The VUCA approach as a solution concept to corporate foresight challenges and global technological disruption

Jari Roy Lee Kaivo-oja and Iris Theresa Lauraeus

Abstract

Purpose – *Under current market conditions of corporate foresight, turbulence is a key element of the business landscape. Turbulence can be summarised using the trendy managerial acronym "VUCA": volatility, uncertainty, complexity and ambiguity. This paper aims to combine, for the first time, scientific discussion of technological disruption with the VUCA approach. Gartner Hype Cycle is used as a case example of technological turbulence and "vucability".*

Design/methodology/approach – *First, the authors present the key concepts of technological disruption and radical innovation. Both these concepts are highly relevant for modern corporate foresight. Second, the authors discuss the key elements of current technological transformation and summarise it to create a bigger picture. Third, the authors link this discussion to the VUCA approach. Fourth, the authors present the new corporate foresight framework, which is highly relevant for corporations and takes current technological transformation more seriously than previous proposals, which expect more stable business and a technological landscape.*

Findings – *Key issues in modern VUCA management are agility (response to volatility), information and knowledge management (response to uncertainty), restructuring (response to complexity) and experimentation (response to ambiguity). Useful foresight tools are challenging tools, decision-making tools, aligning tools, learning tools and the ability to combine these management tools in the practices of corporate foresight and management systems. The VUCA approach is a key solution concept to technological disruption.*

Practical implications – *The authors present the new corporate foresight framework and management tool based on foresight, which help leaders to manage VUCA – especially under the conditions of hyper-competition and technological disruption.*

Originality/value – *Corporate leaders should reinvent the strategic planning framework and adjust it to the VUCA conditions and simply be more strategic. Traps and typical failures of foresight are adopting it too early, giving up too soon, adapting too late and hanging on too long. In particular, technological transformation with disruptive technologies is changing and challenging many basic assumptions of business management and strategic planning. Our comparative analysis with Gartner Hype Cycle (fast technological changes from 2008 to 2016) verifies this important aspect of technological disruption.*

Keywords *Innovation, Decision-making, Knowledge management, Foresight, VUCA, Economic forecasting, Information management, Corporate leader forecasting management, Disruptive technologies, VUCA conditions*

Paper type *Conceptual paper*

Jari Roy Lee Kaivo-oja is Research Director at the Finland Futures Research Centre, Turku School of Economics, University of Turku, Turku, Finland.
Iris Theresa Lauraeus is Post-Doc Researcher at the Department of Information and Service Economy, School of Business, Aalto University, Helsinki, Finland.

1. Introduction

1.1 Technological disruption and challenges of foresight

The importance of new technologies for society arises from the discovery that ideas and their implementation generate growth and well-being (Jones, 2005). How can managers know if a technology will disrupt their organisation and firm? The definition of disruptive technology relates closely to the disruptive innovation concept of Christensen (1997).

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Bower and Christensen (1995) described a new idea that has long affected the considerations of business sustainability: the notion that new technologies can create new markets or radically change, or disrupt, the status quo in existing markets (Bower and Christensen, 1995, Nagy *et al.*, 2016).

We have known for a while that disruptive technologies fundamentally change the ways people live and work and how businesses operate, and disruptive technological changes ultimately affect the global economy (Bower and Christensen, 1995; McKinsey Global Institute, 2013). Existing disruptive innovation theory focuses on key issues such as market characteristics, new markets and low-end innovations (Christensen, 1997). Disruptive innovations are new services and products that initially gain a market share at the bottom end of the market by making a product or service available to a new group of "low-end" consumers that are less wealthy or skilled than consumers of such products have been historically.

One definition of a disruptive innovation focuses on the functional quality and cost of an innovation. This definition defines disruptive innovations as an innovation with a "good enough" functionality that has a low cost (Christensen *et al.*, 2006, 2000, 2008; Paap and Katz, 2004; Thomond and Lettice, 2002; Nagy *et al.*, 2016). Theoretically, the lower quality and lower-priced innovation incrementally improves until eventually the innovation competes with market-leading products, thus strongly disrupting the market status quo (Bower and Christensen, 1995; Nagy *et al.*, 2016).

The other definition of disruptive innovations focuses not on an innovation's cost or quality but on market characteristics. Danneels (2004), Markides (2006) and Tellis (2006) advocated that disruptive innovations change the performance metrics, or consumer expectations, of a market. Because Christensen and Bower characterised marketplace disruptions, or the effects new technologies can have on existing marketplaces, an opportunity exists to define how new technologies facilitate these market changes (Nagy *et al.*, 2016). Recently, Nagy *et al.* (2016) studied how to redefine and identify disruptive innovations. By using the innovation adoption theory, three innovation characteristics are identified as *ground disruptive innovations in a technology*, not a marketplace. These characteristics are an innovation's technical standard, functionality and ownership (Nagy *et al.*, 2016).

The difference between the definitions of *disruptive technology* and *disruptive innovation* is that the former does not restrict market entrants to first target low-end markets and then move from the bottom end towards the "upmarket" end. Eventually, disruptive innovation moves up the market and displaces established competitors (Koski *et al.*, 2016).

There is also a critical difference between *radical innovations* and *disruptive innovation*. Three innovation characteristics have been identified in innovation adoption literature as having *the potential to change markets*:

1. radical functionality;
2. discontinuous technical standards; and
3. an innovation's ownership (Thomond and Lettice, 2002).

Radical functionality is recognised in innovation adoption literature through articles describing *radical innovations*, or innovations that provide a user the ability to undertake a new behaviour or accomplish a new task that *was impossible before the invention of the innovation* (Abernathy and Utterback, 1978; Anderson and Tushman, 1990; Dahlin and Behrens, 2005).

Important technologies can come in any field or emerge from any scientific discipline, but these share four characteristics:

1. high rate of technological change;
2. broad potential scope of impact;
3. large economic value that could be affected; and
4. substantial potential for disruptive economic impact (McKinsey Global Institute, 2013).

To be economically disruptive, a technology must have broad reach – impacting companies and industries and affecting (or giving rise to) a wide range of machines, products or services. The technology is rapidly advancing or experiencing breakthroughs. *Disruptive technologies* typically demonstrate a rapid rate of change in capabilities in terms of price/performance relative to substitutes and alternative approaches, or these experience breakthroughs that drive accelerated rates of change or discontinuous capability improvements (McKinsey Global Institute, 2013).

First, in the literature of disruptive technology, there have been notions of economically disruptive technologies. For example, McKinsey have analysed these kinds of technologies. These identified technologies have significant potential to drive economic impact and disruption by 2025. An *economically disruptive technology* must have the potential to create massive economic impact. The value at stake must be large in terms of profit pools that might be disrupted. Technologies that matter have the potential to change the status quo in markets dramatically. They can transform how people live and work, create new opportunities or shift surplus for businesses and drive growth or change comparative advantages for nations (McKinsey Global Institute, 2013). Thus, next we would like to present McKinsey's 12 potentially economically disruptive technologies (their Table E1, and link them to their Table E6), how these primary affect society, businesses and economies (McKinsey Global Institute, 2013) (Table I).

1.2 Disruptive technologies having a primary economic impact

Following the analysis of McKinsey Global Institute (McKinsey Global Institute, 2013, Figures E1 and E6), we can note the following things.

