Katukov (2015) who define how ecosystems create an innovative business environment. Business networks with a higher complexity in interaction patterns between organisations, moving from cooperation to collaboration, are able to generate greater innovation synergy effects (Russell & Smorodinskaya, 2018).

With their multidisciplinary and multidirectional characteristics, innovation ecosystems are becoming highly interactive and collaborative on a global basis (National Research Council, 2012). The Organisation for Economic Co-operation and Development (OECD) in 2009 recognised that in some cases, minor behavioural changes in an ecosystem's separate elements may lead to large-scale changes in its overall state. In this constantly changing global innovation environment, the likes of which have not been witnessed before (Kidd, 2008), it generates a situation with high degrees of change. Facing this challenging situation, businesses and economies in different parts of the world are searching for new ways to enhance their innovativeness, strengthen their competitiveness and adapt themselves to non-linear global realities (Adner, 2017). To manage the growing complexity and maintain sustainable growth, network-based innovation ecosystems of multiple parties (Smorodinskaya & Katukov, 2015) and collaborative networks of interactive participants (Russell & Smorodinskaya, 2018) are adopted by organisations. So while collective creation of innovation is adopted (Chesbrough, 2003, and Tassey, 2008) by organisations to reap the benefits of innovation from their whole network (MacGregor and Carleton, 2012), the complexity in an organisations partnering and supply chain arrangements, particularly as they expand globally, also increases and makes the organisation more susceptible to changes (VUCA events) that ripple and potentially expand through the ecosystem.

In order to understand and be sensitive to changes in the innovation ecosystem, the third proposed data indicator for complexity is the Global Innovation Index (GII) calculated and co-published by Cornell University, INSEAD, and the World Intellectual Property Organisation (WIPO). It provides a comprehensive analysis of global innovation (Oturakci, 2021), measures the complex multi-actor interactions within the National Innovation System's approach (Watkins, Papaioannou, Mugwagwa, & Kale, 2015; Crespo and Crespo 2016), and the causal complexity of innovation ecosystem (Yu et al 2021). The Global Innovation Index (GII) index has been a live data service since its inception in 2007 and is therefore the second data indicator for complexity.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
C2	The Global Innovation Index (GII) index	Macro	World Intellectual Property Organization	Causal complexity analysis of the Global Innovation Index - Yu et al 2021

Figure 11 - Second Complexity Data Indicator

Supply Chains

A supply chain is a complex network of three or more entities (organisations or individuals) involved in the upstream and downstream flows of products and/or services, along with the related finances and information (Beamon, 1998; Lambert, Cooper, & Pagh, 1998; Mentzer et al., 2001; Serdarasan 2012). Organisations seek to gain a competitive advantage and reduce costs through improved management of their integral supply chains through systemic and strategic coordination (Balfaqih et al., 2016; Bode & Wagner, 2015; Cooper & Ellram, 1993; Cooper, Kano, 2018, Lambert, & Pagh, 1997; Mentzer et al., 2001; Sharma et al., 2022).

The inherent complexity within supply chains has been studied extensively within the literature (Calinescu et al., 2001; Choi and Hong, 2002; Lu & Shang, 2017; Milgate, 2001; Sharma et al., 2022; Sivadasan et al., 2002; Wilding, 1998; Yang & Lin 2019) and is therefore a given. Various studies have examined different ways to manage supply chain complexity as a way to achieve improved

performance (Blecker, Kersten, & Meyer, 2005; Bozarth, Warsing, Flynn, & Flynn, 2009; Koudal & Engel, 2007; Lehyani et al., 2021; Perona & Miragliotta, 2004; Pretorius et al., 2013; Sharma et al., 2022). For example, the work of Calinescu et al., (2001) includes the analysis of supply chain complexity by categorising it into three complexity types: decision-making complexity, structural complexity and behavioural complexity, whereas Sharma et al (2022) use Horizontal, Vertical and Spatial as the supply chain complexity dimensions. Supply chain complexity does not mean “complicated”, but rather it describes a condition of interconnectedness and interdependencies across a network where a change in one element can have an effect on other elements (Christopher 2012). This interconnectedness means complexity accelerates with trends such as globalisation, sustainability, customisation, outsourcing, innovation, and flexibility (Serdarasan 2012).

Fundamentally, firms must continuously monitor complexity in the global supply chain, and, if events outside their control threaten to damage the smooth flow of goods or information, take whatever measures are available to them to reduce the effects (Sharma et al., 2022). Resilience is the ability of firms to outperform their competitors and gain advantage out of disruptive events through managing risks in the supply chain (Carvalho et al., 2012; Sheffi, 2005; Singh et al., 2018).

The Global Supply Chain Pressure Index (GSCPI) is a new measurement of supply chain conditions, created by the Federal Reserve Bank of New York (Benigno et al., 2022) to identify and assess the intensity of supply chain disruptions (Benigno et al., 2022). The Global Supply Chain Pressure Index tries to isolate what's happening on the supply side of the equation, rather than looking at demand factors, to get a more accurate estimate of the state of supply pressures (Safane & Suarez 2022). It does this by combining variables from several commonly used indices such as the Baltic Dry Index, Harpex Index, and Purchasing Manager Index (PMI). The focus on the external rather than the internal aligns well with the goals of the VUCA model.

The research of Ye et al., 2023 recognised the Global Supply Chain Pressure Index as the leading barometer to capture the effect of supply chain disruption,

Bloomberg (2022) uses it to warn of issues and bottleneck in global logistics, and Reuters (2023) leverages it to track and report on global supply chain issues. Kancs (2022) identified the Global Supply Chain Pressure Index as one of the most ‘robust indices’ in their research into the fragility of global supply chains, supply chains which are known to be complex (Bhatia et al 2013). For these reasons the Global Supply Chain Pressure Index (GSCPI) is ideal as the third data indicator for complexity.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
C3	Global Supply Chain Pressure Index (GSCPI)	Macro	Federal Reserve Bank of New York	The effect of the global supply chain and oil prices on the inflation rates in advanced economies and emerging markets- Ye et al 2022

Figure 12 - Third Complexity Data Indicator

Product Complexity Index

As the global population increases (Goldewijk 2005) and peoples lifestyles and living standards change (Brown 1996, Murphy 1989, Nordhaus and Tobin 1972) they consume more products (Myers and Kent 2002) that require ever-increasing amounts of natural resources (Ma et al 2022) to make. The pace and scope of groundbreaking scientific and technological advances are leading to new products today that looked like science fiction yesterday (Anuslu and Firat 2019, Schwab 2016). The products of today’s market also have increased diversity and complexity (Orfi et al 2012). Product complexity is reflected in the production complexity and the variety of products (Yang & Lin 2019). In addition to a products associated direct costs, variety is considered the main source of product complexity, which has been proven to negatively impact product development time, productivity, costs, and customer satisfaction ((Orfi et al 2011). Managing a products complexity is therefore critical to an organisations ability to compete, as the more complex it is, the less substitutable and sensitive to price elasticities it becomes (Arbatli and Hong (2016), Thorbecke et al (2021)).

The Product Complexity Index (PCI), which is hosted by the Harvard Kennedy School of Government and powered by Harvard’s Growth Lab, is a live data feed that ranks the diversity and sophistication of the productive know-how required to

produce a product. Products with a high Product Complexity Index value (the most complex products that only a few countries can produce) include sophisticated machinery, electronics, and chemicals, while the least complex products, those with a low Product Complexity Index value, are raw materials and commodities, wood, textiles, and agricultural products (Felipe et al 2012).

While the Product Complexity Index can act at the macro level, to extract full benefit from its use, its inclusion does require the organisation putting together the VUCA Scorecard to identify what products they deliver and configure the data service to listen for changes or updates to these particular products. While linking back to the internal products introduces an additional overhead and makes the VUCA Scorecard more complex, the benefits of early warning in changes in specific product types directly relevant to the organisation are likely to outweigh this. This is particularly true where organisations have complex portfolios of products that require external partners or materials to produce them, especially those linked to a global value chain (Corcoles et al 2014).

The Product Complexity Index has been widely referenced in academic studies (Thorbecke et al 2021) and taken with the ability to be tailored to the micro level for an organisation's specific products, the Product Complexity Index is the fourth data indicator for complexity.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
C4	Product Complexity Index	Macro and Micro	Harvard Growth Lab	The Relationship between Product Complexity and Exchange Rate Elasticities: Evidence from the People's Republic of China's Manufacturing Industries - Thorbecke et al 2021

Figure 13 - Fourth Complexity Data Indicator

It should be noted that there is a link between the Economic Complexity Index, our first complexity data indicator, and the Product Complexity Index, our fourth, where blended together they help measure the level of complexity of the country's economy and the level of complexity of the products it exports (Khayati 2021). The Economic Complexity Index looks at the diversity in a country's or region's product basket and the relative abundance of a particular product, while the Product Complexity Index shows the complexity of knowledge required to

produce a specific product (Ma et al (2022) and Mealy et al (2019)). Ma et al (2022) identify that the two indexes act as a function of each other; while making it clear the Product Complexity Index shows the complexity of knowledge required to produce a specific product. Mealy et al (2019) show a correlation between the two novel indexes, where countries with high (low) Economic Complexity Index scores tend to specialise in high (low) Product Complexity Index products, which helps explain cross-country differences in GDP/capita and in predicting economic growth. While the Economic Complexity Index employs a similar method to the Product Complexity Index to calculate its values, it uses different underlying data sets and harmonisation approaches (Thorbecke et al 2021).

Complexity – Potential Areas of Further Research

Within economic complexity there are a number of pointers towards the relationship between geo-location, activity, diversity and density of organisations (Hidalgo et al 2007). A number of researchers (Maes 1995, Resnick & Varian 1997) advocate the use of recommendation systems to predict the activities that a region is more likely to enter or exit in the future which will help build a picture of the industry areas of complexity.

A number of organisations are building indexes around innovation, for example the Global Innovation Hubs Index by Tsinghua University and Nature Research (Nature 2022). These are still fairly embryonic and lack any academic review points, but as they mature and iterate, they may become candidates.

The complexity within the supply chain may be linked or influenced by the internal drivers within an organisation such as the product and processes design decisions it makes (Serdarasan 2012), and the supply chain implications in bringing these to market. While outside the scope of this research, understanding the interplay between internal strategic design decisions and the impact of external services required to deliver these could influence the VUCA data sets being captured and examined. Organisation with an international aspect may also incur greater complexity within their supply chain versus those that operate solely in a domestic market (Berchicci, 2013) and the identification of local supply chain

indexes could enrich the external picture for those non-international organisations.

Complexity Summary

The research into potential candidate data indicators to act as a proxy for complexity successfully indicated four different sources, all of which were referenced in academic literature. In most cases they were also covered in more mainstream news sources as well, such as Reuters and Forbes. The research also showed areas for further research, demonstrating a depth of options for complexity data indicators.

5. Ambiguity

By their very nature, ambiguous data sources differ from those of volatility, uncertainty, and complexity. The definition of Ambiguity used within this research is “Information available, but potential for misreads and confusion”. This means that the person reviewing the information source might not even know it is ambiguous. The picture is further complicated by the nature of the organisation using VUCA, meaning that what might be a useful data indicator for one organisation is not necessarily useful to another. Take the example of a global airline, it receives information from a data indicator saying an airport is closed. But it is ambiguous why it is closed; is it due to a passing tropical storm, or something more fundamental like an IT system failure? An airline could begin to collect data for common reasons for airport closures, like local weather, and enrich their VUCA model with this to make the picture less ambiguous. But, as a generic data indicator, airports and weather are likely to have limited appeal to all organisation types, and a data indicator for common causes of root issues can only be learned over time.

Therefore, the data indicators provided are ambiguous, they are recognised as such in the underpinning research that is used to justify their inclusion. It does not mean they are not without value or merit, quite the opposite. In the example above the airline still needs to know the airport is closed so it receives an early

signal to investigate the cause. Further, when the ambiguous data indicators are combined with those from volatility, uncertainty, and complexity, some of the ambiguity falls away and the sum of the combined parts is greater than the individual domains and their data indicators.

Company Report and Financial Statement

At national and international level there is a need for reliable, quality, and transparent financial information about a company to assess its performance, mainly through the company reporting and financial statements (Zuca et al 2023). Understanding what is happening at a company, through their Company Report and Financial Statements enables an organisation to understand what its peers, partners, and competitors are doing, which may provide signals about the business operating environment it finds itself in. However, it has been shown that company reporting and financial statements can be ambiguous and therefore open to misinterpretation. Chen et al (2011) state that “subjective assertions in financial statements influence the judgments of market participants when they assess the value and profitability of the reporting corporations and management may attempt to conceal the negative and to accentuate the positive with “prudent” wording”. They go on to say, “unexpected negative earnings are often accompanied by ambiguous statements and sometimes by promises of glorious future”. Benjamin Graham (1973), widely known on Wall Street as the “father of value investing” (Mahapatra 2013), described in his best-known work, *The Intelligent Investor*, how financial reports were ambiguous through the need to “guess” their meaning and the need to be on the lookout for “items that may mean a good great deal more or less than they say”. Graham (1973) goes on to say that the reports were also open to ‘misreads’, a tenet of ambiguity, where the more dependant analysis is on the future predictions, “the more vulnerable it becomes to possible miscalculations and serious error”. Research has also shown that as innovative accounting techniques are employed, such as creative accounting, the quality of financial accounting information is impacted, losing its utility, and shifting to being ambiguous (Zuca et al 2023).

Corporate transparency through the free, easy public access to company information such as annual reports and financial statements, can improve the performance of companies and is one of the main tools for combating corruption (Koroleva and Tikhomirova 2021). Research by Ertugrul et al (2017) suggests 'that the readability and tone ambiguity of a firm's financial disclosures are related to managerial information hoarding' and therefore a lack of transparency. Transparency helps build trust in an organisation as part of a business ecosystem. Organisations with less readable and more ambiguous annual reports not only suffer from less transparent information disclosure but also bear the increased cost of external financing (Ertugrul et al (2017). Rjiba et al (2021) highlight a similar concern with annual reports that when the disclosure tone is ambiguous, that it increases cost of equity capital. They hypothesise that ambiguous reporting 'deters investors' ability to process and interpret annual reports, leading to higher information risk, and thus higher cost of equity financing'. Research by Yin et al (2022) shows that 'obfuscating financial reports increases the risk of stock price crash'. Koroleva and Tikhomirova Research Paper itself is interesting as it notes its own results are ambiguous on the link between company transparency with market capitalisation, although it did find statistically significant results for the other two indicators it researched.

In the UK, Companies House, a UK government funded and run executive agency, keeps records on all registered companies in the UK (Shahaab et al 2023) and ensures its available in the public domain (Mason 2005). It provides a range of data products including a free monthly snapshot of information called the 'company data product' for live companies on the public register that includes basic information, registered office address, industrial classification (SIC), company status such as 'live' or 'dissolved', and critically the date of last accounts or confirmation statement filed and when the next one is due. Detailed information can also be accessed via an API from Companies House, so for example BP's, a multinational oil and gas company headquartered in London, 408-page 2022 annual report is available for analysis. A number of countries have similar standards, for example 10-K's in the US, and/or have entities that offer a similar

service to Companies House, for example U.S. Securities and Exchange Commission (SEC) in the US (Kenton 2023).

An organisations company report and financial statement are key tools it has to build trust, but as research has shown, these can also be ambiguous. Companies House provides the de facto standard for accessing this information from a trusted government source (Mason 2005, Shahaab et al 2023). Company reports are therefore the first data indicator for ambiguity.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
A1	Company Reporting	Micro	Companies House (UK)	Annual Report Readability, Tone Ambiguity, and the Cost of Borrowing - Ertugrul et al 2017

Figure 14 - First Ambiguity Data Indicator

It should be noted that while company reporting and financial statements potentially provide a rich data source direct from a company, there are some key draw backs. The first is with the frequency that they are produced and made available for consumption, which is likely to be once a year, and the timing may not align with other signals. The second is that there is likely to be some manual processing required to absorb the produced documents and determine the level of ambiguity, itself not without risk. The third issue is that the data indicator is micro rather than macro, in that it is tied to just one company. That said, it does allow analysis of key companies in the ecosystem and the approach could be layered to allow a number of companies to be reviewed, leading to a Macro data indicator. All considered though, the production and submission of company reporting and financial statements provide a key data indicator, even with the associated risks.

Social Media Influencers

In social media, influencers are people with significant power to influence others with different posts and a huge number of followers (Fernandes et al 2023, Yang and Wang 2023). Consumers are increasingly using social media to gather information on which to base their decisions to purchase products (Gülpınar 2023). Products or brands presented by social media influencers will directly

impact consumers buying decisions, both positively and negatively (Yeo et al 2023). In the political sphere social media influencers also impact citizens' political views and voting behaviours and may lead to them becoming more polarised (Ding et al 2023).

There is however no guarantee that social media influencers are subject experts or have untainted views. Human judgments are inherently noisy, ambiguous and sometimes biased (Liu et al 2015). Liu et al also go on to identify that with online sourced data, a major challenge is quality control, as the (often anonymous) people casting a view have 'unknown and highly diverse levels of expertise'. Followers of a social media influencers also tend to share the content generated by the social media influencers, amplifying its reach and acting as a powerful electronic word of mouth (Balaban et al 2022)

Social media influencers can also have disproportionately larger impact on other users decisions via the social media medium (Yang and Wang 2023). While Snapchat, a social media platform, is used by 65% of 18- to 29-year-olds in the US (Auxier and Anderson 2021), a single social media post by Kylie Jenner, an Influencer, in Feb 2018 complaining about a usability-focused redesign of a product wiped \$1.3bn from Snapchats market capitalisation (The Guardian, 2018). Yet within three years, by most measures, the company had continued to grow; share price had tripled from \$17 a share to almost \$75, revenue had grown from \$1.1bn in 2018 to \$4.1bn in 2021, and critically that market valuation went from \$18.5bn in 2028 to \$90.0bn in 2021. Leaders therefore need to be aware of posts by social media influencers about their products, brand, reputation, and organisation, as their role, insight and impact is ambiguous (Andhini and Ramadhan 2023). Some posts could be genuine early signals of a product fault, while others could be misreads or non-issues generating confusion. The growth of social media and technology affordances has dramatically changed the communication approach in terms of message control, audience scale, source ambiguity, receiver ambiguity, and temporal ambiguity, and have consequently affected the social influence process (Flanagin 2017, Balaban et al 2022).

Most of the mainstream social media platforms, such as Facebook, Instagram, YouTube, etc provide a way to track data via an API. X, formerly known Twitter, is a proven platform for social media influencers to post on, and while the overall traffic has reduced since its acquisition and rebrand (Koetsier 2023) it still has a sizeable footprint and reach. It also provides a range of API tools to access data (Savas 2021), such as when a social media influencer is posting about a product or brand, and the reach and impact of these posts.

The impact of social media influencers is researched extensively (Čop et al 2024, Al-Zahari et al 2023, Mardon et al 2023, Pourazad et al 2023, Singh et al 2023) and X provides a way to interrogate posts related to the organisations products or brands, and for these reasons this makes social media influencers profiles on X the second data indicator for ambiguity.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
A2	Social Media Influencers	Micro	X, formerly Twitter	Online Social Influence and the Convergence of Mass and Interpersonal Communication - Flanagin 2017

Figure 15 - Second Ambiguity Data Indicator

Consumer Reviews

An important source of data for a business is consumer reviews. Consumer reviews contribute to improving the quality of products and improving the provision of services (Van Ninh et al 2023). While positive reviews build trust (Shankar et al, 2002), negative reviews require businesses to address issues to reduce unfavourable impacts (Le & Ha, 2021) or else they reduce products purchase probability and lead to consumers browsing for substitute products elsewhere (Varga and Albuquerque 2023). Conflicting consumer reviews that provide mixed or contradictory feedback from customers can create ambiguity for businesses trying to gauge satisfaction levels or identify areas for improvement. For example, receiving both positive and negative reviews for the same product or service may indicate varying perceptions among different customer segments or highlight areas of inconsistency in product quality or service delivery, making

it challenging for businesses to derive data driven actionable insights or make informed decisions.

Consumers have also changed how they shop, with more interest now in online shopping (Mahesan et al 2023) where leaving reviews is baked into the customer journey (e.g., purchase, and post-purchase), resulting in a growth of easy to access reviews across a range of platforms (Abdulrahman and Khder 2022). Leaving online reviews is free and anonymous, but if consumers share anything it is likely to be negative overall, with negative information being more widely communicated than positive (Colmekcioglu et al 2022).

Consumer confusion also plays a role in negative reviews and is caused in part by ambiguous information and differing tolerance levels for ambiguity by consumers (Dharmasena and Jayathilaka 2021). Ambiguity in a product or service purchase arises from having scanty, unreliable or conflicting information about the outcome (West and Broniarczyk 1997). Ambiguous product cues—cues with multiple interpretation options—may also impact consumer decision making. For example, there may be ambiguity in the labelling of products as ‘regional’ or ‘local’ which can lead to situations where consumers are potentially misled (Herz et al 2023).

While there are a number of leading indexes that track overall consumer sentiment, such as the Organisation for Economic Co-operation and Development (OECD) Consumer confidence index (CCI) (Pehlivanoğlu et al 2021) and the Index of Consumer Sentiment (ICS) by the Survey Research Centre of the University of Michigan (Howrey 2001), the aim for this data indicator is for more focused feedback on the products and services the business offers. Consumers are increasingly using the expanded opportunities the internet provides to express opinions regarding the products and services they purchase as they post online their opinions, reviews, ratings, stories, photos and videos of products and service experiences (Bradley et al 2016). Their peers are using this information to learn about products and services before making a purchase, bypassing traditional brand communications (Stevens et al 2022) as they often trust reviews more than advertising (Varga and Albuquerque 2023). The reviews

and ratings of other consumers are traditionally viewed as highly credible (Herr et al 1991) and 79% of consumers believe those reviews to be as trustworthy as personal recommendations (Murphy, 2020, Varga and Albuquerque 2023). A leading source of online reviews is Trustpilot (Carter and Stokes 2022, Littlechild 2021, Sthapit and Bjork 2019) which provides a global online open-review community in multiple languages with real time customer review analytics providing business the ability to publicly respond to customer reviews (Lewis 2015). This ability to access consumer reviews in real time provides business with a data indicator that helps address ambiguity and potentially provides them an early signal that a product or service they provide has review movement, either positive or negative. Trustpilot also provides the ability to track peer and competitor brands, again potentially identifying a rise in feedback in the market segment.

Online consumer reviews and their impact is a heavily researched field (Cho et al 2024, Jha et al 2023, Yang et al 2023, Yu et al 2023, Dinulescu and Prybutok 2022) and Trustpilot provides a standardised way to access consumer reviews making this the third data indicator for ambiguity.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
A3	Consumer Reviews	Micro	Trustpilot	Effects of negative reviews and managerial responses on consumer attitude and subsequent purchase behaviour: An experimental design - Le and Ha (2021)

Figure 16 - Third Ambiguity Data Indicator

Trend Analysis

Trend analysis is a systematic approach to examining patterns or trends in data over time, one which is often then used to in prediction and forecasting (Lou et al 2024, Wu et al 2023). The interpretation of the trends and their implications can lead to ambiguity though depending on various factors such as the quality of data, the complexity of the phenomena being analysed, and the context in which the analysis is conducted. Even the density of plots in traditional line charts can be

‘perceived ambiguously, which obstructs the user's identification of underlying trends in complex data sets’ (Xue et al 2024).

Google launched a service, called Insights for Search, back in 2008, which over time evolved into Google Trends. The use of Google Trends search query data has a relatively long tradition in a wide range of fields including business, economics, communications, tourism, etc. (Wang et al 2024). Google Trends provides the counts of a selected word (or phrase) relative to other searches. The addition of trend data, such as that of Google Trends, into traditional time series models, can produce better predictions than models without Google Trends search data (Wu et al 2023). Google trends data has been used by researchers in a wide array of fields, from forecasting unemployment rates linked to the digital divide (Mulero and Garcia-Hiernaux 2023) to ‘deviations from the “natural” interest’ of nuclear power plant construction projects (Smirnov et al 2022).

Google Trends has also been deployed to identify VUCA events. Research (Wang et al 2024) showed that combining Google Trends search query data with predictive models could be used to monitor and predict epidemics, such as COVID-19, and when used with Wiener methods it outperformed established approaches such as autoregressive integrated moving average (ARIMA) and long short-term memory (LSTM). Boy (2023) showed how Google Trends could ‘provide robust, finely grained, and replicable evidence on mental health measures at the population level’ when examining how a ‘global shock modulates people's online searches’, in this case COVID-19. Google Trends as a way to detect epidemics and diseases has been researched extensively in literature and has been proven at ‘detecting regional flu outbreaks before conventional Centers for Disease Control and Prevention surveillance systems’ (Carneiro and Mylonakis 2009), further demonstrating its potential strength as a data set within the VUCA scorecard.

Trend analysis is a well-established approach in research (Soru and Marshall 2024). Google Trends (Jensen et al 2024, Kamiński et al 2024, Suzuki et al 2023, You et al 2023, Wahyuningrum et al 2022) provides an open source and easy to

use data point to access trend data and is therefore the fourth data indicator for ambiguity.

ID	Title	Type (Macro / Micro)	Source	Key Linked Paper
A4	Trend Analysis	Marco and Micro	Google Trends	A Novel Framework to Forecast COVID-19 Incidence Based on Google Trends Search - Wang et al (2024)

Figure 17 - Fourth Ambiguity Data Indicator

Ambiguity – Potential Areas of Further Research

The use of Large Language Models that can ‘parse, interpret, and forecast trends from vast repositories of textual data ... in the ever-evolving landscape of data-driven decision making’ (Soru and Marshall 2024) is clearly a nascent area with huge scope for exploitation.

Research (Lauriola and Levin 2001) has shown a correlation between attitudes toward ambiguity and attitudes toward risk, particularly when the risky choice was to avoid a loss rather than to achieve a gain. It would be interesting to research and understand how blending the ambiguous data of the VUCA Scorecard with that of volatility, uncertainty, and complexity impacts this position. It is hypothesized that when blended and enhanced with additional data indicators, that the attitude toward ambiguity may change positively.

Ambiguity Summary

While ambiguous data indicators can provide valuable insights into patterns and changes over time, it is essential for researchers and practitioners to acknowledge and address potential sources of ambiguity to ensure the validity and reliability of the analysis. This may involve conducting sensitivity analyses, considering alternative explanations, and communicating the limitations and uncertainties associated with the analysis. Researchers need to be aware that for some data indicators, for example Google Trends, the results are likely to be influenced by consumption patterns and internet penetration rates (Mulero and Garcia-Hiernaux 2023).

6. Results - Map of Key Data Indicators

The research in this paper tested the assumption of the existence and validity of data indicators on which to build a Pattern of Life model to underpin a VUCA Scorecard. For each of the four domains, four data indicators were identified through a structured and repeatable search process, and the full set are shown below in Figure 18 - Data Indictors Full Set. Every data indicator had significantly robust theoretical research to warrant its inclusion.

		Title	Type (Macro / Micro)	Source	Key Linked Paper
Volatility Unexpected or unstable behaviours for unknown duration	V1	CBOE Volatility Index	Macro	Chicago Board Options Exchange	The Investor Fear Gauge - Whaley, R. E. (2000)
	V2	Gas and Electricity Wholesale Energy Prices (UK)	Macro	The Office of Gas and Electricity Markets (Ofgem)	Intensification of the Prices Volatility for Oil and Natural Gas - Prisecaru and Calanter 2022
	V3	Individual Share Price	Micro	London Stock Exchange	On the effects of Covid-19 pandemic on stock prices: an imminent global threat - Fasanya et al 2023
	V4	Fiscal Impact Measure	Macro	The Hutchins Center Fiscal Impact Measure	Fiscal volatility, financial crises and growth - Afonsoa and Jalles 2012
Uncertainty Lack of predictability and potential for surprises	U1	Economic Policy Uncertainty Index	Macro	Economic Policy Uncertainty Index	Measuring Economic Policy Uncertainty - Baker et al 2016
	U2	World Uncertainty Index	Macro	World Uncertainty Index	World Uncertainty Index. NBER Working Paper - Ahir et al 2022
	U3	Index of Economic Freedom	Macro	The Heritage Foundation	The impact of higher quality government regulation of business and greater economic freedom on living standards - Cebula et al 2016
	U4	Unemployment Rate	Macro	The Office for National Statistics (ONS)	Economic sentiment during the COVID pandemic: evidence from search behaviour in the EU - van der Wielen and Barrios 2021
Complexity Many interconnected parts that interact in many ways	C1	Economic Complexity Index	Macro	The Observatory of Economic Complexity (MIT)	Economic and technological complexity: A model study of indicators of knowledge-based innovation systems - Hidalgo and Hausmann 2009
	C2	The Global Innovation Index (GII) index	Macro	World Intellectual Property Organization	Causal complexity analysis of the Global Innovation Index - Yu et al 2021
	C3	Global Supply Chain Pressure Index (GSCPI)	Macro	Federal Reserve Bank of New York	The effect of the global supply chain and oil prices on the inflation rates in advanced economies and emerging markets- Ye et al 2022
	C4	Product Complexity Index	Macro and Micro	Harvard Growth Lab	The Relationship between Product Complexity and Exchange Rate Elasticities: Evidence from the People's Republic of China's Manufacturing Industries - Thorbecke et al 2021
Ambiguity Information available, but potential for misreads and confusion	A1	Company Reporting	Micro	Companies House (UK)	Annual Report Readability, Tone Ambiguity, and the Cost of Borrowing - Ertugrul et al 2017
	A2	Social Media Influencers	Micro	X, formerly Twitter	Online Social Influence and the Convergence of Mass and Interpersonal Communication - Flanagin 2017
	A3	Consumer Reviews	Micro	Trustpilot	Effects of negative reviews and managerial responses on consumer attitude and subsequent purchase behaviour: An experimental design - Le and Ha (2021)
	A4	Trend Analysis	Macro and Micro	Google Trends	A Novel Framework to Forecast COVID-19 Incidence Based on Google Trends Search - Wang et al (2024)

Figure 18 - Data Indictors Full Set

The full set of results shown in Figure 18 - Data Indictors Full Set are now transposed across and used to populate the VUCA Scorecard. The two figures below show the VUCA Scorecard populated with a complete set of all sixteen

data indicators (Figure 19 - Populated VUCA Scorecard), along with the author of the key journal paper that underpins the justification for its inclusion (Figure 20). It should be noted that while the key paper is shown, as the research above documents, each data indicator has multiple reference points and therefore a substantial presence in literature and research to justify its inclusion. To the best of the knowledge of this researcher, this is the first time theoretically sound VUCA data indicators have been explicitly identified and mapped for each VUCA domain providing a novel contribution to knowledge.

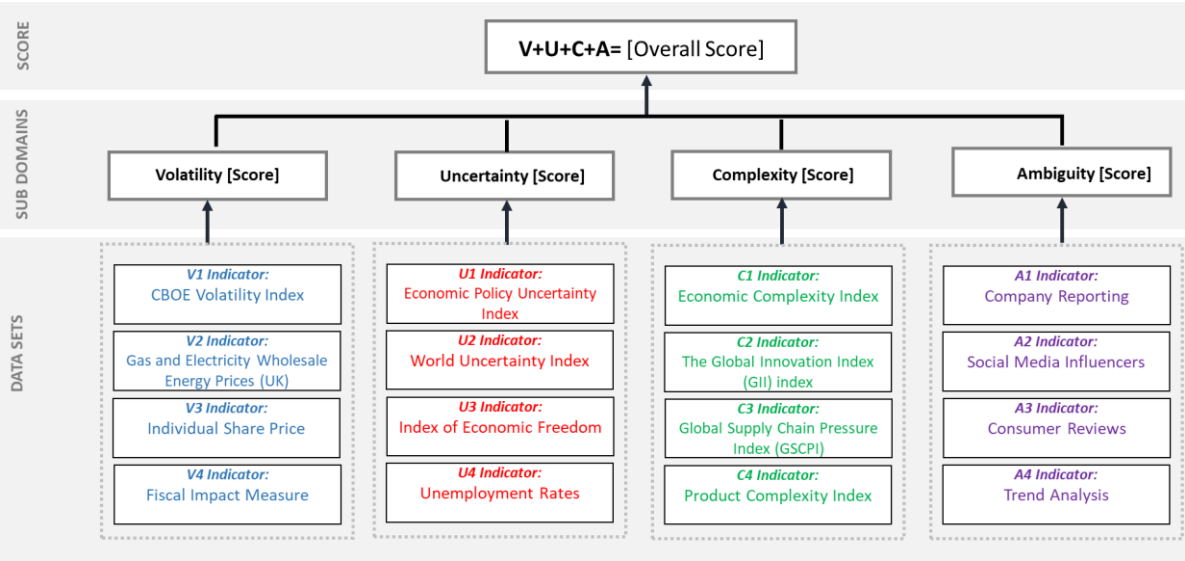


Figure 19 - Populated VUCA Scorecard

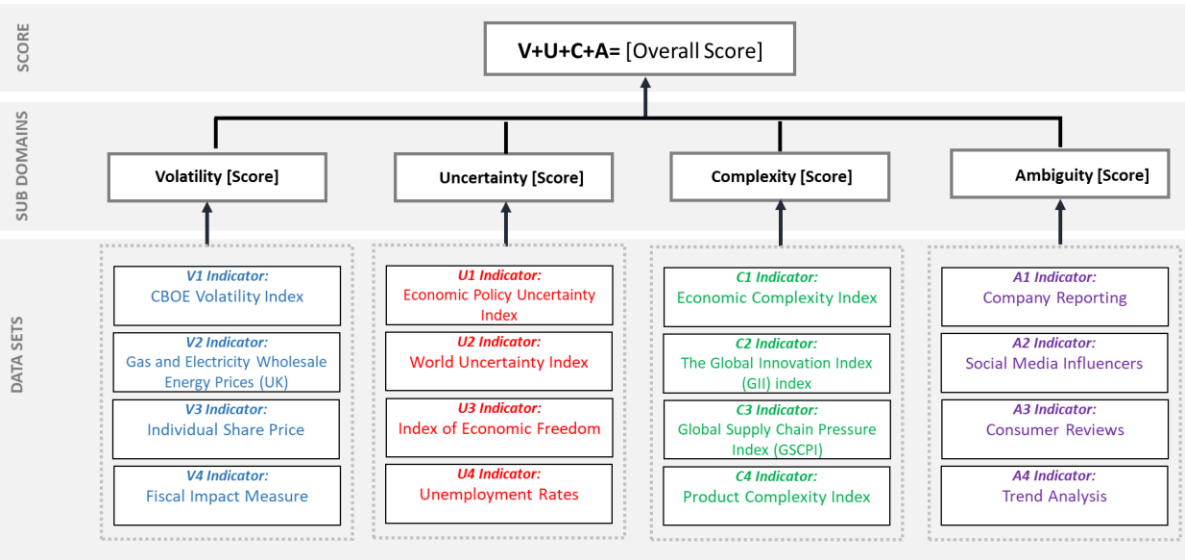


Figure 20 - VUCA Scorecard Populated with References

7. Discussions and Conclusion

In order to understand the turbulent business environment (Ansoff 1979, Grant 2003) in which organisations operate, VUCA (Kail EG 2010, Bennett and Lemoine 2014) has emerged as a way to frame it. Data indicators from the external world can play a key role in making sense of what is taking place in the world (Bhageshpur 2019).

Following a two-step methodology, this paper addressed the research aim ‘Can VUCA be underpinned by rigorous theoretical data sources?’. It found through a structured and repeatable process, data indicators could be identified in literature that mapped to the domains of VUCA, and these were supported with real world implementations that applied the theory.

The research found that some of the data points came from well-established mainstream sources, with deep academic underpinnings such as the CBOE Volatility Index (Gökgöz and Kayahan 2023, Whaley 1993) and the Economic Policy Uncertainty Index (Baker et al 2016, Iqbal et al 2020, Xi et al 2023). In a few cases, the identified data indicator was backed by literature, but there wasn't a single elegant index constructed around it, for example, company reports and financial statements (Zuca et al 2023, Benjamin Graham 1973). In these cases, services such as those provided by governments had to be used to access the data. The different data indicators mainly provided primary data, often in a raw format. Where in a few cases it was not primary data, it was one step removed (i.e. the technology platforms users were engaged on, such as Twitter, were just tallying up the raw data with no changes to it).

The research showed for researchers and practitioners it can be an effort to build and maintain data indicators. In a number of cases data indicators, while appearing to be a good fit, were discounted as they had become defunct and fallen into disrepair. There is also no guarantee the same fate will not befall the data indicators listed in this research, although it is highly likely others will appear and supersede those in existence today, particularly as AI and ML come more into play. The other issue to recognise is what is free and available today may not be tomorrow. When work started on the VUCA Scorecard, Twitter was a very

serious data indicator candidate. But after the acquisition and rebranding to X, there are concerns about the data quality, the implementation of new pay walls, and changes to a number of features, meaning it may not offer the benefits it once did. The same fate could materialise for other data indicators over time, and therefore researchers and practitioners need to ensure they have alerts in place when data does not arrive or does not arrive in the shape they expect.

A number of data indicators have multiple implementations, often based on the same or very similar underlying methodologies. For example, the Index of Economic Freedom data indicator used in this research is from the Heritage Foundation and would appear to be the most referenced in recent research. However, while that is based on four pillars of information, the Fraser Institute also has a less referenced Index of Economic Freedom, that includes an extra fifth pillar. It is beyond the scope of this research to decide which implementation of a data indicator best suits the needs of the organisation building a VUCA Scorecard. Organisations will need to undertake their own investigation into the underlying methodology of any data indicator, its robustness, and fit. It is not impossible though that they could use multiple implementations of the same or very similar data indicators within a model if the delta between the different data indicators warrants it.

Where keyword association is employed, it is particularly useful when the matched pair is made available, providing the organisation with additional insight. For example, with the World Uncertainty Index, not only do organisations see a spike in the uncertainty score, but they are potentially given additional insight into the reason, such as the examples of Brexit or COVID19 being the paired word, and this will allow them to both analyse other data indicators for correlation and better target strategic responses.

Limitations on Research

VUCA is trying to add structure to an intrinsically challenging world. This research builds on that premise and is trying to shine a light on data indicators that can help organisations and strategic thought leaders respond to the signals they receive. However, it is impossible to capture all the features that make up the

world, so there will always be gaps. This is true of any approach and needs to be fully appreciated going in as VUCA is not a silver bullet providing a perfect view of the world for analysis. The more valid data indicators that are added, the smaller that gap should become.

Most of the data indicators, and particularly the indices, have critics to some extent regarding how the indexes are built. This often means the indexes evolve and their underlying methodologies change or are updated over time to reflect the latest thinking and research. Researchers will need to periodically check the underlying models to ensure the data indicator still meets their needs.

Practitioner Guidance

The data indicators presented have been researched extensively in journals to assure their robustness. There is however no preconception that an organisation will use any of them. Neither is it envisioned that an organisation would use all sixteen. They are not intended as a mandatory or minimum starter set. Rather they represent a pre-validated list of candidates that an organisation may find useful to select from if the subject matter of the data indicator fits the needs of their organisations VUCA Scorecard. Practitioners will need to identify and validate their own data indicators to fully populate their own VUCA Scorecard, which may or may not include some data indicators from this research.

A number of the data indicators come from a composite or aggregate indicator (CI). CI's compile a number of individual indicators into a single index, based on an underlying model of the multidimensional concept, and are increasingly recognised as a useful tool for analysis (OCED 2008). CI's therefore act as a useful single dimension metric to represent a more complex underlying set of data (individual indicators). Care needs to be taken when using a CI as a data indicator to understand VUCA ensuring that the underlying model is fully comprehended and that the aggregated individual indicators capture the required features of the model (Santos and Brandi 2017).

Research Summary and Contribution to Knowledge

The aim of this research was to identify sixteen rigorous theoretical data sources underpinned in literature, four for each VUCA domain of volatility, uncertainty, complexity, and ambiguity. The research succeeded in this aim and demonstrates how robust data indicators could be sourced to fully populate a VUCA Scorecard and therefore made a novel contribution to knowledge by showing this for the first time. As a strategic decision-making tool, the VUCA Scorecard can help provide leaders with data driven insights into their turbulent business environments that then helps them craft strategic responses grounded in data.

Conflict of Interest

The author declares no conflict of interest.

Ethics Statement

The author has read and agreed to the Committee on Publication Ethics (COPE) international standards for authors. All data was collected and stored in line with Cranfield University standards and policies.

7 Research Paper 5 - Visualising VUCA: A Case Study

Introduction to Paper

The preceding papers addressed a number of interlinked areas of research:

- Research Paper 1, Literature Review located in Chapter 2, showed the 'Input' stage was underserved in literature and presented a clear research gap.
- Research Paper 2, located in Chapter 4, undertook statistically significant quantitative research that showed VUCA events are experienced, with a clear before and after state.
- Research Paper 3, located in Chapter 5, proposed new and original novel ideas and artefacts to aid researchers and practitioners in visualising VUCA.
- Research Paper 4, located in Chapter 6, proved that the data indicators used to populate a VUCA Scorecard could be identified in a repeatable way and underpinned by rigorous theoretical research published in peer reviewed journals, thereby validating their use.

Research Paper 5 takes these outputs, consolidates them, and seeks to answer the overall research aim 'Can VUCA be visualised?' through a worked implemented example (i.e. Case Study of a real company and VUCA event).