- The disruptive technologies that *drive most economic growth and productivity* are mobile internet, automation of knowledge work, the Internet of Things, cloud technology, advanced robotics, 3D printing, advanced oil and gas exploration and recovery.
- The disruptive technologies that *create most the new products and services* are mobile internet, the Internet of Things, cloud technology, advanced robotics, autonomous vehicles, next-generation genomics, 3D printing and advanced materials.
- The disruptive technologies which *create the most opportunities for entrepreneurship* are mobile internet, cloud technology, next-generation genomics and 3D printing.
- The disruptive technologies that *change patterns of consumption* are mobile internet, cloud technology and 3D printing.

Thus, it is very important to elaborate on different aspects of disruptive technologies. It is usual that impacts of disruptive technologies are not elaborated in detail in many firms. However, these four channels of technological disruption need attention in the technology and corporate foresight studies (Figure 1).

2. Gartner Hype Cycle

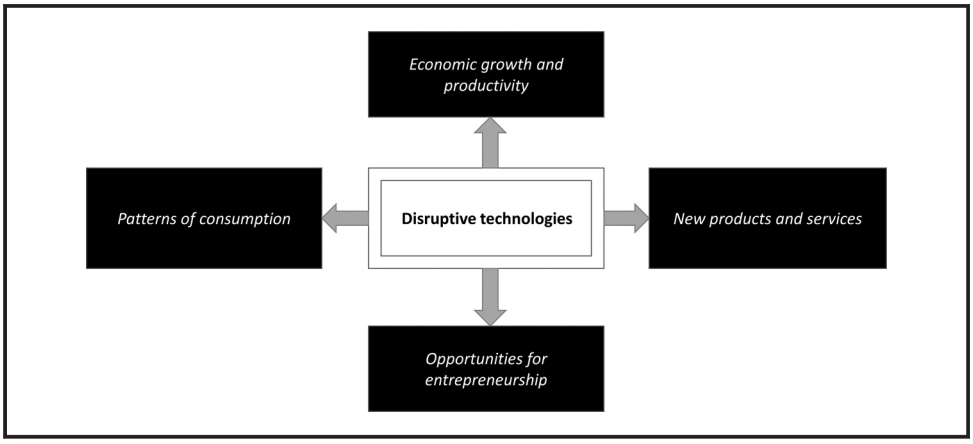
The Hype Cycle for the Emerging Technologies report is the longest-running annual technological foresight report, providing a cross-industry perspective on the technologies and trends that business strategists, chief innovation officers, R&D

Table I Twelve potentially economically disruptive technologies demonstrated how they, primarily, could affect society, businesses and economies

Disruptive technologies	*Description*	*Primary economic impact*
Mobile internet	Increasingly inexpensive and capable mobile computing devices and internet connectivity	Changes patterns of consumption Creates opportunities for entrepreneur Creates new products and services Drives economic growth or productivity
Automation of knowledge work	Intelligent software systems that can perform knowledge work tasks involving unstructured commands and subtle judgements	Changes nature of work Changes organizational structure Drives economic growth or productivity
The internet of things	Networks of low-cost sensors and actuators for data collection, monitoring, decision-making and process optimization	Changes quality of life, health and environment Creates new products and services Drives economic growth or productivity
Cloud technology	Use of computer hardware and software resources delivered over a network or internet, often as a service	Changes patterns of consumption Creates opportunities for Entrepreneur Creates new products and services Drives economic growth or productivity
Advanced robotics	Increasingly capable robots with enchanged senses, dexterity and intelligent used to automate tasks or augment humans	Changes quality of life, health and environment Changes nature of work Creates new products and services Drives economic growth or productivity
Autonomous and near-autonomous vehicles	Vehicles that can navigate and operate with reduced or no human intervention	Changes quality of life, health and environment Creates new products and services Poses new regulatory and legal challenges
Next-generation genomics	Fast, low-cost gene sequencing, advanced big data analytics and synthetic biology ("writing" DNA)	Changes quality of life, health and environment Creates opportunities for Entrepreneur Creates new products and services Poses new regulatory and legal challenges
Energy storage	Devices or systems that store energy for later use, including batteries	Changes quality of life, health and environment Shifts surplus between producers or industries
3D printing	Additive manufacturing techniques to create objects by printing layers of material based on digital models	Changes patterns of consumption Creates opportunities for Entrepreneur Creates new products and services Drives economic growth or productivity
Advanced materials	Materials designed to have superior characteristics (e.g. strength, weight and conductivity) or functionality	Changes quality of life, health and environment Creates new products and services
Advanced oil and gas exploration and recovery	Exploration and recovery techniques that make extraction of unconvential oil and gas economical	Shifts surplus between producers or industries Drives economic growth or productivity Changes comparative advantage for nations
Renewable energy	Generation of electricity from renewable sources with reduces harmful climate impact	Changes quality of life, health and environment Shifts surplus between producers or industries

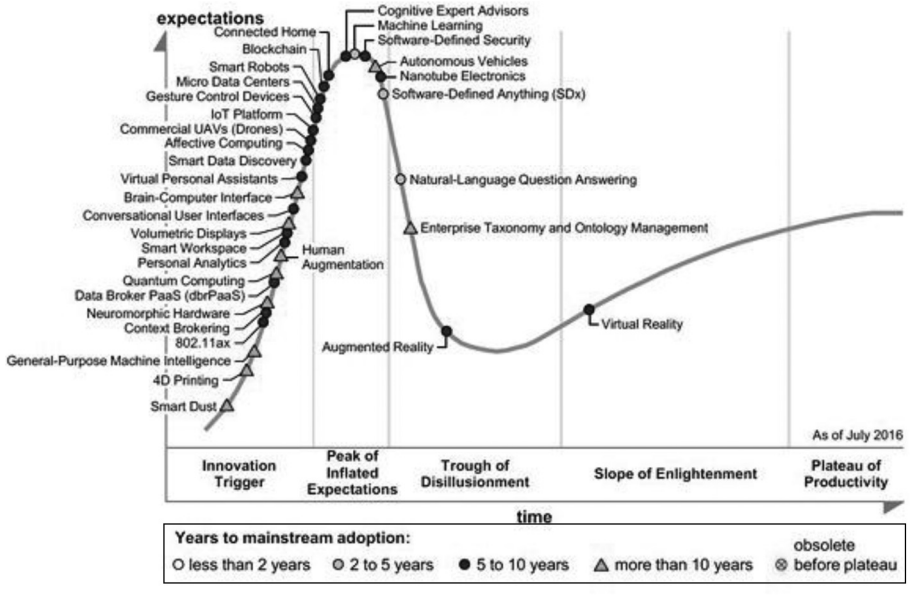
Source: McKinsey Global Institute Analysis, Table E1 cross-analysed and linked to Table E6

Figure 1 The four channels of technological disruption



leaders, entrepreneurs, global market developers and emerging-technology teams should consider in developing emerging-technology portfolios. Theories behind the Hype Cycle, Fenn and Raskino (2008), argued that three human nature phenomena are responsible for the curve's shape: attraction to novelty, social contagion and heuristic attitude in decision-making. They argued that hype cycles, in general, create winners and losers in markets. Hype-driven expectations and the aim towards maturity together create Hype Cycle phenomena (Figure 2 in Fenn and Raskino's study, 2008). The key argument in the context of this theoretical discussion is that "when people are free to do as they please, they usually imitate each other" (Fenn and Raskino, 2008, pp. 25-28).

Figure 2 Gartner Hype Cycle for emerging technologies



Source: Gartner (July 2016)

Adamuthe *et al.* (2015, p. 317) studied, among others, the description of Hype Cycle phases given by Fenn (1999):

- *Technological/innovation trigger phase*: A breakthrough, public demonstration, product launch or other event generates significant press and industry interest.
- *Peak of inflated expectations phase*: During this phase of over-enthusiasm and unrealistic projections, a flurry of well-publicised activity by the technology leaders results in some successes but more failures as the technology is pushed to its limits. The only enterprises making money are conference organisers and magazine publishers.
- *Trough of disillusionment phase*: Because the technology does not live up to its overinflated expectations, it rapidly becomes unfashionable and the press abandons the topic.
- *Slope of enlightenment phase*: Focused experimentation and solid hard work by an increasingly diverse range of organisations lead to a true understanding of the technology's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools become available to ease the development process.
- *Plateau of productivity phase*: The real-world benefits of the technology are demonstrated and accepted. Tools and methodologies are increasingly stable as these enter their second and third generation. The final height of the plateau varies, depending on whether the technology is broadly applicable or benefits only a niche market.

Phase 1 creates positive hype and Phase 3 creates negative hype. The peak of inflated expectations phase is between positive and negative hypes.

2.1 Understanding the dynamics of technological disruption: comparing Gartner Hype Cycle between 2008 and 2016

In 2008, the Hype Cycle included erasable paper printing system, context delivery architecture, behavioural economics, mobile robotics, augmented reality, surface, computers, cloud computing, 3D printing, microblogging, green IT, social computing platforms, solid-state drives, public virtual world, Web 2.0, service-oriented business applications, virtual assistance, RFID, corporate blogging, idea management, social network analysis, electronic Ppaper, tablet PC, SOA, location-aware applications and basic Web applications (Gartner, 2008a).

The competitive environment has been changing significantly over the past decades. All factors such as globalisation, fast technological changes, codification of knowledge, the internet, talent and employee mobility, increased rates of technological transfer, the emergence of new customer needs and the innovation of products and business models contributed to the increase in industry turbulence (Vecchiato and Roveda, 2010, Vecchiato, 2015).

The Gartner Hype Cycle indicates that fast developments in technologies mean that there are always traps and new challenges for firms. Traps are adopting too early, giving up too soon, adapting too late and hanging on too long. The anticipated value of innovation depends on the mindsets of decision makers. Typically, adoption decision makers in firms need to pay much attention to risks, foresight competences and mindsets of decision makers. The adoption decisions are linked to organisation capability to manage risks and uncertainties. The adoption decisions are also linked to the maturity level of organisations' foresight capabilities (Fenn and Raskino, pp. 49-61; Lahiri *et al.*, 2008; Rohrbeck and Gemünden, 2011).

In 2016, the situation was very different compared to Gartner Hype Figure in 2008. The 16 new technologies were included in the Hype Cycle for the first time. These new technologies include 4D printing, general-purpose machine intelligence, 802.11ax, context brokering, neuromorphic hardware, data broker PaaS (dbrPaaS), personal analytics, smart workspace, smart data discovery, commercial UAVs (Drones), machine learning, nanotube electronics, software-defined anything (SDx), enterprise taxonomy and ontology management, blockchain and connected home. In addition, some earlier items remain, namely, the volumetric displays, brain computer interface, visual personal assistants, affective computers, IoT platforms, gesture control devices, micro data centres, smart robotics, machine learning, autonomous vehicles, natural-language question answering, augmented reality and virtual reality (Gartner, 2016; Gartner, 2008a, 2008b).

One emerging aspect of technological change is the rise of a platform economy. Platforms have different scales. Some are working on a small scale, whereas others are working on a big scale. New technologies such as the technologies stated above can provide new opportunities to change the scale of platform. Choudary (2015) presented five key elements of a platform: data, infrastructure and community, marketplace-community and network-marketplace. Presented with a choice of platform structure, new technologies are providing many new options and opportunities.

Various foresight practices and techniques ("strategic – or corporate – foresight") have been developed to support strategic planning in fast-paced environments and thus help decision makers cope with uncertainty (Rohrbeck and Gemünden, 2011; Vecchiato and Roveda, 2010; Vecchiato, 2015). Today, the terms "corporate foresight" and "strategic foresight" have become widely common for encompassing such future-oriented practices and techniques (Rohrbeck and Schwarz, 2013; Vecchiato and Roveda, 2010; Vecchiato, 2015).

Today, Gartner's prediction that leading technological revolutionary areas are smart machine technologies, which will revolutionise manufacturing and its related industries, includes the following: smart dust, machine learning, virtual personal assistants, cognitive expert advisors, smart data discovery, smart workspace, conversational user interfaces, smart robots, commercial UAVs (Drones), autonomous vehicles, natural-language question answering, personal analytics, enterprise taxonomy and ontology management, data broker PaaS (dbrPaaS) and context brokering (Gartner¨s Hype Cycle for Emerging Technologies, 2016).

Emerging technologies are enabling entirely new business models, driving a platform revolution. Platform-enabling technologies, which are making new business models possible, include neuromorphic hardware, quantum computing, blockchain, IoT platform, software-defined security and software-defined anything (SDx) (Gartner¨s Hype Cycle for Emerging Technologies, 2016).

We can present the following summary. Some technologies from 2008 Hype Cycle were foresighted very well and these are nowadays very popular: such technologies were tablet PCs, the internet of things, cloud services, 3D printers, solid-state drive and augmented reality. In 2016, 14 technologies were taken off the Hype Cycle including hybrid cloud computing, consumer 3D printing, enterprise 3D printing and speech-to-speech translation. These technologies are not considered "hype" anymore. Additional technologies removed from the Hype Cycle include 3D bioprinting systems for organ transplants, advanced analytics with self-service delivery, bioacoustic sensing, citizen data science, digital dexterity, digital security, the internet of things, neurobusiness and people-literate technology (Gartner, 2008a, 2008b; Gartner, 2016).

Gartner Inc. reveals three distinct technological trends that are the highest priority for organisations facing rapidly accelerating digital business innovation:

1. transparent immersive experiences;
2. the perceptual smart machine age; and
3. the platform revolution.

These three overarching technological trends profoundly create new experiences with unrivalled intelligence and offer platforms that allow organisations to connect with new business ecosystems (Gartner's 2016 Hype Cycle for Emerging Technologies).

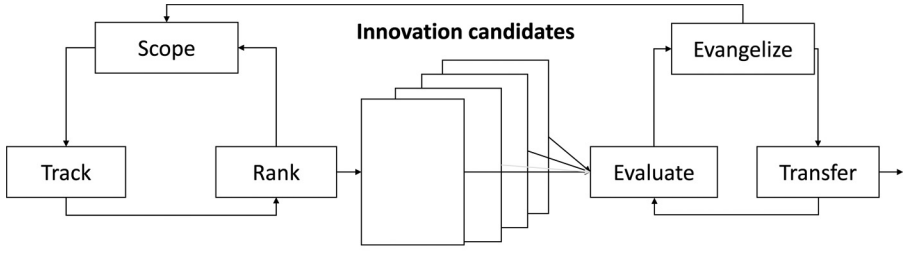
3. Corporate foresight, management, leadership and relevant mindsets

3.1 The STREET process: two wheels of this novel innovation

In Figure 3, there is a visual description of the STREET process. This process is two-wheeled process, which decision makers of innovation management can use when they analyse novel technologies.