Visualising VUCA: A Case Study

James Vickery

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK, and

Enes Unal

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Dr. Leon Williams

Centre for Competitive Design (C4D), Cranfield University, Cranfield, UK

Abstract

Key Finding – The Case Study demonstrated that for a real-world organisation (EasyJet) and event (COVID) that the data can be collected and used to populate a VUCA Scorecard, generate Patterns of Life over a preceding period, visually represent the data on a VUCA BreachMap, and identify a VUCA event taking place with a higher degree of certainty. The visualisations clearly and quickly convey a VUCA event is taking place, thereby providing new and original novel ideas and artefacts to aid researchers and practitioners.

Purpose – The purpose of this paper was to consolidate preceding interlinked research, test the applicability of the constituent parts, and demonstrate how it could be applied to a real-world organisation and event in a repeatable way. Undertaking the Case Study would provide insight into how to use the VUCA decision making tools, known as the VUCA Event Deck, and any nuances in how to extract maximum value from these.

Methodology – A company was selected that would likely have an adverse experience to the VUCA event of COVID-19, ensuring the transition from Normal Conditions to Turbulent Condition could be visualised. All data used was publicly available and open source removing any privacy concerns. The input and Pattern

of Life models produced were quantitative, while the final visualisations were overlaid with qualitative information to aid decision making.

Additional Findings – The outputs from the VUCA Event Deck are also likely to have wider applicability for researchers in general, for example those trying to better understand the turbulent external environment. While the VUCA artefacts won't prescribe what action is taken to respond to a VUCA event, they provide data driven insights to the causes, which should remove guess work and generate improved responses.

Research Implications – By understanding the characteristics of the volatility, uncertainty, complexity, and ambiguity that underpin a VUCA Event through data driven insights, researchers and practitioners are better placed to respond to the Event to ensure not just survival but compete.

Originality/Value – To the best of the knowledge of this researcher this arguably the first time that VUCA events in the turbulent external environment have been visualised. and provides other VUCA researchers, the majority of whom primarily focus on configuring the internal mechanics of an organisation to respond to VUCA events with extremely useful data and insights to support them in tailoring their response.

Contribution to the Thesis – The research conducted in this paper shows that the overall research aims to develop a set of visual tools that aid strategic decision makers identify turbulent events takes place can be achieved and that VUCA can be visualised.

Keywords:

VUCA, Case Study, turbulent business environment, Scorecard, Strategic decision making, Pattern of Life, PoL

1 Introduction

Research reported in the preceding Research Papers (located in Chapters 4 to 6) demonstrated that VUCA events are experienced, theorised how a VUCA Scorecard could be constructed, identified a collection of candidate data sets to act as a guide for populating the VUCA Scorecard, and proposed the use of Pattern of Life analysis to run against the data indicators to generate visualisations of when a VUCA event may be forming.

The Case Study in this Chapter seeks to test the different strands of research and implement a working example of the full set of VUCA artefacts to test if VUCA events can be detected and visualised. This Case Study is required to validate the research and ensure VUCA events can be seen in the data. The data sets used will be historical and focus on the time period when COVID-19 first appeared, including the months preceding its emergence. This is in line with the research of the Research Paper 2, which focused on this period for the VUCA surveys, and showed categorically that this VUCA event could be experienced. It also avoids the potential issue of using real time data from today, as there is no guarantee that a VUCA event would take place, therefore being unable to prove the research hypothesis either way. The table below (Figure 13) shows the unique research being leveraged.

Paper	Key Research	Implementation
Paper 2 - Sensing VUCA Pre and Post COVID-19: A Survey	Primary data (surveys) showed VUCA events could be detected during COVID-19	Use of COVID-19 as the event to examine during the implementation as proven it can be experienced
Paper 3 - Visualising VUCA to aid strategic decision making in turbulent times	Use of conceptual theory building to develop the VUCA Scorecard	Use of the VUCA Scorecard to validate its use as a decision-making tool
Paper 3 - Visualising VUCA to aid strategic decision making in turbulent times	Pattern of Life to build a baseline and then visualise the data sets identified	Use of Pattern of Life as the method to visualise the data sets testing its fit for purpose
Paper 4 - Can VUCA be underpinned by rigorous theoretical data sources	Secondary data (theoretical review) research to build out validated candidate data sets	Use of some identified data sets and the guidance in the paper to build out data sets

Figure 13 - Link to Research Papers

The implementation Case Study in this Chapter will be produced in a fully documented, structured, and repeatable way, using publicly available data, enabling researchers and practitioners to repeat the outcomes.

2 Case Study Scope Boundaries

The aim of the implementation Case Study is to build on existing research to produce actual visualisations and test these to see if VUCA events can be detected. Due to time and cost constraints only one company is examined in detail in this Case Study. It is manually intensive to collect, process, model and visualise the data sets, while at the same time testing the integrity of the VUCA artefacts.

Data science activities are outside of the scope of the implementation. For example, the research is not looking to normalise all the various data sets into a single scaling system and visual line. An extensive amount of work would be required to load, store, optimise, analyse, and tune the data to be able to achieve this which is beyond the scope of this research but provides a fertile ground for future research. The same is also true for the use of neural networks, training AI to learn patterns, deep learning, feedback loops, vectors, etc, which are all out of scope, although again these all offer extensive rich avenues for further research.

3 VUCA Scorecard and Data Sets Design

The implementation Case Study sets out to identify four data sets, one for each of the four VUCA domains, volatility, uncertainty, complexity, and ambiguity, covering the same VUCA event. The data sets needed to be free and available in the public domain, and ideally primary data. It also needed to cover the twelve-month period from July 2019 to June 2020, as COVID-19 began in the middle of this period.

In order to test the Case Study against actual data a real company was selected, and the associated data sets selected emulated what that company might realistically be expected to collect for their VUCA Scorecard to understand their environment. An organisation in the travel industry was chosen as the research assumption was VUCA events linked to COVID-19 should clearly show up for

that industry. The company selected was therefore easyJet, an airline based in the UK that operates over 900 routes in more than 34 countries.

The data indicators selected sought to offer a mixed perspective by both utilising some of the data sets identified in the Research Paper (Chapter 6) , but also to prove the process in that paper and introduce new data sets that were unique to the company and industry to build on established data sets with those more tailored to the use case. The logic therefore behind the four data sets selected was as follows:

- Volatility – The research in Chapter 6 showed that individual stock prices were a recognised measure of volatility for a company. For this reason, this data indicator was selected and the individual stock price for easyJet plc (EZJ) which is listed on the London Stock Exchange was added as the descriptor to target in on the data being collected. With its link back to literature and being publicly available, the monthly percentage change in stock price for easyJet was therefore selected as the data indicator.
- Uncertainty – To balance the VUCA Scorecard and help take a holistic view of the external environment, it was decided a use a macro data set (i.e. a data set about the wider industry, not just EasyJet) for uncertainty. The research in Research Paper 4 identified uncertainty data sets that were provided by the Economic Policy Uncertainty Index. This looks at the frequency of keywords in newspaper coverage linked to uncertainty. In particular they have a set of novel Twitter-based Uncertainty Indexes that provides daily English-language tweets containing both uncertainty terms as well as economic terms (Zhou et al 2023). The Twitter-based Uncertainty Indexes potentially offers advantages over other uncertainty indexes as it relies on analysing the sentiment of tens of millions of tweets, arguably more representative of the mood of the crowd than investor sentiment indexes (El Khoury and Alshater 2022, Baker et al., 2021). This is provided as a free data set of this in a downloadable Excel format for analysis for the required time period and was therefore selected.

- Complexity - For complexity, a unique data indicator was researched for the Case Study that captured the complexity within the travel and airline industry. The research in Research Paper 4 gave some pointers though to aid thinking, particularly around supply chains. An airport has an extensive and complex ecosystem that involves the airport operator, airlines, employee, catering companies, baggage companies, security, etc., in order to operate. To process optimal numbers of passengers at an airport, all parts of the complex ecosystem need to be working in concert. While EasyJet primarily operates from Luton airport, Heathrow airport is the largest in the UK and therefore a useful barometer of a complex travel operation. It also publishes monthly traffic statistics including historical data in Excel for free. This data set included passenger numbers per month, which are therefore used to populate the VUCA Scorecard as they rely on a complex system in order to achieve a high throughput of travellers.
- Ambiguity – In undertaking the research into rigorous theoretical data sources, trends were identified as an ambiguous source of data as covered in Chapter 6. Google Trends was the proposed as a way to capture trend data sets as it provides flexibility in the search term (descriptor) used to target the data set retrieved, as well as providing flexibility on the data ranges used. The search term used was ‘Travel Disruptions’ as it was felt this was generic enough that people would already be searching for it, but if there was a VUCA event forming, then there would hopefully be an increase in its usage, it would trend, and it would be the type of search term an airline might track.

The primary (original data) and secondary (processed) data sets were downloaded in Excel from the relevant official sources as shown below in Figure 14. Some minor analysis and formatting were required to the data sets to produce month data indicators that could populate the PoL and VUCA Visualisation. Extracts from the data can be found in Appendix B, including calculations.

Focus	Data Set	Source
Volatility	Individual stock price for easyJet	https://www.londonstockexchange.com/stock/EZJ/easyjet-plc/company-page
Uncertainty	Economic Policy Uncertainty Indexes	https://www.policyuncertainty.com/twitter_uncert.html
Complexity	Passenger numbers at Heathrow Airport	https://www.heathrow.com/company/investor-centre/reports/traffic-statistics
Ambiguity	Google Trends data	https://trends.google.com/trends

Figure 14 - Data Sources

These data sets built on the research in the Research Paper 4. One data set, the Economic Policy Uncertainty Index, was used exactly as it is published. Two further data sets from the Research Paper were also used, Stock Price and Google Trends, but these required an additional ‘descriptor’ to be added to the targeted data sets to tune what was collected. Finally, a new data set for complexity, namely passenger numbers was used. Figure 15 below shows a populated VUCA Scorecard with these data sets. It also shows the weighting between the data sets is evenly balanced in this example, so each is worth 25% of the overall VUCA score.

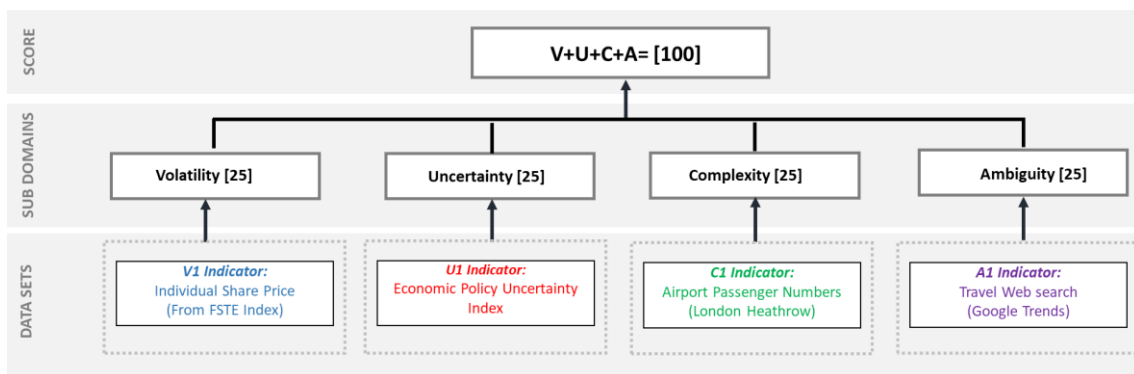


Figure 15 - VUCA Scorecard Populated

4 How to Visualise VUCA

While the research in Chapters 4, 5, and 6 identified the VUCA Scorecard, Pattern of Life, and how to generate the data indicators, there is still a need to provide guidance on how to assemble the artefacts and read them. The VUCA

Visualisations use the following terminology to provide a shared vocabulary to describe what is happening in the artefacts:

- **Pattern of Life** - The Pattern of Life is derived from historical data. By reviewing this you can infer what normal looks like. It is likely and expected there will be some natural movement in the data, for example prices rise and fall, stocks go up and down, and the daily patterns of people change, and this would be reflected in the data as part of normal day to day activity. For all the data sets looked at in this Case Study there was always some level of movement, this was expected.
- **Pattern of Life Baseline and VUCA Threshold Gap** - The average score (numerical value) for the historical data is taken as the baseline and acts as ground zero. The normal movements up and down from the baseline in the historical data gives us our Pattern of Life range, with a lower threshold and a higher threshold. Some movement is always expected as variance occurs day to day. The difference between the baseline and the high or low threshold score is known as the VUCA Threshold Gap.
- **Normal Conditions** – The external operating environment has two states. The first of these is Normal Conditions, where the day-to-day activities and movements within the data indicators form normal Pattern of Life behaviour. This state is analogous with business as usual (BAU) within an organisation.
- **Turbulent Conditions** – The second state for the external operating environment is Turbulent Conditions. This is when external behaviour falls outside the expected norms defined by the Pattern of Life. In this situation, it is likely the organisation will move from BAU to a different footing to deal with the emerging crisis. This turbulent state mirrors the theory within Strategic Management research.
- **VUCA Breach** - When the Pattern of Life thresholds are exceeded, then this is classed as a VUCA Breach that indicates a VUCA event maybe happening. Depending on the data type, a VUCA Breach could be positive or negative. For example, prices can rise or fall, so a sudden catastrophic

rise or drop would trigger a breach as the behaviour is outside the expected norms.

- **VUCA Peak** - The severity of the VUCA Breach is an important factor in determining the significance of the event taking place, and the likely levels of turbulence that will be experienced. A VUCA Peak aids in the visual identification of this and occurs when the VUCA Breach score is at least three times the VUCA Threshold Gap (the difference between the Pattern of Life baseline and either the high or low boundary)

The following two examples are used to illustrate how visualising works. In the first example (Figure 16), the data indicators come in over a period of time and the variance in their score is used to develop a Pattern of Life Baseline.

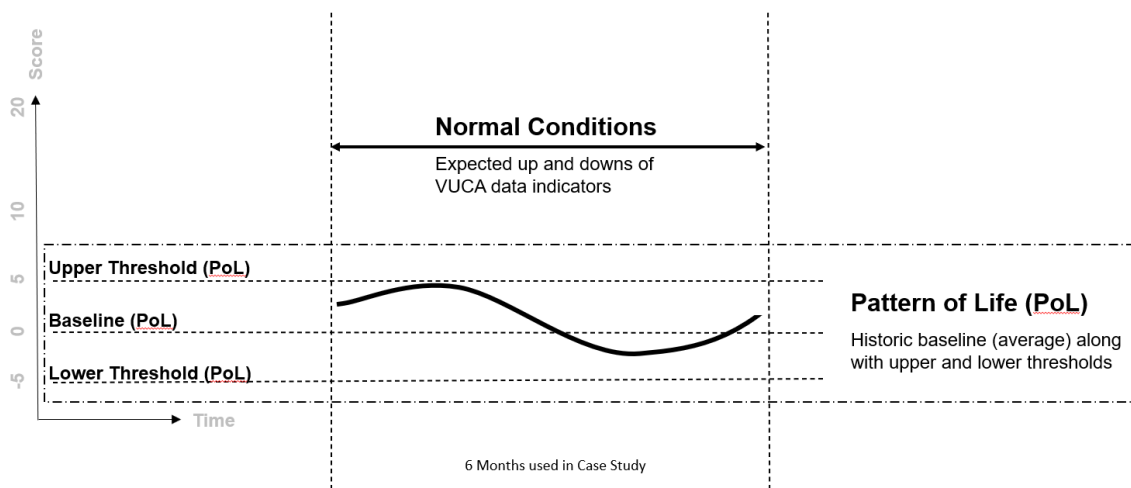


Figure 16 - VUCA Baseline generated in Normal Conditions

In this illustrative example the baseline was 0, and the data had an upper threshold of 5, and a lower threshold of -5, a VUCA Threshold Gap of 5, and a range of 10. All of the data indicators received fell within the expected Pattern of Life, meaning Normal Conditions were observed. It is noted the period of time required to develop the Pattern of Life can vary, though in this Case Study six months of historical data are used to produce the Pattern of Life.

In the second example below (Figure 17), the data indicator scores rise above the thresholds that the Pattern of Life set, resulting in a potential VUCA event. The organisation enters Turbulent Conditions and the VUCA Breach quickly exceeds three times the VUCA Threshold Gap, resulting in a VUCA Peak, a VUCA Breach of significant impact, likely requiring immediate action to address. This visual artefact is known as the VUCA BreachMap as it clearly maps when a Pattern of Life baseline has been breached. The VUCA BreachMap, along with the VUCA Scorecard form two of the key artefacts used to visualise VUCA, and collectively they are known as the VUCA Event Deck.

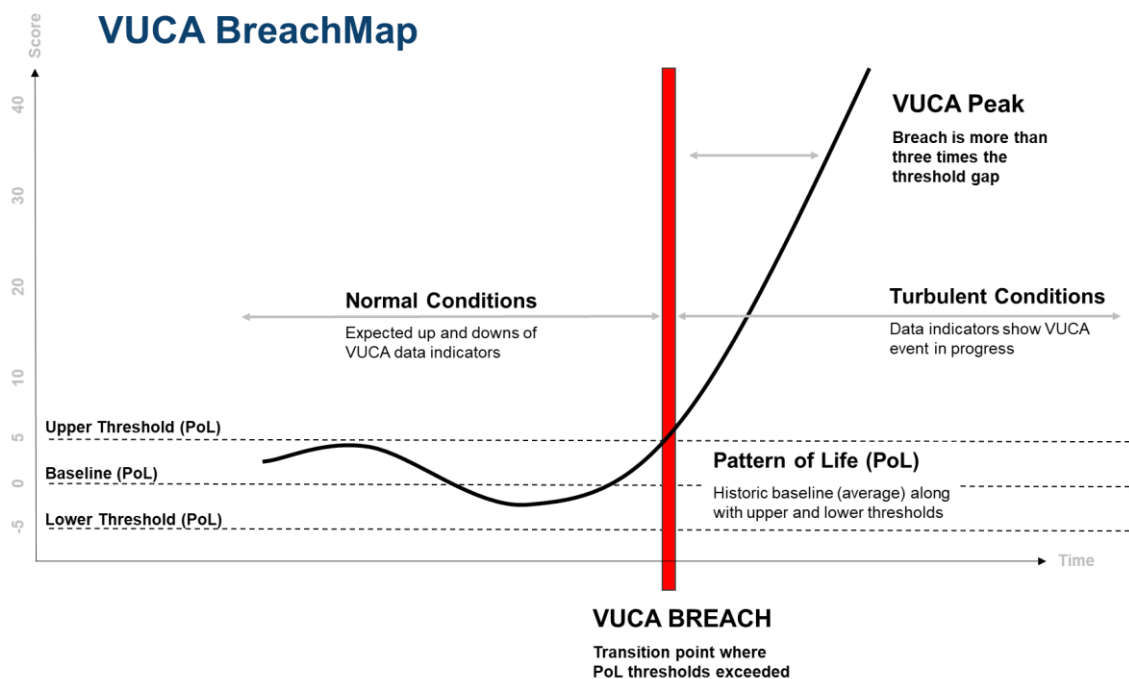


Figure 17 - VUCA Event Visualised

There are a couple of points to note. The first is that the Case Study is looking at one data indicator in the example above (Figure 17), so while the Case Study has a VUCA Breach, it is only for one VUCA domain. The VUCA Impact Scale (Appendix C) says VUCA Breaches are required on multiple VUCA domains (volatility, uncertainty, complexity, and ambiguity) for this to be classed as a VUCA event. So while one VUCA Breach, particularly one with a VUCA Peak present, means the organisation has work to do, in isolation it is unlikely to be a

crisis event along the lines of CVOID-19, as that requires multiple VUCA domains to experience a VUCA Breach. The Case Study below shows a worked example of this in action. The second point to note is that when generating a VUCA Visualisation in real time, the Pattern of Life baselines and thresholds will need to be re-evaluated and potentially reset from time to time. Using the stock market as an example, the value of an asset tends to increase over time (typically a number of years), so what was once the baseline in the past may not be representative of today. Researchers and practitioners will need to track any data indicators they use to produce their Pattern of Life and decide if re-baselining is required and on what cadence.

5 Results and Discussion

Now that a VUCA vocabulary has been defined in Section 4 above to describe what is visually taking place, the data sets for each VUCA domain that were identified were used to populate the VUCA Scorecard and data collection began. For each of the data indicators, the data sets were collected from each of the sources (Figure 18) as a Microsoft Excel extract, The data for each of the VUCA domains was inserted against a twelve-month timeline in Excel as shown in full in Appendix B, with a sample to illustrate shown below in Figure 18. Using this data, visualisations, namely a graph, were produced that showed the movements in the data on a month-to-month basis.

Domain	Baseline						COVID-19					
	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20
Volatility	9%	1%	0%	19%	8%	0.08	6%	-2%	-21%	-48%	6%	13%
Uncertainty	141,330	221,030	209,160	198,810	158,440	141,270	142,920	153,290	444,190	445,720	370,560	293,340
Complexity	7,754,139	7,680,327	6,777,115	6,994,212	6,233,801	6696079	6,099,370	5,442,081	3,106,845	206,600	228,018	350,283
Ambiguity	12	14.5	12.4	0	7.5	8	5.75	38.25	7	3.25	2.6	11.75

Figure 18 - Data Sample

A Pattern of Life for each data set was then established by looking at the first six months and using the highs and lows from this to derive the baseline and thresholds. Visually, the test was to see if the Pattern of Life was breached by

one or more of the data sets once COVID-19 began to emerge, and ideally if a VUCA Peak could be visualised.

COVID-19 Event	Key Date
First cases in Wuhan	12th Dec 2019
The Pan American Health Organisation/WHO Regional office for the Americas (PAHO/AMRO) issued its first epidemiological alert. Recommendations cover international travellers, infection prevention and control.	16th Jan 2020
Worldwide deaths from the 2019 Novel Coronavirus reach 1,013	10th Feb 2020

Figure 19 - WHO Key Initial COVID-19 Events

To aid with synchronising any changes in the data patterns with COVID-19, a COVID-19 timeline of key initial events is used (Figure 19), with the events of the timeline sourced from the World Health Organisations (WHO) COVID-19 interactive timeline, a trusted online resource about the pandemic.

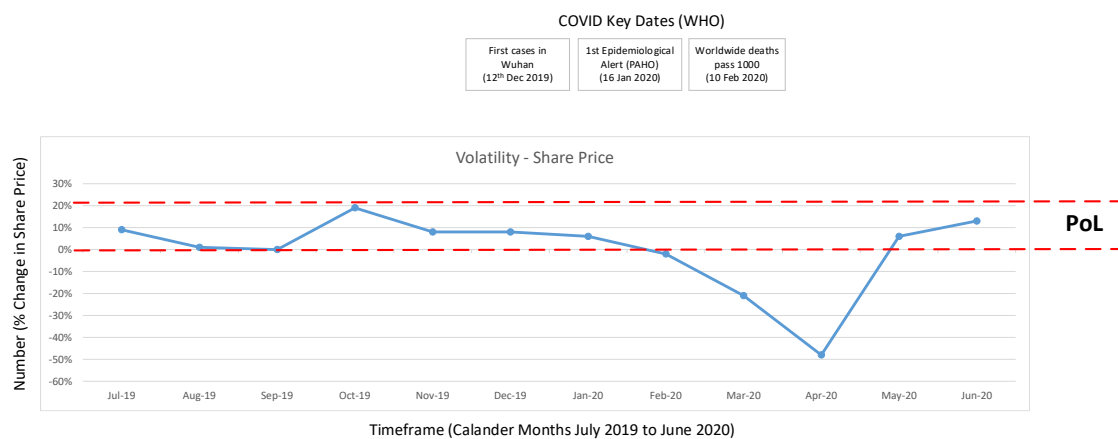


Figure 20 - Volatility Visualisation

The first visualisation shown above (Figure 20) was for volatility and looked at the easyJet share price on the London Stock Exchange (LSE)². The horizontal axis

² While the case study chose to use a micro data set that focused solely on the company in the case study, in this case EasyJet, in more sophisticated and complex implementations it could be possible to use the share prices from a range of company to build a wider intelligence picture of the environment.

shows the twelve-month period whereas the vertical axis shows the percentage change in share price each month. The Pattern of Life (PoL) had a low of 0% and a high of 19%, giving a baseline of 9.5%, a total range of 19%, with a threshold movement of 9.5% against the baseline being required to break the PoL. This represents normal behaviour over the first six months in the graph and provided the PoL. In the six months preceding COVID-19 the share prices were relatively stable against the baseline and never dropped below 0%.

The data shows that the initial first cases of COVID-19 had little to no impact on the PoL, it wasn't until the first epidemiological alert that the pattern really started to change and by the time deaths had reached a 1000 worldwide a clear breach of PoL was visible. The negative percentage drop really stands out, as that is the first time it happened during this time span, along with the velocity of the drop, peaking with the share price dropping -48%. Against the baseline, this drop represented a 57.5% total change and was 6.05 times the normal VUCA Threshold Gaps (difference between the baseline and highs and lows), so this change was highly significant.

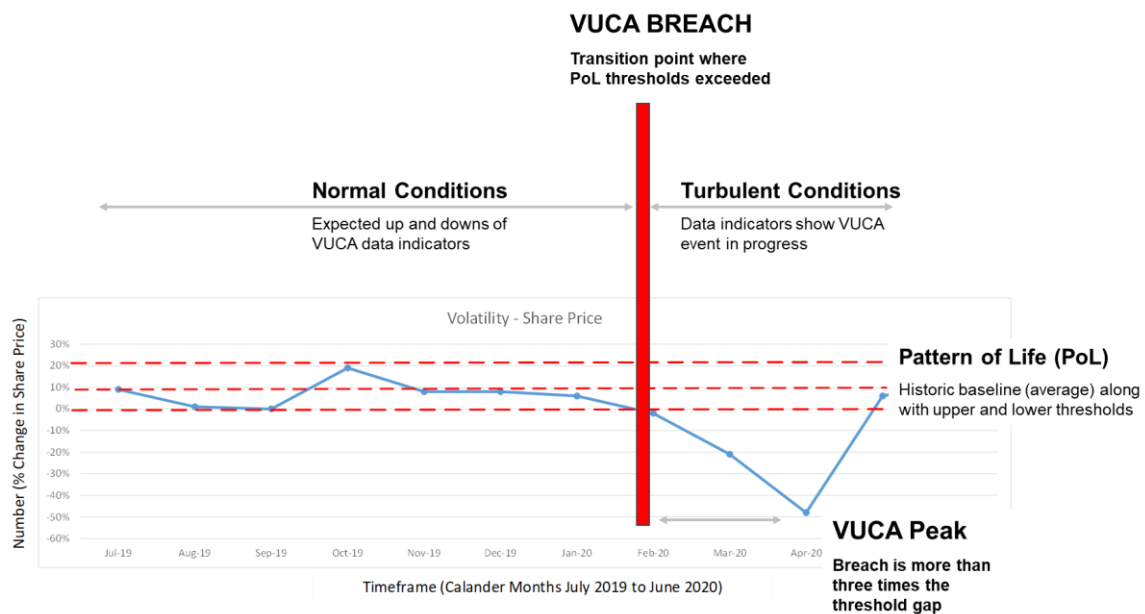


Figure 21 - Volatility and VUCA Mark Up

The visualisation has been expanded further (Figure 21) with the full set of VUCA vocabulary overlaid on the VUCA BreachMap to aid in reading the visualisation and cross referencing the volatility example back to the underpinning decision-making research. Within this expanded example we can see that the Pattern of Life baseline was set at an expected monthly 9.5% change in share price, and the thresholds defined as +/- 9.5% from the baseline. Once the VUCA event impacted, shown by the VUCA Breach line which captures when the thresholds were exceeded, there was a negative drop in share price. The organisation, in this case easyJet, moved from Normal Conditions to Turbulent Conditions, and the total negative drop in share price was six times above the baseline, resulting in a VUCA Peak, which occurs when the VUCA Breach is at least three times above normal tolerance.

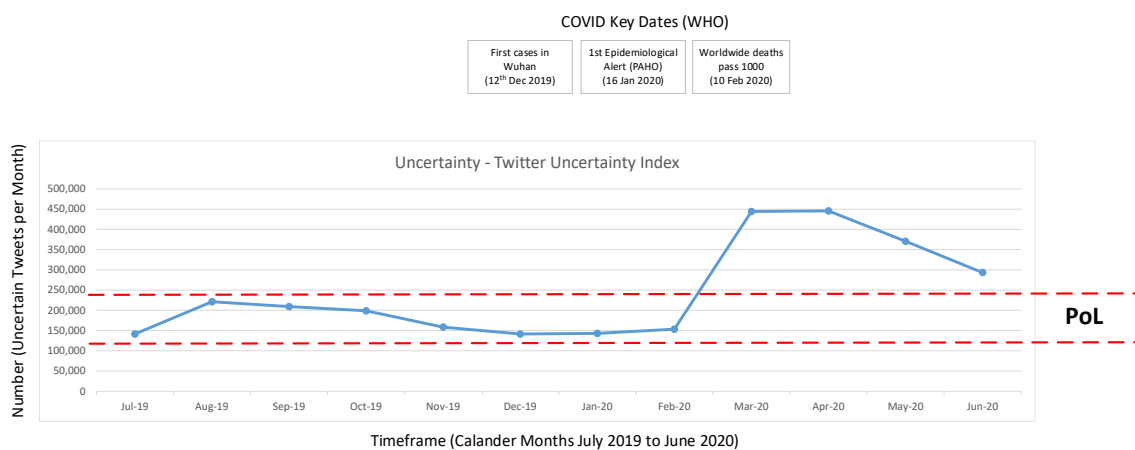


Figure 22 - Uncertainty Visualisation

The second visualisation shown above (Figure 22) was for uncertainty and looked at the Twitter-based Uncertainty Indexes provided by the Economic Policy Uncertainty Index (a macro cross industry data set). The horizontal axis shows the twelve-month period whereas the vertical axis shows the number of tweets each month that mentioned uncertainty, with the scale going up to 500,000. The first six months of historical data were used to generate the PoL and showed a low of 141,270 and a high of 221,040, giving a range of 79,700 in normal

operation. The baseline was set at 181,150 and the VUCA Threshold Gap was 39,880 (difference between the baseline and highs and lows).

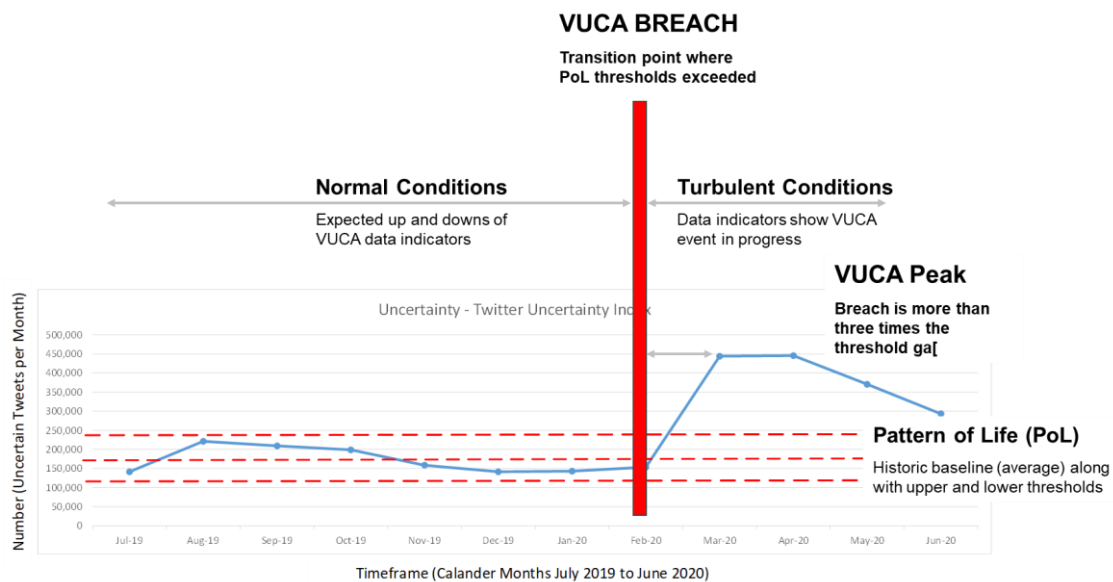


Figure 23 - Uncertainty and VUCA Mark Up

The uncertainty graph above (Figure 23) has been marked up using the VUCA BreachMap visual aid. The visuals show the initial COVID-19 events in January 2020 had no impact. It was February 2020 before there was a sudden and pronounced spike, with the volume of tweets peaking at 445,720 in April 2020.

Considering that in the initial six month baseline the monthly number of tweets featuring uncertainty in the text had never moved more than 79,700 in a month, the new highs visible during the VUCA Breach showed 264,570 additional tweets against the baseline, which was 6.63 times the VUCA Threshold Gap (39,850) and a clear indication that a VUCA Peak had been reached.

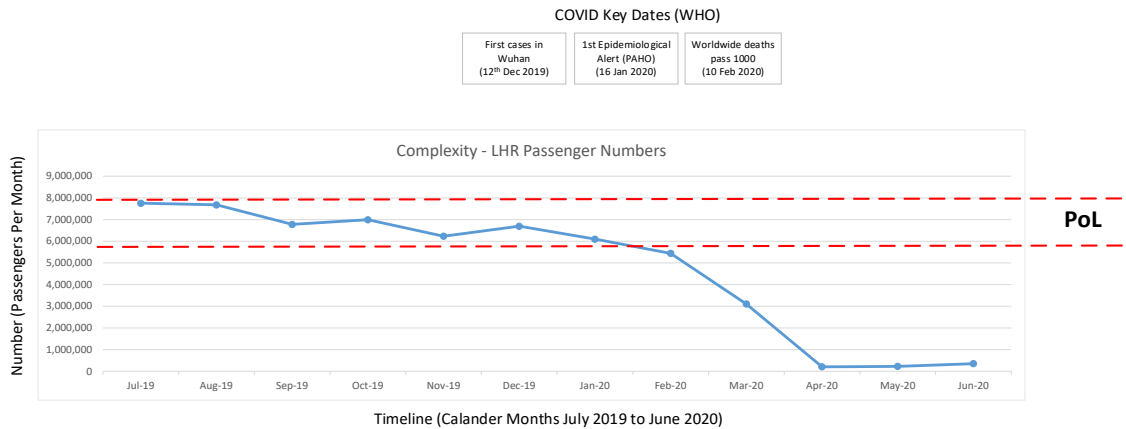


Figure 24 - Complexity Visualisation

The third visualisation (Figure 24) was for complexity and tracked the number of passengers passing through London Heathrow, the UK busiest airport catering for international and domestic flights. For the first six months the monthly average number of passengers ranged from a high of 7,754,139 and a low of 6,233,801 giving a range of 1,520,338. It is likely the initial highs were linked to the UK summer holiday season, and the actual PoL range is closer to 750,000, though for the purpose of this analysis, the range of 1,520,338 is retained to err on the side of caution, giving a baseline of 6,993,970 passengers per month transiting through London Heathrow Airport.

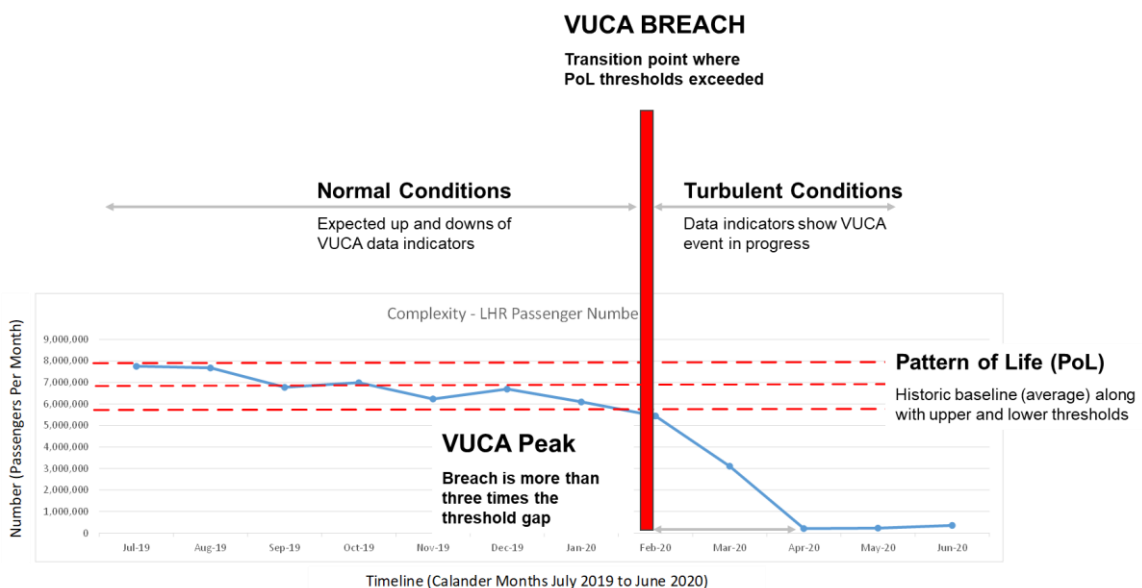


Figure 25 - Complexity and VUCA Mark Up

A VUCA BreachMap visualisation was produced (Figure 25) that clearly shows that once COVID-19 began to impact, the passenger numbers dropped sharply. Nationally implemented full travel bans did not fully take hold until March 2020, so the drop to almost zero in April is expected, but the visualisation does show the reduced numbers and the overall trajectory months before this, giving travel companies, and particularly easyJet, potentially early notice of an issue. The VUCA Peak was the highest recorded in the Case Study, reaching 8.93 times the VUCA Threshold Gap, well above the 3 times required for a VUCA Peak.

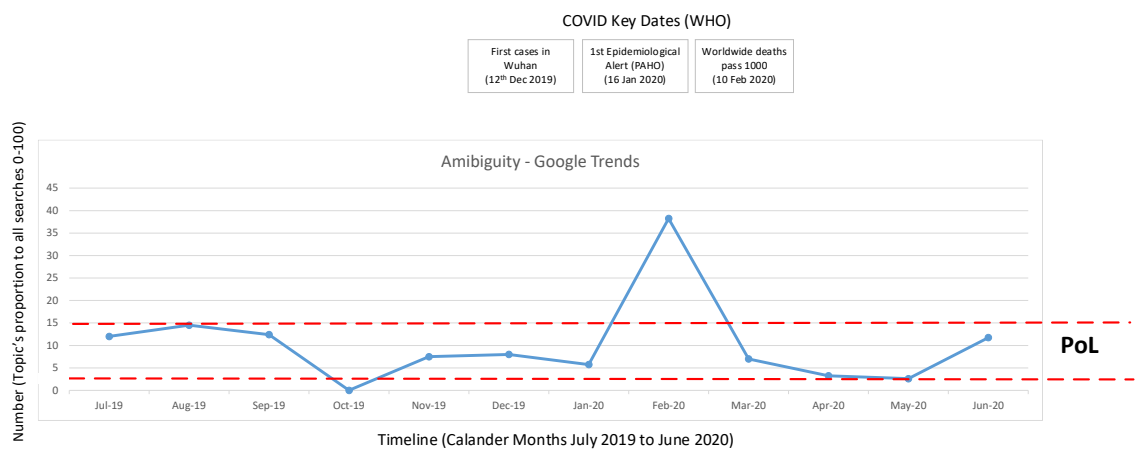


Figure 26 - Ambiguity Visualisation

The fourth and final visualisation shown above (Figure 26) was for ambiguity and used Google Trends data for searches with the keywords of 'Travel Disruption'. The use of this data set demonstrates the flexibility in the VUCA toolset, but also the care that needs to be taken to ensure the data sets selected are relevant to the particular organisation being examined. This data set produced a PoL which showed a high score of 14.5 and a low of 5.75. The scale used by Google Trends looks at the search terms keywords and scores this out of 100 proportional to all other searches.

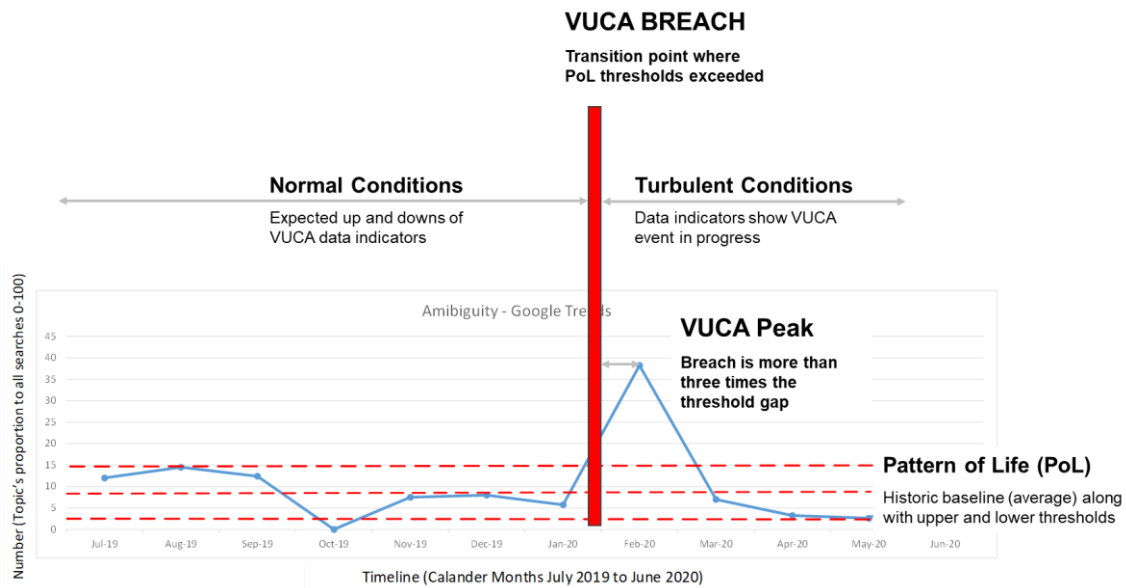


Figure 27 - Ambiguity and VUCA Mark Up

The VUCA BreachMap visualisation (Figure 27) showed a very clear and pronounced spike once the COVID-19 epidemiological alert was released, with the percentage of searches increasing dramatically to a total score of 38.25 from a baseline of 7.25, an increase of 31, clearly breaking the PoL tolerances and producing a VUCA Breach for ambiguity. The VUCA Peak was 4.28 times the VUCA Threshold Gap, again clearly showing a potential VUCA event of significance.