In Figure 10, there is a visual description of the STREET process. This process is two-wheeled process, which decision-makers of innovation management can use when they analyse novel technologies. The stages of the STREET process are scoping, tracking, ranking, evaluation, evangelisation and transfer. In *the scoping stage*, managers decide what is valuable to you and how much risk you will take to get it. This scoping stage is actually risk analysis, where you define actual reasons for innovation development. The second stage, *the tracking stage*, is where you seek out relevant innovations from a broad range of sources and track their progress along the Hype Cycle to notice advances in their maturity. In this stage, you try to find candidates that broadly match your organisation's scope of required innovation and fall within its risk comfort zone. In the third stage, *the ranking stage*, you consider alternative candidates by ranking potential innovations and selecting those worthy of immediate attention. The fundamental aim of ranking is to identify those inventions or innovations that more likely bring significant benefit to your organisation within a time frame that fits your risk profile. An essential aspect of ranking is to avoid the danger of assessing an innovation simply on its own merits (which, at the peak of inflated expectations, can be hard to determine) rather than in relation to other options for investing the same limited resources. This stage is, in a way, a cost benefit and first risk analysis of alternative options. Ranking is a very important but often overlooked step in adopting the right potential innovation. In *the evaluation stage*, an expert investigates each of the top-ranked innovation candidates where a lack of knowledge or understanding still prevents you from deciding whether to move forward. In this stage, laboratory and paper investigations as well as prototyping and piloting are performed to understand each potential invention's value and eliminate potential value gaps. There can be a planned

Figure 3 The STREET process: two wheels of novel innovation analysis



Source: Fenn & Raskino (2008, p. 99)

evaluation program inside an organisation, which one can have at regular decision points. The key result of evaluation stage is a decision to take one of four courses:

1. move forward with adoption and progress to the evangelisation and transfer stages;
2. revisit the evaluation in revised form;
3. return the candidate to the track phase until it matures further; or
4. drop the potential innovation from further considerations.

The fifth stage, *the evangelisation stage*, includes various activities such as inspiration and education, and involves other people to obtain the cooperation and support of all those who will influence the successful adoption of the innovation by its ultimate users. In the final stage, in *the transfer stage*, you need to continue to inspire, educate and involve other people to transfer responsibility to those who will implement or use the innovation. This stage is demanding because it requires more than transferring knowledge. This stage also requires the ability to spark enthusiasm and a deep sense of ownership required for the innovation to take hold. In this final stage, all essential pieces of information and knowledge gained in Stages 1-5 should be used and mobilised to implement the transfer stage (Fenn and Raskino, 2008, pp. 96-99). The key challenge in many organisations is how to implement the STREET process or something similar to the innovation management method in the volatility, uncertainty, complexity and ambiguity (VUCA) environment. The scoping, tracking, ranking and decision-making processes must be organised in some way. When strategic decisions are made, the evaluation, evangelisation and transfer phases must take place.

3.2 Corporate foresight, management, leadership and relevant mindsets

Since the late 1980s, the term "foresight" has been used to describe activities, which inform decision makers by improving the inputs about the long-term future of an organisation (Keenan, Loveridge, Miles and Kaivo-oja, 2003; Vecchiato, 2015). The concepts foresight and strategic or corporate foresight need to be briefly discussed. The concept of foresight has been used since the late 1980s to describe an inherent human activity (von der Gracht *et al.*, 2010). The concepts of strategic, organisational and corporate foresight have been used to describe future research activities in corporations (von der Gracht *et al.*, 2010) or in other organisations. Martin (2010) and Coates (2010) emphasised that foresight deals with the long-term future and Vecchiato and Roveda (2010) used strategic foresight deliberately to emphasise the tight relationship between foresight and strategy formulation (Rohrbeck and Gemünden, 2011).

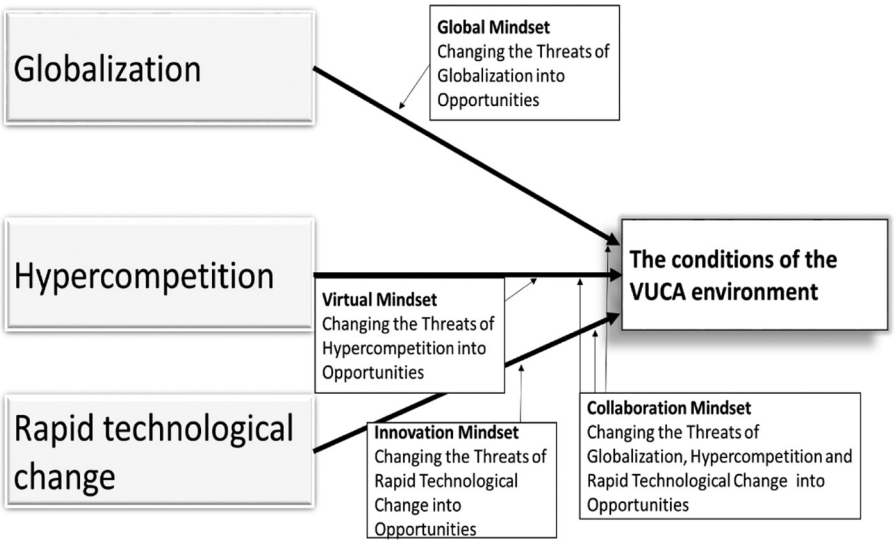
Future thinking can simply be about foresight training, helping individuals and organisations with new competencies and new skills. At a deeper level, future thinking can help create more effective strategy. By understanding the alternative, used and disowned futures, organisations can become far more innovative. At a deeper level, future thinking can create capacity (Inayatullah, 2008).

Academic studies have generated knowledge on the need for corporate foresight systems (Ruff, 2006, Rohrbeck and Gemünden 2011) and the value contribution of strategic foresight (Vecchiato and Roveda, 2010; Burt and Van der Heiden, 2008).

In Figure 4, we have figured out key elements of the competitive landscape which are relevant for the VUCA environment. Globalisation, hypercompetition and rapid technical change create key preconditions for the VUCA environment. The key challenge for leaders is to change the threats of competitive landscape into opportunities. The role of mindsets is very important in this respect. As we know, the mind matters (Lahiri *et al.*, 2008)

A global mindset or the ability to view the world using a broad perspective converts globalisation threats into growth opportunities by thinking beyond geographic boundaries,

Figure 4 Framework showing relationships by VUCA environment



Source: Modification of Lahiri *et al*. (2008, p. 313)

valuing integration across borders and appreciating regional and cultural diversity. *An innovation mindset* is a mental framework that fosters development and the implementation of new ideas. *A virtual mindset*, or the ability of managers to hand over their companies' activities to external providers, turns hypercompetition into prospects for growth by facilitating flexibility and responsiveness. Finally, *a collaboration mindset* means willingness allowing companies or corporations to engage in business partnerships. A collaborative mindset integrates all other mindsets which can lead to synergy by business complementarities (Lahiri *et al*., 2008). We can conclude that these four critical mindsets help corporations to manage disruptive technological innovations. The ability to change threats into opportunities is a critical asset in the VUCA conditions (Lahiri *et al*., 2008, Krupp and Schoemaker, 2014).

3.3 Paradigms for modelling uncertain futures and decision environments

In relation to uncertain futures of tomorrow, there are two key approaches to uncertain futures, which are presented in Table II. The first approach, the ARK approach, refers to

Table II Strategic approaches, approach of results and knowledge and approach of knowledge, actions and results

	ARK approach	*KAR approach*
Task	Make decisions Action-oriented	Generate knowledge Learning-oriented
Nature	Agenda-driven Individuals dominate	Organization-driven Holistic and shared
Time frame	Now	Future
Mechanism	Event-focused	Process-focused
Dynamics	Self-interest dominates Protect information	Trust and commitment Share information

Source: Akhter (2003, p. 21)

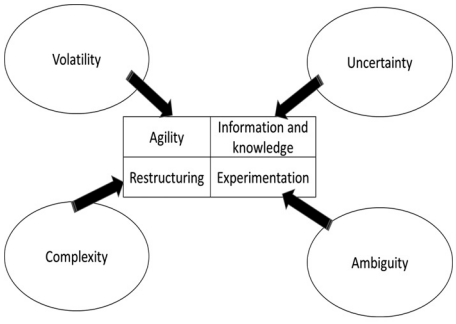
actions (decisions), results and knowledge. The problem of the ARK approach is that decision makers have to "put out fires", so to speak. The ARK approach to strategic planning often results in an exercise in solving today's problems rather than exploring tomorrow's opportunities, which leave corporations unprepared to deal with emerging disruptions and emerging events (Akther, 2003).

An alternative approach to modelling and approaching uncertain futures is the KAR approach, where the process starts with knowledge mapping and integration, leading to action and results. This approach allows the use of foresight and associated insights. The KAR approach to strategic planning provides both the structure and the context for knowledge management. The strong underlying logic is that knowledge should lead the company into the future, influencing decisions about customers, competitors, the corporation and the environment. The assumption is that the focus on knowledge development will encourage leaders and managers to share information and thereby create an environment in which trust and commitment can play a constructive role in developing individual and shared cognitions (Akther, 2003, p. 21).

Both ARK and KAR approaches can be applied in the VUCA conditions. The difference between these approaches is that the role of foresight knowledge is different. In the ARK approach, foresight knowledge is linked to the agenda of decision makers. In the KAR approach, foresight knowledge is based on active foresight analyses, which typically include diagnosis, prognosis and prescriptions. In Figure 5, we present four alternative and complementary paradigms for modelling the future. These alternatives are highly relevant for foresight in the turbulent VUCA conditions.

Our proposal is that leaders of corporations and companies should combine the KAR approach and adopt Model D (Figure 3), if they want to integrate foresight activities to the practices of management and leadership in corporations. A fundamental purpose of foresight modelling is to help understand the future and to support planning or adaptation. We do not want to underestimate the role of the ARK approach in corporate planning and management. If leaders and decision makers are able to integrate foresight knowledge to their agenda of decision-making, it may be possible to get more value added from foresight

Figure 5 Alternative approaches to futures



Notes: Complementary paradigms to futures; (a) anticipating the future based on best available knowledge; (b) quantifying future uncertainty; (c) exploring multiple plausible futures; (d) combining the three paradigms to address different sources of uncertainty within a foresight problem
Source: Maier *et al*. (2016, p. 155)

in their corporations. However, we propose that possibilities are better in the KAR approach.

4. The volatility, uncertainty, complexity and ambiguity definitions and approach

The term VUCA has gained currency in the military during late 1990s to describe an environment of volatility, uncertainty, complexity and ambiguity. It reflects a shift from traditional Cold War military conflicts to asymmetric warfare with agile, dispersed opponents fighting under different rules for causes we do not fully understand. Business conditions are increasingly encountering VUCA conditions as well and this poses deep new challenges. After all, short-run pressures are in conflict with long-run challenges. Peter Drucker was one of the first to emphasise that management is doing things right and that leadership is about doing the right things (Drucker, 2008). However, under the VUCA conditions, it is not easy to define what the right things are, and how to do things in right ways. Next, we will clarify the VUCA definitions (Lawrence, 2013, Sullivan, 2012a, 2012b).

4.1 Volatility

The "V" in the VUCA acronym stands for volatility. It means the nature, speed, volume and magnitude of change that is not in a predictable pattern (Lawrence, 2013, Sullivan, 2012a). Volatility is turbulence, a phenomenon that is occurring more frequently than in the past. The BCG study concluded that financial turbulence has increased in intensity and persists longer than in the past (Lawrence, 2013; Sullivan, 2012b). Other drivers of turbulence in business today include digitisation, connectivity, trade liberalisation, global competition and business model innovation (Lawrence, 2013; Reeves and Love, 2012).

4.2 Uncertainty

The "U" in the VUCA acronym stands for uncertainty, or the lack of predictability of issues and events (Lawrence, 2013; Kingsinger and Walch, 2012). Volatile times make it difficult for leaders to use past issues and events as predictors of future outcomes, making forecasting extremely difficult and decision-making challenging (Lawrence, 2013; Sullivan, 2012a).

4.3 Complexity

The "C" in VUCA stands for complexity. As HR thought leader Sullivan (2012a) noted, there are often numerous and difficult-to-understand causes and mitigating factors (both inside and outside the organisation) involved in a problem. This layer of complexity, added to the turbulence of change and the absence of past predictors, adds to the difficulty of decision-making. It also leads to confusion, which can cause ambiguity, the last letter in the acronym (Lawrence, 2013).

4.4 Ambiguity

Ambiguity is the lack of clarity about the meaning of an event (Caron, 2009), or, as Sullivan (2012a), Lawrence (2013) wrote, the "causes and the 'who, what, where, how, and why' behind the things that are happening (that) are unclear and hard to ascertain". Col. Eric G. Kail defined ambiguity in the VUCA model as the "inability to accurately conceptualise threats and opportunities before they become lethal" (Lawrence, 2013; Kail, 2010). A symptom of organisational ambiguity, according to Kail (2014), is the frustration at results when compartmentalised accomplishments fail to add up to a comprehensive or enduring success.

Furthermore, we will introduce the VUCA characteristics, examples and approach written by Bennett and Lemoine (2014) to the Herald Business Review (Figure 6).

5. Volatility, uncertainty, complexity and ambiguity model and the Gartner Hype Cycle

The VUCA approach and the Gartner Hype Cycle can be seen to complement approaches to each other. In next sections, we explain how these two approaches are complementary.

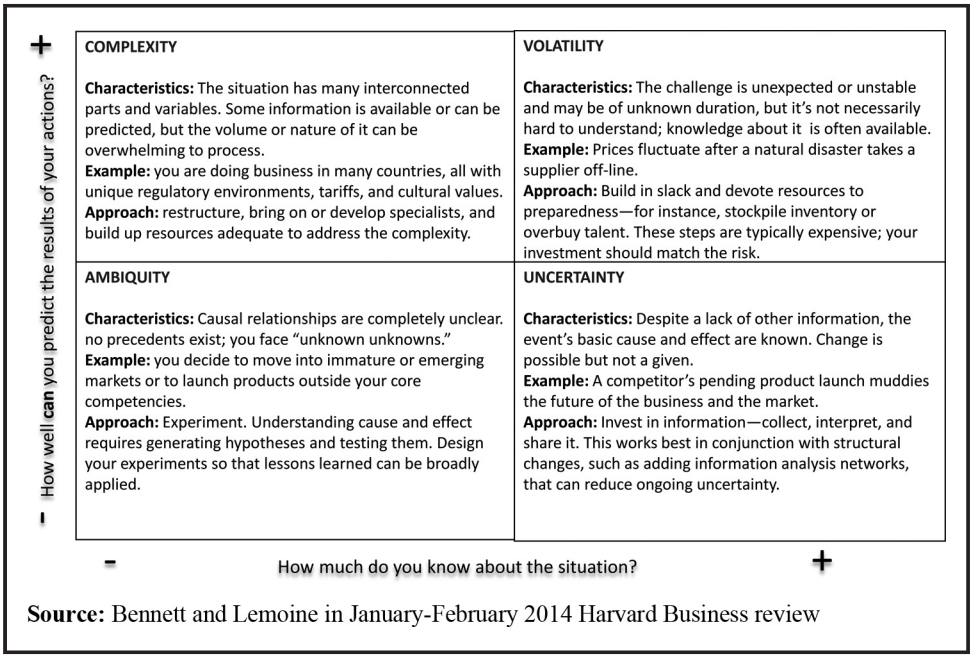
5.1 Volatility and the Gartner Hype Cycle