For the shown ambiguity visualisation (Figure 26) the data set was collected from Google Trends using the keyword 'Travel Disruption' and the additional descriptor 'UK'. It is useful to rerun the analysis, but with a different descriptor, in this case 'Worldwide' to see how that impacts the results. The results shown below (Figure 28) show two important differences straight away.

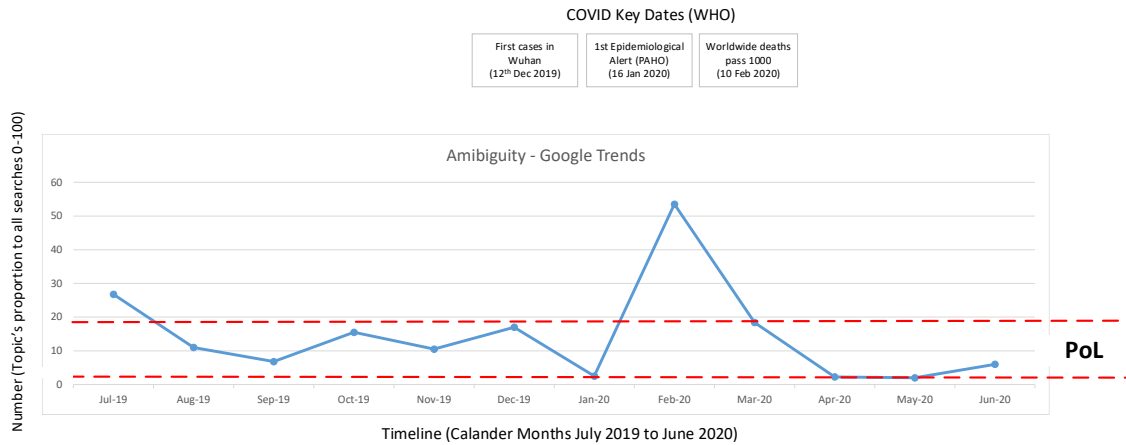


Figure 28 - Ambiguity Worldwide Visualisation

First the scale has changed on Google Trends as there have been more searches with those terms on a global basis showing a larger overall search proportional to all other searches, and the horizontal numerical score grading now goes to 60, whereas previously it went to 45. Secondly, the initial shape of the data has changed. It is interesting to note the breach of the PoL threshold at the start, though this is below the score required to be declared a VUCA Peak, and with none of the other data sets showing this, we can rule out this being a VUCA event, in all likely hood it was linked to flight delays during summer holiday periods.

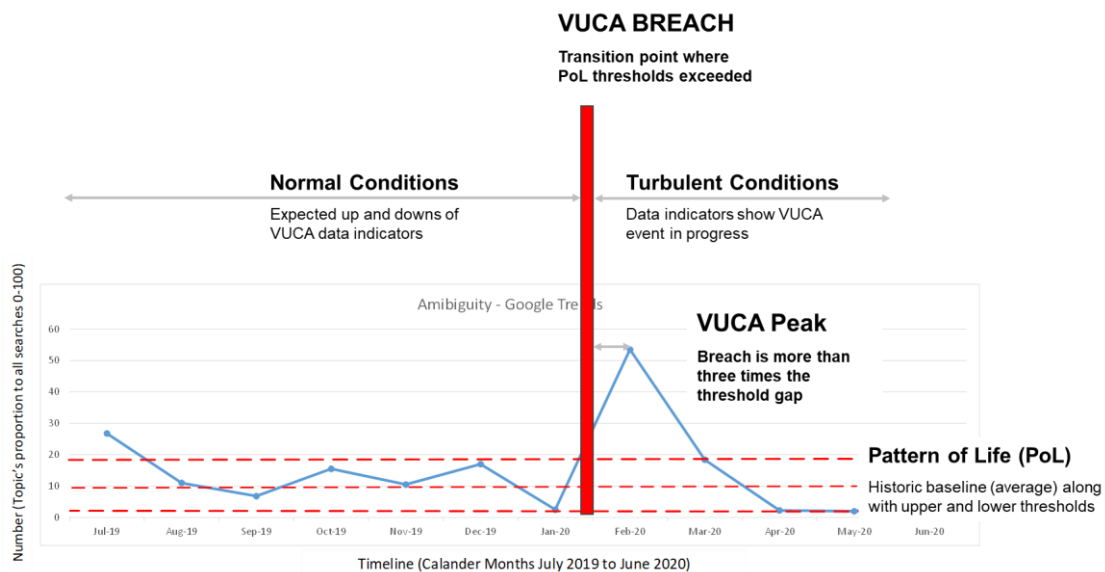


Figure 29 - Ambiguity Worldwide and VUCA Mark Up

The VUCA BreachMap Visualisation (Figure 29) shows the VUCA Breach position mirroring that of the UK data sets and starting in January 2020. It also forms a VUCA Peak at the same point in time, namely February 2020. We can see the total number of searches as a proportion to other searches rose to 53.5, and increase 41.6 against the baseline, meaning that the worldwide VUCA Peak had a higher increase than just the UK, with the VUCA Peak being 8.16 times the VUCA Threshold Gap. If the results had shown the worldwide situation was of a lower score, it may have indicated that in this example easyJet should focus on its UK operation first as the impact was greater.

Even if the PoL was calculated using the July 2019 high of 26.75, the VUCA Breach would still end up being 3.68 times the VUCA Threshold Gap, and still result in a VUCA Peak. This review of different data indicators for ambiguity and the adjusting of the parameters that form the PoL still show a VUCA Peak in all cases, indicating visually just how pronounced the change was from Normal Conditions to Turbulent Conditions.

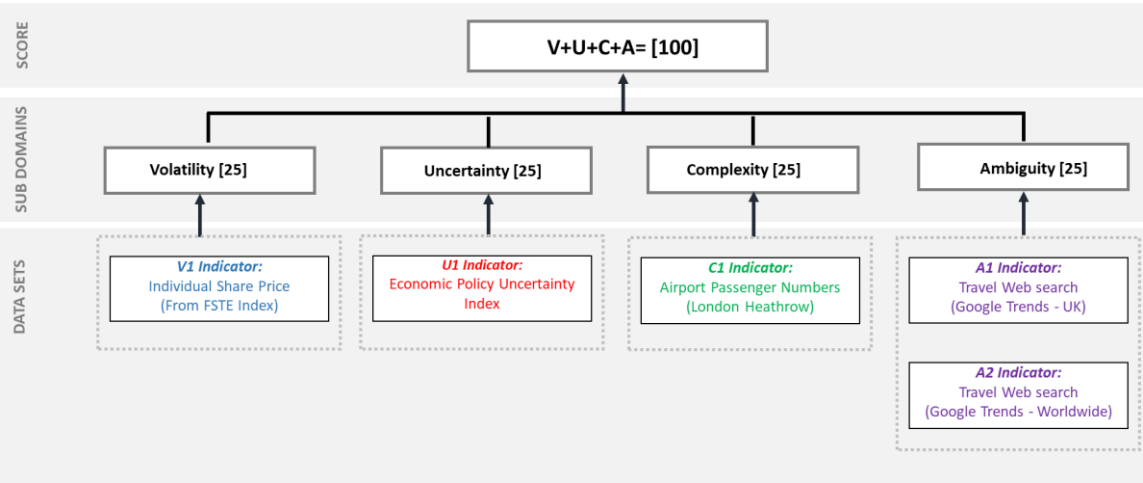


Figure 30 - VUCA Scorecard Multiple Entries

The VUCA Scorecard conceptualised in this research is designed to support this combining of data sets. In this Case Study example, easyJet could choose to use both ambiguity data set as shown above (Figure 30), and weight the importance of one above the other, for example 60/40 as shown below (Figure 31). Any

proposed spilt would depend on the rating of the data (e.g. gold standard), what is being tracked, and what decision-making is being sought. For the Case Study, the weighting of each domain was kept simple with an equal weighting of 25% each, though if additional data sets are added as shown in Figure 31, a case could be made for increasing the weighting for Ambiguity while decreasing the others. It was also mentioned earlier in this section that for share price, other airline share prices could be added under Volatility, and doing this would lead to each being shown on the VUCA Scorecard and the weighting for Volatility likely being increased as well.

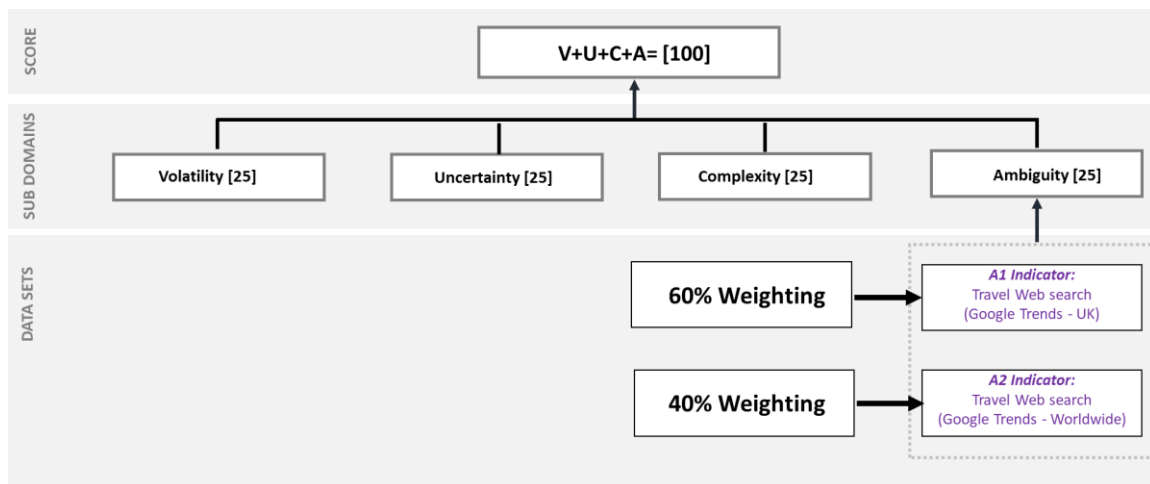


Figure 31 - VUCA Scorecard Weighting

In the example above (Figure 31), the Ambiguity score still only makes up 25% of the overall VUCA score. For the user building out the VUCA Scorecard, it could be that combining and weighting multiple data sets differently, particularly those that are trusted and have been validated to a higher standard, would produce VUCA Visualisations that they have a higher degree of confidence in with improved data to target strategic responses. So, in the example above, the VUCA Scorecard could be adjusted to reflect that the ambiguity domain has more data sets and the weighting could be adjusted to 20/20/20/40 to represent this, though within this Case Study, each VUCA domain is weighted equally and only a single set of Google Trends data, UK, is used.

The visualisation below (Figure 32) shows each of the four separate VUCA Scorecard outputs combined into a single representation. Doing this allows the overall landscape to be assessed at once and enables quicker visual interpretation of the results, particularly where multiple PoL are being breached at the same time. The red line indicates the overall average where the deviation from PoL begins, and clearly identifies that with all domains experiencing a VUCA breach it is highly likely a VUCA event is taking place. When this visual is coupled with the ones from the individual domains which all show a VUCA Peak has been reached, this further compounds the likelihood that a significant VUCA event is taking place requiring intervention from strategic decision makers. While outside the scope of this research, it would be possible to combine the PoL and data for each domain into a single VUCA visual artefact, providing a simplified ‘summary’ view of a single PoL.

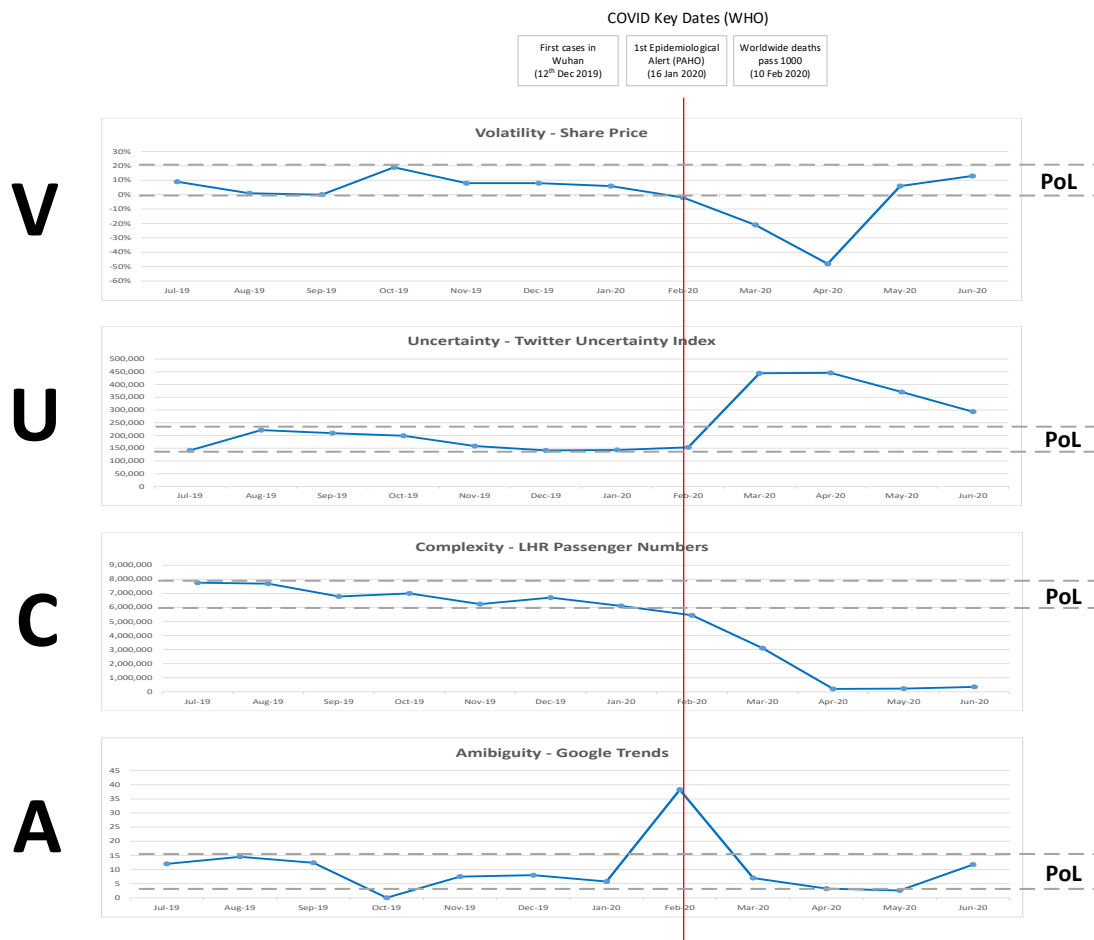


Figure 32 - Combined VUCA Visualisation

When analysing the data and results above, it can be clearly seen that the social media derived data from Google Trends spikes sooner than any other data sources. This is interesting particularly when compared to the Twitter-based Uncertainty Index which is also derived from social media data. However, the Google Trends data does have some material difference in its make up that could potentially explain the position. The Google Trends data is derived from searches on a worldwide basis, whereas Twitter tends to be US centric. The first COVID-19 death was in China on the 9th January 2020, and the first laboratory-confirmed overseas cases were reported in the Far East, in Thailand on the 13th January 2020 and then Japan 15th January 2020. It is therefore likely that searches around 'Travel Disruption' were already taking place in this geographical area, leading to it showing up in the data sooner than other sources. This innate understanding of how the data set is comprised is important for researchers and practitioners to understand when selecting data sets to populate their VUCA Scorecards, as it could influence the sources selected and weightings given.

There is also a wider trade off to be aware of here, while Google Trends data looks like it could signal early, it is by its very nature ambiguous. Other data sets, such as passenger numbers might temporally be slightly behind, but are more factual. This blending of different data sets across VUCA is a core strength of the VUCA Scorecard as it gives a holistic and balanced perspective across the environmental turbulence. Those organisations that are configured to be very lean and agile may choose to go early on one or two VUCA Scorecard data indicators to get ahead of the market or a potential VUCA event, but in doing so are content to accept the associated risks this may bring.

Breaching of a single PoL in itself does not signify a VUCA event is happening. As identified in the Research Paper on data indicators, a social media influencer posting messages online can generate adverse media coverage that warrants a response to manage the situation, but for a large number of organisations this is just day to day operational business. The VUCA Impact Scale produced in the Research Paper 3, and contained in Appendix C for reference, should be used to

help guide decision makers when a VUCA events is happening, i.e. the PoL for multiple VUCA domains has been breached.

Another observation of the implementation of the VUCA Scorecard is that a number of the data sets used offer the option to collect additional data sets at the same time. For example, for travel disruption further individual descriptors could be added to Google Trends to access additional data set that might be useful (i.e. 'airports closed' or 'hotel closed'). London Heathrow provides cargo as well as passenger data, which could be useful for certain industries, such as those selling goods or involved in logistics, and may be of more value in that situation than the number of passengers data.

6 VUCA Event Deck Guidance and Replication

The Case Study showed that VUCA events could be visualised. In order to help disseminate the research and ensure the process can be replicated by researchers and practitioners, simple to follow guidance is provided that formally brings all the artefacts together into the VUCA Event Deck.

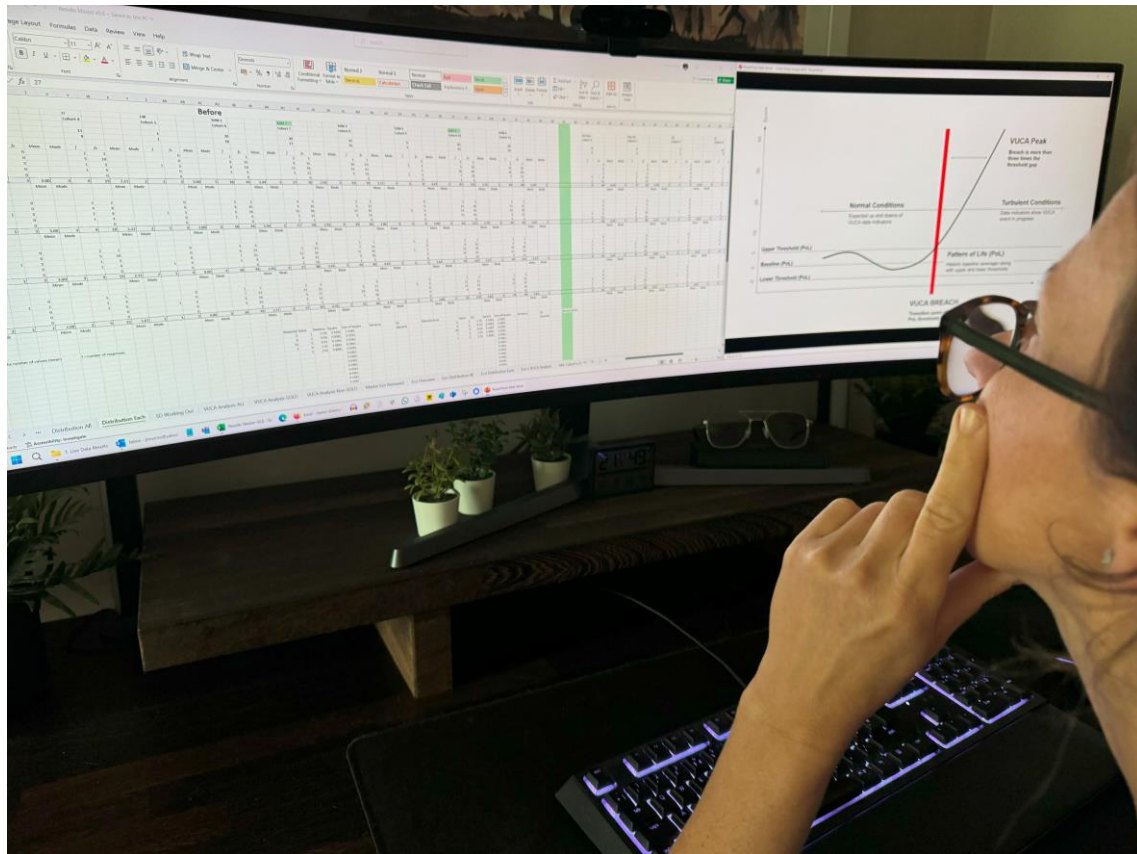


Figure 33 - VUCA in Action

Figure 33 above shows the VUCA Event Deck, in particular the VUCA BreachMap being generated from data in Excel, being used by a practitioner at a company to model their own organisational situations. The VUCA Event Deck provides everything required to model the external environment and detect VUCA events using the artefacts and process developed in this research.

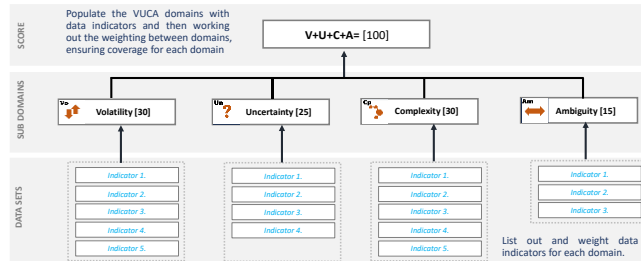
A three-step model (Figure 34), provides guidance in one place on how to use the VUCA Event Deck. A detailed step by step guide to both replicate the Case Study but also generate new VUCA artefacts is included in Appendix D.

VUCA Event Deck

Step 1 – Populate VUCA Scorecard

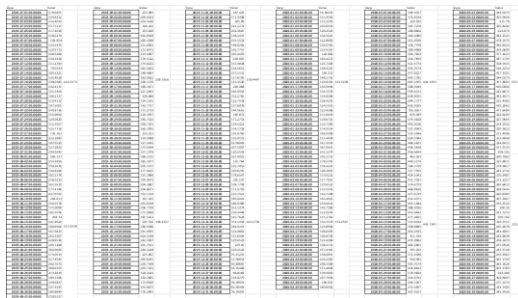
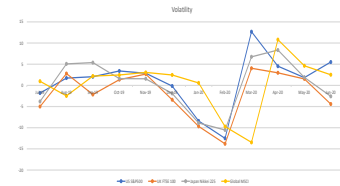
VUCA Scorecard Template

This template can be used to sense and understand VUCA events in the external environment. Identify data indicators for each of the VUCA domains to build a data driven picture of the external landscape and its turbulence. The data indications can capture social, economic, governmental, public, and private trends/patterns. Weighting of domain can be tailored based on the quality and number of data indicators in each VUCA domain.



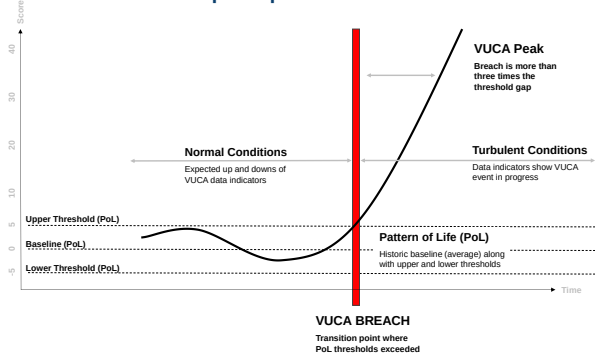
V_o Volatility	Definition: Unexpected or unstable behaviours for unknown duration Example: Stock market and share prices, shares trade over a large range
U_n Uncertainty	Definition: Lack of predictability and potential for surprises Example: How much of a new product will you sell?
C_p Complexity	Definition: Many interconnected parts that interact in many ways Example: Supply chain with multiple tiers of suppliers and sub-suppliers
A_m Ambiguity	Definition: Information available, but potential for misreads and confusion Example: Airport is closed – is this due to bad weather or IT system failure?

Step 2 – Collect Data and Model



Step 3 - VUCA BreachMap Analysis

VUCA BreachMap Template



VUCA Impact Scale	
VUCA Domains Breached	Condition and Response
0	Normal operating environment and conditions
1	One VUCA domain breached, likely to be self contained and addressed as business as usual
2	Two VUCA domains breached and possible early signal that VUCA event may be inbound with the environment becoming turbulent
3	Three VUCA domains breached and VUCA event is close to progress, action required to manage turbulent conditions
4	All VUCA domains breached and severe VUCA event in progress, immediate action required to prevent disaster

Figure 34 - VUCA Event Deck Guidance

The three steps shown in Figure 34 are:

1. Use the VUCA Scorecard Template, supported by the VUCA descriptions and VUCA iconography (all covered in Research Paper 3) to identify and record a set of data indicators across the VUCA domains. This can be done individually, but groups are likely to brainstorm an optimal candidate set of data indicators.
2. Capture the data sets identified on the VUCA Scorecard. This may require some iteration based on what data is available and in what format, remembering that the ideal data sets are open and publicly available. Use the data to build a Pattern of Life and produce a baseline for the data. The simplest way to achieve this is model the data in a spreadsheet like Excel and then use supporting features like charts and graphs.
3. Once the Pattern of Life has been produced, use the VUCA BreachMap to track and understand where a VUCA breach has occurred, aid by the VUCA Impact Scale.

The VUCA Event Deck and three steps outlined above enable actors to sense VUCA events today by leveraging the artefacts produced, and processes outlined. The VUCA BreachMap in particular is key as it supports a quantitative storytelling narrative with clear summarised visuals produced from quantitative data to justify action and can be easily shared with executive teams in organisations. In time more sophisticated implementations may see the data captured in real time with the VUCA BreachMap visualisation continuously updated and monitored.

As it is unlikely that VUCA events will be happening every day, it is envisioned that users would build their own implementation of the VUCA toolset with data sets relevant to the organisation, and use it like an alarm system, with it running continuously in the background and alerting them, for example via email, when PoL is breached and a VUCA event is detected.

7 Case Study Insights

This implementation of the VUCA Event Deck set out to bring together the different strands of research undertaken in Chapters and see if a working construct of the full set of VUCA artefacts could be produced with actual data sets to test if VUCA can be visualised. An airline, easyJet, and a global VUCA event, COVID-19, were used for the Case Study example. The results from the VUCA Scorecard clearly show that the data can be collected and used to populate a VUCA Scorecard, generate Patterns of Life over a preceding period, visually represent the data on a VUCA BreachMap, and identify a VUCA event taking place with a higher degree of certainty through the breach of multiple Patterns of Life.

The results also proved the mixed use of different data sets, some taken from the Research Paper 4 which conducted rigorous theoretical research into candidate data sets, and some completely new for this Case Study. The Case Study also explored the use of multiple data sets for the Ambiguity domain and showed how the flexibility in the artefacts would work in practice.

8 Implementation Limitations

The VUCA Scorecard data sets provided data indicators, which are leveraged to alert leaders early to changes in their environment which may require a response. How the VUCA toolset is implemented will impact how timely the alerting is, with a fully automated solution potentially alerting in real time, whereas a manual set up will be limited by how often the data is collected and processed.

It is likely that some data sets may experience drawbacks of some nature for 'the utility of an index relies on the data on which it is built, which is important for understanding its capacity and limitations' (El Khoury and Alshater 2022). For example, the Twitter-based Uncertainty Index is made up primarily from the US population, skews towards younger users and more towards Democrat members of the population. Social media networks like Twitter are also susceptible to bad actors, such as online bots (automated message posting) and the diffusion of

false information (Baker et al 2021). Future research may blend data sets from multiple sources as this may offer a way to offset some of these limitations.

9 Further Research

This worked implementation opens the door to a wide range of further research opportunities. The first is the generation of more worked examples, both of other industries during COVID-19 and for other VUCA events (the 2008 stock market crash for example) to further validate the research, but also to identify more candidate data sets and seek to identify cross domain patterns of interest and/or signals (for example, on average does one industry tend to experience VUCA events before others?).

It would also prove useful to alter the mix of geographical data sources and further analyse the temporal implications of these for global events to better understand the spread and impact of VUCA events.

Pattern of Life itself could be researched in more depth to focus on the optimal duration of preceding timelines to generate a baseline. This research used six months, but the COVID-19 spike was so pronounced that a shorter Pattern of Life might have sufficed. Conversely for VUCA events that are not so globally impactful and more subtle to detect, it might require a longer Pattern of Life analysis to see the change.

10 Research Summary and Contribution to Knowledge

The Case Study in the implementation of the research validates that VUCA events in the turbulent external environment can be visualised. To the best of the knowledge of this researcher this arguably the first time this has been achieved, and provides other VUCA researchers, the majority of whom primarily focus on configuring the internal mechanics of an organisation to respond to VUCA events with extremely useful data and insights to support them in tailoring their response. The outputs from the VUCA Event Deck are also likely to have wider applicability

for researchers in general, for example those trying to better understand the turbulent external environment. While the VUCA artefacts won't prescribe what action is taken to respond to a VUCA event, they provide data driven insight to the causes, which should remove guess work and generate improved responses.

11 Conflict of Interest

The author declares no conflict of interest.

12 Ethics Statement

The author has read and agreed to the Committee on Publication Ethics (COPE) international standards for authors. All data was collected and stored in line with Cranfield University standards and policies.

8 Results

This Chapter summarises the research results from across the interlinked strands to reflect back to the Method Chapter and ensure all the research questions have been addressed. The initial Literature Review (Research Paper 1) showed that VUCA research had focused on the internal response an organisation develops, and there was a gap in sensing VUCA events and visualising these to aid strategic decision makers. This research therefore sought to address that gap through its research questions (RQ's) and overall research aim.

Research Question: RQ 1: Can VUCA events be classified as an experience that can be tracked?

Result: The surveys (Research Paper 2) proved with certainty that VUCA events could be experienced. Using COVID-19 as the event, this was tested with over 150 participants and the results categorically showed that VUCA events were experienced, there was a clear distinction between 'before' and 'after' states, which were experienced differently, and each VUCA domain was also experienced differently. This outcome demonstrated that potentially there was an array of signals in various combinations that could provide insights into the VUCA events taking place.

Research Question: RQ 2: Can a strategic tool be developed to reveal the phenomenon of VUCA events, as they occur?

Result: Tracing the roots of VUCA back through existing research within the field of Strategic Management helped resolve the role and design of a strategic decision-making tool, resulting in the VUCA Scorecard (Research Paper 3). The boundary between Normal Conditions and Turbulent Conditions in existing research was identified as a key theory for understanding when VUCA events formed and came into play. The use of Pattern of Life also was researched as a method to take data and produce a baseline for Normal Conditions. VUCA

iconography, an Impact Scale, and other assets were also developed. Combined, these artefacts provide important building blocks to answer the overall research question.

Research Question: RQ 3: Is there rigorous theoretical underpinning of the data sources for VUCA?

Result: Research Paper 4 mapped sixteen data indicators, four for each domain of VUCA (Volatility, Uncertainty, etc.), back to existing research and theory found within literature. This research provided a candidate list of data sets that could be used, along with key referenced papers and a practical implementation of the data indicators that provides publicly available primary data to populate a VUCA Scorecard.

Overall Research Aim: Can VUCA be visualised?

Result: Research Paper 5 consolidated the unique research of the interlinked Research Papers 2, 3, and 4 into a Case Study implementation to see if VUCA could be visualised. It used outputs from each paper to achieve this through the VUCA Event Deck and showed that for the selected Case Study, an airline during COVID-19, that VUCA could indeed be visualised. This makes a unique contribution to knowledge and for arguably the first time provides the design-science and design-thinking scholarly community and strategic decision makers in strategic and innovation management with data driven insight into VUCA events.

8.1 Mapping of RQ's to Results

Figure 35 (next page) provides traceability back for each of the original research questions to the corresponding result and where this was produced.

Research Questions	Result
RQ 1: Can VUCA events be classified as an experience that can be tracked?	Paper 2 addressed this question and confirmed that VUCA events, and their domains, could be classified and experienced.
RQ2: Can a strategic tool be developed to reveal the phenomenon of VUCA events, as they occur?	Paper 3 addressed this question and developed a number of artefacts
RQ 3: Is there rigorous theoretical underpinning of the data sources for VUCA	Paper 4 addressed this question and confirmed the link between data indicators and existing research
Overall Research Aim: Can VUCA be visualised?	Paper 5 demonstrated this through a Case Study that consolidated the interlinked research from the separate Research Papers.

Figure 35 - Overall Mapping of RQ's to Results

8.2 VUCA Discovery Summary

The following table (Figure 36) shows which Research Papers addresses which research question.

Research Themes	Paper 1	Paper 2	Paper 3	Paper 4
RQ 1: Can VUCA events be classified as an experience that can be tracked?	✓	✓		
RQ 2: Can a strategic tool be developed to reveal the phenomenon of VUCA events, as they occur?			✓	
RQ 3: Is there rigorous theoretical underpinning of the data sources for VUCA?				✓

Figure 36 - Correlation Between the Papers and Research Questions

The research questions one to three were answered through the outputs from the Research Papers (found in Chapters 4, 5, and 6) with the overall research aim 'Can VUCA be visualised?' answered through a worked implemented example (i.e. Case Study of a real company and VUCA event in Chapter 7).

8.3 Synthesis of The Results

The aim of the thesis is to explore if VUCA could be visualised. The interlinked Research Papers undertook discrete research activities to answer specific research questions that were required to be able to develop a set of artefacts that could be used to answer the overall research aim. The artefacts included the VUCA Scorecard to aid decision making, research of data indicators as key building blocks for Pattern of Life, and the VUCA BreachMap to aid storytelling. The placing of VUCA within the field of Strategic Management and existing research helped identify the VUCA specific vocabulary to describe a VUCA event taking place. Taken together and consolidated in the Case Study, this thesis demonstrated how VUCA could be visualised for arguably the first time. Not just visualised, but how it could also pass meaningful data driven insights to those responsible for developing responses. The data driven insights would depend on the data sets used but could cover areas such as airports being closed, customer footfall dropping, or sudden price changes in the supply chain. These insights provide pointers on where to start, rather than just an opaque 'its hard out there'.

8.4 Research Hypotheses Revisited

The thesis proposed two research hypotheses at the outset and these are now reflected back on. The experiment planning ensured the two research hypotheses were addressed through research in the relevant Chapters (Research Papers). The primary hypothesis was a directional hypothesis, that 'events are time based and will change over time', which was proven in both Research Paper 2 (Survey) and Research Paper 5 (Case study). Through statistical analysis, Research Paper 2 clearly demonstrated that VUCA events and the individual VUCA domains evolve and change over time. The Case Study in Research Paper 5 put this into action and visualised the changing nature of

events and showed how organisations move through Normal Conditions to Turbulent Conditions as the events change over time. The Case Study showed how EasyJet went from being in Normal Conditions for the first six months, to Turbulent Conditions from month seven onwards as the PoL changed and moved outside the baseline, showing a VUCA event was taking place, and that 'events are time based and will change over time'.

The secondary hypothesis was a complex hypothesis "... a change in variable 1 will influence variables 2 & 3 etc...". This was proven in Research Paper 5 (Case Study) where a change in variable 1 (the Normal Conditions the organisation experienced became Turbulent Conditions), influenced variable 2 (VUCA decision making tools where the PoL moved outside its baseline and was clearly showing a VUCA event was detected and visualised), which in turn influenced variable 3 (VUCA BreachMap updated to show a VUCA event is taking place and what the characteristic so it are). The visual tools, such as the VUCA BreachMap, along with data driven insights and data indicators, can be used to drill into what is happening and illuminate key areas of concern, such as passenger number falling fast. These inbound signals to the organisation support the crafting of a strategic response. The changes in state, from Normal Conditions to Turbulent Conditions, cascade through the different variables as each detects a change in its input, borne out the hypothesis. At a macro level the changes in the external environment (variable 1) and VUCA toolset (variable 2) should initiate a change at the organisation (variable 3), as it realises it is moving from Business as Normal (BAU) to crisis or survival mode and seeks to craft a response that will likely mean doing things differently.

9 Discussion

This Chapter discusses the main themes of this research.

9.1 VUCA Events Can be Experienced

The second Research Paper, “Sensing VUCA Pre and Post COVID-19: A Survey”, clearly showed through quantitative research that VUCA could be experienced, and that the difference experienced was statistically significant as evidenced by the large Cohen’s d score. This was done through a survey with 153 participants in a controlled setting. There was a clear before and after, not just for the VUCA event itself, COVID-19, but also for each VUCA domain which showed a different impact (i.e. volatility was experienced differently to complexity). Further insights were identified that recognised how countries cultural and working practices impacted the results, and that participants experiences of the VUCA event differed depending on where they were in the VUCA lifecycle. The implications are wide ranging from the research. It validates the design of the decision-making tool and its ability to provide data driven insights across the different VUCA domains (volatility, uncertainty, etc.), but also suggests future research that could potentially allow the tools to be configured for local or regional uniqueness to improve the strategic response.

9.2 VUCA as Part of Strategy

VUCA, as a field of research, does not appear to have a natural home in literature. For example, it is not a subset of climate change, electrical engineering, distributed computing, psychology, or biology, yet has repeatedly appeared in journals in all those fields.

The constituent parts of VUCA, the volatility, uncertainty, complexity, and ambiguity, have all been researched extensively in their own right. For example, complexity theory (Yang 2024, Turner and Baker 2019) is a multidisciplinary framework that studies complex systems characterized by numerous interacting components, nonlinear dynamics, and emergent properties. So how does a researcher frame and centre VUCA as a domain of research?

This is not a new problem though. The field of Strategic Management, which traces its own roots back through the early Greeks (circa 500 BC) who used it to describe the art of leadership by generals (van Aartsengel and Kurtoglu 2013) and Sun Tzu's whose 'The Art of War' (circa 500BC) focused on military strategy and tactics (Shih and Hwang, 2018) has a rich history of researchers grappling with how to frame the external operating environment that organisations find themselves in and the impact this brings. A cornucopia of terms such Environmental Dynamism (AlMulhim 2023), Environmental Volatility (Schuh et al 2022), and the Chaotic Business Environment (Hapenciuc and Aurel 2014) have been used to describe the world, along with descriptions such as unpredictability, state of flux, instability, and unexpected, to outline the conditions and challenges organisations face.

Within Strategic Management, the term 'turbulent business environment' has emerged as one of the most dominant ways to frame the operating environment within Strategic Management. First introduced by Emery and Trist (1965), Ansoff (1979) followed this by producing a rating for environmental turbulence, and then more widespread usage followed by leading researchers in the field of strategy such as Johnson and Scholes (1989) Prahalad and Hamel (1990) and Grant (2003).

The initial set of VUCA research that was undertaken from 2007 to 2016, and covered in the Literature Review (Chapter 2), fell into three categories, namely Strategy and Leadership, Human Resources, and General Business Management, in essence the strategic activities to align and manage the organisation. They all saw VUCA as reflecting the turbulent business environment organisations had to respond to. And while Bartscht (2015) clearly identified the need to explore this environment it was only Bennett and Lemoine (2014) that really deconstructed VUCA down to each of its constituent parts arguing each has to be understood in isolation, as what works for one domain will not work for another, and assess what this means for solution development. VUCA therefore naturally sits under the field of Strategic Management.

9.3 VUCA Research Today

In reviewing the literature for VUCA, in particular published journal articles, it is clear that VUCA is not centred within one domain of research, such as design, marketing or economics, rather it comes up across all fields of study. This is perhaps not surprising given its modern use (post 2007) has been to act as a catch-all to describe the challenging external conditions of the world organisations face today. As an example, Kopackova et al (2024) in their paper 'Digital transformation leaders wanted' list 'VUCA environment' as a keyword for their paper, yet VUCA is not mentioned in the paper Title, Highlights or Abstract, and appears just twice in the main body where it is used in just the first paragraph to set context about the world and conditions that businesses operate in. This approach is typical of the use of VUCA in a large number of published papers. Bennett and Lemoine (2014) also identified this issue in their much-referenced VUCA paper, stating that VUCA has become a trendy byword for saying 'unpredictable change' with all the words being used interchangeably, with pundits and leaders being insensitive to the differences in meaning.

While this might seem detrimental to VUCA as an area of research, there are a number of undeniable positives. The use of VUCA is expanding, evidenced by its growing appearance in more journals which clearly demonstrates that VUCA is a term embedded in the common lexicon now and one that is cited extensively. This use of the term VUCA is expanding across multiple fields of study and research domains, evidencing a broadening of its acceptance as a term by researchers. Its use has become almost the de facto shorthand to describe the challenging external conditions organisations operate in today. Using the term VUCA is now almost justification enough in itself that if an organisation is faced with a 'VUCA environment', to use Kopackova et al (2024) example where for them it is used 'to describe today's business world', then that is a strong enough call to action for change within an organisation or field of study. To further evidence the growth and use of the term compare the results in the table below (Figure 37) which undertook an identical, repeatable search against Cranfield universities SearchPoint in different years. The results show a 1,153% increase in articles using the term VUCA. In essence, VUCA has gone mainstream.

Search Term	Data	Results (articles returned)
VUCA	7th March 2016	165
VUCA	24th February 2024	2068

Figure 37 - VUCA Searches

The journals where authors have published are wide and varied, with few if any repeat patterns of publishing, further evidencing its broadening appeal. For example, in 2024, papers have been published in ‘Journal of Computers in Education’, ‘Journal of Open Innovation: Technology, Market, and Complexity’ and ‘Frontiers in Psychology’ amongst others.

The “Journal of Open Innovation Technology, Market, and Complexity” (Luis Mayo-Alvarez et al 2024) is a strong textbook example of how VUCA can be referenced in journals. The authors cite VUCA seventy-three times in their paper, clearly linking it to the external environment and threats these impose on an organisation, but the core research is focused on the internal response, in this case improvements to planning, executing and controlling agile project delivery methodologies.

The early pioneers in applying VUCA to business during 2007 to 2016, such as Coates (2009) and Bennett and Lemoine (2014), were largely doing the same thing, using VUCA to position their research on ways to improve the internal organisation to respond against challenges in the external world. Bartscht (2015) was one the first researchers to really explore how an organisation needed to continuously “explore” their environment (increased exploration activity), which leads to improved situational understanding.

When reviewing the literature of VUCA, it is notable that a disproportionate number of published articles come from the research area of Human Resources, which includes management education, change management, talent management, training, learning and development, leadership coaching, etc. When a search of the term ‘VUCA’ was conducted on Cranfield University SearchPoint on 24th February 2024, out of the twenty articles the results returned

that were published between the 1st January 2024 and 24 February 2024, the majority fitted within the Human Resources domain as shown below (Figure 38):

Author & Year	Title	Journal
Kopackova et al 2024	Digital transformation leaders wanted: How to prepare students for the ever-changing demands of the labor market.	International Journal of Management Education
Juera 2024	Digitalizing skills development using simulation-based mobile (SiM) learning application	Journal of Computers in Education
Korlipara and Shah 2024	Power of words”: impact, concerns and applications of nonviolent communication training	European Journal of Training and Development
Zawadzki et al 2024	Trait emotional intelligence among future leaders: how business students are prepared for the VUCA world	Journal of Organisational Change Management
Chowdhury 2024	Navigating the VUCA Terrain: Unveiling HR Strategies for Modern Organisational Agility	SEISENSE Journal of Management
Jannah et al 2024	Navigating Uncertainty: Exploring Elementary School Teachers' Perspectives on Metacognitive Development in the VUCA Era.	Indonesian Journal on Learning & Advanced Education
Rahayuet al 2024	Analyzing transferable skills of vocational students to align with industry demands	Jurnal Pensil Volume
Garrido 2024	Leading collaborative change amid a crisis: a framework to liberate a team's leadership skills and promote sales performance	Journal of Work-Applied Management

Figure 38 - Human Resources Focused Papers 2024

This focus on Human Resources makes sense, as research shows that organisations through their people need to be developed as one of the ways to be able to deal with the changing world VUCA brings and explains why this is a rich area of research. This is part of how the ‘response’ to the data driven ‘sense’ signals the VUCA Event Deck provides is formulated, as organisations need to develop their capabilities to respond (Bennett and Lemoine 2014, Bartscht 2015).

9.4 VUCA can be Visualised

The Case Study drew together and consolidated the independent strands of research; the VUCA survey results, the focus on strategic decision-making tools, the VUCA Scorecard design, the rigorous theoretical underpinning of data sources, and the VUCA BreachMap to produce a worked example of VUCA visualised for an actual organisation, an airline, during a VUCA event, in this case COVID-19. The visualisations overlaid with the VUCA vocabulary and mark-ups enable a user to quickly see that the organisation has suffered both a VUCA Breach (the Pattern of Life threshold has been crossed) and a VUCA Peak (this occurs when the size of the impact is at least three times the normal Pattern of Life variance). Where this has happened across multiple VUCA domains (volatility, uncertainty, complexity, and ambiguity), as is the case for the airline, then we can say with a high degree of confidence that a VUCA event is taking place requiring strategic intervention as the organisation is experiencing extreme environmental turbulence, with the potential to impact its very survival.

This ability to see VUCA in action for arguably the first time is powerful and helps reduce information overload. It quickly allows decision makers to assess what is happening without reverting to dense reports and complex spreadsheets, yet still provides valuable data driven insights. This visual phenomenon of VUCA events allows a user to see all the moving parts at once to rapidly take stock the emerging situation, increasing the chances of successful strategic intervention. The VUCA Visualisation also provides a clear call to action by making the VUCA event real, requiring organisations to respond rather than just saying it's a hard and challenging landscape out there which in turn induces intellectual laziness. Further, it provides a structured repeatable way for organisations to identify early a move from Normal Conditions to Turbulent Conditions based on data.

9.5 Aiding Strategic Decision Makers

The VUCA Event Deck, with its ability to visualise the change in operating conditions from Normal to Turbulent, provides strategic decision makers with a decision-making tool to enable evidence based, informed and effective decisions. These decisions are now taken within a structured, repeatable, and auditable

framework that supports them with data driven insights to evaluate options, predict outcomes, and determine the best course of action based on specific goals, criteria, or constraints they have. If they have developed pre-canned responses, for example a playbook, the data driven signals will indicate what response they should action.

The visual nature of the VUCA Event Deck means that decision making is accelerated and VUCA Breaches can be seen quickly as the VUCA BreachMap aggregates up all the underlying data, which is potentially significant, into a single clean visual. The VUCA Scorecard defines the data sets used, allowing a decision maker to go back and drill into the data to get the richest picture possible of what is happening.

The data sets used can be wide ranging, and more sophisticated implementations may see data sets that relate to partners or competitors in their ecosystem, for example, a partner that they are dependent on as part of their supply chain. Being able to see VUCA events forming in the ecosystem and being able to follow the data to unpack these to obtain key insights could be key to responding quickly.

9.6 Teaching and Disseminating VUCA

This research has developed a range of artefacts along with guidance of their usage to help transfer knowledge to the peer group and ensure that both researchers and practitioners can deploy the decision-making tools to help understand an organisations operating environment and identify VUCA events. The VUCA Scorecard can help users structure their thinking and populate data indicators that help them understand events happening around them. The data indicators research in Research Paper 4 identified a candidate list of 16 data sets users can leverage day one to start building out VUCA Visualisation. The guidance on the VUCA Event Deck, particularly how to build VUCA Visualisations, and the supporting VUCA vocabulary, iconography, and supporting assets such as the VUCA Impact Rating, enables a shared understanding to support quicker situation awareness and decision making.

The research has also been taught and disseminated at a number of events. This includes lectures to master's students studying Management and Disruptive Innovation at Cranfield University School of Management and Cranfield University Centre for Competitive Design (C4D) between 2020 and 2023. Lectures have been given over 10 times with typical class sizes of 35 to 40 students each time, and an example of the slide pack used can be found in Appendix E – teaching collateral. Figure 39 shows a selection of images from lectures given.

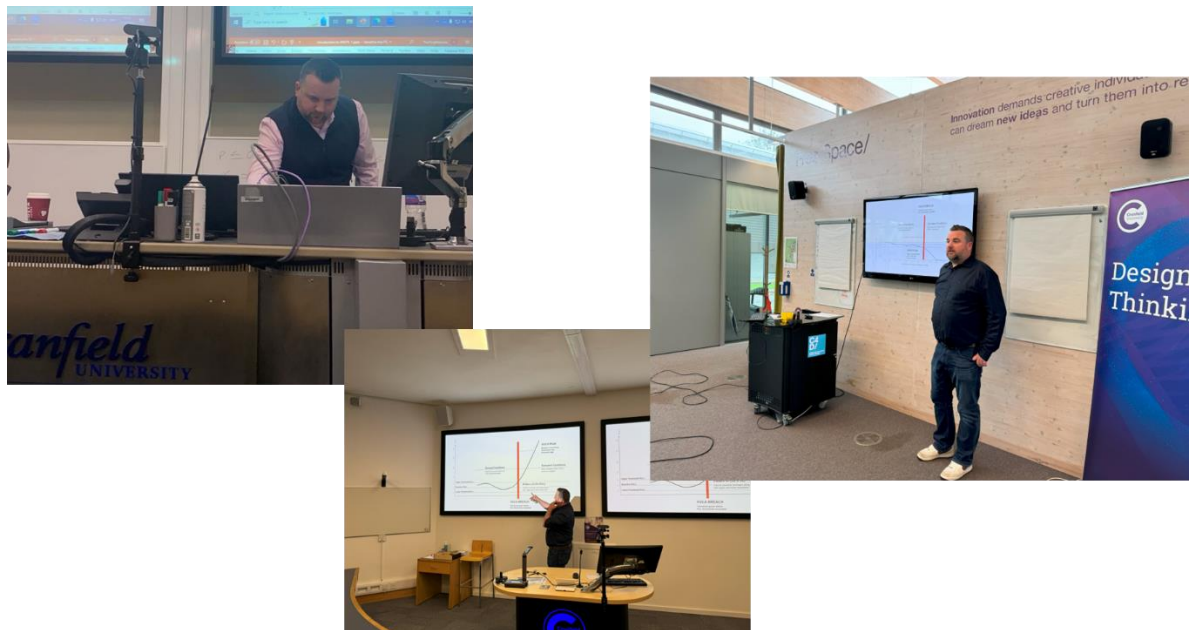


Figure 39 - Lectures 2020 to 2023

Lectures have been at least half a day and have covered the origins of VUCA, the VUCA Event Deck, and hands on sessions with the various VUCA artefacts that have been developed. Students were given guidance on how to complete the VUCA scorecard and then had breakout sessions to complete this, sometimes individually and sometimes in groups. Figure 40 shows a student completing the VUCA Scorecard.



Figure 40 - Completing VUCA Scorecard

Figure 41 on the next page shows a number of completed VUCA Scorecards, each from a different group from a number of different lectures as part of a mini assignment undertaken during the lecture. This provided the opportunity to use the VUCA artefacts and access additional one-to-one input if required. Once complete each group was asked to present back the data indicators they identified on their VUCA Scorecard to the whole class. This gave an opportunity to discuss how each group went about identifying data indicators, which often led to other groups extending their own list.

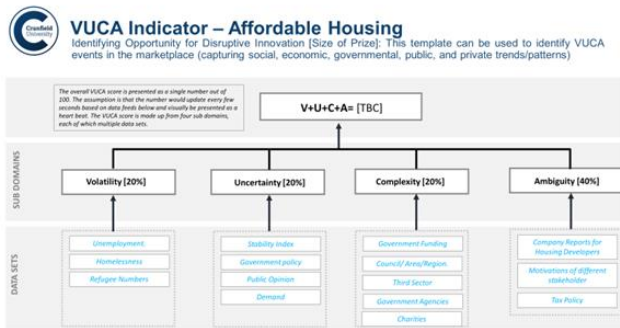
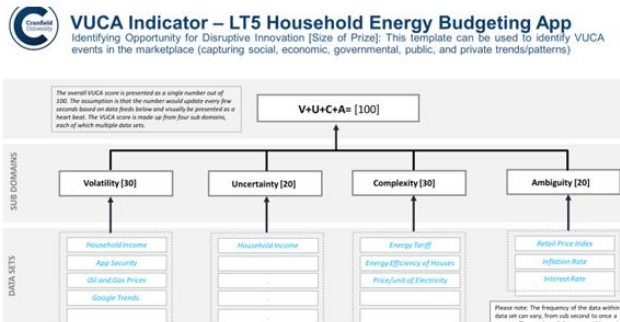
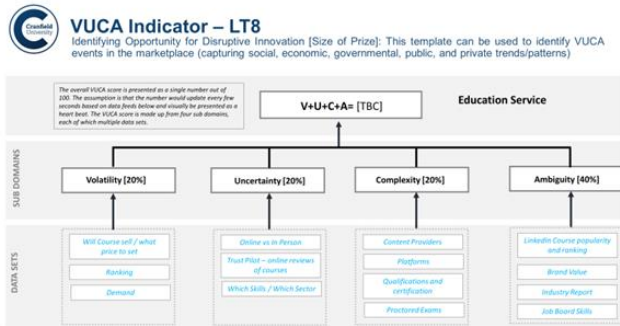
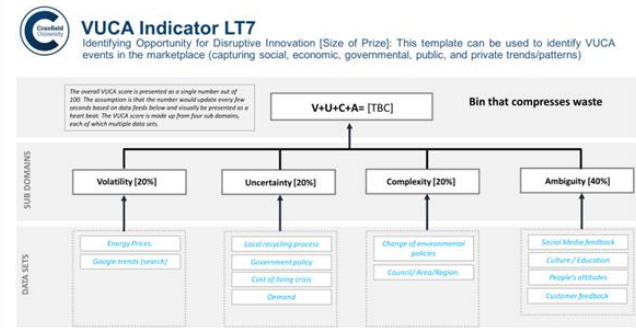
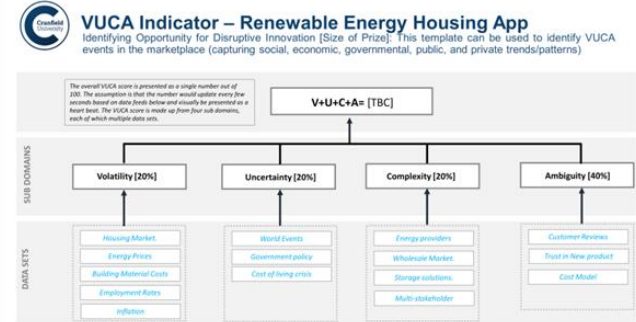


Figure 41 - Completed YUVA Scorecards

Alongside lectures, workshops following a similar format have been run with industry. It has often been the case that organisations have undertaken some form of leadership development or cultural change programme that has covered VUCA, but from the point of it being internally focused, and they have sought out more information on defining VUCA and identifying its formation. These workshops have also included hand on sessions with the VUCA Event Deck and its various artefacts. Figure 42 shows a workshop taking place with an industry team.

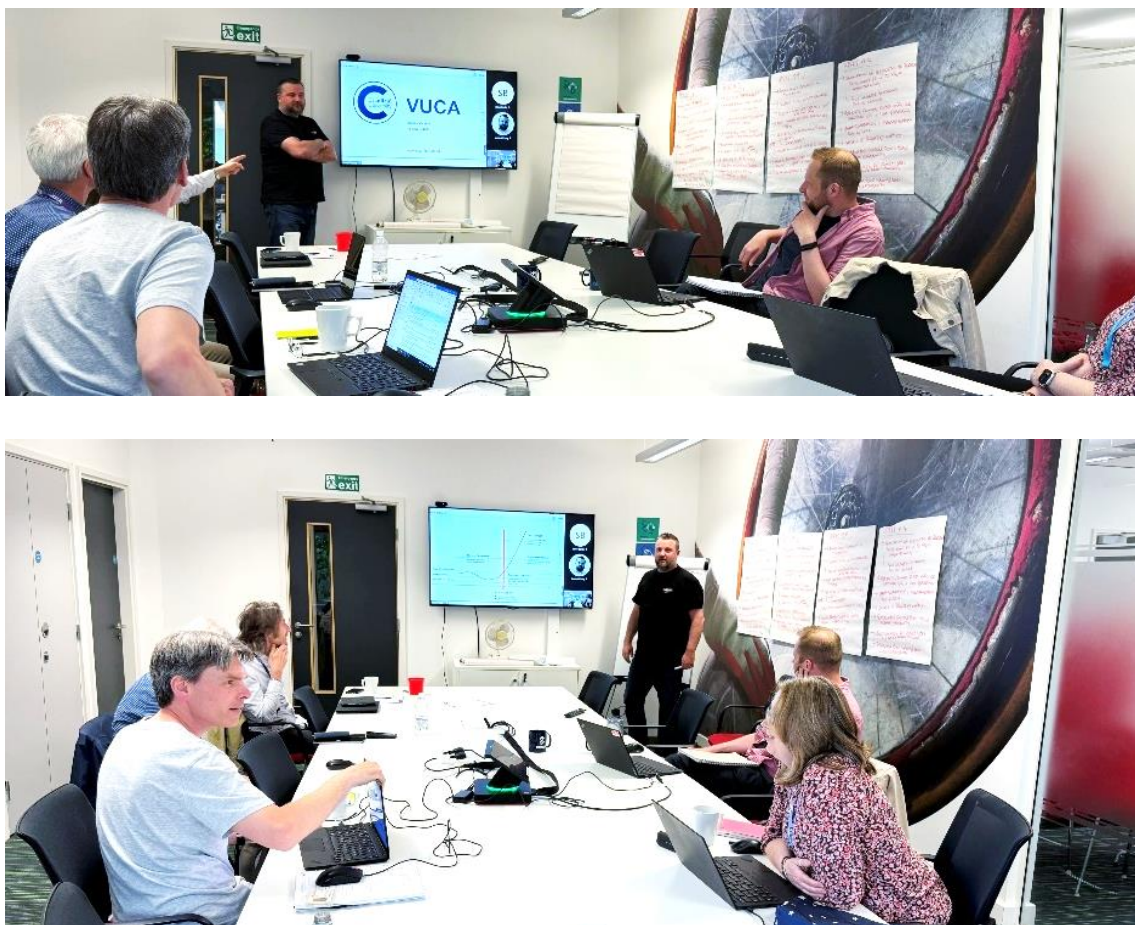


Figure 42 - Industry Workshops

Alongside these examples, the research has been presented at 3MT events and published in industry practitioner quarterly magazines.

9.7 Implications for Researchers

This research presents several implications for researchers across various disciplines:

- **Theory Development:** Researchers can use the VUCA Visualisation as a basis for developing new theories or extending existing ones. By exploring the data driven input signals of volatility, uncertainty, complexity, and ambiguity, researchers can contribute to a deeper understanding of how organisations and societies adapt and thrive in turbulent environments, particularly those experiencing VUCA events.
- **Intervention Strategies:** Investigating effective intervention strategies, the response to VUCA events and Turbulent Conditions is crucial. Researchers can explore how organisations can build resilience, target innovation, enhance decision-making processes, and develop adaptive strategies for deployment to navigate VUCA events successfully and even grow, using the input signals this research provides.
- **Cross-disciplinary Research:** Given the interdisciplinary nature of VUCA events and the required responses, researchers from diverse fields such as management, psychology, economics, sociology, and political science can collaborate to provide comprehensive insights into adaptive organisational structures and systems.
- **Longitudinal Studies:** Longitudinal research designs can shed light on how VUCA events evolve over time and their implications for organisational behaviour, strategy, and performance. Tracking changes and patterns can help identify trends and inform future decision-making, particularly with regard to best practice for Pattern of Life baselining in different contexts.

9.8 Implications for Practitioners

This research has significant implications for practitioners across various industries and organisational contexts:

- **Data Engineering** – Using the VUCA artefacts from this research, practitioners have the building blocks to construct a real time alerting service for both VUCA events and Turbulent Conditions. Doing this likely requires the design and implementation of a data ingest engine, processing logic, a visualisation layer, and a notification service. Practitioners will need to think about how they collect and store the data, dealing with variance in its velocity, variety, and volume. There are clearly opportunities to leverage machine learning and AI to aid with this, particularly the identification of Pattern of Life and VUCA Breaches.
- **Decision Making** – The VUCA Visualisation provides a comprehensive and data driven view into what is taking place with the external operating environment. Decision makers and decision-making processes should leverage the VUCA Visualisation to enhance decision quality ensuring optimal responses to VUCA events are crafted.
- **Strategic Planning**: Practitioners must recognise and adapt to the dynamic nature of the business environment. This involves incorporating VUCA considerations into strategic planning processes to anticipate and respond effectively to emerging challenges and opportunities.
- **Agility and Adaptability**: In VUCA environments, agility and adaptability are critical organisational competencies. Practitioners should foster a culture of innovation, flexibility, and rapid response to changing circumstances, enabling organisations to thrive amidst uncertainty and disruption. This position is supported extensively in literature on the subject of VUCA, particularly that which focuses on the internal aspects of Strategic Management (the response).

- **Stress Testing for Resilience:** Organisations can undertake war gaming type exercises, using synthetic data, to simulate VUCA events and observe how their organisation deals with the mock crisis. This has the potential to identify gaps in their agility, readiness and responses, aiding them in the development of a playbook they can implement when similar events appear.

9.9 Potential Weaknesses in VUCA Model

In undertaking the research, it became clear that of the four VUCA domains (volatility, uncertainty, complexity, and ambiguity) that ambiguity is underserved as both an area of research and potentially for data indicators as well. There is a wealth of research on areas like complexity and uncertainty, but far less on ambiguity. This is perhaps due to its intrinsic nature that it makes it hard to pin down and be scientifically precise in nature. During the research activities such as the survey and testing of VUCA Scorecard, it was evident that practitioners and participants struggled most with ambiguity as a domain. Extra guidance, such as the VUCA Descriptions and VUCA Iconography, helped address this issue both for the research and in the development of artefacts.

The following further weaknesses were identified (Figure 43), with potential mitigations proposed.

Weakness in VUCA Model	Mitigations
Overgeneralisation - The VUCA model may oversimplify complex situations and using the acronym may allow organisations the opportunity to avoid dealing with detail.	The use of VUCA as a shorthand for hard crisis situations has already been observed in literature. The development of a way to visualise VUCA and provide detail should help address this issue, but also the value of the outputs will warrant the effort to better understand VUCA.
Lack of Prescriptive Guidance – Historically there has been limited guidance on how to	The artefacts developed in this research directly address this weakness and for the first

frame and understand VUCA events and translate insights into actionable strategies.	time define how to frame and understand VUCA events with meaningful data driven insights.
External Factors – VUCA primarily focuses on external environmental factors and therefore may overlook internal factors which could contribute to the evolving situation.	While further research would be required to fully understand the impact, in theory there is nothing to prevent internal data being added to the VUCA Scorecard. The interaction of VUCA Visualisation and internal data would need to be researched.
Resignation to Fate – Organisations could misinterpret signals and believe they are helpless victims of external circumstances rather than owning own destiny.	The work in this research offers organisations hope. It crystallises what is taking place and provides insights to target responses. This is a step forward and offers a path to respond.
Cultural Variations – How VUCA is sensed and responded to may not fully account for cultural variations, for what is considered volatile or ambiguous in one cultural context may be perceived differently in another, requiring nuanced approaches.	The artefacts developed are flexible enough to deal with cultural variations. Further research though would help distil what these could be and provide guidance to users to account for known contextual differences and allowing tailoring of the tools.
Risk of Paralysis - Focusing too much on the environment and waiting on the next set of data could lead organisations to become overly cautious or hesitant to act, fearing the unknown consequences.	Having data driven insights is a clear step forward as it provides signals on what is taking place and allows organisations to strategize potential responses. Leadership and internal training, areas of existing VUCA research, should also be leveraged to promoted action over inaction. The VUCA Visualisation also provide a clear call to action as it makes the VUCA event real.
Threat Focus – Organisation may focus too much on the threats and challenges VUCA induces, rather than seeing it as an opportunity for growth.	Development of a playbook with examples of how organisations took advantage of VUCA events to grow would be a useful development to research. The existing internal research would also support organisations positioning for growth.

Figure 43 - VUCA Weakness and Mitigations

9.10 Limitations of Research

To address a clear research gap, this research focused on visualising VUCA to aid strategic decision makers, in essence the input part of the strategic conceptual model outlined in the Introduction (Chapter 1) and updated below (Figure 44). This research does not seek to understand how strategic responses or mitigations to the VUCA events unfolding are crafted or implemented, it focuses purely on the input signal – confirmation that a VUCA event is taking place along with data driven insights on what is causing it. There is extensive pre-existing literature on the output stage and how to respond to VUCA that can be leveraged, the focus therefore was on providing a rich visual input. The marrying of outputs (strategic responses) to the input (data driven insights) provides greater certainty of a successful counter to the event taking place, removing guesswork.

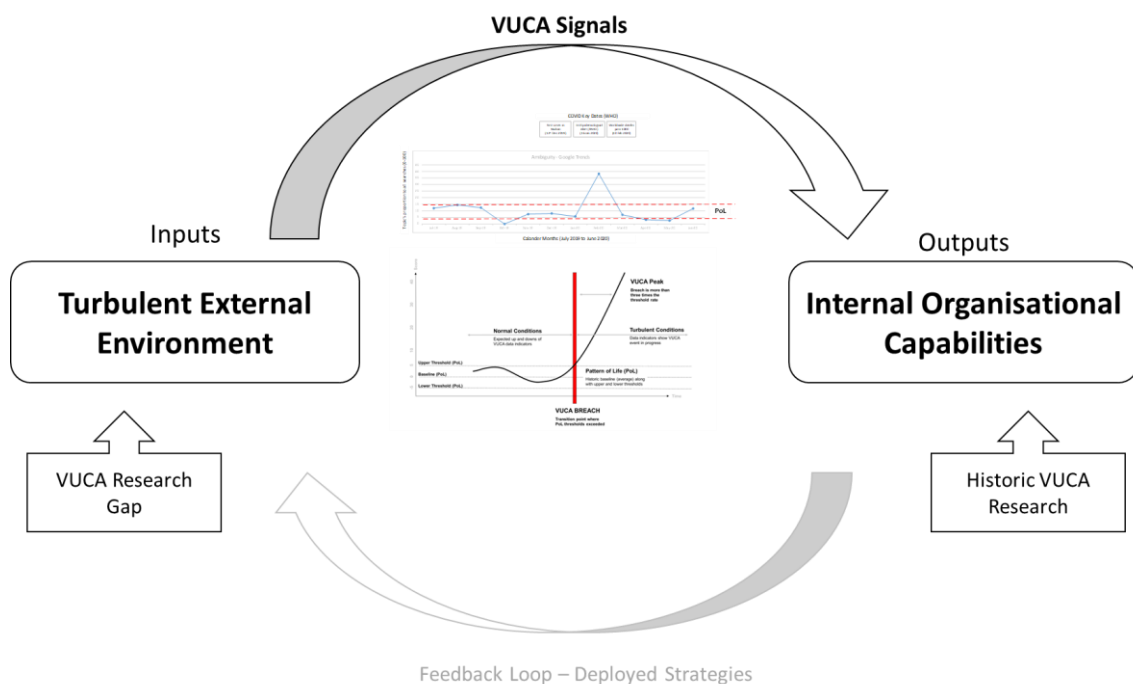


Figure 44 - VUCA Inputs to Strategy Development

It is recognised that while this research visualises VUCA for arguably the first time, this is just the first step on that journey. Further examples and case studies need to be developed to enable enhancement of the artefacts developed in this research.

9.11 Recommendations for Future Research

This research focused on visualising VUCA events taking place in organisations turbulent operating environment. In doing so it opened up a plethora of underserved areas for future research.

The interaction of VUCA Visualisation and the existing extant body of research that focused primarily on the internal development of capabilities to respond to VUCA events needs to be blended in future research to extract maximum value. The hard data driven signals that the VUCA Visualisation decision making tools from this research provide need to be joined or coded to existing research on how to respond. This could lead to a richer and fuller picture of both the external and internal factors within Strategic Management and provide elegant pre-determined solutions to crises that appear, or at the very least provide improved paths to resolution.

Leveraging the VUCA Visualisations and decision-making tools could enable organisations to improve resilience and innovation. Within future research it may be possible to use synthetic data to simulate a VUCA event, thereby allowing an organisation to stress test itself against different scenarios and understand the readiness levels it has, its resilience. This could involve studying resilient organisational structures, agile methodologies, and dynamic capabilities that enable organisations to thrive amidst rapid changes. Innovations could be targeted to emerging threats in the market through the data driven insights to take advantage of the adverse conditions to innovate and compete. Organisations able to do this at a quicker clock speed than their competitors will gain a competitive advantage. As part of the processes of resilience building and taking advantage of innovation gaps, the role of leadership in navigating VUCA could be examined to investigate the characteristics, behaviours, and skills of effective leaders in volatile, uncertain, complex, and ambiguous situations. Additionally, exploring how leadership development programs can better prepare individuals to lead in VUCA contexts, particularly the decision-making processes during simulated crises and high-pressure situations to improve decision quality and speed in such contexts would be a valuable undertaking.

Time and cost constraints meant that only one Case Study was developed. The working implementation of the VUCA Event Deck should now be tested against other organisations for cross applicability. The Case Study showed that for the travel sector, and particularly an airline, the impact of the VUCA events was clear, and a pattern could be seen. Now the VUCA Visualisation tools have been developed, it would be helpful to conduct similar case studies across a range of VUCA events and organisation types to further prove the method, fully assess the VUCA artefacts cross capability, identify any wider patterns, and fully appreciate any uniqueness or gaps that appear.

It should be noted that while this research focused on visualising VUCA, the ethnicity of this in developing a shared culture and language is for future research. This is the start of the visualising VUCA journey.

10 Conclusion

This thesis aimed to explore how a better understanding of VUCA and VUCA events could help thought leaders to make important strategic decisions to steer a safe and prosperous path for their organisation. It started by identifying and highlighting the gaps in research, where the primary focus had been to understand the building and transformation of internal organisation capabilities to respond to VUCA events, with little exploration of how to sense and understand VUCA in the external turbulent environment in which organisations operate in.

The thesis therefore set out with a number of research objectives and questions to better understand VUCA events and their intrinsic composition, with the aim of providing researchers and practitioners improved data driven insights to the VUCA events taking place. The final results addressed each of the research questions that were set out through distinct activities undertaken in a structured, methodical, and fully repeatable process, while proving the original hypotheses. The results were then discussed with a number of specific insights about VUCA reflected upon with clear implications of the findings for theory and practice.

10.1 Reflection on Research Aims, Objectives and Questions

This research set out to answer the overall research aim of 'Can VUCA be visualised?'. To do this, it developed a number of research objectives and questions which are reflected upon below (Figure 45).

Research Objective	Research Question	Paper
Objective 1 - Synthesise available literature and conduct a critical literature	RQ 1 - Can VUCA events be classified as an experience that can be tracked	Paper 1 - How can VUCA better help 'thought leaders' with strategic change: a systematic literature review
Reflection		

There was a clear paucity of quality Research Papers in existence at the point in time when the literature review was conducted. What did exist confirmed a number of assumptions about the focus of existing research; that it was internally focused, where the gap was, and the external focus. While the amount of journal articles published since the review has increased dramatically there has fortunately been no change of direction in what was originally found, in fact it has strengthened the position. It is hard to see how the literature review could have been done later in the process, and changing the parameters of the method would have allowed through low quality articles that were not peer reviewed. The literature that was covered helped with the framing of paper 2, and how it would answer RQ 1.

Research Objective	Research Question	Paper
Objective 2- Conduct primary quantitative research to better understand VUCA events and their different states.	RQ 1 - Can VUCA events be classified as an experience that can be tracked	Paper 2- Sensing VUCA Pre and Post COVID-19: A Survey

Reflection

The chosen method worked as planned and delivered clear results that were subject to statistical analysis. The use of the survey tool was helpful, as was having the group complete it as part of a focused session. Trying to just send the survey out to different people over email or online groups resulted in a poor response rate and was not a viable option to collect the required data, it would have also introduced quality control concerns. The hardest trade off was balancing the survey length and ensuring succinct and engaging questions to get the high return rate versus the researchers' thirst for more data and an expanded question set. While a more qualitative approach, such as interviews, may have supported a wider range of exploration into VUCA, the robustness of the quantitative analysis supported by the survey tool was critical to this overall body of work.

Research Objective	Research Question	Paper
Objective 3 - Explore what decision-making tools could be developed, baselined, and populated with data to aid strategic leaders.	RQ 2 - Can a strategic tool be developed to reveal the phenomenon of VUCA events, as they occur?	Paper 3 - Visualising VUCA to aid strategic decision making in turbulent times

Reflection

The research objective was achieved, and the research question answered. The research moves the conversation on from theory to the practical design of artefacts, critical to achieving the research aim. The qualitative approach to testing the VUCA Scorecard enabled groups to brainstorm data indicators, and as an approach this worked well.

One key reflection though is on the categorisation of data indicators. For a limited number of these, different arguments could be made for which VUCA domain they sit in, as they are often suggested from the viewpoint and perspective of the person or group completing the VUCA Scorecard. With hindsight it may have been beneficial to have collected these in a more analytical way to enable analysis of the distribution in the hope of seeing common data indicators that were regularly mis-classified, and more time to question the groups on their thinking behind their current classification. Additional guidance could then be developed, although there is probably always an element of the user perspective and what makes sense for their organisation that comes into play, particularly if they don't undertake rigorous theoretical underpinning of the data indicator.

Research Objective	Research Question	Paper
Objective 4 - Evaluate existing evidence and theory to test if data indicators can be validated within existing research.	RQ 3 - Is there rigorous theoretical underpinning of the data sources for VUCA?	Paper 4 - Can VUCA be underpinned by rigorous theoretical data sources
Reflection		
<p>While the research question was successfully answered, the method used, a structured and repeatable systematic literature review with semi-structured search strings, was exceptionally resource intensive and took far longer to complete than anticipated. While it proved and provided the academic rigour, the time required may disincentivise some actors, particularly practitioners. To the best knowledge of this author this was the first time this exercise had been done, and therefore repeat runs may offer opportunities and insights to optimise it further. The concept of a pre-approved candidate list where the research has already been undertaken would be a great addition that could be both leveraged and added to by researchers and practitioners in the community, maybe incorporating an element of peer review. There is also a need to keep a watching brief as Large Language Models (LLM's) trained on academic journals appear and if these offer more sophisticated search and prompt capabilities.</p>		

Figure 45 - Reflection

The approach and method used in each Research Paper worked, and consolidating these outputs enabled the implementation Case Study to be undertaken with real world data to demonstrate the visualisation of VUCA for a real organisation during a real VUCA event. The ability to take public open-source data, underpinned by research justification, and use this to populate the VUCA Scorecard, VUCA BreachMap, and the Pattern of Life method clearly demonstrated how the research built on existing theory and combined the outputs of this body of work to achieve in full the overall research aim. All the research can be repeated and replicated, including with different data indicators, for different organisations, and different VUCA events, enabling researchers and practitioners to leverage the work to visualise VUCA and experiment further. The research therefore made a clear contribution to knowledge.

10.2 Contribution to Knowledge

The contribution of this thesis lies in exploring the sensing, detecting and visualising of VUCA events, along with a greater understanding of the constituent parts that make up a VUCA event. In doing so it breaks VUCA down from being just a shorthand for saying it's a challenging world, and provides detail, context, and colour to that picture. In essence this is the 'input' part of the equation to the 'output' (building internal capabilities to respond). The input stage has traditionally been underserved, with most researchers and practitioners focusing on the output, and therefore this research makes a valuable contribution to the community in this area.

More specifically, the thesis makes the following theoretical contribution to knowledge as set out below. To the best knowledge of the author this was one of the first attempts to undertake the research performed and the contributions are unique.

Single Contribution to Knowledge: The ability to visualise VUCA

Through the implementation Case Study, this thesis is arguably an early indicator that for the first time VUCA can be visualised for the design-science and design-thinking scholarly community and for practitioners in strategic and innovation

management. This is groundbreaking as it allows researchers and practitioners to see VUCA events, potentially in real time as they form. The implementation Case Study consolidated, tested, and validated all the interlinked and continuous research that had taken place, primarily in the Research Papers, to produce a working example of a VUCA Event Deck, which comprises at its core the VUCA Scorecard and VUCA BreachMap (Figure 46). The VUCA Event Deck also provides a set of VUCA specific terminology to aid users in identifying and categorising the VUCA event taking place using a common vocabulary, iconography to aid recall, and guides such as the VUCA Impact Scale (Chapter 5) to aid decision making.

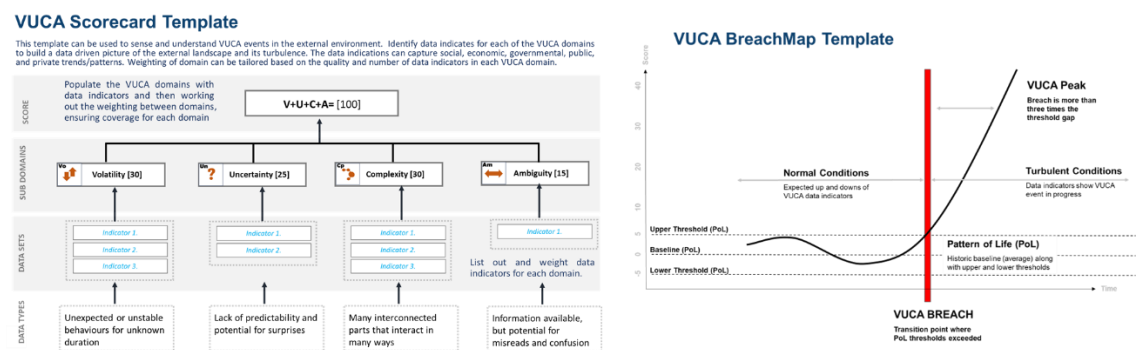


Figure 46 - VUCA Event Deck

These visualisations provide a structured way to identify data indicators and categorise these by VUCA domain on the VUCA Scorecard. A summary of the process is provided in Chapter 7, with a full step by step guide provided in Appendix D. Once data has been collected it can be used to build out the Pattern of Life, which in turn populates the VUCA BreachMap visualisation that makes sense to the community and aids them in detecting when a VUCA event is taking place along with data driven insight into the make-up of the event. The visual nature of the VUCA Event Deck helps the community understand the data indicators being collected and quickly assess the situation when turbulence occurs by clearly showing a breach in the Pattern of Life. The visual nature expedites the identification of changes in the baseline which helps with temporal

aspects, where time of response may be critical, and reduces cognitive load where traditionally the volume of information could be hard to consume (for example, large sets of numbers in a spreadsheet).

This research directly addressed the gap identified in literature and conducted research that explored in depth the VUCA input stage, the turbulent environment, and proposes new original, novel ideas and artefacts to aid researchers and practitioners. This contribution is hugely relevant to the growing conversation on VUCA and directly helps researchers and practitioners better understand VUCA events to develop internal capabilities and formulate responses. The research from this thesis has already started to be shared and disseminated with peers that include researchers and practitioners. The key principles of VUCA, VUCA artefacts, and obtaining VUCA focused data sets, have been taught to multiple classes of master's and executive education students, as well as workshops with industry practitioners where all the artefacts produced have been used. The key concepts have been presented at events such as 3MT competitions.

10.2.1 Additional Findings

Through undertaking the research, a number of inter-related findings were identified that supported the contribution to knowledge. Again, to the best knowledge of the author this was one of the first attempts to undertake the research performed and the findings are arguably unique

First, through primary data collection and analysis, it was one of the first instances to quantitatively demonstrate VUCA events can be experienced, both as a whole and each of its individual parts separately (the volatility, uncertainty, complexity, and ambiguity). The research showed a clear before and after state that was statistically significant using Cohen's *d* analysis, and that as the individual parts were experienced differently, there was not one uniform impact from VUCA.

Second, through theoretical research, it linked VUCA within the field of Strategic Management, and in particular Environmental Turbulence. This work

demonstrated that VUCA was not new, but part of existing and long-standing research into Strategic Management and strategic decision making.

Third, through theory building through conceptual methods, a VUCA Scorecard was developed that could act as a much-needed strategic decision-making tool to detect and understand VUCA events. Through the use of different data sets, the VUCA Scorecard could be configured and customised to be tightly targeted to the organisation undertaking the analysis. The VUCA Scorecard was developed to be transferable across organisations and industries, thereby ensuring wide applicability. Its fitness for purpose was validated via qualitative research with focus groups.

Fourth, through both theoretical research and theory building through conceptual methods, Pattern of Life was identified as a way to bring the VUCA Scorecard to life. This research was unique as it was the first time the Pattern of Life technique had been applied to VUCA and also as a way to populate a scorecard. This approach meant that it offered the opportunity to run a real time instance of the VUCA Scorecard and see VUCA events forming as they happened.

Fifth, through theoretical research, data sets were identified that could be used as candidate indicators within the VUCA Scorecard. This is arguably the first time a link has been established between the data required to understand VUCA events and existing peer reviewed research of potential VUCA data sets. This work validates the robustness of the data sets to populate a VUCA Scorecard.

Finally, the overall body of work in this thesis in exploring VUCA provides much needed insight into the formation and visualisation of VUCA events that will provide both researchers and practitioners data driven signals to shape internal capability building against. It also opens up a wide range of avenues for additional research in the area.

11 References

- Abbas, J., Balsalobre-Lorente, D., Amjid, M.A., et al, (2024); Financial innovation and digitalization promote business growth: The interplay of green technology innovation, product market competition and firm performance, *Innovation and Green Development*, Volume 3, Issue 1, 2024,100111,ISSN 2949-7531, <https://doi.org/10.1016/j.igd.2023.100111>.
- Abdulrahman, M.S.A., & Khder, M. A. (2022) "Customers Real Reviews and Feedback Using Mobile Application," 2022 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems (ICETSIS), Manama, Bahrain, 2022, p470-476, doi: 10.1109/ICETSIS55481.2022.9888865.
- Ackoff, R.L. (1998), "A systemic view of transformational leadership", *Systemic Practice and Action Research*, Vol. 11 No. 1, pp. 23-36.
- Ackoff, R.L. (2006), "Why few organizations adopt systems thinking", *Systems Research and Behavioral Science*, Vol. 23 No. 5, pp. 705-708.
- Adner, R. (2017) Ecosystem as structure: an actionable construct for strategy, *J. Manag.*, 43 (1) (2017), pp. 39-58, 10.1177/0149206316678451
- Afonsoa, A., & Jalles, J.T. (2012) Fiscal volatility, financial crises and growth; *Applied Economics Letters*, 2012, 19, 1821–1826
- Aguilar, F.J. (1967), "Scanning the Business Environment", Macmillan
- Ahiabenu, K. (2023) Increasing Competition Between Banks And Mobile Money Companies: Competitors Or Allies?, *ICTACT Journal on Soft Computing* Volume: 14 Issue 1 (2023) ISSN: 0976-6561 Online ISSN: 2229-6956
- Ahir, H., Bloom, N., & Furceri D., (2020) 60 Years of Uncertainty, <https://www.imf.org/en/Publications/fandd/issues/2020/03/imf-launches-world-uncertainty-index-wui-furceri>, accessed 5 Jan 2024
- Ahuja, V., Yang, J. & Shankar, R. (2009) Study of ICT adoption for building project Management in the Indian construction industry. *Automation in Construction*, 18 (4),415-423.