Volatility issue is seen especially in yearly innovation trigger changes of the Gartner Hype Cycles. If we observe all innovation triggers and their fast changes from 2008 to 2016, we can just present an observation that volatility has been a key issue from 2008 to 2016. Companies and corporations need a lot of agility to manage all these innovation triggers in their business administrations. In Table III, this aspect is verified by the Gartner Hype Cycle material.

5.2 Uncertainty and the Gartner Hype Cycle

The yearly reports of the Gartner Hype Cycle (2008-2016) reveal that technological choices of companies and corporations are facing a lot of uncertainty. In the Gartner Hype Cycle, expectations vary dramatically in the Gartner's Hype Curve. In the peak of inflated expectations curve, expectations are reaching the peak level but they go dramatically down during the phase of trough of disillusionment. This dramatic change in expectations indicates directly how much there is uncertainty in the field of technological management. This large variation of expectations is not the full story of the Gartner Hype Cycle because expectations start to increase during the phases of slope of enlightenment and plateau of productivity. Again, leaders and managers face a lot of uncertainty concerning these technologies. Companies and corporations need up-to-date information and knowledge to

Figure 6 The VUCA characteristics are in two dimensions



Source: Bennett and Lemoine in January-February 2014 Harvard Business review

Table III Gartner innovation trigger phases in 2015 and 2016

2015			*2016*		
Gartner Hyper Cycle: innovation trigger	*From*	*To*	*Gartner Hyper Cycle: innovation trigger*	*From*	*To*
Smart dust	10	More than 10 years	Smart dust	10	More than 10 years
Virtual personal assistants	5	10	4D printing	10	More than 10 years
Digital security	5	10	General purpose machine intelligence	10	More than 10 years
People-literate technology	5	10	Context brokering 802.11ax	5	10
Bioacoustic sensing	10	More than 10 years	Neoromorphic hardware	10	More than 10 years
Quantum computing	10	More than 10 years	Data broker PaaS (dbrPaaS)	5	10
Brain-computer interface	10	More than 10 years	Quantum computing	10	More than 10 years
Human augmentation	10	More than 10 years	Personal analytics	5	10
Volumetric displays	10	More than 10 years	Smart workplace	5	10
3D bioprinting systems for organ transplants	5	10	Volumetric displays	10	More than 10 years
Smart robots	5	10	Conversational user Interfaces	5	10
Affective computing	5	10	Brain computer interface	10	More than 10 years
Connected home	5	10	Virtual personal assistants	5	10
IoT platform	5	10	Smart data discovery	5	10
Biochips	5	10	Affective computing	5	10
Citizen data science	10	More than 10 years	Commercial UAVs (Drones)	5	10
Neurobusiness	5	10	IoT platform	5	10
Software-defined security	5	10	Gestrure control devices	5	10
Digital dexterty	5	10	Micro data centres	5	10
Micro data centres	5	10	Smart robots	5	10
Smart advisors	5	10	Blockchain	5	10
Advanced analytics with self-service delivery	1	2	Connected home	5	10
Autonomous vehicles	5	10	Cognitive experts advisors	5	10

Source: Gartner (2015, 2016)

manage all these innovation triggers in their business administrations. In Table IV, this aspect is verified by the Gartner Hype Cycle material.

5.3 Complexity and the Gartner Hype Cycle

In general, we can note that all phases of the Gartner Hype Cycle reflect complexity of technological development. In relative terms, the complexity of technological options is largest in the technological trigger and peak of inflated expectations phases, where there are very

Table IV Gartner trough of disillusionment phases in 2015 and 2016

2015			*2016*		
Gartner Hyper Cycle: innovation trough of disillusionment	*From*	*To*	*Gartner Hyper Cycle: innovation trough of disillusionment*	*From*	*To*
Natural language questions answered	5	10	Software-defined anything (SDs)	2	5
Hybrid cloud computing	2	5	Natural-language questions answer	2	5
Augmented reality	5	10	Enterprise taxonomy and ontology	11	More than 10 years
Cryptocurrency exchange	2	5	Augmented reality	5	10
Autonomous field vehicles	5	10			
Virtual reality	5	10			

Source: Gartner (2015, 2016)

many technological options, which could be potentially a source of success for firms. Fewer technological options and complexity of technological options can be found during the phases of trough of disillusionment, slope of enlightenment and plateau of productivity. Complexity seems to be on the lowest level in the final phase of the Gartner Hype Cycle. In this phase, there are only few technological options left. Companies and corporations need restructuring skills to manage all these complex patterns of technologies in their business administrations. In Table V, this aspect is verified by the Gartner Hype Cycle material.

5.4 Ambiguity and the Gartner Hype Cycle

Behaviour with ambiguity aversion is typical for many decision makers. In real life, it is not always possible to evade ambiguity in technological decisions. Another obvious strategy to avoid ambiguity would be to select future technologies only during the phase of plateau of productivity. The phase of technology triggers shows that ambiguity cannot be avoided easily. Companies and corporations need experimentation skills to manage ambiguity challenges of technologies in their business administrations. In Table VI, this aspect is verified by the Gartner Hype Cycle material.

6. The volatility, uncertainty, complexity and ambiguity cases and challenges for corporate leadership and management

6.1 The volatility, uncertainty, complexity and ambiguity case companies

The notion of VUCA was introduced by the USA Army War College to describe the more volatile, uncertain, complex and ambiguous, multilateral world which resulted from the end of the Cold War (Kingsinger and Walch, 2012). The acronym itself was not created until the late 1990s, and it was not until the terrorist attacks of 11 September 2001, that notion and acronym really took hold. VUCA was subsequently adopted by strategic business leaders to describe the chaotic, turbulent and rapidly changing business environment that has become the "new normal".