Ajith, P. (2015) "KESHAVA -Holistic Employee Selection Framework in the VUCA World", SCMS Journal of Indian Management, Quarterly, October - December 2015

Al-Zahari, N.S., Zainal, N.Z., Seman, S.A.A., Salleh, N.F. (2023) Influence Unleashed: How Social Media Influencers Credibility Drives Viral Success; Global Business & Management Research. 2023 Special Issue, Vol. 15, p84-92.

AlMulhim, A.F. (2023) "Knowledge management capability and organizational performance: a moderated mediation model of environmental dynamism and opportunity recognition", Business Process Management Journal, Vol. 29 No. 6, pp. 1655-1679. <https://doi.org/10.1108/BPMJ-10-2022-0515>

Albeaik, S., Kaltenberg, M., Alsaleh, M., Hidalgo, C.A. (2017) Improving the Economic Complexity Index, Working Paper (arXiv:1707.05826) Publication Year: 2017

Alberto, B. M. & Fernando, L. L. (2007). A firm-level analysis of determinants of ICT adoption in Spain. *Technovation*, 27, 352-366.

Alghamdi, S., Hilton, B., Alhasawi, Y., Corso A., Hilton, J. (2022) "Artifact for Strategic Decision-Making by Telecommunication Firms," 2022 4th International Conference on Emerging Trends in Electrical, Electronic and Communications Engineering (ELECOM), Mauritius, 2022, pp. 1-9, doi: 10.1109/ELECOM54934.2022.9965246.

Allport, G. W. (1954). *The Nature of Prejudice*. Cambridge, MA: Addison-Wesley.

Alshawi, S. (2010). Organisational, technical and data quality factors in CRM adoption: SMEs perspective. *Industrial Marketing Management*, 40(3), 376-383.

Aminu, N. (2019) Energy prices volatility and the United Kingdom: Evidence from a dynamic stochastic general equilibrium model; *Energy*, Volume 172, 2019, Pages 487-497, ISSN 0360-5442, <https://doi.org/10.1016/j.energy.2019.01.092>.

Andhini, G.K., & Ramadhan, A.S. (2023) "The Role of Social Media Influencer towards Fashion Brand Sales for Indonesia's Young Consumers," 2023 8th

International Conference on Business and Industrial Research (ICBIR), Bangkok, Thailand, 2023, pp. 155-160, doi: 10.1109/ICBIR57571.2023.10147431.

Anitha, M., & Aruna, J. (2014) Adoption of Human Resource Information System in Organisations, *Journal of Contemporary Research in Management*, Vol. 9, No. 4, Oct - Dec, 2014

Anitha, M., & Aruna, J. (2015) Employee Retention Enablers: Generation Y Employees, *SCMS Journal of Indian Management*, Quarterly, July - Sept 2015

Annabelle, C., & Stokes, S. (2022) Availability of 'Do-It-Yourself' orthodontics in the United Kingdom; *Journal of Orthodontics* Volume: 49 Issue 1 (2022) ISSN: 1465-3125 Online ISSN: 1465-3133

Ansoff, H. I. (1957) 'Strategies for diversification' *Harvard Business Review*, Vol. 30, pp. 113–124.

Ansoff, H. I. (1979). *Strategic Management*. London: Macmillan.

Anuşlu, M.D., & Firat, S.U. (2019) Clustering analysis application on Industry 4.0-driven global indexes, *Procedia Computer Science* 158 (2019) 145–152

Apergis, N., Mustafa, G., Malik, S., (2023) The role of the COVID-19 pandemic in US market volatility: Evidence from the VIX index, *The Quarterly Review of Economics and Finance*, Volume 89, 2023, Pages 27-35, ISSN 1062-9769, <https://doi.org/10.1016/j.qref.2023.03.004>.

Apeti, A.E., Combes, J.L., Minea, A. (2024) Inflation targeting and fiscal policy volatility: Evidence from developing countries; *Journal of International Money and Finance*, Volume 141, 2024, 102996, ISSN 0261-5606, <https://doi.org/10.1016/j.jimonfin.2023.102996>.

Arbatli, E., & Hong, G.H. (2016) "Singapore's Export Elasticities: A Disaggregated Look into the Role of Global Value Chains and Economic Complexity." IMF Working Paper No. 16–52.

Argyris, C. (1994) Good Communication That Blocks Learning, *Harvard Business Review*, July-Aug 1994

Armanious, M. & Padgett, J.D. (2021) "Agile learning strategies to compete in an uncertain business environment", *Journal of Workplace Learning*, Vol. 33 No. 8, pp. 635-647. <https://doi.org/10.1108/JWL-11-2020-0181>

Azevedo, G., & Gates, A. (2018) Wake Up! The World Is Out of Balance and If You Do Nothing You Are Part of the Problem: An Interview With Henry Mintzberg. *Journal of Management Inquiry*, 2018, 28 (2), pp.180-186. 10.1177/1056492618761811. hal-02915588

Baker, S., Bloom, N., Davis, S. (2016) Measuring Economic Policy Uncertainty, *The Quarterly Journal of Economics*, Volume 131, Issue 4, November 2016, Pages 1593–1636, <https://doi.org/10.1093/qje/qjw024>

Baker, S., Bloom, N., Davis, S.J., & Renault, T. (2021) Twitter-Derived Measures of Economic Uncertainty; Vols. 1–14

Balaban, D.C., Szambolics, J., Chirică, M. (2022) Parasocial relations and social media influencers' persuasive power. Exploring the moderating role of product involvement; *Acta Psychologica*, Volume 230, 2022, 103731, ISSN 0001-6918, <https://doi.org/10.1016/j.actpsy.2022.103731>.

Baldwin, J. M. (1904) "The Genetic Progression of Psychic Objects," *Psychological Review* 11 (1904): 216–221

Baldzhy, M., Khavrova, K., Guseva, O., Goloborodko, A., Artyomova, A. (2023) Risk management strategies in the global business environment: analysis of complex dependencies and effectiveness of measures. *GeSec: Revista de Gestao e Secretariado*; 2023, Vol. 14 Issue 10, p19237-19252, 16p

Balfaqih, H., Nopiah, Z. M., Saibani, N., Al-Nory, M. T. (2016) Review of supply chain performance measurement systems: 1998–2015. *Computers in Industry*, 82(October 2016), 135–150. <https://doi.org/10.1016/j.compind.2016.07.002>

Banerjee, A. (2023) Risk Return Analysis of FTSE Listed Select Stocks with FTSE100 Index; *Journal of Accounting, Business and Management (JABM)* vol. 30 no. 2 (2023) 59-69

Barbier, L., & Tenengeh, R. (2022). Enhancing Public Service Delivery in a VUCA Environment in South Africa: A Literature Review. *RUDN Journal of Public Administration*. 9. 418-437. 10.22363/2312-8313-2022-9-4-418-437.

Barbuscia A, Pailhé A, Solaz A; Epicov team. (2023) Do Income and Employment Uncertainty Affect Couple Stability? Evidence for France During the COVID-19 Pandemic. *Eur J Popul*. 2023 Jul 3;39(1):19. doi: 10.1007/s10680-023-09665-4. PMID: 37395827; PMCID: PMC10317946.

Barquissau, D.N., Pett, T.L. Sers, F.C. (2024), "Can independent hotels survive? A Case Study of how technology changes the industry", *Journal of Business Strategy*, Vol. 45 No. 1, pp. 17-24. <https://doi.org/10.1108/JBS-10-2022-0178>

Bartscht, J. (2015) "Why systems must explore the unknown to survive in VUCA environments", *Kybernetes*, Vol. 44 Iss 2 pp. 253 - 270

Baruch, Y. (2004). "Transforming careers from linear to multidirectional career paths: organisational and individual perspectives. *Career Development International*, 9(1), 58-73.

Batten, J.A., Choudhury, T., Kinatader, H. et al. (2023) Volatility impacts on the European banking sector: GFC and COVID-19. *Ann Oper Res* 330, 335–360 (2023). <https://doi.org/10.1007/s10479-022-04523-8>

Battiston, S., Puglia, M., Kaushik, R., Tasca, P., Caldarelli, G. (2012) Debrank: Too central to fail? financial networks, the FED and systemic risk. *Sci. Rep.* 2, 541 (2012).

Bauerlein, M. (Ed.) (2011), *The Digital Divide: Arguments For and Against Facebook, Google, Texting, and the Age of Social Networking*, Penguin, New York, NY.

Bauman, Z. (2008), *Consuming Life*, Polity Press, Cambridge.

Beamon, B. (1998) Supply chain design and analysis: Models and methods, *International Journal of Production Economics*, Vol.55, No.3, pp. 281–294, 1998.

Beck, J. C., & Wade, M. (2004). "Got game: How the gamer generation is reshaping business forever." Boston:. Harvard Business School Press; First Printing edition (1 Sept. 2004)

Beckers, A. M. & Bsath, M. Z. (2002). A DSS classification model for research in human resource information systems. *Information Systems Management*, 19(3), 41-50

Bell, M. (2013) Why big business and the NSA sift through your data patterns <https://www.channel4.com/news/nsa-spying-pattern-of-life-data-analysis-intelligence> (10 June 2023)

Benigno, G., Di Giovanni, J., Groen, J., Noble, A. (2022) A New Barometer of Global Supply Chain Pressures . Federal Reserve Bank of New York Liberty Street Economics. <https://libertystreeteconomics.newyorkfed.org/2022/01/a-new-barometer-of-global-supply-chain-pressures/> (accessed 15.24 on 22/04/2023)

Bennett, N., & Lemoine, G.J. (2014) What a difference a word makes: Understanding threats to performance in a VUCA world. *Business Horizons*. Volume 57, Issue 3, May–June 2014, Pages 311-317

Berchicci, L. (2013) Towards an open R&D system: Internal R&D investment, external knowledge acquisition and innovative performance. *Research Policy*, 42(1): 117–127.

Berrisch, J., Pappert, S., Ziel, F., Arsova, A. (2023) Modeling volatility and dependence of European carbon and energy prices, *Finance Research Letters*, Volume 52, 2023, 103503, ISSN 1544-6123, <https://doi.org/10.1016/j.frl.2022.103503>

Beveridge, M., Gear, A.E. Minkes, A.L. (1997) "Organizational learning and strategic decision support", *The Learning Organization*, Vol. 4 No. 5, pp. 217-227. <https://doi.org/10.1108/09696479710186403>

- Beyer, S.M., Mullins B.E., Graham, S.R., Bindewald, J.M. (2018) Pattern-of-Life Modeling in Smart Homes, IEEE Internet Of Things Journal, Vol. 5, No. 6, December 2018 5317
- Bhageshpur, K. (2019) Data Is The New Oil -- And That's A Good Thing, Forbes Technology Council Post Nov 15, 2019,08:15am EST (accessed 24/01/2022)
- Bhatia, G., Lane, C., Wain, A. (2013) Building Resilience in Supply Chains, January 2013, World Economic Forum Industry Agenda Report
- Blecker, T., Kersten, W., Meyer, C. (2005). Development of an Approach for Analyzing Supply Chain Complexity. In T. Blecker & G. Friedrich (Eds.), Mass Customization Concepts – Tools – Realization (pp. 47–59). Berlin: Gito Verlag.
- Bloom, N., Ahir, H., & Furceri D., (2022) Visualizing the Rise of Global Economic Uncertainty, Havard Bussines Review, September 29, 2022 <https://hbr.org/2022/09/visualizing-the-rise-of-global-economic-uncertainty>
- Bloomberg (2022) New York Fed Warns of Worrisome New Pressure on Global Supply Chain, Ana Monteiro (author) Bloomberg.com. 5/18/2022, pN.PAG-N.PAG. 1p.
- Bloomquist, C. (2014). "Mentoring Gen X librarian." Public Libraries, 53(3),30-33.
- Boccaletti, S., Latora, V., Moreno, Y., Chavez, M. Hwang, D. (2016) Complex networks: Structure and dynamics. Phys Rep 424, 175 (2006).
- Bode, C., & Wagner, S. M. (2015) Structural drivers of upstream supply chain complexity and the frequency of supply chain disruptions. Journal of Operations Management, 36: 215–228.
- Bodenhause, G.V., & Peery, D. (2009) Social Categorization and Stereotyping In vivo: The VUCA Challenge, Social and Personality Psychology Compass 3/2 (2009): 133–151, 10.1111/j.1751-9004.2009.00167.x
- Bonacich, P. (1987) Power and centrality: A family of measures. Am. J. Soc. 1170 (1987).

Bourne, M. (2021). Performance measurement and management in a VUCA world. *International Journal of Production Research*, 59(24), 7311–7316. <https://doi.org/10.1080/00207543.2021.2004042>

Boy, F., (2023) "Google Trends™ Dynamics for the Guidance of Open-Source Intelligence: Augmentation of Social-Media and Survey Surveillance of Population Mental Health," 2023 IEEE International Symposium on Technology and Society (ISTAS), Swansea, United Kingdom, 2023, pp. 1-9,

Bozarth, C. C., Warsing, D. P., Flynn, B. B., Flynn, E. J. (2009). The impact of supply chain complexity on manufacturing plant performance. *Journal of Operations Management*, 27(1), 78–93.

Bozma, G., Urak, F., Bilgic, A., & Florkowski, W.J. (2023) The volatility of beef and lamb prices in Türkiye: The role of COVID–19, livestock imports, and energy prices. *Public Library of Science One*, San Francisco Vol. 18, Iss. 3, (Mar 2023): e0282611. DOI:10.1371/journal.pone.0282611

Braca, P. (2022) "Keynote: Multi-domain situational awareness - From the underwater to the space domain to improve maritime surveillance," 2022 IEEE Conference on Cognitive and Computational Aspects of Situation Management (CogSIMA), Salerno, Italy, 2022, pp. 97-97, doi: 10.1109/CogSIMA54611.2022.9830685.

Bradley, G.L., Sparks, B.A, & Weber, K. (2016), "Perceived prevalence and personal impact of negative online reviews", *Journal of Service Management*, Vol. 27 No. 4, pp. 507-533. <https://doi.org/10.1108/JOSM-07-2015-0202>

Breen, M., & Doak, E. (2023) The IMF as a global monitor: surveillance, information, and financial markets, *Review of International Political Economy*, 30:1, 307-331, DOI: 10.1080/09692290.2021.2004441

Brown, L.R. (1996) Who will feed China? *The Futurist*; Washington Vol. 30, Iss. 1, (Jan/Feb 1996): 14.

Brzozowski, M., & Siwińska-Gorzelak, J. (2010) The Impact Of Fiscal Rules On Fiscal Policy Volatility; *Journal of Applied Economics*. Vol XIII, No. 2 (November 2010), 205-231

Bu, R., Hizmeri, R., Izzeldin, M., Murphy, A., Tsionas, M., (2023) The contribution of jump signs and activity to forecasting stock price volatility; *Journal of Empirical Finance*, Volume 70, 2023, Pages 144-164, ISSN 0927-5398, <https://doi.org/10.1016/j.jempfin.2022.12.001>.

Burmeister, M. (2009). "It's all about me becomes a cross generational conversation." 63(5), 92-93.

Cabanes, B. (2023) "Should We Keep Brainstorming to Innovate?," in *IEEE Engineering Management Review*, vol. 51, no. 2, pp. 12-14, 1 Second Quarter, June 2023, doi: 10.1109/EMR.2023.3260312.

Cadot, O., Carrère, C., Strauss-Kahn, V. (2011) Export diversification: what's behind the hump?, *Rev. Econ. Stat.*, 93 (2) (2011), pp. 590-605

Cadot, O., Carrère, C., Strauss-Kahn, V. (2013) Trade diversification, income, and growth: what do we know?, *J. Econ. Surv.*, 27 (4) (2013), pp. 790-812,

Calinescu, A., Efstathiou, J., Huaccho, H.L. Sivadasan, S. (2001) Classes of complexity in manufacturing. In *Proceedings of the 17th national conference on manufacturing research, NCMR 2001: Advances in manufacturing technology XV* (pp. 351–356). University of Cardiff, UK.

Calmotti, M. S. C., & Caba L. F. E. (2022) Macroeconomic Effects of Fiscal Policy during the Covid-19 Crisis: Evidence from Bolivia at a Regional Level

Cannon, A.R., & St John, C.H. (2007) Measuring Environmental Complexity: A Theoretical and Empirical Assessment, *Organizational Research Methods*; Apr 2007; 10, 2; ProQuest pg. 296

Carneiro, H. A., & Mylonakis. E.. (2009) 'Google trends: a web-based tool for real-time surveillance of disease outbreaks'. *Clin Infect Dis*. 2009 Nov 15;49(10):1557-64. doi: 10.1086/630200. PMID: 19845471.

- Caron, D. (2009) It's a VUCA world. Available at: (last accessed: 06 April 2016).
- Carvalho, H., Azevedo, S.G., Cruz-Machado, V. (2012), "Agile and resilient approaches to supply chain management: influence on performance and competitiveness", *Logistics Research*, Vol. 4 Nos 1/2, pp. 49-62.
- Cashin, D., Lenney, J., Lutz, B., Peterman, P. (2017). "Fiscal Policy and Aggregate Demand in the U.S. Before, During and Following the Great Recession," Finance and Economics Discussion Series 2017-061. Washington: Board of Governors of the Federal Reserve System, <https://doi.org/10.17016/FEDS.2017.061>.
- Cavaye, M. & Hussain, H. (2007). IT alignment and performance in small manufacturing firms. *Journal of Strategic Information Systems*, 11, 109-132.
- Cebula, R., Rossi, F., & Clark, J. (2016) The impact of higher quality government regulation of business and greater economic freedom on living standards: Evidence from OECD nations. *Journal of Entrepreneurship and Public Policy*, 5(1), 82–94. <https://doi.org/10.1108/JEPP-11-2015-0034>
- Cebulla A, Szpak Z, Howell C, Knight G, Hussain S. (2023) Applying ethics to AI in the workplace: the design of a scorecard for Australian workplace health and safety. *AI & SOCIETY: Journal of Knowledge, Culture and Communication*. 2023;38(2):919-935. doi:10.1007/s00146-022-01460-9
- Cevik, S., & Ninomiya, K. (2023) Chasing the sun and catching the wind: Energy transition and electricity prices in Europe. *J Econ Finan* 47, 912–935 (2023). <https://doi.org/10.1007/s12197-023-09626-x>
- Chandler, A.D. (1962) *Strategy and Structure: Chapters in the History of the American Industrial Enterprise* (MIT Press). Accessed via Google books.
- Chandler, A.D. (1977) *The Visible Hand: The Managerial Revolution in American Business* (Harvard University Press). Accessed via Google books. <https://www.jstor.org/stable/j.ctvjghwrj>

Chatterjee, U. (2023) World Uncertainty Indices, Financial Markets, and U.S. GDP Growth; *Journal of Accounting & Finance* Volume: 23 Issue 4 (2023) ISSN: 2158-3625

Chaudhari, V., & Damle, M. (2023) "Strategic Decisions using Machine Learning with Interpretative Structural Modelling (ISM) on Digital Platform Data for Marketing Intelligence," 2023 International Conference on Inventive Computation Technologies (ICICT), Lalitpur, Nepal, 2023, pp. 58-64, doi: 10.1109/ICICT57646.2023.10134285.

Chen, C., Huang, Y., Yang, F., (2024) Semantics matter: An empirical study on economic policy uncertainty index, *International Review of Economics & Finance*, Volume 89, Part A, 2024, Pages 1286-1302, ISSN 1059-0560, <https://doi.org/10.1016/j.iref.2023.08.015>.

Chen, C.-L., Liu, C.-L., Chang, Y.-C., Tsai, H.-P. (2011) "Exploring the Relationships between Annual Earnings and Subjective Expressions in US Financial Statements," 2011 IEEE 8th International Conference on e-Business Engineering, Beijing, China, 2011, pp. 1-8, doi: 10.1109/ICEBE.2011.47.

Chen, C.-Y., Chen, P.F., Jin, Q. (2015) Economic freedom, investment flexibility, and equity value: a cross-country study; *Account. Rev.*, 90 (5) (2015), pp. 1839-1870

Chen, H.-M., Blasch, E., Sullivan, N., Chen, G. (2022) "Trajectory-Based Pattern of Life Analysis," 2022 IEEE International Conference on Image Processing (ICIP), Bordeaux, France, 2022, pp. 2591-2595, doi: 10.1109/ICIP46576.2022.9897585.

Chen, Z., Cihan, M., Jens, C.E., Page, T.B. (2023) Political Uncertainty and Firm Investment: Project-Level Evidence from M&A Activity. *Journal of Financial and Quantitative Analysis*. 2023;58(1):71-103. doi:10.1017/S0022109022000904

Chesbrough, H.W. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston, MA (2003)

Choi T Y, & Hong Y (2002) Unveiling the structure of supply networks: case studies in Honda, Acura, and Daimler Chrysler[J]. *Journal of Operations Management*, 2002, 20(5):469-493.

Chowdhury, M. (2024) Navigating the VUCA Terrain: Unveiling HR Strategies for Modern Organisational Agility, *SEISENSE Journal of Management*, Vol 7 No 1 (2024): DOI: <https://doi.org/10.33215/wbm33665>, 67-82

Christopher, M. (2012) Managing Supply Chain Complexity: Identifying the Requisite Skills, *Supply Chain Forum: International Journal*. 2012, Vol. 13 Issue 2, p4-9

Ciolacu, M.I., Mihailescu, B., Rachbauer, T., Hansen, C., Amza, C., Svasta, P. (2023). Fostering Engineering Education 4.0 Paradigm Facing the Pandemic and VUCA. *Procedia Computer Science*. 217. 10.1016/j.procs.2022.12.213.

CIPD (2014) 'Research report L&D: New challenges, new approaches' Chartered Institute of Personnel and Development, accessed at cipd.co.uk on 12/04/2016

CIPD (2015) 'Research report L&D: Evolving roles, enhancing skills' Chartered Institute of Personnel and Development, accessed at cipd.co.uk on 12/04/2016

Claveria, O., Sorić, P. (2023) Labour market uncertainty after the irruption of COVID-19. *Empir Econ* 64, 1897–1945 (2023). <https://doi.org/10.1007/s00181-022-02304-7>

Coates, B., (2009). The Arya Leader: A VRIO For Competitive Advantage. *Business Renaissance Quaterly*, 4(3), 39-60.

Colizza, V., Barrat, A., Barthelemey, M., Vespignani, A. (2008) The role of the airline transportation network in the prediction and predictability of global epidemics. *Proc Natl Acad Sci* 103, 2015–2020 (2008).

Colmekcioglu, N., Marvi, R., Foroudi, P., Okumus, F. (2022) Generation, susceptibility, and response regarding negativity: An in-depth analysis on negative online reviews; *Journal of Business Research*, Volume 153, 2022, Pages 235-250, ISSN 0148-2963, <https://doi.org/10.1016/j.jbusres.2022.08.033>.

Comes, T. (2016) Cognitive biases in humanitarian sensemaking and decision-making lessons from field research, 016 IEEE International Multi-Disciplinary Conference on Cognitive Methods in Situation Awareness and Decision Support, Publication Year: 2016, Page(s): 56 – 62

Cone (2006). "The 2006 Cone millennial cause study: The millennial generation: Pro-social and empowered to change the world." Retrieved from http://www.greenbook.org/Content/AMP/Cause_AMPlified.pdf

Cooper, M. C., & Ellram, L. M. (1993). Characteristics of supply chain management and the implications for purchasing and logistics strategy. *International Journal of Logistics Management*, 4(2), 13–24.

Cooper, M. C., Lambert, D. M., Pagh, J. D. (1997). Supply chain management: More than a new name for logistics. *International Journal of Logistics Management*, 8(1), 1–14.

Cooray, A., Gangopadhyay, P., Das N., (2023) Causality between volatility and the weekly economic index during COVID-19: The predictive power of efficient markets and rational expectations, *International Review of Financial Analysis*, Volume 89, 2023, 102792, ISSN 1057-5219, <https://doi.org/10.1016/j.irfa.2023.102792>.

Čop, N.G., Culiberg, B., Komen, I.F. (2024) Exploring social media influencers' moral dilemmas through role theory, *Journal of Marketing Management*, 40:1-2, 1-22, DOI: 10.1080/0267257X.2023.2241468

Craddock, R., Watson, E., and Saunders, W., (2016) "Generic Pattern of Life and behaviour analysis," 2016 IEEE International Multi-Disciplinary Conference on Cognitive Methods in Situation Awareness and Decision Support (CogSIMA), San Diego, CA, USA, 2016, pp. 152-158, doi: 10.1109/COGSIMA.2016.7497803.

Cragg, P. & King, M. (1993). Small-firm computing: motivators and inhibitors. *MIS Quarterly*, 17(1), 47-53.

Crespo, N.F., & Crespo C.F. (2016) Global innovation index: Moving beyond the absolute value of ranking with a fuzzy-set analysis, *Journal of Business Research* 69 (2016) 5265–5271

Crisp, R. J., & Hewstone, M. (1999). Differential evaluation of crossed category groups: Patterns, processes, and reducing intergroup bias. *Group Processes and Intergroup Relations*, 2, 303–333.

Cristelli, M., Tacchella, A., Gabrielli, A., Caldarelli, G., Pietronero, L, (2013) Measuring the intangibles: a metrics for the economic complexity of countries and products. *PLoS ONE* 8 (8), e70726. doi:10.1371/journal.pone.0070726, Accessed 2017 September, 22PMID: 23940633

Cui, Y., Robinson, J.D., Rymer, R.E., Minnix, J.A., Cinciripini, P.M. (2022) You Don't Need An App—Conducting Mobile Smoking Research Using A Qualtrics-Based Approach, *Frontiers In Digital Health Journal*, Volume 3, 2022 Doi=10.3389/Fdgh.2021.799468, Issn=2673-253x

Cunado, J., Gabauer, D., Gupta, R. (2024) Realized volatility spillovers between energy and metal markets: a time-varying connectedness approach; *Financial Innovation*; Heidelberg Vol. 10, Iss. 1, (Dec 2024): 12. DOI:10.1186/s40854-023-00554-7

Curnin, S., Brooks, B., Owen, C., Brooks, O. (2023). Perceptions of strategic decision-making by crisis management teams during exercising: Establishing key dimensions. *Journal of Contingencies and Crisis Management*, 31, 338–352. <https://doi.org/10.1111/1468-5973.12442>

Cushman, J., Kelly, M., Fusco-Rollins, M., Faulkner, R. (2021). Resource Review—Using Qualtrics Core XM for Surveying Youth. *Journal of Youth Development*. 16. 161-167. 10.5195/jyd.2021.886.

Córcoles, D.A., Díaz-Mora C.B., Gandoy, R.B. (2014) Product sophistication: A tie that binds partners in international trade, *Economic Modelling* 44 (2014) S33–S41

Dagci Yuksel, B., Ersoz, F. (2024) Evaluation of ERP software selection criteria with fuzzy AHP approach: an application in the metal production enterprises in the aviation industry. *Int J Syst Assur Eng Manag* (2024). <https://doi.org/10.1007/s13198-024-02287-x>

Dai, P., Xiong, X., Zhou, W., (2019) A global economic policy uncertainty index from principal component analysis; *Finance Research Letters* 40, 101686 (2021), <https://arxiv.org/abs/1907.05049>

Dajcman, S., Kavkler, A., Levenko, N., Romih, D., (2022) 'Spillover effects of economic policy uncertainty on adult and youth unemployment' *Review of Economic Perspectives* Volume: 23 Issue 1 (2022) ISSN: 1804-1663 Online ISSN: 1804-1663

Das, N., & Gangopadhyay, P., 2023. Did weekly economic index and volatility index impact US food sales during the first year of the pandemic? *Financial Innovation*, 9(1), pp. 57.

David, C.D., & Dragomir, A.N. (2021) "Reducing the Impact of Sars-Cov-2 on the Business Environment - Factors of Change, Strategies and Statistics" *Studies in Business and Economics*, vol.16, no.3, 2021, pp.32-43. <https://doi.org/10.2478/sbe-2021-0043>

Davidescu, A.A., Apostu, S.-A., Stoica, L.A. (2021) Socioeconomic Effects of COVID-19 Pandemic: Exploring Uncertainty in the Forecast of the Romanian Unemployment Rate for the Period 2020–2023. *Sustainability* 2021, 13, 7078. <https://doi.org/10.3390/su13137078>

Dawson, T. L., & Stein, Z. (2011) "Virtuous Cycles of Learning: Redesigning Testing During the Digital Revolution" (Presented to the International School on Mind, Brain, and Education, Ettore Majorana Center for Scientific Culture, Erice, Italy, 2011).

Day, M., & Lichtenstein, S., (2006) Strategic supply management: The relationship between supply management practices, strategic orientation and

their impact on organisational performance, *Journal of Purchasing and Supply Management*, Volume 12, Issue 6, 2006, Pages 313-321, ISSN 1478-4092,

Dellantonio, S., Mulatti, C., Remo, R. (2013) Artifact and Tool Categorization. *The Review of Philosophy and Psychology*. 4. 407–418. 10.1007/s13164-013-0140-9.

Deloitte (2014) 'Fit 4 VUCA' 2014 Deloitte & Touche publishing http://www2.deloitte.com/content/dam/Deloitte/za/Documents/humancapital/ZA_Fit4VUCA_FSI_28012015.pdf (last accessed 12/04/2016)

DeLone, W.H. (1981). Firm size and characteristics of computer use. *MIS Quarterly*, 5(4), 65–77.

Demir, E., García-Gómez, C.D., Díez-Esteban, J.M., Farinha, J.B. (2023) How does uncertainty impact IPO activity? International evidence, *Finance Research Letters*, Volume 58, Part C, 2023, 104517, ISSN 1544-6123, <https://doi.org/10.1016/j.frl.2023.104517>.

Denyer, D., & Tranfield, T. (2009), "Producing a systematic review", in Buchanan, D.A. and Bryman, A. (Eds), *The Sage Handbook of Organizational Research Methods*, Sage, London.

DePietro, R., Wiarda, E. & Fleischer, M.(1990). The context for change: organization, technology and environment. In Tornatzky, L.G. & Fleischer, M. (Eds), *The Process of Technological Innovation*, Lexington Books, Lexington, MA, 151-175

DeVaney, S.A. (2015) *Journal of Financial Service Professionals*. Nov 2015, Vol. 69 Issue 6, p11-14. 4p

Dharmasena, T. & Jayathilaka, R. (2021) The nexus between information and consumer confusion: information provider vs information recipient. *Tourism Review of AIAEST - International Association of Scientific Experts in Tourism*, 76(3), pp. 594-613.

Dhifaoui, Z., Ben Jabeur, S., Khalfaoui, R., & Nasir, M. A. (2023). Time-varying partial-directed coherence approach to forecast global energy prices with stochastic volatility model. *Journal of Forecasting*, 42(8), 2292–2306. <https://doi.org/10.1002/for.3015>

Di Vita, G., Spina, D., De Cianni, R. et al. (2023) Enhancing the extended value chain of the aromatic plant sector in Italy: a multiple correspondence analysis based on stakeholders' opinions. *Agric Econ* 11, 15 (2023). <https://doi.org/10.1186/s40100-023-00257-8>

Dialga, I. & Vallée, T., (2021) The index of economic freedom: methodological matters. *Studies in Economics and Finance*, 38(3), pp. 529-561.

Dias, S., Espadinha-Cruz, P., Matos, F. (2023) A Porter's Five Forces Model Proposal for Additive Manufacturing Technology: A Case Study in Portuguese industry, *Procedia Computer Science*, Volume 217, 2023, Pages 165-176, ISSN 1877-0509, <https://doi.org/10.1016/j.procs.2022.12.212>.

Ding, C., Wael, J., Guo, H. (2023) Electoral Competition In The Age Of Social Media: The Role Of Social Media Influencers; *MIS Quarterly*. Dec2023, Vol. 47 Issue 4, p1647-1662. 16p.

Dinulescu, C., & Prybutok, V. (2022) In authority, or peers we trust? Reviews and recommendations in social commerce; *Behaviour & Information Technology*. Oct2022, Vol. 41 Issue 13, p2887-2904. 18p.

Docherty, A. J. (2004). E-commerce adoption support and advice for UK SMEs. *Journal of Small Business and Enterprise Development*, 11(3), 315-328.

Dombrowski, U., & Henningsen, N. (2019) "Systems of objectives in a VUCA world within the Lean Enterprise," 2019 International Symposium on Systems Engineering (ISSE), Edinburgh, UK, 2019, pp. 1-7, doi: 10.1109/ISSE46696.2019.8984468.

Dos Santos, S.F., & Brandi, H.S. (2017) Selecting portfolios for composite indexes: application of Modern Portfolio Theory to competitiveness. *Clean Techn*

Environ Policy 19, 2443–2453 (2017). <https://doi.org/10.1007/s10098-017-1441-y>

Draayer, E., Stracuzzi, D., Ulmer, C., McMahon, N. (2022) Pattern-of-Life Activity Recognition In Seismic Data, Applied Artificial Intelligence, 36:1, 2057400, DOI: 10.1080/08839514.2022.2057400

Draycott, R. (2012) “Marketing is dead” says Saatchi & Saatchi CEO. The Drum. Retrieved from <http://www.thedrum.com/news/2012/04/25/marketing-dead-says-saatchi-saatchi-ceo>

Drucker, P. F. (1974) Management: Tasks, Responsibilities, Practices (New York: HarperCollins, 1974)

DuCoin, C., & Kuo, P.C. (2023) Creating an integrated strategic plan, Surgery Journal, 2023, ISSN 0039-6060, <https://doi.org/10.1016/j.surg.2023.11.006>.

Duncan R. (1972) Characteristics of Organizational Environments and Perceived Environmental Uncertainty, Administrative Science Quarterly. Sep72, Vol. 17 Issue 3, p313-327. 15p.

Dzotsenidze, T. (2021) Economic Complexity Index (Eci) As Best Indicator For Growth Prediction, Economic Profile Vol 16, Issue 1 (21), Pp 108-115 (2021) Kutaisi University, 2021.

Ecker-Ehrhardt, M. (2023) Public Legitimation by “Going Personal”? The Ambiguous Role of International Organization Officials on Social Media. Politics and Governance, 11(3), pp. 213-225.

Eisenhardt, K.M., (1989) Building Theories from Case Study Research. Academy of Management Review 14, 532–550. doi:10.5465/AMR.1989.4308385

El Khoury, R., & Alshater, M. M. (2022). Spillovers between Twitter Uncertainty Indexes and sector indexes: Evidence from the US. Borsa Istanbul Review, 22(5), 961-974.

Elkins M.J., K. McRitchie and M. Scoones (2007). “From the Silent Generation to generation X Y and Z: Strategies for Managing the Generation Mix.” 240-45.

Ellis, P.M. (1974) Characterization of the Annual Pattern of Life Insurance Sales, *The Journal of Risk and Insurance*, Vol. 41, No. 4 (Dec., 1974), pp. 735-738
Published By: American Risk and Insurance Association

Emery, F. E., & Trist, E. L. (1965). The Causal Texture Of Organizational Environments. *Human Relations*, Feb65, Vol. 18 Issue 1, p21-32. 12p.

Ertugrul, M., Lei, J., Qiu, J., Wan, C. (2017) Annual Report Readability, Tone Ambiguity, and the Cost of Borrowing. *Journal of Financial and Quantitative Analysis*. 2017;52(2):811-836. doi:10.1017/S0022109017000187

Etzkowitz, H., & Leydesdorff, L., (1995). "The Triple Helix -- University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development". Rochester, NY. .

Fang, Y., Fan, Y., Haroon, M., Dilanchiev, A. (2023) Exploring the relationship between global economic policy and volatility of crude futures: A two-factor GARCH-MIDAS analysis, *Resources Policy*, Volume 85, Part A, 2023, 103766, ISSN 0301-4207, <https://doi.org/10.1016/j.resourpol.2023.103766>.

Fasanya, I., Periola, O. & Adetokunbo, A. (2023) On the effects of Covid-19 pandemic on stock prices: an imminent global threat. *Qual Quant* 57, 2231–2248 (2023). <https://doi.org/10.1007/s11135-022-01455-0>

Feldman, D. (2005) The Food's No Good and They Don't Give Us Enough: Reflections on Mintzberg's Critique of MBA Education, *Academy of Management Learning & Education* Volume: 4 Issue 2 (2005) ISSN: 1537-260X Online ISSN: 1944-9585

Felipe, J., Kumar, U., Abdon, A., Bacate, M. (2012) Product complexity and economic development, *Structural Change and Economic Dynamics* 23 (2012) 36– 68 (article Available online 17 September 2011)

Fernandes, J.M., & P. Afonso, P. (2021) "Engineering education in a context of VUCA," 2021 4th International Conference of the Portuguese Society for Engineering Education (CISPEE), Lisbon, Portugal, 2021, pp. 1-8, doi: 10.1109/CISPEE47794.2021.9507229.

Fernandes, M., Medeiros, M.C., Scharth, M., (2014) Modeling and predicting the CBOE market volatility index, *Journal of Banking & Finance*, Volume 40, 2014, Pages 1-10, ISSN 0378-4266, <https://doi.org/10.1016/j.jbankfin.2013.11.004>.

Fernandes, R., Rodrigues, A.P., Shetty, B. (2023) "Influencers Analysis from Social Media Data," 2022 International Conference on Artificial Intelligence and Data Engineering (AIDE), Karkala, India, 2022, pp. 217-222, doi: 10.1109/AIDE57180.2022.10059732.

Fischer, K. W., & T. R. Bidell (2006) "Dynamic Development of Action, Thought, and Emotion," in *Handbook of Child Psychology: Theoretical Models of Human Development*, W. Damon and R. M. Lerner (eds.) (Hoboken, NJ: Wiley, 2006), 313–399.

Flanagin, A. J. (2017). Online social influence and the convergence of mass and interpersonal communication: Online social influence. *Human Communication Research*, 43(4), 450–463. <https://doi.org/10.1111/hcre.12116>

Fletcher, G., & Griffiths, M. (2020), "Digital transformation during a lockdown", *International journal of Information Management*, Vol. 55, Article 102185.

Flynn, M.T., et al, (2008) Employing ISR: SOF best practices. *Joint Forces Quarterly*, 50, pp. 56-61, 2008.

Follett, M.P. (1926) "The Giving of Orders", *Scientific foundations of business administration* (1926): 29-37.

Foschi, R., Riccaboni, M., Schiavo, S. (2014) Preferential attachment in multiple trade networks. *Phys Rev E* 90, 022817 (2014).

Franceschet, M. (2011) Pagerank: Standing on the shoulders of giants. *Comm. ACM* 54, 92 (2011).

Franz, N. (2016) Targeted killing and pattern-of-life analysis: weaponised media. *Media, Culture & Society*. 39:111-121, SAGE Publications, 2016.

Freund, L. B., & Rendahl, P. (2020). Unexpected Effects: Uncertainty, Unemployment, and Inflation. *Cambridge Working Papers in Economics*,

Cambridge-INET Working Paper Series No. 2020/20, University of Cambridge, Faculty of Economics

Fridgeirsson, T., Ingason, H., Jónasson, H., Kristjansdottir, B. (2021) The VUCAility of Projects: A New Approach to Assess a Project Risk in a Complex World. Sustainability. 13. 3808. 10.3390/su13073808.

FT (2023) - Wall Street 'fear gauge' tumbles as investors spy end of Fed's inflation fight - <https://www.ft.com/content/8202fc60-4ee0-4bbe-bda0-3f8d40bd8853>, Accessed 20 Dec 2023

Galli, B.J. (2018) Decision-Making Tools and Strategic Planning in Project Environments: The Overlap Of The Two Concepts. Journal of Modern Project Management, 6(2)

Gao, J., Ling, H., Blasch, E., Pham, K., et al, (2013) "Pattern of Life from WAMI objects tracking based on visual context-aware tracking and infusion network models," Proc. SPIE 8745, Signal Processing, Sensor Fusion, and Target Recognition XXII, 87451K (23 May 2013); doi: 10.1117/12.2015612

Garrido, S. (2024), "Leading collaborative change amid a crisis: a framework to liberate a team's leadership skills and promote sales performance", Journal of Work-Applied Management, ahead-of-print <https://doi.org/10.1108/JWAM-06-2023-0053>

Gemici, E. & Zehir, C. (2023), "High-performance work systems, learning orientation and innovativeness: the antecedent role of environmental turbulence", European Journal of Innovation Management, Vol. 26 No. 2, pp. 475-503. <https://doi.org/10.1108/EJIM-05-2021-0243>

George, B. (2017). VUCA 2.0: A strategy for steady leadership in an unsteady world. Forbes HBS Working Knowledge. <https://www.forbes.com/sites/hbsworkingknowledge/2017/02/17/vuca-2-0-a-strategy-for-steady-leadership-in-an-unsteady-world/?sh=1061015413d8>. Accessed 10 Jan 2025

Gerras, S., Clark, M., Allen, C., et al. (2010). Strategic Leadership Primer (Third Edition). 71.