Table V Gartner peak of inflated expectations phases in 2015 and 2016

2015			*2016*		
Gartner Hyper Cycle: peak of inflated expectations	*From*	*To*	*Gartner Hyper Cycle: peak of inflated expectations*	*From*	*To*
Smart Advisors	5	10	Gesture control devices	5	10
Advanced analytics with self-defence delivery	2	5	Micro data centres	5	10
Autonomous vehicles	5	10	Smart robots	5	10
Internet of things	5	10	Blockchain	5	10
Speech-to-speech translation	2	5	Connected home	5	10
Machine learning	2	5	Cognitive expert advisors	5	10
Warables	5	10	Machine learning	2	5
Cryptocurrencies	5	10	Software-defined security	5	10
Consumer 3D printing	5	10	Autonomous vehicles	11	More than 10 years
			Nanotube electronics	5	10
			Software-defined anything (SDx)	2	5

Source: Gartner (2015, 2016)

Table VI Gartner Plateau of productivity phases in 2015 and 2016

2015		*2016*	
Gartner Hyper Cycle: plateau of productivity		*Gartner Hyper Cycle: plateau of productivity*	
From	*To*	*From*	*To*
Nothing		Nothing	

Source: Gartner (2015, 2016)

In a business context, the VUCA concept took off after the global financial crisis of 2008 and 2009. Since then, it has featured heavily in the development of leadership skills in various organisations. The concept describes a business environment characterised by:

- *Volatility*: A brutal increase in four dimensions of the changes that we face today in business environment: type, speed, volume and scale.
- *Uncertainty*: As a result of volatility, we are unable to predict future events in business field.
- *Complexity*: Widespread confusion, with no clear connection between cause and effect, affects all organisations nowadays.
- *Ambiguity*: There is a lack of precision, and the existence of multiple meanings within the conditions surrounding us in organisations (Table VII).

In today's ever competitive and very rapidly changing market place, the impact of excellent customer service has never been more important. With a global market, the Internet of Things and virtual purchasing, the world is a very different place. In modern leadership jargon, a term that is showing up constantly to highlight the fast-paced, changing environment is VUCA (Hyken, 2016). In today's world, these aspects of volatility, uncertainty, complexity and ambiguity are now seen sometimes as the "norm" in the business environment.

In 2010, Unilever, one of the world's largest consumer goods companies, pledged to double the size of their business in the next 10 years while reducing its environmental footprint and increasing its social impact. Sustainability became a central component of their new business model, one based on the VUCA principles (Lawrence, 2013; Sullivan, 2012a, 2012b; Dan, 2012).

In 2010, Supply Chain Quarterly staff reported that consumer goods giant Procter & Gamble (P&G) was revising its supply chain to reflect changes it expects in a VUCA world. Global Product Supply Officer R. Keith Harrison reported on the steps the company was taking to ensure that company's supply chain could accommodate the VUCA of today's business worlds (Lawrence, 2013). Mack *et al.* (2015) reported in the book "Managing in a VUCA World", that companies with success stories in the past decades used the VUCA approach (for example, Amazon, Facebook, Microsoft and eBay.). These examples indicate that in corporations, the VUCA approach is adopted as a relevant foresight approach.

Table VII The VUCA case companies

Year	*The VUCA case companies*
11.9.2001	The notion of VUCA was introduced by the US Army War College 11.9.2001
2000-2010	The past decades success stories: Amazon, Facebook, Microsoft and eBay
2001	Fast-food giant McDonald's was a frontrunner in adapting 2001 VUCA
2010	Unilever, one of the world's largest consumer goods companies
2010	The consumer goods giant, Procter & Gamble (P&G)
2010	IBM, Shell and Nokia, Samsung Electronics, Ernst & Young and KPMG
2010	Daimler Chrystler, Mercedes-Benz and Toyota
2010	Walt Disney Company, Sony Pictures Entertainment and Fox Entertainment
2011	In 2011, Diversey, a privately owned company, provided cleaning, sanitizing and selling and servicing customers in 175 countries
2012	Volkswagen, BMW and Audi
2013	YouTube
2016	Kellogg Company

Source: Katzenbach (2010) and Hyken (2016)

6.2 The volatility, uncertainty, complexity and ambiguity challenges for corporate leadership and management

Leadership agility and adaptability are now required skills if organisations are to succeed in this VUCA world. As Horney, Pasmore and O'Shea, authors of "Leadership Agility: A Business Imperative for a VUCA World", noted, to succeed, "leaders must make continuous shifts in people, process, technology, and structure. This requires flexibility and quickness in decision making" (Horney *et al.*, 2010).

The VUCA inherent in today's business world is the "new normal", and it is profoundly changing not only how organisations do business but also how business leaders lead. The skills and abilities leaders once needed to help their organisations thrive are no longer sufficient. Today, more strategic, complex critical-thinking skills are required of business leaders. They need to understand the VUCA leadership and apply the VUCA approach to the Customer Service Leadership "tool-kit" in a rapidly changing world (Hyken, 2016). To address VUCA, the "solution strategy" is to change the words and address the problems. The companies and leaders need to change and meet the new innovative challenges (Hyken, 2016):

- *From volatility – to – vision* (Hyken, 2016): Companies need to be able to communicate effectively, and this involves targeted communication, communicating a sense of purpose and leading people towards a vision. They need to be focused and ensure the team's efforts are aligned and focused on the right goal. They need to provide the direction and articulate the endgame so that it is clear to all.
- *From uncertainty* – to – *understanding* (Hyken, 2016): The companies must not be afraid to ask questions (clarify), both of their team and customers. The leaders need to understand their team/customers' motives, their hopes, fears and desires. Companies need to develop an open mind, both within corporate leaders and their team to explore new ideas. Thus, always seek feedback to review and reflect on actions.
- *From complexity* – to – *clarity* (Hyken, 2016): Leaders need to keep things simple, cut through complexity and deal with core issues. They need to rely more on intuition, to trust gut instinct and experience to cancel out anything unnecessary. Leaders need to communicate succinctly, with structure and with reason.
- *From ambiguity* to *agility* (Hyken, 2016): Company leaders need to be decisive, adapt quickly to changing circumstances and make decisions with confidence. They need to adapt, innovate, learn from mistakes and continuously seek new ways to get better. The leaders need to empower their workers, cut out unnecessary bureaucratic processes, develop clear communication channels and use collaboration and give teams possibilities to do a great work.

In Figure 7, we present a synthesis about the VUCA challenges and key solutions. The volatility of the environment requires agility with organisational culture. The uncertainty of the environment requires updated information and knowledge management. The complexity of the environment requires active restructuring of a corporate organisation. The ambiguity of the environment requires experimentation of management activities in corporations.

6.3 Foresight tools relevant to the volatility, uncertainty, complexity and ambiguity environment

In recent management and leadership literature, Krupp and Schoemaker (2014) presented a comprehensive answer, the Sig Discipline model, to meet the VUCA challenge. In Figure 8, the model is presented.

In this paper, we are not discussing all the elements of the six disciplines. We focus on foresight aspects of corporate leadership. However, from Figure 4, we can learn the