Gheorghe, M., & Roman, A., (2024) 'The unemployment rate and the future of the employment market in Romania The impact of inflation A study on the Romanian post-pandemic economy dominated by uncertainty.' Theoretical & Applied Economics = Economie teoretica si aplicata Volume: 31 Issue 1 (2024) ISSN: 1841-8678 Online ISSN: 1844-0029

Ghosh, S. (2022) "COVID-19, clean energy stock market, interest rate, oil prices, volatility index, geopolitical risk nexus: evidence from quantile regression", Journal of Economics and Development, Vol. 24 No. 4, pp. 329-344. <https://doi.org/10.1108/JED-04-2022-0073>

Giaume L, Le Roy B, Daniel Y, Lauga Cami H, Jost D, Travers S and Trousselard M (2024) Psychological, cognitive, and physiological impact of hazards casualties' trainings on first responders: the example of a chemical and radiological training. An exploratory study. Front. Psychol. 15:1336701. doi: 10.3389/fpsyg.2024.1336701

Gigerenzer, G.F., (2007), "the Intelligence of the Unconscious", Viking, New York.

Glaser, B. (1978), Theoretical Sensitivity: Advances in the Methodology of Grounded Theory, The Sociology Press, Mill Valley, CA.

Goharshenasan, A., Sheikh Aboumasoudi, A., Shahin, A. and Ansari, A. (2022) "Prioritizing the economic indicators of SSC: an integrative QFD approach of performance prism and BSC", Benchmarking: An International Journal, Vol. 29 No. 2, pp. 522-550. <https://doi.org/10.1108/BIJ-11-2020-0582>

Goldberg, P. (1968). Are women prejudiced against women? Trans-Action: Social Science and Modern Society, 5, 28–30.

Goldewijk, K.K. (2005) Three Centuries of Global Population Growth: A Spatial Referenced Population (Density) Database for 1700–2000. Population and Environment volume 26, pages 343–367 (2005). <https://doi.org/10.1007/s11111-005-3346-7>

Goleman, D (1998) "What Makes a Leader?" Harvard Business Review, The Best of Harvard Business Review on Leadership. Emotionally Intelligent Leaders, Product # 8156, 2003.

Gomez-Gallego, J.C., Moreno-Enguix, M.d.R., Gomez-Gallego, M. (2022) The relation between the index of economic freedom and good governance with efficiency of the European Structural Funds; Papers in regional science Volume: 101 Issue 2 (2022) ISSN: 1056-8190 Online ISSN: 1435-5957

Gouldner, A. W. (1959). "Organizational Analysis." in Sociology Today. edited by R. K. Merton, L. Broom and L. S. J. Cottrell. New York, Basic Books, 400-428.

Goyal, A. (2020) "A Critical Analysis of Porter's 5 Forces Model of Competitive Advantage", Journal of Emerging Technologies and Innovative Research, Vol. 7, No. 7, pp. 1-17, 2020

Graham, B. (1973) The Intelligent Investor (Revised 1973 edition) by Harper Business Essentials, 2003, 640 pages. ISBN 0-06-055566-1.

Grant, R.M. (2003) Strategic planning in a turbulent environment: evidence from the oil majors. Strategic management journal, 24 (6), 491–517.

Grauwe, P.D., Foresti, P., (2023) Interactions of fiscal and monetary policies under waves of optimism and pessimism; Journal of Economic Behavior & Organization, Volume 212, 2023, Pages 466-481, ISSN 0167-2681, <https://doi.org/10.1016/j.jebo.2023.05.024>.

Greenwood, D. M. (2002). Gaining and sustaining organizational support through a socio technical intervention. Consulting Psychology. Journal of Practice Research, 54, 104-115.

Griffith, T.L., Majchrzak, A. & Giustiniano, L. (2023) Hyperloop transportation technologies: practices for open organizing across VUCA contexts. J Org Design 12, 99–120 (2023). <https://doi.org/10.1007/s41469-023-00141-1>

Grooper, D. M., Jahera, J., & Chu, J. (2015). Political power, economic freedom and Congress: Effects on bank performance. *Journal of Banking and Finance*, 60, 76–92. <https://doi.org/10.1016/j.jbankfin.2015.08.005>

Gross, G.A., Little, E., Park, B., Llinas, J., Nagi, R. (2015) "Application of multi-level fusion for Pattern of Life analysis," 2015 18th International Conference on Information Fusion (Fusion), Washington, DC, USA, 2015, pp. 2009-2016.

Grzybowska, K., & Tubis, A.A. (2022) Supply Chain Resilience in Reality VUCA—An International Delphi Study. *Sustainability* 2022, 14, 10711. <https://doi.org/10.3390/su141710711>

Guo P, Zhu H, You W (2018) Asymmetric dependence between economic policy uncertainty and stock market returns in G7 and BRIC: a quantile regression approach. *Financ Res Lett* 25:251–258

Gwartney, J., Lawson, R., Hall, J. , (2011). 2011 Economic Freedom Dataset, publicado en *Economic Freedom of the World: 2011 Annual Report*. In *Economic Review* (Vol. 11, Issue 3).

Gökgöz, H., & Kayahan, C. (2023). Analysis of the interaction of Participation 30 Index with Dow Jones Islamic Markets Index and CBOE Volatility Index. *KOCATEPEİİBFD*, 25(2), 246-256. <https://doi.org/10.33707/akuiibfd.1257942>

Gülpınar, G., Uzun, M.B., Iqbal, A., Anderson, C., Syed, W., Al-Rawi, M.B.A. (2023) A model of purchase intention of complementary and alternative medicines: the role of social media influencers' endorsements; *BMC Complementary Medicine and Therapies* Volume: 23 Issue 1 (2023) ISSN: 2662-7671 Online ISSN: 2662-7671

Haas, H.G. (1992). *The Leader Within: An Empowering Path of Self-Discovery*, Harper Collins, N.Y.

Habermas, J. (1975) *Legitimation Crisis* (T. McCarthy, Trans.). (Boston, MA: Beacon Press, 1975)

Haines, V. Y. & Petit, A. (1997). Conditions for Successful Human Resource Information Systems. *Human Resource Management*, 36(2), 261-275.

Hall, J.G. (2013) Is tangled the new wicked? *Expert Systems*, Volume 30, Issue 2, May 2013, Pages 128-128

Hamel, G. & Prahalad, C.K. (1990) "Strategic intent", *Harvard Business Review*, Vol. 67 No. 3, pp. 63-76.

Hamel, G. (2009) Moon shots for management. *Harvard Business Review* 87(2): 91 – 98.

Hapenciuc, V., & Aurel, B. (2014) Knowledge Management and Business Cycle in Chaotic Business Environment. *Proceedings of the International Conference on Intellectual Capital, Knowledge Management & Organizational Learning* (2014) ISSN: 2048-9803

Haryo. K. (2014). Does the credible fiscal policy reduce its volatility? The case of Indonesia. *Journal of Applied Economic Sciences*. 9. 382-393.

Hashim, M., Ashmel, M., Tlemsani, I., Matthews, R., Mason-Jones, R., Ndrecaj, V. (2022) Emergent Strategy in Higher Education: Postmodern Digital and the Future? *Administrative Sciences* 12: 196.
<https://doi.org/10.3390/admsci12040196>

Hazgui, S., Sebai, S., & Mensi, W., (2022). Dynamic frequency relationships between bitcoin, oil, gold and economic policy uncertainty index. *Studies in Economics and Finance*, 39(3), pp. 419-443.

Heifetz, R. (1994) *Leadership Without Easy Answers*. Cambridge, MA: Harvard University Press.

Henon, E. (2006). "Why and how generation y saves and spends. *Benefits and Compensation Digest*, 43, 30-32.

Hentschel, L. (2003) Errors in Implied Volatility Estimation; *The Journal of Financial and Quantitative Analysis*. Vol. 38, No. 4 (Dec., 2003), pp. 779-810 (32 pages) Published By: Cambridge University Press

Henwood, K., & Pidgeon, N. (2006). Grounded Theory. In G. M. Breakwell, S. Hammond, C. Fife-Schaw, & J. A. Smith (Eds.), *Research methods in psychology* (3rd ed., pp. 342–364). Sage Publications, Inc.

Hernandez, J.S., & Allen, T.C. (2013) Transformation of Pathologists: Responding in a Volatile, Uncertain, Complex, and Ambiguous Environment, *Archives of Pathology & Laboratory Medicine*, QQPLM, 603, Volume 137; Issue 5; ISSN: 00039985

Hernández-Betancur, J.E., Montoya-Restrepo, I., Montoya-Restrepo, L.A. (2020) The tree of science of deliberate and emergent strategies, *IIMB Management Review*, Volume 32, Issue 4, 2020, Pages 413-433, ISSN 0970-3896, <https://doi.org/10.1016/j.iimb.2020.12.004>.

Herr, P.M., Kardes, F.R. & Kim, J. (1991), "Effects of word-of-mouth and product-attribute information on persuasion: an accessibility-diagnostics perspective", *Journal of Consumer Research*, Vol. 17 No. 4, pp. 454-462.

Hersey, P., & Blanchard, K. (2000). *Management of Organizational Behavior*, 8th edition, Prentice Hall, N.J.

Herz, M., Diamantopoulos, A., Riefler, P. (2023) Consumers' use of ambiguous product cues: The case of "regionality" claims; *Journal of Consumer Affairs* Volume: 57 Issue 3 (2023) ISSN: 0022-0078 Online ISSN: 1745-6606

Hidalgo, C.A., & Hausmann, R. (2009) The building blocks of economic complexity. In: *Proceedings of the National Academy of Sciences*, 106, pp. 10570–10575 (2009)

Hidalgo, C.A., Klinger, B., Barabási, A.L., Hausmann, R. (2007) The product space conditions the development of nations *Science*, 317 (5837) (2007), pp. 482-487, Jul 2007

Hilgevoord, J., & Uffink, J. (2001) "The Uncertainty Principle", *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta & Uri Nodelman (eds.), URL = <https://plato.stanford.edu/archives/spr2024/entries/qt-uncertainty/>.

Hjortdahl, P. (1992) Continuity of care: general practitioners' knowledge about, and sense of responsibility toward their patients. *Family Practice*, 9 (1), 3–8.

Hlavatý, J., & Ližbetin, J. (2021) The Use of the Art of War Ideas in the Strategic Decision-making of the Company, *Transportation Research Procedia*, Volume 55, 2021, Pages 1273-1280, ISSN 2352-1465, <https://doi.org/10.1016/j.trpro.2021.07.110>.

Horney, N., Pasmore, B., O'Shea, T. (2010) *Leadership Agility: A Business Imperative for a VUCA World*, Human resource planning. - New York, NY : HRPS, ISSN 0199-8986, ZDB-ID 8522935. - VOLUME 33/ISSUE 4

Hoverstadt, P. (2008), "The viable system model", in Reynolds, M. and Holwell, S. (Eds), Chapter 3, *Systems Approaches to Managing Change: a Practical Guide*, Springer, London, pp. 87-133.

Howe, N. & Strauss, W. (1991) *Generations: The History of America's Future, 1584 to 2069*. Harper Perennial.

Howe, N. and Strauss, W. (2000), *Millennials Rising: The Next Great Generation*, Vintage Books, New York, NY.

Howrey, E.P. (2001). The Predictive Power of the Index of Consumer Sentiment. *Brookings Papers on Economic Activity* 2001(1), 175-207. <https://doi.org/10.1353/eca.2001.0008>.

Huizenga, H. M., Zadelaar, J. N., Jansen, B. R. J., Olthof, M. C., Steingroever, H., Dekkers, L. M. S., van Duijvenvoorde, A. C. K., Figner, B., & Agelink van Rentergem, J. (2023). Formal Models of Differential Framing Effects in Decision Making Under Risk. *Decision*. Advance online publication. <https://dx.doi.org/10.1037/dec0000201>

Humphrey, Albert (2005). "SWOT Analysis for Management Consulting" *SRI Alumni Newsletter* (SRI International), download from on 06/04/2016

Hussain, M., Bashir, U. & Rehman, R.U. (2023) Exchange Rate and Stock Prices Volatility Connectedness and Spillover during Pandemic Induced-Crises:

Evidence from BRICS Countries. *Asia-Pac Financ Markets* (2023).
<https://doi.org/10.1007/s10690-023-09411-0>

Hu"gle, T., & Grek, V. (2023) Digital transformation of an academic hospital department: A Case Study on strategic planning using the balanced scorecard. *PLOS Digit Health* 2(11): e0000385. <https://doi.org/10.1371/journal.pdig.0000385>

Immerwahr, J. (2015), "Generational differences", *TeachPhilosophy101 (TF101)*, available at: <http://www.teachphilosophy101.org/#!/generational-differences/odobq> (accessed 28 March, 2016).

International Labour Organization (2022) *World Employment and Social Outlook: Trends 2022*. https://www.ilo.org/global/research/global-reports/weso/trends2022/WCMS_834081/lang--en/index.htm

International Monetary Fund (2020) *60 Years of Uncertainty, Finance & Development*, March 2020.

Iqbal, U., Gan, C., & Nadeem, M., (2020) Economic policy uncertainty and firm performance, *Applied Economics Letters*, 27:10, 765-770, DOI: 10.1080/13504851.2019.1645272

Islam, M. R. (2018). Wealth inequality, democracy and economic freedom. *Journal of Comparative Economics*, 46(4), 920–935. <https://doi.org/10.1016/j.jce.2018.01.002>

Isık, C., Ercan S., Serdar, O., (2020) Testing the efficacy of the economic policy uncertainty index on tourism demand in USMCA: Theory and evidence, *Tourism economics : the business and finance of tourism and recreation* Volume: 26 Issue 8 (2020) ISSN: 1354-8166 Online ISSN: 2044-0375

Isık, C., Simionescu, M., Ongan, S. et al. (2023) Renewable energy, economic freedom and economic policy uncertainty: New evidence from a dynamic panel threshold analysis for the G-7 and BRIC countries. *Stoch Environ Res Risk Assess* 37, 3367–3382 (2023). <https://doi.org/10.1007/s00477-023-02452-x>

Jahan, A., Edwards, K. L., Bahraminasab, M., (2016) 'Chapter 4 - Multi-criteria decision-making for materials selection', Multi-criteria Decision Analysis for Supporting the Selection of Engineering Materials in Product Design (Second Edition), Butterworth-Heinemann, 2016, Pages 63-80, ISBN 9780081005361

Jankowicz, A. D. (2004) Business Research Projects, Cengage Learning EMEA; Fourth Edition, ISBN 1844800822

Jannah, W.N., Agustin, M., Rahman, R., and Herman, T., (2024) Navigating Uncertainty: Exploring Elementary School Teachers' Perspectives on Metacognitive Development in the VUCA Era, Indonesian Journal on Learning and Advanced Education, p-ISSN 2655-920x, e-ISSN 2656-2804, Vol. 6, No. 1, January 2024 32-46

Jaques, E. A. (1976) General Theory of Bureaucracy (London: Heinemann Educational, 1976)

Jensen, P.M., Danielsen, F., Jacobsen, S.K, Vikstrøm, T., (2024) Fair concordance between Google Trends and Danish ornithologists in the assessment of temporal trends in Danish bird populations highlights the informational value of big data. Environ Monit Assess 196, 276 (2024). <https://doi.org/10.1007/s10661-024-12439-y>

Jha, I., Bharti, N., Malik, S. (2023) "The impact of online reviews on product perception and purchase intention," 2023 International Conference on Advances in Electronics, Communication, Computing and Intelligent Information Systems (ICAECIS), Bangalore, India, 2023, pp. 111-115, doi: 10.1109/ICAECIS58353.2023.10169949.

Jin, S., Zhou, C., Peng, H. (2023) Does price limit reduce stock price volatility on the limit up and down day?, Finance Research Letters, Volume 58, Part A, 2023, 104302, ISSN 1544-6123, <https://doi.org/10.1016/j.frl.2023.104302>.

Johansen, B., (2007) Get There Early: Sensing the Future to Compete in the Present. San Francisco, CA: Berrett-Koehler Publishers, Inc

Johansen, B. (2012), *Leaders Make the Future. Ten New Leadership Skills for an Uncertain World*, Berrett-Koehler Publishers Inc., San Francisco, CA.

Johnson, G. & Scholes, K. (1989) *Exploring Corporate Strategy*. Hemel Hempstead, Prentice Hall, 1989

Johnson, G, Scholes, K. Whittington, R. (2008). *Exploring Corporate Strategy*. 8th ed. FT Prentice Hall, p. 55-57

Johnson, G., Scholes K, Whittington, R. (2010) *Exploring Strategy* (9th Edition). London, UK: Prentice Hall

Johnson, L. (2021) Exploring factors associated with pregnant women's experiences of material hardship during COVID-19: a cross-sectional Qualtrics survey in the United States, *BMC Pregnancy Childbirth* (2021) <https://doi.org/10.1186/s12884-021-04234-1>

Johnson, N. (2009), "Simply Complexity: a clear guide to complexity theory", Oneworld Publications

Juera, L.C. (2024) Digitalizing skills development using simulation-based mobile (SiM) learning application. *J. Comput. Educ.* 11, 29–50 (2024). <https://doi.org/10.1007/s40692-022-00246-8>

Junior, I.D., & Alves, M.D.C. (2023) The balanced scorecard in the education sector: A literature review. *Cogent Education*, 10(1)

Kahneman, D. (2011) *Thinking, Fast and Slow*, Publisher Farrar, Straus and Giroux, ISBN 978-0374275631

Kahneman, D., & Tversky, A. (1979) "Prospect Theory: An Analysis of Decision under Risk," *Econometrica*, vol. 47, no. 2, pp. 263–291, 1979

Kail, E (2010) Leading in a VUCA Environment: V Is for Volatility, *Harvard Business Review*. <http://blogs.hbr.org/frontline-leadership/2010/11/leading-in-a-vuca-environment.html>. Posted November 3, 2010. Accessed 6th April 2016

Kaminski, D.W., Hall, J.G. (2015) *Towards Process Design for Efficient Organisational Problem Solving*, BUSTECH 2015 : The Fifth International

Conference on Business Intelligence and Technology, ARIA, 2015. ISBN: 978-1-61208-395-7

Kamiński, M., Miętkiewska-Dolecka, M., Kręgielska-Narożna, M., Bogdański, p., (2024) Popularity of Surgical and Pharmacological Obesity Treatment Methods Searched by Google Users: the Retrospective Analysis of Google Trends Statistics in 2004–2022. OBES SURG 34, 882–891 (2024)

Kanacs, d'A. (2022) "Enhancing Resilience: Model-based Simulations," NATO Science and Technology Organization (STO), Papers 2212.11108, arXiv.org.

Kandoussi, M., & Langot, F. (2022). Uncertainty Shocks and Unemployment Dynamics. *Economics Letters*, 219: 110760. <https://doi.org/10.1016/j.econlet.2022.110760>

Kano, L. (2018) Global value chain governance: A relational perspective. *Journal of International Business Studies*, 49(6): 684–705.

Kano, N., Seraku, N., Takashi, F., & Tsuji, S. (1984). Attractive quality, and must-be quality, Hinshitsu. *The Journal of the Japanese Society for Quality Control*, 14(2), 39–48.

Kaplan, R.S., & Norton, D.P. (1992). "The Balanced Scorecard—Measures that Drive Performance". *Harvard Business Review*. No. January–February 1992. ISSN 0017-8012. Retrieved 2020-01-15.

Kasof, J. (1993). Sex bias in the naming of stimulus persons. *Psychological Bulletin*, 113, 140–163.

Kavanagh, Michael J., Gueutal, Hal G. And Tanneen-Baum, Scott I. (1990) *Human Resource Information Systems: Development and Application*. Boston: PWS-Kent Publishing Co., 1990.

Kegan, R. (1994), "In Over Our heads: The Mental Demands of Modern Life" Cambridge, MA: Harvard University Press

Kelle, U., (2005). "Emergence" vs. "Forcing" of Empirical Data? A Crucial Problem of "Grounded Theory" Reconsidered [52 paragraphs]. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, Vol. 6 No. 2.

Kelley, H.H., & Thibaut, J.W. (1954), "Experimental studies of group problem solving and process", in Lindzey, G. (Ed.), *Handbook of Social Psychology*, Vol. 2, Addison-Wesley, Cambridge, MA.

Kengatharan, L., & Ford, J.S.D. (2021) Dividend Policy And Share Price Volatility: Evidence From Listed Non-Financial Firms In Sri Lanka; *International Journal of Business and Society*, Vol. 22 No. 1, 2021, 227-239

Kenton, W. (2023) 10-K: Definition, What's Included, Instructions, and Where to Find it; Investopedia. Accessed 27 Dec 2023. <https://www.investopedia.com/terms/1/10-k.asp>

Kerckhoven, S.V., & O'Dubhghaill, S. (2021) GameStop: How online 'degenerates' took on hedge funds; *Exchanges: The Interdisciplinary Research Journal* 2021 8(3), pp. 45-54

Khalifa, A.S. (2023), "Contesting Mintzberg's five Ps for strategy: it is time for a product recall", *Journal of Strategy and Management*, Vol. 16 No. 1, pp. 112-127. <https://doi.org/10.1108/JSMA-12-2021-0243>

Khanmohammadi, E., Safari, H., Zandieh, M., Malmir, B., Tirkolaei, E. B. (2024) "Development of Dynamic Balanced Scorecard Using Case-Based Reasoning Method and Adaptive Neuro-Fuzzy Inference System," in *IEEE Transactions on Engineering Management*, vol. 71, pp. 899-912, 2024, doi: 10.1109/TEM.2022.3140291.

Khayati, A. (2021) The Role of Economic Complexity in Increasing Exports and Growth, *LSE Economic Complexity in GCC Countries series*, <https://blogs.lse.ac.uk/mec/2021/07/28/the-role-of-economic-complexity-in-increasing-exports-and-growth>, Accessed 6 May 2023

Kiarsi, M. (2021), "Optimal fiscal and monetary policy under different fiscal instruments", *Journal of Economic Studies*, Vol. 48 No. 1, pp. 167-190.
<https://doi.org/10.1108/JES-11-2019-0508>

Kidd, P.T. (2008) Agile holonic network organizations, G.D. Putnik, M.M. Cruz-Cunha (Eds.), *Encyclopedia of Networked and Virtual Organizations*, IGI Global, Hershey, PA (2008), pp. 35-42

Kim, A.B. (2023) *Index Of Economic Freedom*, The Heritage Foundation, heritage.org, ISBN: 978-0-89195-309-8

Kinsinger, P. and Walch, K. (2012), "Living and leading in a VUCA world", available at: <http://knowledge.network.thunderbird.edu/research/2012/07/09/kinsinger-walch-vuca/> (accessed 23 April 2013).

Kipley, D., Lewis, A., Jewe, R. (2012) "Entropy – disrupting Ansoff's five levels of environmental turbulence", *Business Strategy Series*, Vol. 13 No. 6, pp. 251-262.
<https://doi.org/10.1108/17515631211286083>

Kitson, F., (1971) *Low intensity operations: Subversion, insurgency, peacekeeping*. Stackpole Books, 1971.

Knight, F. (1921), "Risk, Uncertainty, and Profit", Boston: Hart, Schaffner & Marx.

Knott, P. J. (2006). A typology of strategy tool applications. *Management Decision*, 44(8), 1090-1105. <https://doi.org/10.1108/00251740610690630>

Koetsier, J. (2023) Post-Musk Twitter: At Least One Stat Is Up; *Forbes.com*, <https://www.forbes.com/sites/johnkoetsier/2023/10/17/post-musk-twitter-at-least-one-stat-is-up/>; accessed Nov 2023.

Kondo, Y., Asatani, A., and Sakata, I., (2022) "Evaluating Emerging Technologies on the Gartner Hype Cycle by Network Analysis : A Display Technology Case Study," 2022 Portland International Conference on Management of Engineering and Technology (PICMET), Portland, OR, USA, 2022, pp. 1-11, doi: 10.23919/PICMET53225.2022.9882631.

Kopackova, H., Šimonová, S., & Reimannová, I., (2024). Digital transformation leaders wanted: How to prepare students for the ever-changing demands of the labor market. *The International Journal of Management Education*. 22. 100943. 10.1016/j.ijme.2024.100943.

Korlipara, M. and Shah, H. (2024), "'Power of words': impact, concerns and applications of nonviolent communication training", *European Journal of Training and Development*, Vol. 48 No. 1/2, pp. 90-111. <https://doi.org/10.1108/EJTD-03-2022-0030>

Koroleva, E., & Tikhomirova, M. (2021) *Firm Performance: Is Transparency Important?* Kidmore End: Academic Conferences International Limited.

Koster, K. (2013). "Communication and engagement. *Employee Benefit News*

Kotler P., & Caslione, J. A. (2009) *Chaotics. The Business of Managing and Marketing in the Age of Turbulence*, Amacom publishing

Kotter, J. (2001), "What leaders really do", *Best of HBR*, *Harvard Business Review*, Vol. 79 No. 11, pp. 85-96.

Koudal, P., & Engel, D. A. (2007). Globalization and emerging markets the challenge of continuous global network optimization. *Building Supply Chain Excellence in Emerging Economies*, 98, 37–66.

Kouzes, J.M., & Posner, B.J. (2002), *The Leadership Challenge*, 3rd ed., John Wiley & Sons, San Francisco, CA.

Kunda, Z., Miller, D. T., & Claire, T. (1990). Combining social concepts: The role of causal reasoning. *Cognitive Science*, 14, 551–577.

Kwabi, F., Owusu, A., Ezeani, E. et al. (2024) The impact of political uncertainty on the cost of capital. *Rev Quant Finan Acc* (2024). <https://doi.org/10.1007/s11156-023-01236-2>

Kyung, R., Kye, K. (2020) Study on the CBOE Volatility Data Forecast Using Statistical and Computational Simulations, Published in: 2020 IEEE International

IOT, Electronics and Mechatronics Conference (IEMTRONICS), 09-12 September 2020, ISBN: 978-1-7281-9616-9

Lambert, D. M., Cooper, M. C., Pagh, J. D. (1998) Supply chain management: Implementation issues and research opportunities. *International Journal of Logistics Management*, 9(2), 1–19.

Landaluce-Calvo, M, I., (2024) Online relationships versus face-to-face relationships. Proposal of a methodology for the holistic analysis of Likert-type scales. *Qual Quant* (2024). <https://doi.org/10.1007/s11135-024-01846-5>

Lane, R.O., & Copsey, K.D. (2012) "Track anomaly detection with rhythm of life and bulk activity modeling," 2012 15th International Conference on Information Fusion, Singapore, 2012, pp. 24-31.

Lauriola, M. & Levin, I.P. (2001), Relating individual differences in Attitude toward Ambiguity to risky choices. *J. Behav. Decis. Making*, 14: 107-122. <https://doi.org/10.1002/bdm.368>

Lawrence P.R. & Lorsch J.W. (1967) Differentiation and Integration in Complex Organizations, *Administrative Science Quarterly*. Jun67, Vol. 12 Issue 1, p1-47. 47p. 12 Charts.

Lawrence, K. (2013). Developing Leaders in a VUCA Environment. *UNC Executive Development*, 1-15.

Le, L. H., & Ha, Q.-A. (2021). Effects of negative reviews and managerial responses on consumer attitude and subsequent purchase behavior: An experimental design. *Computers in Human Behavior*, 124, 106912.

Leduc, S., & Liu, Z. (2016). Uncertainty shocks are aggregate demand shocks. *Journal of Monetary Economics*, 82: 20–35. <https://doi.org/10.1016/j.jmoneco.2016.07.002>

Lees, G. (2004), "Improving strategic oversight: the CIMA strategic scorecard", *Measuring Business Excellence*, Vol. 8 No. 4, pp. 5-12. <https://doi.org/10.1108/13683040410569352>

Lehyani, F., Zouari, A., Ghorbel, A., Tollenaere, M. (2021) Defining and Measuring Supply Chain Performance: A Systematic Literature Review, *Engineering Management Journal*, 33:4, 283-313, DOI: 10.1080/10429247.2020.1834309

Leonard, M., David, A., Shelton, P. (2023) Volatility and irregularity Capturing in stock price indices using time series Generative adversarial networks (TimeGAN); Working Paper, <http://arxiv.org/abs/2311.12987>

Leonhard, G. (2014) Understanding and embracing digital transformation: the future of business, commerce and society, Accessed May 2017, from <https://futuristgerd.com/2014/11/new-presentation-on-slideshare-digital-transformation-the-future-of-business-commerce-and-technolo/>

Lesnikova, P., Schmidtova, J., Cichocka, I. (2023). Strategy formulation activities with emphasis on strategic management tools and techniques in Slovak companies. *Problems and Perspectives in Management*, 21(3), 54-68. doi:10.21511/ppm.21(3).2023.05

Lewis, T., (2015) Manage online brand reviews with Trustpilot; *PR Week (USA)* Volume: 18 Issue 4 (2015) ISSN: 1524-1696

Li, L. (2022), Digital transformation and sustainable performance: The moderating role of market turbulence, *Industrial Marketing Management*, Volume 104, 2022, Pages 28-37, ISSN 0019-8501

Lichtenstein, B.B., Uhl-bien, M., Marion, R., Seers, A., Douglas, J., & Schreiber, C. (2006), "Complexity leadership theory: an interactive perspective on governing in a complex adaptive system", *E:CO*, Vol. 8 No. 4, pp. 2-12.

Lilja, J., Snyder, K., Sten, L.M. (2022). Teaming for Quality in the VUCA Landscape: Exploring key elements for a progressive leap in team-based practices to drive quality, sustainability, and regeneration. *Proceedings of the 28th Annual Conference, International Sustainable Development Research Society*, Retrieved from <https://urn.kb.se/resolve?urn=urn:nbn:se:miun:diva-46716>

Lim, H.J., Mali, D. (2023) An analysis of the effect of audit effort (hours) on stock price volatility: evidence of increasing demand reducing uncertainty. *International Journal of Disclosure and Governance* (2023).

Lim, S. H., Poonawala, H., Wynter, L. (2019) "Combining Micro and Macro Features for Online Pattern-of-Life Movement Prediction," 2019 International Conference on Data Mining Workshops (ICDMW), Beijing, China, 2019, pp. 587-594, doi: 10.1109/ICDMW.2019.00089.

Lindborg, H. J. (2010). Curbing career fears, Understand and use VUCA to manage threats. *Quality Progress*, 43(10), 52–53

Littlechild, S. (2021) Exploring customer satisfaction in Great Britain's retail energy sector Part I: The comparative use of Trustpilot online reviews in four sectors; *Utilities Policy*, Volume 73, 2021, 101298, ISSN 0957-1787, <https://doi.org/10.1016/j.jup.2021.101298>.

Liu, N., & Gao, F. (2022) The world uncertainty index and GDP growth rate, *Finance Research Letters*, Volume 49, 2022, 103137, ISSN 1544-6123, <https://doi.org/10.1016/j.frl.2022.103137>.

Liu, P., Chen, Y., Mu, y. (2024) The impact of climate risk aversion on agribusiness share price volatility, *Finance Research Letters*, Volume 61, 2024, 104797, ISSN 1544-6123, <https://doi.org/10.1016/j.frl.2023.104797>.

Liu, Q., Ihler, A., Fisher, J. (2015) "Boosting crowdsourcing with expert labels: Local vs. global effects," 2015 18th International Conference on Information Fusion (Fusion), Washington, DC, USA, 2015, pp. 9-14.

Liu, S., Zhao, H., Kong, G. (2023) Enterprise digital transformation, breadth of ownership and stock price volatility; *International Review of Financial Analysis*, Volume 89, 2023, 102713, ISSN 1057-5219, <https://doi.org/10.1016/j.irfa.2023.102713>.

Liu, X., Zhao, Y., Xu, T., Wahab, F., Sun, Y., Chen, C. (2023) Efficient False Positive Control Algorithms in Big Data Mining. *Applied Sciences* (Switzerland). 2023;13(8). doi:10.3390/app13085006

Locke, K.D., (2001) *Grounded Theory in Management Research*, SAGE Publications, ISBN 0 7619 64274

Lopes, H.E.G., Rodrigues, V.C., Leite, R.S., & Gosling, M. (2023) Business Model Canvas and Entrepreneurs: Dilemmas in Managerial Practice. *Brazilian Business Review*, 20(3), pp. 260-280.

Lou, Z., Li, M., Kong, N., Campbell N. L., Tu, W., (2024) "An Improved Statistical Modeling Approach to Individual Anticholinergic Drug Use Trend Analysis," in *IEEE Journal of Biomedical and Health Informatics*, vol. 28, no. 2, pp. 1122-1133, Feb. 2024, doi: 10.1109/JBHI.2023.3332598.

Loungani, P., Mishra, S., Papageorgiou, C., Wang, K., (2017) World trade in services: evidence from new data. IMF Working Paper WP/17/77

Lu, G., & Shang, G. (2017) Impact of supply base structural complexity on financial performance: Roles of visible and not so-visible characteristics. *Journal of Operations Management*, 53: 23–44.

Lubowiecki-Vikuk, A., Budzanowska-Drzewiecka, M., Borzyszkowski, J., & Taheri, B. (2023), "Critical reflection on VUCA in tourism and hospitality marketing activities", *International Journal of Contemporary Hospitality Management*, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/IJCHM-04-2022-0479>

Luis Mayo-Alvarez, Shyla Del-Aguila-Arcentales, Aldo Alvarez-Risco, M. Chandra Sekar, Neal M. Davies, Jaime A. Yáñez (2024) Innovation by integration of Drum-Buffer-Rope (DBR) method with Scrum-Kanban and use of Monte Carlo simulation for maximizing throughput in agile project management, *Journal of Open Innovation: Technology, Market, and Complexity*, Volume 10, Issue 1, 2024, 100228, ISSN 2199-8531, <https://doi.org/10.1016/j.joitmc.2024.100228>.

Lymer, A. (1997). *The internet and small businesses: a study of impacts*. Fifth European Conference on Information Systems, Cork Publishing, Cork

Ma, F., Wang, H., Schandl, H., Fishman, T., Tan, X., Li, Y., Shi, L., Wang, P., Chen, W.Q. (2022) Exploring the relationship between economic complexity and

resource efficiency, *Resources, Conservation and Recycling*, Volume 186, 2022,106530,ISSN 0921-3449,

Mace, M. (1971) *Directors: Myth and Reality* (Boston: Division of Research, Harvard Business School, 1971).

Macit, E., & Abaci, N.I. (2023) Farmers' Decision-Making on Kiwi Production as an Alternative to Hazelnut by Value Chain Analysis: A Case Study from Türkiye. *Erwerbs-Obstbau* 65, 2437–2448 (2023). <https://doi.org/10.1007/s10341-023-00924-6>

MacGregor, S.P. & Carleton, T. (Eds.) (2012) *Innovation, Technology, and Knowledge Management: Vol. 19. Sustaining Innovation: Collaboration Models for a Complex World*, Springer, New York, NY (2012)

Maes, P. (1995) in *Readings in Human–Computer Interaction* (eds Baecker, R. M., Grudin, J., Buxton, W. A. S. & Greenberg, S.) 811–821 Morgan Kaufmann, 1995

Mahapatra, L. (2013) “8 Brilliant Lessons From The Investor That Taught Warren Buffett Everything He Knows” *Business Insider*. Accessed 16 Dec 2023 at <https://www.businessinsider.com/eight-lessons-from-benjamin-graham-2013-2?r=US&IR=T>

Mahesan, S.S., Uma U.R.S., & Ganesan, R. (2023) "Customer Perception on Online Cosmetic Product Purchases Using Association Rule Mining Based on Customer Feedback," 2023 International Conference on Self Sustainable Artificial Intelligence Systems (ICSSAS), Erode, India, 2023, pp. 714-720, doi: 10.1109/ICSSAS57918.2023.10331647.

Maheshkar, C., Poullose, J., Sharma, V. (2024). Data-Driven Decision Making in the VUCA Context: Harnessing Data for Informed Decisions. In: Poullose, J., Sharma, V., Maheshkar, C. (eds) *Data-Driven Decision Making*. Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-97-2902-9_1

Major, J., & Clarke, D. (2022), "Regenerative tourism in Aotearoa New Zealand – A new paradigm for the VUCA world", *Journal of Tourism Futures*, Vol. 8 No. 2, pp. 194-199.

Malterud, K. (2001) The art and science of clinical knowledge: evidence beyond measures and numbers. *Lancet*, 358, 397–400.

March, J. (1991), "Exploration and exploitation in organizational learning", *Organization Science*, Vol. 2 No. 1, pp. 71-87.

Mardon, R., Cocker, H., Daunt, K. (2023) How Social Media Influencers Impact Consumer Collectives: An Embeddedness Perspective, *Journal of Consumer Research*, Volume 50, Issue 3, October 2023, Pages 617–644, <https://doi.org/10.1093/jcr/ucad003>

Marion, R. (2008), "Complexity theory for Organisations and Organisational leadership", in Uhl-Bien, M. and Marion, R. (Eds), Chapter 1, *Complexity Leadership Part 1: Conceptual Foundations*, Information Age Publishing Inc., Charlotte, NC.

Martin, C. A. (2005). "From high maintenance to high productivity: What managers need to know about Generation Y." *Industrial and Commercial Training*, 37(1), 39-44.

McAfee, A. (2003). When too much IT knowledge is a dangerous thing. *Sloan Management Review*, 44, 83-89.

McElhaney, K.A. (2008). *Just good business: The strategic guide to aligning corporate responsibility and brand*. San Francisco, CA: Berrett-Koehler Publishers; 1 edition (30 Nov. 2008)

Mckinsey & Company (2015) 'Heidrick & Struggles on the changing nature of leadership' accessed at on 12/04/2016

Mealy, P., Farmer, J.D., Teytelboym, A. (2018) A New Interpretation of the Economic Complexity Index (February 4, 2018). Available at SSRN: <https://ssrn.com/abstract=3075591> or <http://dx.doi.org/10.2139/ssrn.3075591>

Mealy, P., Farmer, J.D., Teytelboym, A. (2019) Interpreting economic complexity. *Science Advances* 9 Jan 2019, Vol 5, Issue 1, DOI: 10.1126/sciadv.aau1705

Mendo, F. A. & Fitzgerald, G. (2005). A multi-dimensional framework for SME e-business progression. *Journal of Enterprise Information Management*, 18, 678-96.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., et al. (2001) Defining supply chain management. *Journal of Business Logistics*, 22(2), 1–25.

Meredith, J. (1993), "Theory Building through Conceptual Methods", *International Journal of Operations & Production Management*, Vol. 13 No. 5, pp. 3-11. <https://doi.org/10.1108/01443579310028120>

Merton, R. (1957). *Social Theory and Social Structure*, Free Press, Glencoe, Ill.

Miettinen, A., Jalovaara, M., (2023) 'Unemployment delays first birth but not for all. Life stage and educational differences in the effects of employment uncertainty on first births' *Finnish Yearbook of Population Research*; Helsinki Vol. 57, (2023): 1-12. DOI:10.1016/j.alcr.2019.100320

Mikhailov, S., Kashevnik A., Smirnov, A. (2020) "Tourist Behaviour Analysis Based on Digital Pattern of Life," 2020 7th International Conference on Control, Decision and Information Technologies (CoDIT), Prague, Czech Republic, 2020, pp. 622-627, doi: 10.1109/CoDIT49905.2020.9263945.

Milgate M. (2001) Supply chain complexity and delivery performance: an international exploratory study[J]. *Supply Chain Management*, 2001, 6(3):106-118.

Miller, C.A., Guidry, J.P.D., Dahman, B., Thomson, M.D. (2020) A Tale of Two Diverse Qualtrics Samples: Information for Online Survey Researchers. *Cancer Epidemiol Biomarkers Prev.* 2020 Apr;29(4):731-735. doi: 10.1158/1055-9965.EPI-19-0846. Epub 2020 Feb 17. PMID: 32066616; PMCID: PMC8758054.

Miller, T.W. (2023) "Dynamic responses of energy prices to oil price shocks", *Managerial Finance*, Vol. 49 No. 2, pp. 357-377. <https://doi.org/10.1108/MF-07-2021-0321>

Minciu, M., Berar, F.A., Dobrea, R. (2020). New decision systems in the VUCA world. *Management & Marketing. Challenges for the Knowledge Society*. 15. 236-254. 10.2478/mmcks-2020-0015.

Mingwen, Y., Zheng, Z., Mookerjee, v., Chen, H. (2023) Responding to Online Reviews in Competitive Markets: A Controlled Diffusion Approach; *MIS Quarterly* Volume: 47 Issue 1 (2023) ISSN: 0276-7783 Online ISSN: 2162-9730

Mintzberg, H. (1978) Patterns in Strategy Formation. *Management Science* 24

Mintzberg, H. (1994) The Fall and Rise of Strategic Planning, *Harvard Business Review*

Mintzberg, H., & Waters, J.A. (1985) Of Strategies, Deliberate and Emergent, *Strategic Management Journal* (pre-1986); Chichester Vol. 6, Iss. 3, (Jul-Sep 1985): 257-272 (16 pages)

Mintzberg, H., Ahlstrand, B., & Lampel, J. (1998), *Strategy Safari: The Complete Guide through the Wilds of Strategic Management*, Pearson Education, Harlow.

Mirabeau, L., & Maguire, S. (2014), From autonomous strategic behavior to emergent strategy. *Strat. Mgmt. J.*, 35: 1202-1229. <https://doi.org/10.1002/smj.2149>

Miranda-Belmonte, H., Muñiz-Sánchez, H., Corona, F., (2023) Word embeddings for topic modeling: An application to the estimation of the economic policy uncertainty index; *Expert Systems with Applications*, Volume 211, 2023, 118499, ISSN 0957-4174

Mirchandani, A. A. & Motwani, J. (2001). Understanding small business electronic commerce adoption: An empirical analysis. *Journal of Computer Information Systems* Spring, 70-73.

Mishra, S., Tewari, I., Toosi, S. (2020) Economic complexity and the globalization of services, *Structural Change and Economic Dynamics* 53 (2020) 267–280

Molnar, A.R., Lybrand, W.A., Hahn, L., Kirkman, J.L., Riddleberger, P.B., (1963) "Undergrounds in Insurgent, Revolutionary and Resistance Warfare", American University Washington DC, 1963.at <http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=AD0436353>

Montero, J., Naimy, V., Farraj, N.A., Khoury, R.E. (2024) Natural disasters, stock price volatility in the property-liability insurance market and sustainability: An unexplored link; *Socio-Economic Planning Sciences*, Volume 91, 2024, 101791, ISSN 0038-0121, <https://doi.org/10.1016/j.seps.2023.101791>.

Moreland, S., Mahmoud, A., Njoya, E.T (2023) National Competitive Advantage Perspective of Global Aviation Hubs: The Middle East Big Three. *Journal of Aerospace Technology and Management* Volume: 15 (2023) ISSN: 2175-9146 Online ISSN: 2175-9146

Morrison, G., Buldyrev, S.V., Imbruno, M. et al. (2017) On Economic Complexity and the Fitness of Nations. *Sci Rep* 7, 15332 (2017). <https://doi.org/10.1038/s41598-017-14603-6>

Mulero, R., & Garcia-Hiernaux, A. (2023) Forecasting unemployment with Google Trends: age, gender and digital divide. *Empir Econ* 65, 587–605 (2023). <https://doi.org/10.1007/s00181-022-02347-w>

Mulvenna, M. (2016) "The' Soft-Push': mining internet data for marketing intelligence The 'Soft-Push': Mining Internet Data for Marketing," no. June, 2016

Munde, G. (2010). "Considerations for managing an increasingly intergenerational workforce in libraries." *Library Trends*, 59 (1/2), 89.

Munir, K., & Riaz, N. (2020) Fiscal Policy, Macroeconomic Flux and Inflation Volatility in Pakistan; *Journal of Applied Economics and Business Research* JAEBR, 10(4): 194-206 (2020) Copyright © 2020 JAEBR ISSN 1927-033X

Munroe, T. (2012). Is Silicon Valley Sustainable? Triple Helix Association. Retrieved from <https://www.triplehelixassociation.org/helice/volume-1-2012/helice-issue-1/silicon-valley-sustainable>

Munteanu, A.I., Bibu, N., Nastase, M., Cristache, N., Matis, C. (2020) "Analysis of Practices to Increase the Workforce Agility and to Develop a Sustainable and Competitive Business" Sustainability 12, no. 9: 3545. <https://doi.org/10.3390/su12093545>

Murphy, K.M., Shleifer, A., Vishny, R.W. (1989) Industrialization and the big push. J. Polit. Econ. 97 (5), 1003–1026.

Murphy, R. (2020), "Local consumer review survey", available at: <https://www.brightlocal.com/research/local-consumer-review-survey-2020/#> (access Nov 2023)

Murthy, V., & McKie, D. (2009), Please Don't Stop the Music: An Ensemble Leadership Repertoire for Productive Sustainability, and Strategic Innovation in Uncertain Times, World Association for Sustainable Development (WASD), Inderscience, London, 189pp.

Murthy, V., & Murthy, A. (2014) Adaptive leadership responses, Introduction to an emerging classification of zeitgeist enactments, practices and virtues for a VUCA world, World Journal of Entrepreneurship, Management and Sustainable, Development, Vol. 10 No. 3, 2014, pp. 162-176

Myers, N., Kent, J. (2003) New consumers: the influence of affluence on the environment. Proc. Natl. Acad. Sci. U.S.A. 100 (8), 4963–4968.

National Research Council (2012) Rising to the Challenge: U.S. Innovation Policy for the Global Economy, National Academies Press, Washington, DC (2012)

Nature (2022) Global Innovation Hubs Index 2022, Center for Industrial Development and Environmental Governance (CIDEG) at Tsinghua University and Nature Research <https://www.nature.com/articles/d42473-022-00486-3>

Neuman, W. L., (2014) *Social Research Methods: Qualitative and Quantitative Approaches*, Seventh Edition, Pearson Education Limited, ISBN 10: 1-292-02023-7

Nguyen, P.C., Schinckus, C., Nguyen, B.Q., & Tran, D.L.T. (2022) "International portfolio investment: does the uncertainty matter?", *Journal of Economics and Development*, Vol. 24 No. 4, pp. 309-328.

Ngwakwe, C. (2022) *Stock Market Volatility during Rumours of War and Actual War: Case of Russia-Ukraine Conflict*. *Acta Universitatis Danubius. Economica, Galati* Vol. 18, Iss. 3, (2022).

Nica, I. (2020) *An approach to the index of economic freedom using the data mining technique in the economic environment context; Theoretical and Applied Economics*, Volume XXVII (2020), No. 2(623), Summer, pp. 131-146

Niehaus, M., Hansen, K., Mocan, M., Barmayoun, D. (2023) "Unraveling Successful Company Organizations: A Research Design to Explore Strategies for Thriving Amid Market Turbulence" *Administrative Sciences* 13, no. 9: 204. <https://doi.org/10.3390/admsci13090204>

Nieto-Chaupis, H., (2021) "The Interrelation Poverty-Unemployment from the Theory of Entropy in Modern Societies," 2021 Fifth World Conference on Smart Trends in Systems Security and Sustainability (WorldS4), London, United Kingdom, 2021, pp. 266-270, doi: 10.1109/WorldS451998.2021.9514025.

Nikolaou, I., & Tsalis, T. (2013). Development of a sustainable balanced scorecard framework. *Ecological Indicators*. 34. 76–86. 10.1016/j.ecolind.2013.04.005.

Nikseresht A, Hajipour B, Pishva N, Mohammadi H.A. (2022) Using artificial intelligence to make sustainable development decisions considering VUCA: a systematic literature review and bibliometric analysis. *Environ Sci Pollut Res Int*. 2022 Jun;29(28):42509-42538. doi: 10.1007/s11356-022-19863-y. Epub 2022 Apr 4. PMID: 35377115.

Nishimoto, H. (2021) Scenario Planning in Healthcare Development in the VUCA World. Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management. AI, Product and Service: 12th International Conference, DHM 2021, Held as Part of the 23rd HCI International Conference, HCII 2021 https://doi.org/10.1007/978-3-030-77820-0_9

Nordhaus, W., Tobin, J. (1972) Is growth obsolete? In: Economic growth. Fiftieth anniversary, Colloquium 5, National Bureau of Economic Research

Nottar, D.I.D.S., Cezar, G.S., Martins, V.A., & Bertolini, G.R.F., (2023) The Relationship Between Financial Indicators and Financial Intermediaries' Stock Price Volatility Listed on the BM&FBOVESPA Index in the Crisis Period of 2008 and 2020 (Covid-19): GCG. Revista de Globalización, Competitividad y Gobernabilidad, 17(2), pp. 67-82.

Nugapitiya, O., & Wickramarachchi, R. (2023) "Strategies to Overcome Information Overload in the Workplace: A Systematic Literature Review," 2023 IEEE 8th International Conference for Convergence in Technology (I2CT), Lonavla, India, 2023, pp. 1-5, doi: 10.1109/I2CT57861.2023.10126353.

Ochoa, C., & Revilla, M. (2022). Acceptance and coverage of fast invitation methods to in-the-moment surveys. International Journal of Market Research, 64(5), 565-574. <https://doi.org/10.1177/14707853221085204>

Ochoa, C., Revilla, M., Versteeg, D. (2016). Getting closer to in the moment insights generation. Combining behavioral data and survey data collection. In Proceedings of the ESOMAR World New Orleans Congress, New Orleans, 18–21 September 2016. ISBN: 92-831-0289-4.

OECD (2008) Handbook on constructing composite indicators: methodology and user guide. Methodology, vol 3. doi: 10.1787/9789264043466-en

OECD (2009) Applications of Complexity Science for Public Policy: New Tools for Finding Unanticipated Consequences and Unrealized Opportunities OECD Publishing, Paris (2009)

Okorie, O., Russell, J., Cherrington, R., Fisher, O., Charnley, F. (2023) Digital transformation and the circular economy: Creating a competitive advantage from the transition towards Net Zero Manufacturing, Resources, Conservation and Recycling, Volume 189, 2023, 106756, ISSN 0921-3449

Orfi, N., Terpenny, J., Sahin-Sariisik, A. (2011) Harnessing Product Complexity: Step 1—Establishing Product Complexity Dimensions and Indicators, The Engineering Economist, 56: 59–79, 2011.

Orfi, N., Terpenny, J., Sahin-Sariisik, A. (2012) Harnessing Product Complexity: Step 2—Measuring and Evaluating Complexity Levels, Engineering Economist. 2012, Vol. 57 Issue 3, p178-191.

Osterwalder, A. (2005). "What is a business model?". business-model-design.blogspot.com. Archived from the original on 2006-12-13. Retrieved 2023-11-10

Oturakci, M. (2021) Comprehensive analysis of the global innovation index: statistical and strategic approach, Technology Analysis & Strategic Management Journal, 2021 DOI: 10.1080/09537325.2021.1980209

Packowski, J., Francas, D., Fitzer, A., Knein, E., Streuber, P. (2014) LEAN SCM - Part 1-5: Supply Chain Management for the VUCA World, Pharm. Ind. 76, Nr. 1, 69-73 (2014)

Palshikar, G. K. (2001) Matching Patterns, Intelligent Enterprise; San Mateo Vol. 4, Iss. 6, (Apr 16, 2001): 46-51.

Pang A.S.-K. (2007) Get there early: the VUCA opportunity. IFTF's Future Now. <http://future.iftf.org/2007/08/get-there-ear-2.html>. Posted August 28, 2007. Accessed May 5, 2012.

Parmer, L.L., Dillard, J.E., Hughes, M., (2023) Creative Entrepreneurship and the McKinsey 7S Framework: Utilizing a Servant Leadership Style. American Journal of Management, 23(3), pp. 64-78.

Pastor-Satorras, R., Castelalano, C., Miegheem, P. V., Vespignani, (2015) A. Epidemic processes in complex networks. *Rev Mod Phys* 87, 925 (2015).

Peer, E., Brandimarte, L., Samat, S., Acquisti, A. (2017) Beyond the Turk: Alternative platforms for crowdsourcing behavioral research, *Journal of Experimental Social Psychology*, Volume 70, 2017, Pages 153-163, ISSN 0022-1031, <https://doi.org/10.1016/j.jesp.2017.01.006>

Pehlivanoğlu, F., Akdağ, S. & Alola, A.A. (2021) The causal nexus of geopolitical risks, consumer and producer confidence indexes: evidence from selected economies. *Qual Quant* 55, 1261–1273 (2021). <https://doi.org/10.1007/s11135-020-01053-y>

Perona, M., & Miragliotta, G. (2004). Complexity management and supply chain performance assessment: A field study and a conceptual framework. *International Journal of Production Economics*, 90(1), 103–115.

Peters, T.J., & Waterman, R.H. (1982). *In search of excellence : lessons from America's best-run companies*. New York :Harper & Row,

Peterson, C. and Seligman, M.E.P. (2004), *Character Strengths and Virtues: A Handbook and Classification*, Oxford University Press, New York, NY.

Phan, T.C. (2023) Energy prices volatility, natural resource policy-making and green economic recovery in post COVID-19 era: Evidence from BRICS countries, *Resources Policy*, Volume 87, Part A, December 2023, 104255

Piaget, J. (1932) *Moral Judgment of the Child* (New York, NY: Free Press, 1932).

Pietraszewski, P., Gniadkowska-Szymańska, A., Bolek, M. (2023) Expected vs. real growth of companies listed on the London Stock Exchange. *J Econ Finan* 47, 646–668 (2023). <https://doi.org/10.1007/s12197-023-09623-0>

Pinkess, A. (2008). “Employer branding: Show you really care to win staff. *Brand Strategy*, 38.

Pleshko, L.P., & Heiens, R.A. (2007) The contemporary product-market strategy grid and the link to market orientation and profitability, *Journal of Targeting*,

Measurement and Analysis for Marketing Vol. 16, 2, 108–114 © 2008 Palgrave Macmillan Ltd 0967-3237

Polanyi, M. (1958) *Personal Knowledge. Towards A Post-Critical Philosophy*. London: Routledge

Porter, M.E. (1979) "How Competitive Forces Shape Strategy", *Harvard Business Review*, May 1979 (Vol. 57, No. 2), pp. 137–145.

Porter, M.E. (1985), "Competitive Advantage: Creating and Sustaining Superior Performance", Free Press, a division of Macmillan Inc., New York, NY.

Porter, M. E. (1998). *On Competition*. Boston, MA: Harvard Business School Press

Porter, M.E. (1990) *The Competitive Advantage of Nations* (1st ed.). Palgrave, New York Press

Pourazad, N., Lara, S., Shreya N., (2023) A Comparison of Social Media Influencers' KPI Patterns across Platforms: Exploring Differences in Followers and Engagement On Facebook, Instagram, YouTube, TikTok, and Twitter; *Journal of Advertising Research* Volume: 63 Issue 2 (2023) ISSN: 0021-8499 Online ISSN: 1740-1909

Prahalad, C. K., & Hamel, G., (1990) 'The core competence of the corporation'. *Harvard business review*, 68 (3), 79–91.

Pratt, L., Bisson, C., Warin, T. (2023) Bringing advanced technology to strategic decision-making: The Decision Intelligence/Data Science (DI/DS) Integration framework, *Futures*, Volume 152, 2023, 103217, ISSN 0016-3287, <https://doi.org/10.1016/j.futures.2023.103217>.

Pretorius, C., Ruthven, G. A., Von Leipzig, K. (2013) An empirical supply chain measurement model for a national egg producer based on the supply chain operations reference model. *Journal of Transport and Supply Chain Management*, 7(1), 1–13. <https://doi.org/10.4102/jtscm.v7i1.97>

Pretzel, B. (2023) The Climate Toolbox—A Microsoft® Excel® Based Tool for Assessing and Comparing the Effects of Internal Climates on Museum Artefacts. *Heritage* 2023, 6, 3745–3756. <https://doi.org/10.3390/heritage6040198>

Prisecaru, P. & Calanter, P. (2022) Intensification of the Prices Volatility for Oil and Natural Gas. *Global Economic Observer*, 10(2), pp. 46-52.

Pugliese, E., Zaccaria, A., Pietronero, L. (2014). On the convergence of the Fitness-Complexity Algorithm. *The European Physical Journal Special Topics*. 225. 10.1140/epjst/e2015-50118-1.

Putri, N.R., Syarief., R., Asnawi, Y. H. (2023). Core Competence Development Strategy to Achieve Competitive Advantage (Case Study: Dawoon Tea). *Indonesian Journal of Business and Entrepreneurship (IJBE)*, 9(1), 1. <https://doi.org/10.17358/ijbe.9.1.1>

Putro, S., Rianto, R., Wibisana, B.H. (2022) “Making Business Policies And Strategies In The Vuca Era With Technology Development: A Literature Review”, *International Journal of Innovative Technologies in Social Science*, (1(33). doi: 10.31435/rsglobal_ijitss/30032022/7796.

Qingyan, Y., Khalid, A.M., Shujaat, A., Junaid, A., Munir, A., Junaid, J., Romanus, O. (2022) Integrating the Role of Green Fiscal Policies With Energy Prices Volatility and Energy Efficiency: Presenting a COVID-19 Perspective; *Frontiers in Energy Research*, VOL 9, 2022 <https://www.frontiersin.org/articles/10.3389/fenrg.2021.838307>

Raghu Raman (2015), ‘Leading in the VUCA world - How the Armed Forces do it’ TEDx Talks <https://www.youtube.com/watch?v=mZ-IBRGfJyY> (last accessed 12/04/2016)

Rahayu, S., Meirawan, D., Muktiarni, M., Ghinaya, Z., & Sabitri, Z. (2024). Analyzing transferable skills of vocational students to align with industry demands., *Jurnal Pensil: Pendidikan Teknik Sipil*, 13(1), 34 - 46. <https://doi.org/10.21009/jpensil.v13i1.39803>

Rai, S. (2012). "Engaging young employees (Gen Y) in a social media dominated world. International Conference on Emerging Economies - Prospects and Challenges – Review and Retrospection. Procedia -Social and Behavioural Sciences, 37, 257 – 266.

Rajala, A., & Hautala-Kankaanpää, T. (2023), "Exploring the effects of SMEs' platform-based digital connectivity on firm performance – the moderating role of environmental turbulence", Journal of Business & Industrial Marketing, Vol. 38 No. 13, pp. 15-30. <https://doi.org/10.1108/JBIM-01-2022-0024>

Ramakrishnan, S. (2016) Data is the lifeblood of the digital economy, Siliconindia. Oct2016, Vol. 19 Issue 10, p35-36. 2p.

Raman, G., Ramendran, C., Beleya, P., Nodeson, S., & Arokiasamy, L. (2011) "Generation Y in institution of higher learning." International Journal of Economics and Business Modelling, 2 (2), 142-148.

Ren, H., Zhou, W., Wang, H. et al. (2022) An energy system optimization model accounting for the interrelations of multiple stochastic energy prices. Ann Oper Res 316, 555–579 (2022). <https://doi.org/10.1007/s10479-021-04229-3>

Resnick, P. & Varian, H. R. (1997) Recommender systems. Commun. ACM 40, 56–58 (1997)

Reuter, W.H., Tkačevs, O. & Vilerts, K. (2022) Fiscal rules and volatility: the role of stabilising properties and compliance. Empirica 49, 21–52 (2022). <https://doi.org/10.1007/s10663-021-09522-9>

Reuters (2023) NY Fed index shows global supply chain pressures eased further in March, Michael S. Derby (author) Reuters.com. 6/04/2023

Rich-Tolsma, M., & Oliver, J. (2016), Addressing the Complexity Gap: Developing Integrated Thinking Skills at Board Level. Board Leadership, 2016: 1-8. <https://doi.org/10.1002/bl.30034>

Ries, E. (2011) The Lean Startup, Crown Business (USA), ISBN 0307887898

Rjiba, H., Saadi, S., Boubaker, S., Ding, X. (2021) Annual report readability and the cost of equity capital; Journal of Corporate Finance, Volume 67, 2021, 101902, ISSN 0929-1199, <https://doi.org/10.1016/j.jcorpfin.2021.101902>.

Roderick, R. M. (1998) "Strategic Leadership Primer," 1st ed. Carlisle Barracks, PA: U.S. Army War College, 1998.

Rodriguez, A., & Rodriguez, Y. (2015),"Metaphors for today's leadership: VUCA world, millennial and "Cloud Leaders"", Journal of Management Development, Vol. 34 Iss 7 pp. 854 - 866, <http://dx.doi.org/10.1108/JMD-09-2013-0110>

Rodriguez, C.M. (2024) Financial development, fiscal policy and volatility: Their effects on growth; The Journal of International Trade & Economic Development, 2014 Vol. 23, No.2, pages 223–266,

Rogers, B. (2017). Ryan Smith's Qualtrics capitalizes on the rise of the 'experience economy'. Forbes. <https://www.forbes.com/sites/brucerogers/2017/03/02/ryan-smiths-qualtrics-capitalizes-on-the-rise-of-the-experience-economy/#6843ed5c6221>

Rouvrais, S., Winkens, A.K., Leicht-Scholten, C., Audunsson, H., Gerwel, P.C. (2023). VUCA and Resilience in Engineering Education - Lessons Learned. Proceedings of the 19th International CDIO Conference, hosted by NTNU, Trondheim, Norway, June 26-29, 2023

Rowe, J. (2010), "The cybernetics of organising: management and leadership", Kybernetes, Vol. 39 No. 7, pp. 1100-1111, available at: www.emeraldinsight.com/10.1108/03684921011062728 (accessed 11 April 2016).

Russell, M.G., & Smorodinskaya, N.V. (2018) Leveraging complexity for ecosystemic innovation, Technological Forecasting and Social Change, Volume 136, 2018, Pages 114-131, ISSN 0040-1625, (Russell & Smorodinskaya, 2018)

Safane, J., & Suarez, J. (2022) What is the Global Supply Chain Pressure Index? A new tool that tracks how backed up supply chains are around the world, Business Insider, Published Jul 28, 2022, 6:58 PM BST

(<https://www.businessinsider.com/personal-finance/global-supply-chain-pressure-index?r=US&IR=T>)(accessed 15.24 on 22/04/2023)

Sanghoon, C., Pekgün, P., Janakiraman, R., Wang, J. (2024) The Competitive Effects of Online Reviews on Hotel Demand; *Journal of Marketing* Volume: 88 Issue 2 (2024) ISSN: 0022-2429 Online ISSN: 1547-7185

Sanwal, A. (2007) *Portfolio Management: Aligning Investment Proposals with Organizational Strategy*, Hardcover, Wiley, ISBN 0470126884

Sapio, A., & Spagnolo, N., (2020) The effect of a new power cable on energy prices volatility spillovers; *Energy Policy*, Volume 144, 2020, 111488, ISSN 0301-4215, <https://doi.org/10.1016/j.enpol.2020.111488>.

Saraceno, L. (2020) *Economic Complexity: exploration of ranking metrics and investigation of causality between Complexity and Gross Domestic Product per capita*. <http://webthesis.biblio.polito.it/id/eprint/15198>

Sarker, P.K., Bouri, E. & Marco, C.K.L. (2023) Asymmetric effects of climate policy uncertainty, geopolitical risk, and crude oil prices on clean energy prices. *Environ Sci Pollut Res* 30, 15797–15807 (2023). <https://doi.org/10.1007/s11356-022-23020-w>

Satyanarayana, K., Chandrashekar, D., Vighnesh, N.V., Brem, A. (2022) Competitive Analysis or Stakeholder Pre-Commitments? How Firms' Strategic Decision-Making Choices Mediate the Relationship Between its Strategic Posture and Digitalization, *IEEE Transactions on Engineering Management*

Savaş, S. (2021) "Analysis of the Social Media Impact on the Popularity of Cryptocurrencies," 2021 6th International Conference on Computer Science and Engineering (UBMK), Ankara, Turkey, 2021, pp. 67-72, doi: 10.1109/UBMK52708.2021.9558921.

Sayers, R. (2007). "The right staff from X to Y. *Library Management*, 28(8/9), 474-487.

Schick, A., Hobson, P. R., Ibisch, P. L. (2017) Conservation and sustainable development in a VUCA world: the need for a systemic and ecosystem-based approach. *Ecosystem Health and Sustainability* 3(4):e01267. 10.1002/ehs2.1267

Schuh, G., Patzwald, M., Cardoso, M. C. I. (2019) "Resilient Technology Strategy in Volatile Environments: Derivation of Requirements to Enable Long-Term Strategic Positioning in Times of Volatility, Uncertainty, Complexity and Ambiguity," 2019 Portland International Conference on Management of Engineering and Technology (PICMET), Portland, OR, USA, 2019, pp. 1-15, doi: 10.23919/PICMET.2019.8893922.

Schuh, G., Patzwald, M., Warzawa, T. (2022) "Turbulence-induced Initiation of Technology Strategy Development in a Volatile Business Environment," 2022 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Kuala Lumpur, Malaysia, 2022, pp. 1399-1405, doi: 10.1109/IEEM55944.2022.9989873.

Schwab, K. (2016) *The Fourth Industrial Revolution*. World Economic Forum.

Seamon T. (2012) Fight VUCA stress in 2012. <http://learningvoyager.blogspot.com/2011/12/fight-vuca-stress-in-2012.html>. Posted December 28, 2011. Accessed 06 April 2016

Sekera, V., Stopczynski, A. Lehmann, S. (2016) Fundamental structures of dynamic social networks. *Proc Natl Acad Sci* 113, 9977–9982 (2016).

Senge, P. (2006). "The Fifth Discipline: The Art and Practice of the Learning Organisation" Doubleday

Serdarasan, S., (2012) A review of supply chain complexity drivers *Computers & Industrial Engineering* 66 (2013) 533–540 Available online 20 December 2012

Seyal, A. H., Abd Rahman, M. N. & HjAwg Mohamad, H. A. Y. (2007). A quantitative analysis of factors contributing electronic data interchange adoption among Bruneian SMEs. *Business Process Management Journal*, 13(5), 728-746.

Shahaab, A., Khan, I.A., Maude, R., Hewage, C., Wang, Y. (2023) Public service operational efficiency and blockchain – A Case Study of Companies House, UK; *Government Information Quarterly*, Volume 40, Issue 1, 2023, 101759, ISSN 0740-624X, <https://doi.org/10.1016/j.giq.2022.101759>.

Shankar, V., Urban, G. L., & Sultan, F. (2002). Online trust: a stakeholder perspective, concepts, implications, and future directions. *The Journal of Strategic Information Systems*, 11(3–4), 325–344.

Sharma, A., Kumar, V., Borah, S.B., Adhikary, A. (2022) Complexity in a multinational enterprise's global supply chain and its international business performance: A bane or a boon? *Journal of International Business Studies* (2022) <https://doi.org/10.1057/s41267-021-00497-0>

Shaw, S. (2008). "Engaging a new generation of graduates" *Education & Training*, 50(5), 366-378.

Sheffi, Y. (2005), *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*, MIT Press Books, Cambridge, p. 1.

Sheiner, L., Campbell, S., Kovalski, M.A., Milstein, E. (2021) How pandemic-era fiscal policy affects the level of GDP; The Brookings Institution, accessed <https://www.brookings.edu/articles/the-hutchins-centers-fiscal-impact-measure/> (13 Nov 2023)

Sheiner, L., Campbell, S., Kovalski, M.A., Milstein, E. (2021) *The Hutchins Center's Fiscal Impact Measure: Methodology*; The Brookings Institution, accessed <https://www.brookings.edu/articles/the-hutchins-centers-fiscal-impact-measure/> (13 Nov 2023)

Sherif, M. (1948). *An Outline of Social Psychology*. New York, NY: Harper & Brothers.

Shih, C., & Hwang, Y., (2018) Re-worlding the 'West' in post-Western IR: the reception of Sun Zi's the Art of War in the Anglosphere, *International Relations of the Asia-Pacific*, Volume 18, Issue 3, September 2018, Pages 421–448, <https://doi.org/10.1093/irap/lcy009>

Simon, Herbert A. (1962). "The architecture of complexity". Proceedings of the American Philosophical Society, ISSN 0003-049X, 106(6): 467-482, reprinted in E:CO Issue Vol. 7 Nos. 3-4 2005 pp. 138-154

Singh, M.K., Kumar, H., Gupta, M.P. Madaan, J. (2018) "Competitiveness of electronics manufacturing industry in India: an ISM–fuzzy MICMAC and AHP approach", *Measuring Business Excellence*, Vol. 22 No. 1, pp. 88-116.

Singh, P., Sharma, B.K., Arora, L., Bhatt, V. (2023) Measuring social media impact on Impulse Buying Behavior. *Cogent Business & Management*, Abingdon Vol. 10, Iss. 3, (Dec 2023). DOI:10.1080/23311975.2023.2262371

Sivadasan, S., Efstathiou, J., Frizelle, G., Shirazi, R., Calinescu, A. (2002) An information-theoretic methodology for measuring the operational complexity of supplier-customer systems, *International Journal of Operations & Production Management* ISSN: 0144-3577 22(1):80-102 Article publication date: 1 January 2002

Slater, S.F., Olson, E.M., & Hult, G.T.M. (2006) The moderating influence of strategic orientation on the strategy formation capability–performance relationship, *Strategic Management Journal*, Volume 27, Issue 12, Pages 1221–1231

Smircich, L. (1983) Concepts of Culture and Organisational Analysis, *Administrative Science Quarterly*. Sep83, Vol. 28 Issue 3, p339-358. 20p.

Smirnov, D. S., Kuznetsov, I. A., Guseva, A. I., (2022) "Application of Monte-Carlo Method for Modeling Google Trends Rating of "Nuclear Energy" Topic," 2022 4th International Conference on Control Systems, Mathematical Modeling, Automation and Energy Efficiency (SUMMA), Lipetsk, Russian Federation, 2022, pp. 231-233, doi: 10.1109/SUMMA57301.2022.9974138.

Smith, A. (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations* (W. Strahan and T. Cadell, London).

Smorodinskaya, N.V. & Katukov, D.D. (2015) The Cluster Approach to Economic Growth: European and Russian Policies (CGES Working Papers no. WP 2015-01) (2015)

Solinger, O.N., Heusinkveld, S., Cornelissen, J. P. (2024), 'Redefining concepts to build theory: A repertoire for conceptual innovation', *Human Resource Management Review*, Volume 34, Issue 1, 2024, 100988, ISSN 1053-4822, <https://doi.org/10.1016/j.hrmr.2023.100988>

Soru, T., & Marshall, J., (2024) "Trend Extraction and Analysis via Large Language Models," 2024 IEEE 18th International Conference on Semantic Computing (ICSC), Laguna Hills, CA, USA, 2024, pp. 285-288, doi: 10.1109/ICSC59802.2024.00051.

Spence, C., Southall, B., Tozzo, A., et al, (2016) "Pattern of Life analysis for diverse data types," *Proc. SPIE 9828, Airborne Intelligence, Surveillance, Reconnaissance (ISR), Systems and Applications XIII*, 98280D (17 May 2016); doi: 10.1117/12.2224195

Spiegelhalter, D., Pearson, M., & Short, I. (2011), "Visualizing Uncertainty About the Future" *Science* Sept 2011, Vol. 333, Issue 6048

Spyrou, S. (2020) Momentum return volatility, uncertainty, and energy prices: evidence from major international equity markets. *Review of Behavioral Finance*, 12(4), pp. 411-433.

Stalmachova, K.; Chinoracky, R.; Strenitzerova, M. (2022) Changes in Business Models Caused by Digital Transformation and the COVID-19 Pandemic and Possibilities of Their Measurement—Case Study. *Sustainability Journal* 2022, 14, 127. <https://doi.org/10.3390/su14010127>

Stamp, G. (1993) *The Essence of Levels of Work*, Johannesburg: Bioss Southern Africa, 1993

Starbuck, W.H. (2006), "The Production of Knowledge", Oxford University Press, Oxford.

Stein, J. (2013), "The new greatest generation. Why millennials will save us all, Time, Vol. 181 No. 19, pp. 26-34

Stevens, J.L., Esmark Jones, C.L. and Breazeale, M. (2022), "Title redacted: the impact of negative online review censorship", Journal of Product & Brand Management, Vol. 31 No. 4, pp. 570-585. <https://doi.org/10.1108/JPBM-04-2020-2877>

Sthapit, E., & Björk P. (2019) Sources of distrust: Airbnb guests' perspectives; Tourism Management Perspectives, Volume 31, 2019, Pages 245-253, ISSN 2211-9736, <https://doi.org/10.1016/j.tmp.2019.05.009>.

Stojanovikj, M., (2022) Government size, inflation targeting and business cycle volatility; Economic Analysis and Policy, Volume 74, 2022, Pages 1-12, ISSN 0313-5926, <https://doi.org/10.1016/j.eap.2022.01.009>.

Stokking, H., & Strijkers, R. (2012) "Sun Tzu's Art of War for telecom," 2012 16th International Conference on Intelligence in Next Generation Networks, Berlin, Germany, 2012, pp. 43-49, doi: 10.1109/ICIN.2012.6376032.

Sturmberg, J.P. (2010) Variability, continuity and trust – towards an understanding of uncertainty in health and health care, Journal of Evaluation in Clinical Practice ISSN 1356-1294

Sullivan, J. (2012), "VUCA: The new normal for talent management and workforce planning", Ere.net. Retrieved from <http://www.ere.net/2012/01/16/vuca-the-new-normal-for-talent-management-and-workforce-planning/>.

Suzuki, T., Kishi, T., Ishida, M., Rewley, J., Node, K., & Mizuno, A., (2023) The time trend of information seeking behavior about salt reduction using Google Trends: infodemiological study in Japan. Hypertens Res 46, 1886–1891 (2023). <https://doi.org/10.1038/s41440-023-01283-1>

Sušjan, A., & Redek, T. (2008) Uncertainty and Growth in Transition Economies; Review of social economy Volume: 66 Issue 2 (2008) ISSN: 0034-6764 Online ISSN: 1470-1162

Tabesh, P., & Vera, D.M. (2020) "Top managers' improvisational decision-making in crisis: a paradox perspective", *Management Decision*, Vol. 58 No. 10, pp. 2235-2256. <https://doi.org/10.1108/MD-08-2020-1060>

Tacchella, A., Cristelli, M., Caldarelli, G., Gabrielli, A., Pietronero, L. (2012) A new metrics for countries' fitness and products' complexity, *Sci. Rep.*, 2 (2012), p. 723, [10.1038/srep00723](https://doi.org/10.1038/srep00723)

Tagkalakis, A. (2012) Fiscal policy and asset price volatility. *Empirica* 39, 123–156 (2012). <https://doi.org/10.1007/s10663-011-9167-2>

Tajfel, H. (1974). "Social identity and intergroup behaviour". *Social Science Information*, 14, 65–93.

Taleb, N. (2010), "The Black Swan; the impact of the highly improbable" London Penguin.

Taleb, N. (2012), "Antifragile: things that gain from disorder" 2nd edition, London Penguin.

Taskan, B., Junça-Silva, A., & Caetano, A. (2022), "Clarifying the conceptual map of VUCA: a systematic review", *International Journal of Organizational Analysis*, Vol. 30 No. 7, pp. 196-217. <https://doi.org/10.1108/IJOA-02-2022-3136>

Tassey, G. (2008) Globalization of technology-based growth: the policy imperative, *J. Technol. Transfer.*, 33 (6) (2008), pp. 560-578,

Tetenbaum, T., & Laurence, H. (2011), "Leading in the chaos of the 21st century", *Governing in The Chaos of The 21st Century*, Vol. 4 No. 4, pp. 41-49.

The Economist (2017) The world's most valuable resource is no longer oil, but data, May 6th, 2017, edition

Thompson, J.D. (1967) *Organizations in Action*, New York, McGraw-Hill

Thompson, S., (2013) *States of Uncertainty: Youth Unemployment in Europe*. Report. Institute for Public Policy Research. Access URL <http://aei.pitt.edu/74123/>

Thorbecke, W., Chen, C., Salike, N. (2021) The Relationship between Product Complexity and Exchange Rate Elasticities: Evidence from the People's Republic of China's Manufacturing Industries, Published: 01 Sep 2021 Journal: Asian Development Review, volume 38, pages 189-212 (issn: 0116-1105, eissn: 1996-7241, Copyright policy)

Tissera, M., & Weerasinghe, R., (2019) "Auto Generation of Gold Standard, Class Labelled Data Set and Ontology Extension Tool [QuadW]," 2019 Second International Conference on Advanced Computational and Communication Paradigms (ICACCP), Gangtok, India, 2019, pp. 1-6, doi: 10.1109/ICACCP.2019.8882996.

Todd, P. R. & Javalgi, R. (2007) Internationalization of SMEs in India. Fostering Entrepreneurship by leveraging information technology. International Journal of Emerging Markets, 2(2), 160-188

Tolga Er, S., Demir, E., Sari, E. (2023) Suicide and economic uncertainty: New findings in a global setting; SSM - Population Health, Volume 22, 2023, 101387, ISSN 2352-8273, <https://doi.org/10.1016/j.ssmph.2023.101387>.

Turner, J.R. & Baker, R.M., (2019) Complexity Theory: An Overview with Potential Applications for the Social Sciences; Systems, Vol 7, Iss 1, p 4 (2019)

Turulja, L. & Bajgoric, N. (2019) "Innovation, firms' performance and environmental turbulence: is there a moderator or mediator?", European Journal of Innovation Management, Vol. 22 No. 1, pp. 213-232. <https://doi.org/10.1108/EJIM-03-2018-0064>

Uhl-Bien, M., Marion, R., & McKelvey, B., (2007), "Complexity leadership theory: shifting leadership from the industrial age to the knowledge era", The Leadership Quarterly, Vol. 18 No. 4, pp. 298-318.

Ullrich, A., Bertheau, C., Wiedmann, M., Sultanow, E., Korppen, T., & Bente, S. (2021) Roles, tasks and skills of the enterprise architect in the VUCA world," 2021 IEEE 25th International Enterprise Distributed Object Computing Workshop

(EDOCW), Gold Coast, Australia, 2021, pp. 261-270, doi: 10.1109/EDOCW52865.2021.00057.

Van Aartsengel, A., & Kurtoglu, S. (2013) Strategic Planning and Management. In: A Guide to Continuous Improvement Transformation. Management for Professionals. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-35904-0_5

Van Ninh, N., Cuong, N/Q., Nhan, N.T.T. (2023) Investigating The Factors Of Customer Feedback Affecting Product Sales On E-Commerce Platforms; Journal of Global Business and Technology Volume: 19 Issue 2 (2023) ISSN: 1553-5495 Online ISSN: 2616-2733

Van der Wielen W, Barrios S (2021) Economic sentiment during the COVID pandemic: evidence from search behaviour in the EU. J Econ Bus. <https://doi.org/10.1016/j.jeconbus.2020.105970>

Varga, M., & Albuquerque, P. (2023). The Impact of Negative Reviews on Online Search and Purchase Decisions. Journal of Marketing Research, 0(0). <https://doi.org/10.1177/00222437231190874>

Vitali, S., Glattfelder, J., Battiston, S. (2011) The network of global corporate control. PLoS One 6, e25995 (2011).

Vuong, G.T.H., Nguyen, M.H., Wong, W.K. (2022) CBOE volatility index (VIX) and corporate market leverage, Cogent Economics & Finance, 10:1, DOI: 10.1080/23322039.2022.2111798

Wahyuningrum, T., Prasetyo, N., Bahtiar, A. R., Latifah, L., Ramadhani, I. D., Yunitawati, D., (2022) "Google Trends Data About Mental Health During COVID-19 Pandemic Using Time Series Regression," 2022 5th International Seminar on Research of Information Technology and Intelligent Systems (ISRITI), Yogyakarta, Indonesia, 2022, pp. 125-129, doi: 10.1109/ISRITI56927.2022.10052965.

Walter, K. (2010). The Lords of Strategy. Harvard Business Press. ISBN 978-1-59139-782-3

Wang, N., & Qichong Zhou, Q., (2022) Does commodity hedging with derivatives reduce stock price volatility?; Finance Research Letters, Volume 50, 2022, 103321, ISSN 1544-6123, <https://doi.org/10.1016/j.frl.2022.103321>.

Wang, Y., Shi, W., Sun, Y., Yeh, C., (2024) "A Novel Framework to Forecast COVID-19 Incidence Based on Google Trends Search Data," in IEEE Transactions on Computational Social Systems, vol. 11, no. 1, pp. 1352-1361, Feb. 2024, doi: 10.1109/TCSS.2023.3255256.

Watkins, A., Papaioannou, T., Mugwagwa, J., Kale, D. (2015). National innovation systems and the intermediary role of industry associations in building institutional capacities for innovation in developing countries: A critical review of the literature. Research Policy, 44(8), 1407–1418.

Wei-Qiang Huang & Peipei Liu (2022) Asymmetric effects of economic policy uncertainty on stock returns under different market conditions: evidence from G7 stock markets, Applied Economics Letters, 29:9, 780-784, DOI: 10.1080/13504851.2021.1885606

Weick, K.E. (Ed.) (2009), "Enacting an environment: the infrastructure of organising", Making Sense of the Organisation: The Impermanent Organisation, Vol. 2, John Wiley, Chichester, GL, pp. 193-205.

Wereda, W., Moch, N., Wereda, P. (2023). The Customer Service and Building Safe Relationships between the Enterprise and Suppliers in VUCA Times. European Research Studies Journal. XXVI. 268-279. 10.35808/ersj/3110.

West, P., & Broniarczyk, S.M. (1997) Hide or Seek: Factors Influencing Ambiguity Aversion versus Ambiguity Preference; Advances in consumer research Volume: 24 Issue 1 (1997) ISSN: 0098-9258

Weyland, A. (2011). "Engagement and talent management of Gen Y." Industrial and commercial training, 43 (7), 439-445.

Whaley, R. E. (1993) Derivatives on market volatility: Hedging tools long overdue, Journal of Derivatives, 1 (1993), pp. 71-84

- Whaley, R. E. (2000) The Investor Fear Gauge. *The Journal of Portfolio Management*, 26(3), 12–17. <https://doi.org/10.3905/jpm.2000.319728>
- Whiteman, W. E. (1998). Training and educating army officers for the 21st century: Implications for the United States, Military Academy. Fort Belvoir, VA: Defense Technical Information Center.
- Wilding, R. (1998) The supply chain complexity triangle: Uncertainty generation in the supply chain[J]. *International Journal of Physical Distribution & Logistics Management*, 1998, 28(8):599-616.
- Wilkinson, D. (2006) *The Ambiguity Advantage: What great leaders are great at*. Palgrave Macmillan ISBN: 978-1403987655
- Wissner-Gross, A. (2016) Datasets Over Algorithms, <https://www.edge.org/response-detail/26587> Accessed 19 Oct 2017
- Wong C., Skipworth H., Godsell J., Achimugu N. (2012). Towards a theory of supply chain alignment enablers: A systematic literature review. *Supply Chain Management: An International Journal*, 17(4), 419–437
- Wu, D., Xu, Z. & Bach, S. (2023) Using Google Trends to predict and forecast avocado sales. *J Market Anal* 11, 629–641 (2023). <https://doi.org/10.1057/s41270-023-00232-8>
- Wu, X., Li, S., Xu, N., Zhang, W., Wu, D. (2023) User participation depth and innovation performance of Internet companies: the moderating effect of environmental turbulence, *Technology Analysis & Strategic Management*, 35:11, 1412-1425, DOI: 10.1080/09537325.2021.2008893
- Xi, Z., Wang, H., Sun, Q. Ruxia Ma (2023). Uncovering the asymmetric impacts of economic policy uncertainty on green financial markets in China. *Environ Sci Pollut Res* 30, 126214–126226 (2023). <https://doi.org/10.1007/s11356-023-31122-2>
- Xie, J. et al. (2011) Social consensus through the influence of committed minorities. *Phys Rev E* 84, 011130 (2011).