Figure 7 The VUCA challenges and key solution concepts

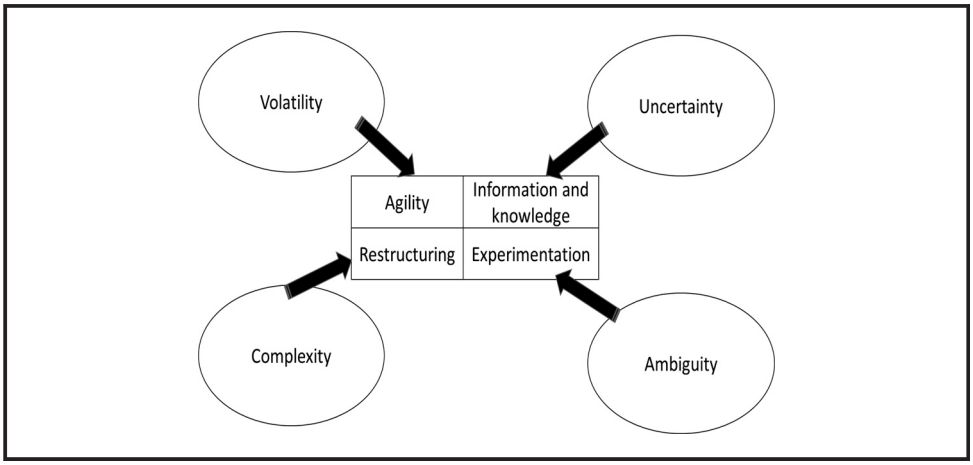
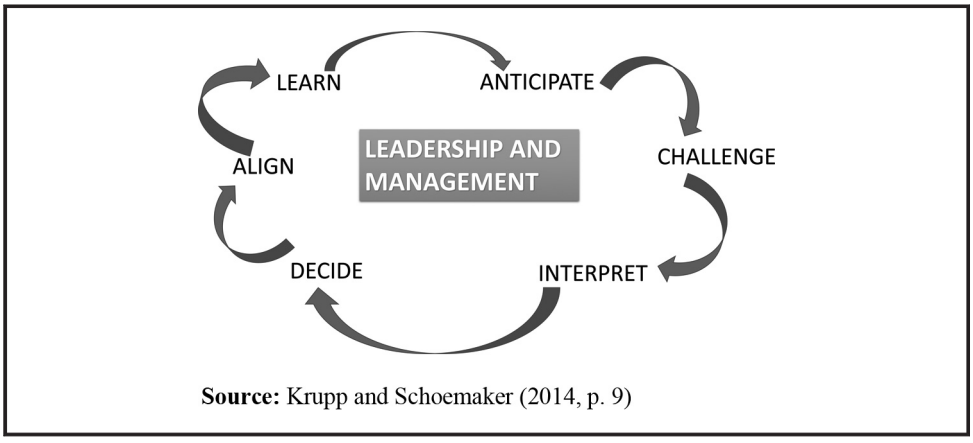


Figure 8 The six disciplines



Source: Krupp and Schoemaker (2014, p. 9)

following messages. Leaders can develop the ability to anticipate changes in the market environment by (Krupp and Schoemaker, 2014, pp. 8-9):

- staying closely connected with customers, partners and competitors, rather than becoming disconnected and reactive;
- interpreting a wide array of data and viewpoints rather than looking only for evidence that confirms their prior beliefs;
- challenging assumptions and the status quo by surrounding themselves with people who think outside the box and are open to new ideas;
- deciding what to do after examining their options and then encourage people to get it done, rather than waffling or belabouring the decision-making process;
- aligning the interests and incentives of stakeholders based on the understanding of different views, rather than relying on their power or position; and
- learning from success and failure by experimentation, making small bets and picking up on lessons from both good and bad outcomes to create quick learning cycles.

In Table VIII, we have reported the tools relevant to the VUCA environment, relevant foresight tools and the key functions of tools inside corporations. Table VIII not only summarises the insights of Krupp and Schoemaker (2014) but also includes some additional remarks of the authors. In particular, we have clarified and outlined the issue of a key foresight tool and the key functions of foresight tools inside corporations in this table.

7. Conclusions

This paper contributes academically and practically to the discussion of disruptive technologies; academically, by redefining disruptive innovations; defining the difference to disruptive innovations, disruptive technologies and radical innovations; and practically, by analysing McKinsey's 12 disruptive technologies and their prior economic impact. We also clarified key impact channels of disruptive technologies.

The disruptive technologies that drive most economic growth and productivity are mobile internet, automation of knowledge work, the Internet of Things, cloud technology, advanced robotics, 3D printing, advanced oil and gas exploration and recovery. The three disruptive

Table VIII Tools relevant to the VUCA environment, relevant foresight tools and the key functions of foresight tools in corporations

Tools relevant to the VUCA environment	*Relevant foresight tools*	*The key functions inside corporations*
Anticipating tools	Statistical forecasting tools, especially based on probability analysis	Identify risks and emerging new mark-markets
Interpreting tools	Statistical forecasting tools, risk analysis, especially based on probability analysis Expert and crowdsourcing methods (Delphi methodology and crowdsourcing techniques)	Analytical reflection of the results of anticipating tools Creation of "big picture" of markets and corporate stakeholders
Challenging tools	Weak signal and Wild Card analyses, creativity tools, the analyses of desirability and feasibility, mirroring and benchmarking tools, technology roadmaps, trend and scenario analyses and competitor analyses	Identify alternatives and uncertainties in the environments Eliminate the conceptional problems of group thinking Amplify weak and strong signals
Decision-making tools	Priority setting tools, multi-objective decision-making tools and models Dr Z methodology and analysis: 1. Don't Rock the Boat, 2. Joining Foreces, 3. Go IT Alone, 4. Look for a Friend and 5. Fight the Good Fight	Help decision makers to be future-oriented decision-makers Enable decision-making with identifying options and comparing alternative options relevant for corporations Precondition to use decision-making tools is to link challenging tools to decision-making tools
Aligning tools	Stakeholder analysis tools Action planning Deep dialogue tools	Bridging differences and understanding stakeholders
Learning tools	Organization of simultaneous experiments Experimental fast learning tools ("valid experiments" and "robust experimental designs") Fast learning organization tools ("easy and quick experiment set-up" and "experimental data available quickly and automatically") Deep learning tools based on AI	Create strong passions for experimentation and learning inside a corporation
Combination tools	Transcendent leadership tools	Transcendent leadership combines: leadership of self, leadership of others and leadership of organization

technologies that change patterns of consumption and create new entrepreneurship and most of the new products and services are mobile internet, cloud technology and 3D printing.

Furthermore, we practically analysed and presented an empirical demonstration of the difference between Gartner's Hype Curve from 2008 to 2016 to verify the scope of technological disruption. Some technologies from 2008 Hype Cycle were foresighted very well, and these are nowadays very popular among consumers and end users: Tablet PCs, the Internet of Things, cloud services, 3D Printers, Solid State Drive were well foresighted, and Augmented Reality. Compared to the period 2008-2016 (Gartner, 2008, 2016), 14 technologies were taken off the Hype Cycle, and 16 new technologies were included in the Hype Cycle for the first time in 2016. Gartner's Hype Curve helps the leaders to understand the dynamics of technological disruption, which is extremely important for corporate and company leaders to be able to foresight the future.

This paper combines the discussions of technological disruption with the VUCA environment and leadership. We verified the critical link between VUCA variables and the phases of Gartner Hype Cycle in this paper using four tables referring to 2015 and 2016 (Gartner, 2015, 2016). Under the VUCA conditions, leaders and managers need a new arsenal of foresights and management tools and methods.

This paper elaborates some key theoretical approaches and practical solutions to the corporations facing turbulent VUCA conditions. These tools can be classified as anticipation tools, interpreting tools, challenging tools, decision-making tools, aligning tools, learning tools and combination tools. With the systematic application of these tools and methods, corporate leaders and managers can face the VUCA tests of surviving in the global markets, where globalisation, hyper-competition and fast, turbulent technological changes test corporations and create increasing volatility, along with uncertainty, complexity and ambiguity. Already, *ad hoc* knowledge and awareness of these VUCA conditions and possible tools are important issues.

Many corporate leaders and managers need an updated understanding of these issues. A global mindset, a virtual mindset, an innovative mindset and a collaborative mindset are all key issues in the VUCA environment. This paper helps corporation leaders and managers to understand key issues which are highly relevant for these mindsets, especially for an innovative mindset.

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Corresponding author

Jari Roy Lee Kaivo-oja can be contacted at: jari.kaivo-oja@utu.fi