Xu, B., (2006) R&D strategy and stock price volatility in the biotechnology industry. *Review of Accounting & Finance*, 5(1), pp. 59-71.

Xu, H., Xu, C., Sun, Y. et al. (2023) Exchange Rate Forecasting Based on Integration of Gated Recurrent Unit (GRU) and CBOE Volatility Index (VIX). *Comput Econ* (2023). <https://doi.org/10.1007/s10614-023-10484-2>

Xue, Y., Paetzold, P., Kehlbeck, R., Chen, B., Kwan, K. C., Wang, Y., Deussen, O., (2024) "Reducing Ambiguities in Line-Based Density Plots by Image-Space Colorization," in *IEEE Transactions on Visualization and Computer Graphics*, vol. 30, no. 1, pp. 825-835, Jan. 2024, doi: 10.1109/TVCG.2023.3327149

Yacoubi, M.E., Hamdi, A., Saikouk, T. (2022) "The impact of Hoshin Kanri and Thinking Process to reach a world class performance Case Study for Aerospace industry," 2022 14th International Colloquium of Logistics and Supply Chain Management (LOGISTIQUA), EL JADIDA, Morocco, 2022, pp. 1-5, doi: 10.1109/LOGISTIQUA55056.2022.9938095.

Yang, K.H., Lee, S. M. & Lee, S. G. (2007) Adoption of information and communication Technology: Impact of technology types, organizational resources and management style. *Industrial Management & Data Systems*, 107(9), 1257-1275.

Yang, M., Chi, Y., Mamaril, K., Berry, A., Shi, X. And Zhu, L. (2020) Communication-Based Approach for Promoting Energy Consumer Switching: Some Evidence from Ofgem's Database Trials in the United Kingdom. *Energies*, 13(19), pp. 5179.

Yang, X., & Lin, Z. (2019) Supply Chain Complexity Meaning and Quantitative Research, Paper submitted to The 31st Chinese Control and Decision Conference (2019 CCDC)

Yang, Y. (2024). Complexity theory for complexity reduction? Revisiting the ontological and epistemological basis of complexity science with Critical Realism. *Journal for the Theory of Social Behaviour*, 1–16. <https://doi.org/10.1111/jtsb.12412>

Yang, Y.J., & Wang, C.C. (2023) "Recently Research on Social Media Influencers," 2023 International Conference On Cyber Management And Engineering (CyMaEn), Bangkok, Thailand, 2023, pp. 444-448, doi: 10.1109/CyMaEn57228.2023.10051103.

Yao, Z., & Liu, Y. (2023) Crude oil volatility forecasting: New evidence from world uncertainty index, Finance Research Letters, Volume 58, Part A, 2023, 104029, ISSN 1544-6123, <https://doi.org/10.1016/j.frl.2023.104029>

Ye, M., Si Mohammed, K., Tiwari, S., Ali Raza, S., Chen, L. (2023) The effect of the global supply chain and oil prices on the inflation rates in advanced economies and emerging markets. Geological Journal, 1– 13. <https://doi.org/10.1002/gj.4742>

Yeo, S.F., Tan, C.L., Lim, K.B., Teo, E. Y., Liew, T. W. (2023) "Social Media Influencer Marketing: A Game-Changer for Consumer Mobile Buying Decisions," 2023 International Conference on Digital Applications, Transformation & Economy (ICDATE), Miri, Sarawak, Malaysia, 2023, pp. 1-5, doi: 10.1109/ICDATE58146.2023.10248741

Yin, R.K., 2009. Case Study Research: Design and Methods, 4th ed. Thousand Oaks, CA.

Yin, S., Chevapatrakul, T., Yao, T. (2022) The causal effect of improved readability of financial reporting on stock price crash risk: Evidence from the Plain Writing Act of 2010; Economics Letters, Volume 216, 2022, 110614, ISSN 0165-1765, <https://doi.org/10.1016/j.econlet.2022.110614>.

Yiyi, S., Rao-Nicholson, R., Fan, D., Li, R. (2022), Are Returns to R&D in the Global Services Industry Impervious to Business Environment Turbulence?; Academy of Management Discoveries Volume: 8 Issue 2 (2022) ISSN: 2168-1007 Online ISSN: 2168-1007

Yong, M., & Lin, L. (2023) Financial development, financial instability, and fiscal policy volatility: International evidence; The North American Journal of

Economics and Finance, Volume 64, 2023, 101873, ISSN 1062-9408, <https://doi.org/10.1016/j.najef.2022.101873>.

You, S. D., Hsiao, P. -Y., Tsai, S., (2023) "Reinforcement Learning for Stock Price Trading with Keywords in Google Trends," 2023 9th International Conference on Applied System Innovation (ICASI), Chiba, Japan, 2023, pp. 109-111, doi: 10.1109/ICASI57738.2023.10179534.

Yu, M., (2023) Forecasting Sector-Level Stock Market Volatility: The Role of World Uncertainty Index, Finance Research Letters, Volume 58, Part C, 2023, 104568, ISSN 1544-6123, <https://doi.org/10.1016/j.frl.2023.104568>.

Yu, T.H., Huarng, K., Huang, D. (2021) Causal complexity analysis of the Global Innovation Index, Journal of Business Research December 2021, 137:39-45

Yu, Y., Khern-am-nuai, W., Pinsonneaultb, A., Wei, Z. (2023) Impacts of Social Interactions and Peer Evaluations on Online Review Platforms; Journal Of Management Information Systems 2023, VOL. 40, NO. 4, 1271–1300 <https://doi.org/10.1080/07421222.2023.2267323>

Yu, Y., Lin, Y., Hou, X., Zhang, X. (2023) Novel optimization approach for realized volatility forecast of stock price index based on deep reinforcement learning model; Expert Systems with Applications, Volume 233, 2023, 120880, ISSN 0957-4174, <https://doi.org/10.1016/j.eswa.2023.120880>.

Yue, T., Ruan, X., Gehricke, S., Zhang, J.E. (2023) The volatility index and volatility risk premium in China, The Quarterly Review of Economics and Finance, Volume 91, 2023, Pages 40-55, ISSN 1062-9769, <https://doi.org/10.1016/j.qref.2023.07.004>.

Zawadzki, K., Wojdyło, M., & Muszyńska, J. (2024), "Trait emotional intelligence among future leaders: how business students are prepared for the VUCA world", Journal of Organisational Change Management, Vol. 37 No. 1, pp. 24-38. <https://doi.org/10.1108/JOCM-07-2023-0292>

Zhang, J., Ruan, X., Zhang, J.E., (2023) Do short-term market swings improve realized volatility forecasts?, *Finance Research Letters*, Volume 58, Part D, 2023, 104629, ISSN 1544-6123, <https://doi.org/10.1016/j.frl.2023.104629>.

Zhang, L., Wang, L., Peng, L., Luo, K. (2023) Measuring the response of clean energy stock price volatility to extreme shocks; *Renewable Energy*, Volume 206, 2023, Pages 1289-1300, ISSN 0960-1481, <https://doi.org/10.1016/j.renene.2023.02.066>.

Zhang, X., Teng, X., Le, Y., Li, Y. (2022) Strategic orientations and responsible innovation in SMEs: The moderating effects of environmental turbulence. *Business Strategy and the Environment*, 32(4), 2522–2539. <https://doi.org/10.1002/bse.3283>

Zhang-Zhang, Y., Rohlfert, S., Varma, A. (2022) "Strategic people management in contemporary highly dynamic VUCA contexts: A knowledge worker perspective," *Journal of Business Research*, Elsevier, vol. 144(C), pages 587-598

Zhou, F., Lee, CC. (2023) Political uncertainty and innovation of export enterprises: international evidence for developing countries. *Econ Change Restruct* 56, 4371–4400 (2023). <https://doi.org/10.1007/s10644-023-09554-0>

Zhou, J., Wu, H., Takada, H. (2021) Notification Timing Control While Reading Text Information. Vol 12765. Springer International Publishing; 2021. doi:10.1007/978-3-030-78321-1_11

Zhou, Q.; Zhu, P.; Zhang, Y. (2023) Contagion Spillover from Bitcoin to Carbon Futures Pricing: Perspective from Investor Attention. *Energies* 2023, 16, 929. <https://doi.org/10.3390/en16020929>

Zhu, X., & Li, Y. (2023) The use of data-driven insight in ambidextrous digital transformation: How do resource orchestration, organizational strategic decision-making, and organizational agility matter?, *Technological Forecasting and Social Change*, Volume 196, 2023, 122851, ISSN 0040-1625, <https://doi.org/10.1016/j.techfore.2023.122851>.

Zio, M.D., Fursova, N.Y., Gelsema, T., Giessing, S., Guarnera, U., Petrauskienė, J., Quensel, L., Scanu, M., Bosch, K.O., Loo, M.P., & Walsdorfer, K. (2016). 'Methodology for data validation 1.0. Revised edition June 2016', Computer Science, Essnet Validat Foundation, Corpus ID: 53693009.

Zuca, M.R., Munteanu, V., Țîntă, A.E. (2023). The Quality Of Financial-Accounting Information In The Creative Accounting Equation – From Exact Relevance And Representation To Uncertainty And Ambiguity. Journal of Information Systems & Operations Management, 17(1), pp. 223-248.

Appendices

Appendix A – Ethical approval letter



29 May 2020

Dear Mr Vickery ,

Reference: CURES/11289/2020
Title: VUCA Survey June 2020

Thank you for your application to the Cranfield University Research Ethics System (CURES).

We are pleased to inform you your CURES application, reference CURES/11289/2020 has been reviewed. You may now proceed with the research activities you have sought approval for.

If you have any queries, please contact CURES Support.

We wish you every success with your project.

Regards,

CURES Team

Appendix B – Data Sets

Data sets cleansed and populated against a twelve-month period from July 2019 to June 2020, used for Case Study

Company	Domain	Metric	Source	Type	Baseline						COVID-19					
					Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20
Easy Jet	Volatility	Share Price	FTSE	Percentage Change	9%	1%	0%	19%	8%	0.08	6%	-2%	-21%	-48%	6%	13%
	Uncertainty	Twitter-based Uncertainty Indices	Economic Policy Uncertainty	Mentions Ave	141,330	221,030	209,160	198,810	158,440	141,270	142,920	153,290	444,190	445,720	370,560	293,340
	Complexity	Airport Passengers	Heathrow Airport	Total Numbers	7,754,139	7,680,327	6,777,115	6,994,212	6,233,801	6,696,079	6,099,370	5,442,081	3,106,845	206,600	228,018	350,283
	Ambiguity	Travel Web Search	Google Trends	Score 0-100	12	14.5	12.4	0	7.5	8	5.75	38.25	7	3.25	2.6	11.75
	Ambiguity	Travel Web Search (WorldWide)	Google Trends	Score 0-101	26.75	11	6.8	15.5	10.5	17	2.5	53.5	18.4	2.25	2.8	2

Thresholds for twelve-month period from July 2019 to June 2020, used for Case Study

Company	Domain	Metric	Source	Type	High	Low	Baseline	Threshold	Range	Largest Monthly	VUCA Peak	Change	x Threshold
Easy Jet	Volatility	Share Price	FTSE	Percentage Change	19	0	9.5	9.5	19	19%	-48	57.5	6.05
	Uncertainty	Twitter-based Uncertainty Indices	Economic Policy Uncertainty	Mentions Ave	221,030	141,330	181,180	39,850	79,700	79,700	445,720	264,540	6.64
	Complexity	Airport Passengers	Heathrow Airport	Total Numbers	7,754,139	6,233,801	6,993,970	760,169	1,520,338	903,212	206,600	6,787,370	8.93
	Ambiguity	Travel Web Search (UK)	Google Trends	Score 0-100	14.5	0	7.25	7.25	14.5	12.4	38.25	31	4.28
	Ambiguity	Travel Web Search (WorldWide)	Google Trends	Score 0-100	26.75	6.8	16.775	9.975	19.95	15.75	53.5	36.725	3.68
	Ambiguity (PoL)	Travel Web Search (WorldWide)	Google Trends	Score 0-100	17	6.8	11.9	5.1	10.2	15.75	53.5	41.6	8.16

easyJet stock price raw data, last downloaded from www.londonstockexchange.com/stock/EZJ/easyjet-plc/company-page on 22nd May 2023

Baseline Date		Date for EJ		Share Price Close
01/06/2019		31/05/2019		733.47
01/07/2019		30/06/2019		802.51
01/08/2019		31/07/2019		811.6
01/09/2019		31/08/2019		811.1
01/10/2019		30/09/2019		968.2
01/11/2019		30/10/2019		1042.29
01/12/2019		29/11/2019		1126.48
01/01/2020		30/12/2019		1199.31
01/02/2020		30/01/2020		1172.78
01/03/2020		28/02/2020		926.53
01/04/2020		31/03/2020		480.73
01/05/2020		30/04/2020		507.84
01/06/2020		31/05/2020		572.5
01/07/2020		30/06/2020		572.5
01/08/2020		31/07/2020		415.23

Twitter Uncertainty raw data, last downloaded from www.policyuncertainty.com/twitter_uncert.html on 22nd May 2023

Data	Value			Data	Value			Data	Value			Data	Value			Data	Value		
2019-07-01 00:00:00	170.0491			2019-09-01 00:00:00	255.085			2019-11-01 00:00:00	167.425			2020-01-01 00:00:00	54.96435			2020-03-01 00:00:00	189.4917		
2019-07-02 00:00:00	139.8312			2019-09-02 00:00:00	204.6353			2019-11-02 00:00:00	171.3308			2020-01-02 00:00:00	151.4549			2020-03-02 00:00:00	175.8134		
2019-07-03 00:00:00	152.4012			2019-09-03 00:00:00	259.9426			2019-11-03 00:00:00	205.89			2020-01-03 00:00:00	115.3599			2020-03-03 00:00:00	220.503		
2019-07-04 00:00:00	157.5131			2019-09-04 00:00:00	346.442			2019-11-04 00:00:00	141.2272			2020-01-04 00:00:00	203.6933			2020-03-04 00:00:00	165.7258		
2019-07-05 00:00:00	117.4016			2019-09-05 00:00:00	219.826			2019-11-05 00:00:00	204.3687			2020-01-05 00:00:00	120.2543			2020-03-05 00:00:00	180.8804		
2019-07-06 00:00:00	118.0279			2019-09-06 00:00:00	432.8548			2019-11-06 00:00:00	138.2437			2020-01-06 00:00:00	134.5021			2020-03-06 00:00:00	264.4089		
2019-07-07 00:00:00	103.856			2019-09-07 00:00:00	289.3588			2019-11-07 00:00:00	195.5932			2020-01-07 00:00:00	122.8005			2020-03-07 00:00:00	255.0926		
2019-07-08 00:00:00	133.5414			2019-09-08 00:00:00	215.0002			2019-11-08 00:00:00	148.0282			2020-01-08 00:00:00	139.0765			2020-03-08 00:00:00	196.7798		
2019-07-09 00:00:00	129.9713			2019-09-09 00:00:00	272.8471			2019-11-09 00:00:00	142.7757			2020-01-09 00:00:00	154.9167			2020-03-09 00:00:00	380.4488		
2019-07-10 00:00:00	338.9468			2019-09-10 00:00:00	219.6067			2019-11-10 00:00:00	169.4493			2020-01-10 00:00:00	140.882			2020-03-10 00:00:00	304.7603		
2019-07-11 00:00:00	134.1458			2019-09-11 00:00:00	176.5522			2019-11-11 00:00:00	220.007			2020-01-11 00:00:00	169.4272			2020-03-11 00:00:00	354.7699		
2019-07-12 00:00:00	111.2763			2019-09-12 00:00:00	174.8222			2019-11-12 00:00:00	151.4838			2020-01-12 00:00:00	125.7204			2020-03-12 00:00:00	421.4774		
2019-07-13 00:00:00	79.9544			2019-09-13 00:00:00	165.3832			2019-11-13 00:00:00	156.5651			2020-01-13 00:00:00	136.4235			2020-03-13 00:00:00	435.9174		
2019-07-14 00:00:00	109.3221			2019-09-14 00:00:00	148.4867			2019-11-14 00:00:00	157.5131			2020-01-14 00:00:00	144.313			2020-03-14 00:00:00	477.8227		
2019-07-15 00:00:00	135.4628			2019-09-15 00:00:00	163.9832			2019-11-15 00:00:00	127.6105			2020-01-15 00:00:00	146.5716			2020-03-15 00:00:00	643.1785		
2019-07-16 00:00:00	138.0385	141.3373		2019-09-16 00:00:00	168.1276	209.1618		2019-11-16 00:00:00	131.3536	158.4447		2020-01-16 00:00:00	129.8185	142.9238		2020-03-16 00:00:00	601.4165	444.1959	
2019-07-17 00:00:00	132.4141			2019-09-17 00:00:00	180.1671			2019-11-17 00:00:00	204.068			2020-01-17 00:00:00	143.9446			2020-03-17 00:00:00	588.9044		
2019-07-18 00:00:00	131.5494			2019-09-18 00:00:00	237.3461			2019-11-18 00:00:00	183.4993			2020-01-18 00:00:00	154.1978			2020-03-18 00:00:00	599.6111		
2019-07-19 00:00:00	108.2137			2019-09-19 00:00:00	238.866			2019-11-19 00:00:00	153.2765			2020-01-19 00:00:00	134.8306			2020-03-19 00:00:00	618.8015		
2019-07-20 00:00:00	110.4132			2019-09-20 00:00:00	154.1535			2019-11-20 00:00:00	125.7518			2020-01-20 00:00:00	136.4235			2020-03-20 00:00:00	644.1777		
2019-07-21 00:00:00	107.5001			2019-09-21 00:00:00	142.7757			2019-11-21 00:00:00	137.6076			2020-01-21 00:00:00	124.5932			2020-03-21 00:00:00	632.0205		
2019-07-22 00:00:00	149.8738			2019-09-22 00:00:00	171.2713			2019-11-22 00:00:00	144.9655			2020-01-22 00:00:00	122.4206			2020-03-22 00:00:00	703.3057		
2019-07-23 00:00:00	155.0692			2019-09-23 00:00:00	210.3997			2019-11-23 00:00:00	140.872			2020-01-23 00:00:00	111.6439			2020-03-23 00:00:00	670.589		
2019-07-24 00:00:00	129.0829			2019-09-24 00:00:00	183.7525			2019-11-24 00:00:00	171.2713			2020-01-24 00:00:00	130.6731			2020-03-24 00:00:00	574.5628		
2019-07-25 00:00:00	115.1057			2019-09-25 00:00:00	160.7291			2019-11-25 00:00:00	134.5021			2020-01-25 00:00:00	123.7389			2020-03-25 00:00:00	493.0136		
2019-07-26 00:00:00	135.7776			2019-09-26 00:00:00	160.1095			2019-11-26 00:00:00	154.1728			2020-01-26 00:00:00	174.9154			2020-03-26 00:00:00	521.0049		
2019-07-27 00:00:00	135.161			2019-09-27 00:00:00	255.221			2019-11-27 00:00:00	139.0765			2020-01-27 00:00:00	146.0308			2020-03-27 00:00:00	513.5046		
2019-07-28 00:00:00	222.2883			2019-09-28 00:00:00	159.9088			2019-11-28 00:00:00	135.0112			2020-01-28 00:00:00	151.4838			2020-03-28 00:00:00	620.5984		
2019-07-29 00:00:00	147.9523			2019-09-29 00:00:00	127.5425			2019-11-29 00:00:00	92.90043			2020-01-29 00:00:00	167.0311			2020-03-29 00:00:00	468.2631		
2019-07-30 00:00:00	127.2822			2019-09-30 00:00:00	179.6564			2019-11-30 00:00:00	207.5007			2020-01-30 00:00:00	167.3934			2020-03-30 00:00:00	426.5638		
2019-07-31 00:00:00	204.0343			2019-10-01 00:00:00	197.1978			2019-12-01 00:00:00	120.2543			2020-01-31 00:00:00	251.1374			2020-03-31 00:00:00	426.6644		
2019-08-01 00:00:00	269.157			2019-10-02 00:00:00	188.2113			2019-12-02 00:00:00	161.4025			2020-02-01 00:00:00	192.2713			2020-04-01 00:00:00	463.033		
2019-08-02 00:00:00	214.3856			2019-10-03 00:00:00	185.2077			2019-12-03 00:00:00	131.764			2020-02-02 00:00:00	178.5595			2020-04-02 00:00:00	440.5174		
2019-08-03 00:00:00	190.3676			2019-10-04 00:00:00	205.1977			2019-12-04 00:00:00	135.7453			2020-02-03 00:00:00	136.4235			2020-04-03 00:00:00	546.1729		
2019-08-04 00:00:00	134.8306			2019-10-05 00:00:00	177.0419			2019-12-05 00:00:00	169.6295			2020-02-04 00:00:00	126.3859			2020-04-04 00:00:00	517.7999		
2019-08-05 00:00:00	181.5778			2019-10-06 00:00:00	131.1866			2019-12-06 00:00:00	178.6547			2020-02-05 00:00:00	119.9222			2020-04-05 00:00:00	424.5343		
2019-08-06 00:00:00	162.0213			2019-10-07 00:00:00	194.0673			2019-12-07 00:00:00	205.597			2020-02-06 00:00:00	117.7021			2020-04-06 00:00:00	411.1921		
2019-08-07 00:00:00	161.5619			2019-10-08 00:00:00	204.3687			2019-12-08 00:00:00	196.7798			2020-02-07 00:00:00	129.6523			2020-04-07 00:00:00	374.6759		
2019-08-08 00:00:00	177.4186			2019-10-09 00:00:00	204.8671			2019-12-09 00:00:00	171.9705			2020-02-08 00:00:00	119.9316			2020-04-08 00:00:00	468.8626		
2019-08-09 00:00:00	193.9592			2019-10-10 00:00:00	192.1314			2019-12-10 00:00:00	223.1921			2020-02-09 00:00:00	142.1188			2020-04-09 00:00:00	471.6739		
2019-08-10 00:00:00	264.611			2019-10-11 00:00:00	167.425			2019-12-11 00:00:00	189.0441			2020-02-10 00:00:00	161.4025			2020-04-10 00:00:00	412.4371		
2019-08-11 00:00:00	194.9578			2019-10-12 00:00:00	165.6198			2019-12-12 00:00:00	186.9386			2020-02-11 00:00:00	210.6431			2020-04-11 00:00:00	491.1484		
2019-08-12 00:00:00	171.0098			2019-10-13 00:00:00	196.7798			2019-12-13 00:00:00	251.1374			2020-02-12 00:00:00	145.7388			2020-04-12 00:00:00	388.0936		
2019-08-13 00:00:00	181.9598			2019-10-14 00:00:00	171.0098			2019-12-14 00:00:00	230.3448			2020-02-13 00:00:00	122.0294			2020-04-13 00:00:00	453.4642		
2019-08-14 00:00:00	298.14			2019-10-15 00:00:00	185.5452			2019-12-15 00:00:00	145.7628			2020-02-14 00:00:00	111.2763			2020-04-14 00:00:00	471.4821		
2019-08-15 00:00:00	241.4624			2019-10-16 00:00:00	201.536	198.8137		2019-12-16 00:00:00	192.1458	141.2758		2020-02-15 00:00:00	154.1978	153.2947		2020-04-15 00:00:00	513.8334	445.7241	
2019-08-16 00:00:00	180.6964	221.0338		2019-10-17 00:00:00	186.9386			2019-12-17 00:00:00	164.9291			2020-02-16 00:00:00	123.8984			2020-04-16 00:00:00	508.8885		293.346
2019-08-17 00:00:00	197.9823			2019-10-18 00:00:00	241.9495			2019-12-18 00:00:00	124.0862			2020-02-17 00:00:00	106.6409			2020-04-17 00:00:00	454.2933		
2019-08-18 00:00:00	242.3307			2019-10-19 00:00:00	424.5198			2019-12-19 00:00:00	111.6439			2020-02-18 00:00:00	104.8734			2020-04-18 00:00:00	411.1194		
2019-08-19 00:00:00	228.6536			2019-10-20 00:00:00	242.3307			2019-12-20 00:00:00	129.6523			2020-02-19 00:00:00	122.4206			2020-04-19 00:00:00	419.0682		
2019-08-20 00:00:00	209.7468			2019-10-21 00:00:00	201.7531			2019-12-21 00:00:00	129.45			2020-02-20 00:00:00	138.4731			2020-04-20 00:00:00	482.2861		
2019-08-21 00:00:00	164.0603			2019-10-22 00:00:00	240.2228			2019-12-22 00:00:00	120.2543			2020-02-21 00:00:00	157.2161			2020-04-21 00:00:00	395.292		
2019-08-22 00:00:00	173.0913			2019-10-23 00:00:00	225.687			2019-12-23 00:00:00	95.11219			2020-02-22 00							

Heathrow Airport Passenger raw data, last downloaded from www.heathrow.com/company/investor-centre/reports/traffic-statistics on 22nd May 2023

Heathrow Traffic Statistics

July 2019 - June 2020

Month	Passengers	Air Transport Movements	Cargo (Metric Tonnes)
July 2019	7,754,139	42,062	130,589
August 2019	7,680,327	41,952	126,864
September 2019	6,777,115	38,986	125,693
October 2019	6,994,212	41,258	137,875
November 2019	6,233,801	37,945	134,328
December 2019	6,696,079	38,310	126,171
January 2020	6,099,370	37,936	115,894
February 2020	5,442,081	35,238	115,859
March 2020	3,106,845	25,798	100,857
April 2020	206,600	4,873	51,003
May 2020	228,018	6,392	78,308
June 2020	350,283	7,205	88,854

Google Trends raw data, last downloaded from trends.google.com/trends 22nd May 2023

Date		UK		World				Date		UK		World	
07/07/2019		12		14				05/01/2020		0		0	
14/07/2019		0		40				12/01/2020		23		10	
21/07/2019		19		31				19/01/2020		0		0	
28/07/2019		17	12	22	26.75			26/01/2020		0	5.75	0	2.5
04/08/2019		19		20				02/02/2020		0		8	
11/08/2019		0		24				09/02/2020		100		100	
18/08/2019		39		0				16/02/2020		39		47	
25/08/2019		0	14.5	0	11			23/02/2020		14	38.25	59	53.5
01/09/2019		16		21				01/03/2020		21		21	
08/09/2019		46		0				08/03/2020		14		30	
15/09/2019		0		13				15/03/2020		0		31	
22/09/2019		0		0				22/03/2020		0		10	
29/09/2019		0	12.4	0	6.8			29/03/2020		0	7	0	18.4
06/10/2019		0		20				05/04/2020		13		9	
13/10/2019		0		16				12/04/2020		0		0	
20/10/2019		0		0				19/04/2020		0		0	
27/10/2019		0	0	26	15.5			26/04/2020		0	3.25	0	2.25
03/11/2019		13		42				03/05/2020		0		0	
10/11/2019		17		0				10/05/2020		0		0	
17/11/2019		0		0				17/05/2020		0		0	
24/11/2019		0	7.5	0	10.5			24/05/2020		13		14	
01/12/2019		21		10				31/05/2020		0	2.6	0	2.8
08/12/2019		0		10				07/06/2020		28		0	
15/12/2019		19		36				14/06/2020		0		0	
22/12/2019		0		16				21/06/2020		9		0	
29/12/2019		0	8	13	17			28/06/2020		10	11.75	8	2

Appendix C – Decision Making Artefact

VUCA Impact Scale

Impact ↑ Low ↓ High	VUCA Domains Breached	Condition and Response
	0	Normal operating environment and conditions
	1	One VUCA domain breached, likely to be self-contained and addressed as business as usual
	2	Two VUCA domains breached and possible early signal that VUCA event maybe inbound with the environment becoming turbulent
	3	Three VUCA domains breached and a VUCA Event is now in progress, action required to navigate turbulent conditions
	4	All VUCA domains breached and serve VUCA Event in progress, immediate action required to ensure survival

Appendix D – Step-by-Step

Detailed Guidance

This Appendix provides detailed step by step guidance to facilitate the repetition of the Case Study and enable researchers and practitioners to use the VUCA toolset to model their own organisations.

Set-Up

The following are advised as the minimum set of recommended tools required to generate VUCA artefacts:

- **A personal computer (PC):** Any laptop, desktop, or tablet (e.g., an iPad) will suffice; the PC does not need to be highly specified. However, it must have sufficient storage capacity for the datasets to be used. In this research, all work was conducted locally on a Windows 11 desktop PC.
- **File compatibility:** The PC must be capable of opening industry-standard file formats, such as .PDF and .CSV files.
- **Internet connection:** Required for research, accessing, and downloading datasets.
- **Access to research tools:** For instance, tools like SearchPoint (Cranfield University), which aggregate input from sources such as ABI Inform ProQuest and EBSCOhost, are highly recommended. Although not strictly necessary, such tools enhance rigour by enabling users to evaluate published research and justify data set inclusion, considering any strengths and weaknesses.

- **Data modelling software:** Microsoft Excel was used for this research to ingest, model the various data sets, and complete all required tasks, but other tools with enhanced features may also be beneficial.
- **Visualisation software:** Tools to create visual VUCA artefacts, such as the VUCA BreachMap. For the Case Study, Microsoft PowerPoint was used for this task.

While the research primarily used Microsoft software, alternative products, such as Google Sheets and Miro (e.g., for Chromebook users), could also be employed effectively.

Step by Step Guide

Note – Screenshots and examples of the datasets and Excel are provided in Chapter 7, as well as Appendices B and C.

Step 1: Select the Organisation

Identify the organisation to be modelled, which could either be of academic interest to the researcher or an organisation the practitioner works for.

Step 2: Define VUCA Domains

Use the VUCA descriptions and VUCA iconography to confirm the focus of each domain, for example, Volatility refers to “Unexpected or unstable behaviours for unknown duration”. It is advised to keep the VUCA descriptions to hand while completing the rest of these steps as they can prove useful to refer back to, particularly when looking at different data sets and deciding under which VUCA domain they sit.

Step 3: Populate the VUCA Scorecard

Use the VUCA Scorecard and populate a set of data points for each domain. The VUCA Scorecard is available as a .PDF or PowerPoint template, and provides guidance on how to complete the VUCA Scorecard. While this can be done by

an individual, results are likely to be improved if the data sets can be crowdsourced in a workshop as this helps stimulate ideas. While this step can be completed on a PC, and the final data sets should be recorded digitally in the VUCA Scorecard, it can be useful to print out the VUCA Scorecard and do this step around a table with pen and paper to aid with discussions and free-flowing thought in a group.

Users should have at least one data set for each domain before moving on to the next step. While there is no maximum number of data sets, it is advised that if this is the first time using the VUCA toolset that users should build a simple implementation to start with, so they are familiar with how each step works and how the data flows through the visual artefacts. Between 1 and 4 data sets for each domain are advised. Once the VUCA artefacts are built out, it is fairly straightforward to enhance the VUCA Scorecard and other VUCA toolset artefacts with more data sets.

Step 4: Review Candidate Datasets

The research undertaken to develop the VUCA toolset identified a candidate set of 16 data points, four for each VUCA domain. While using these data sets is not mandatory, it is advised to review these pre-researched data sets to see if any can be adopted. The candidate data sets will also help illuminate the type of data sets that work well with the VUCA Scorecard.

Step 5: Evaluate Dataset Suitability

Once the VUCA Scorecard has been populated with data sets, the next step is to undertake research to understand if the data sets can be obtained, and if so, whether the format and characteristics of the data are in a state that enables them to be worked with. This research focused on free open-source data sets (and these are advised for repeatability and to minimise cost), though users, be they researchers or practitioners, might have access to proprietary data sets that they can use and add value.

It is advised that users interrogate the data sets thoroughly to understand how they are developed. For example, how the data is collected, whether any applied

models are understood, whether the data set owner publishes information on their methods and how the data set was produced, and whether there is published research underpinning the data set. Users want robust data sets underpinning their VUCA artefacts that they can trust.

With regard to the format and frequency, it may be that the data set is a good fit conceptually but cannot be obtained in a way that is useful. For example, it is not provided in an exportable format, or the frequency of published data is not granular enough. For granularity, this could mean the data point is produced once per year, or there is a two-year lag for published data to be released that makes the characteristics of the data set unusable.

It may also be the case that while a data set is identified in Step 3, once research is undertaken it is discovered that either the data set does not exist or there are concerns about the integrity of the data (for example, published research has identified a critical flaw in how the data is collected).

Step 6: Iterate and Refine Datasets

There is likely to be some iteration between steps 3 and 5, and refinement is often necessary. Data sets will be captured in Step 3 that just don't exist, don't exist in a usable format, or through research are found to have fatal flaws. The user will likely iterate through steps 3 to 5 until they develop a set of data points for each domain they have confidence in. The user should update the VUCA Scorecard as they go to ensure they have a final version with the data sets being used. It can be useful to retain a record of data set ideas that were generated but proved to not be viable.

The user will also need to think about the weighting of the data sets within the VUCA scorecard. For the Case Study, as there was just one data set for each domain, these were weighted equally, with each one being worth 25% of the total VUCA score. Depending on the quality and reliability of data sets and the number for each domain, users may decide to weight domains and/or data sets within a domain differently (for example, one data set is from a gold standard trusted resource and is therefore weighted more highly than others).

Step 7: Record Dataset Details

As the data sets are refined through research the user needs to record some basic information about the data set, for example, the location of the data set, likely a URL. Excel was used for this task during the Case Study and the following were recorded for each data set: The name of the data set, the VUCA domain it fits within, who published it, a short description of the data set, the URL for its location, any published research supporting its inclusion, and key features of the data (i.e. its format, publishing frequency, etc). This set of metadata should be considered the minimum and will act as a good bases for implementation.

Step 8: Download and Organise Datasets

Now that the data sets have been identified, researched, and recorded, each data set can be downloaded for use. Practically the user will need to think about how to label and file each data set. For the Case Study, each had its own name and folder on a hard drive. It is also possible that not all data sets will be exportable. In some cases, the data may need to be copied from an online source and saved in a tool like Excel. If this is done, care needs to be taken to ensure the data copied over is complete and correct. The Excel files is then labelled and saved it's the correct folder.

Step 9: Define Time Period and Frequency

The Case Study was retrospective, and a time period of 12 months was used, with COVID-19 falling in the middle. This provided a period of 6 months to be used to build a baseline for the Pattern of Life (PoL) in the Case Study. Users will need to decide what timelines make the most sense for them, likely to be informed by the data sets available, the frequency with which data is published, and the nature of the organisation they are looking at (for example, seasonal trends may play a key role, and therefore 12 months might be sensible to generate a baseline). For the purposes of this step-by-step guide, 12 months is assumed.

The user will also need to define the frequency on which they want to report. For example, this could be hourly, daily, weekly, monthly or quarterly. In the Case Study, monthly was chosen. Once the frequency has been decided, and again,

this might take some trial and error with the final frequency only becoming clear when working with the data, there may be a task to process some of the data sets to match that format. For the Case Study, Google Trends data was provided weekly, yet the Case Study was monthly. In this case the weekly numbers were added together and divided by the number of weeks to produce a monthly average. Users may have to perform similar processing steps with their data to obtain a set in the required frequency. For the Case Study, Excel was used to perform these tasks, and where this occurred, a processed set of data was stored alongside the original data in the storage folder.

Step 10: Build VUCA Models

Now that the data sets have been obtained, the time period defined, and any data sets that required it have been processed to the required frequency, the VUCA models can be built. For the Case Study, Excel was used. A table was set out that had each of the four data sets on one axis and the time (12 months on the other). The data from each data set was then loaded into the table. For the initial six months the highs, lows, and averages were identified thereby providing the PoL baseline.

If the VUCA toolset is being used to monitor the external environment for changes and the potential move from Normal Conditions to Turbulent Conditions, then as the user adds in the latest data (for example, new data for the latest month) they can analyse this to see if the new data moves outside the PoL baselines, highlighting to them a VUCA event may be forming or already in action. In more sophisticated set ups, it is expected the data collection and alerting could be automated, so the VUCA tooling works like an alarm system, where the organisation is only notified when the PoL is breached (i.e. an email is sent)

Step 11: Generate Graphs and Patterns

With the data formatted and entered into Excel, the user is able to generate a number of graphs, charts, and models using the inbuilt tools and begin to look for patterns. The graphs, charts, and models will enable them to quickly identify key trends in the data and have certainty around their PoL baselines.

Step 12: Create Visual Artefacts

The Excel outputs can now be exported and used with PowerPoint to produce a set of visuals that explain quickly and clearly when a VUCA event is happening, and what the makeup of the VUCA event is (i.e. is it primarily volatility or ambiguity, or an equal mix of all). The VUCA BreachMap is the artefact used to visually tell this story, and once the Excel outputs are added to the template, it is possible to quickly and clearly see if a VUCA breach is taking place and communicate this.

The VUCA Impact Scale can be used at this stage as well to provide clarity on the scale of change, and to ensure it is a VUCA event that is happening, as opposed to a business-as-usual type disruption.

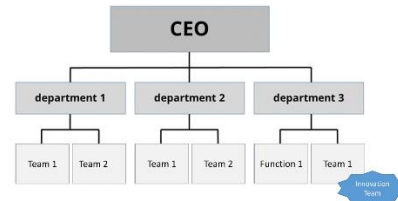
Appendix E – Teaching Collateral

Session Objectives

- Start to give you tools to evidence decisions
- Frame and Define VUCA
- Discuss the significance of detecting VUCA events
- Discuss how to detect VUCA events that will impact companies Innovation and / or resilience
- The Future – Ecosystems, Innovation and VUCA

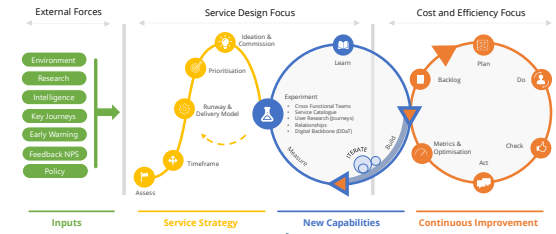
3

Some Context 1



5

Some Context 4



8

Focus of VUCA



9

What is VUCA

“...volatility, uncertainty, complexity, and ambiguity (VUCA) is where we are going, the world is getting connected, a lot more conversations... and everything is getting utterly complicated, with the average lifespan of a Standard & Poor's Dow Jones 500 company down 15yrs”

(Gerd leonhard, 2014, Futurist)

10

Coverage



14



VOUCA Examples

Volatility
Uncertainty
Complexity
Ambiguity



12



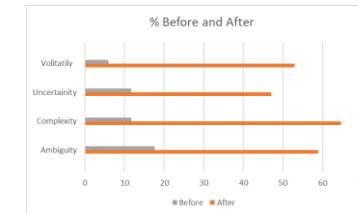
VOUCA Definitions

	Definition	Example
Volatility	Unexpected or unstable behaviours for unknown duration	Stock market and share prices, shares trade over a large range
Uncertainty	Lack of predictability and potential for surprises	How much of a new product will you sell?
Complexity	Many interconnected parts that interact in many ways	Supply chain with multiple tiers of suppliers and sub-suppliers
Ambiguity	Information available, but potential for misreads and confusion	Airport is closed – Is this due to bad weather or something more fundamental like IT system failure?

13



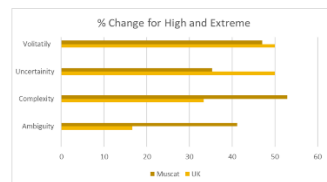
Typical Cohort Results Before & After



15



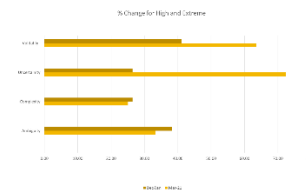
Muscat Cohort X UK Cohort



16



UK 2020 x UK 2021



17



18



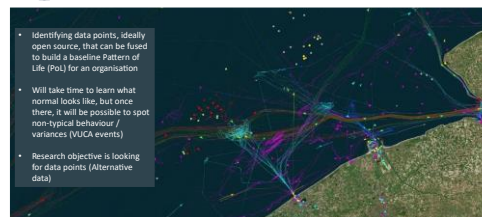
VOUCA – The Research

- Reviewed every journal article covering VOUCA
- Massive focus on Leadership and HR (Coates 2009, Rodriguez and Rodriguez 2013, Bennett and Lemoine 2014)
- Broadly speaking, VOUCA research to date uses it as proxy to say its hard and justify internal organisation transformation
- No commentary on how to detect VOUCA
- If can't sense and understand, how do you respond?
- Signals in data for innovation gaps or resilience

19



How to Detect VOUCA events..?



Identifying VOUCA Events [Patterns and Frequency]

