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Daniel R. A. Schallmo
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Digitalization

Approaches, Case Studies, and Tools for Strategy, Transformation and Implementation

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Editorial Board

Preface

Digitalization affects all sectors of society, particularly economies. At the same time, digitalization opens new networking possibilities and enables cooperation between different actors, who, for example, exchange data and, thus, initiate processes. In this context, digitalization has several aspects, e.g., measurement of digital maturity, digital strategy, digital transformation, and digital implementation.

This special issue delivers empirical and conceptual papers and studies that tackle the challenges and opportunities presented by digitalization. We have arranged the contributions in five parts: Digital Drivers, Digital Maturity, Digital Strategy, Digital Transformation, and Digital Implementation.

Digital Drivers and Digital Maturity addresses the question of what drivers exist for digitalization and how such drivers can be identified and evaluated. It also clarifies what digital maturity is and how it can be evaluated. Included contributions are (1) "Unchartered Territories—Treat your innovation as a disaster," a literature review and conceptual framework; (2) "Future-oriented technology analysis—A classification framework" based on a systematic literature review; (3) "Digital technologies for circular business models in the building industry, classification of conceptual framework," which includes a case study analysis; (4) "The impact of the novel coronavirus outbreak on the development of digital economy in commodity countries," a literature review and comparative analysis; (5) "Digital maturity models—A systematic literature review"; (6) "An approach for a digital maturity model for SMEs based on their requirements" based on a systematic literature review and action research; and (7) "Developing strategies for digital transformation in SMEs with maturity models."

Based on digital drivers and the digital maturity of a company, digital strategy development is an integral part of a company's activities. Although many companies have recognized the need for a digital strategy, developing that strategy in a structured way and integrating individual digitization efforts into a strategic concept still presents challenges. Companies often lack clarity regarding which direction to take with respect to their digital strategy and which general principles and options to apply.

A digital strategy is the strategic form of a company's digitization intentions. The short- and mid-term objectives are to create new or maintain competitive advantages.

Within the digital strategy, digital technologies and methods are applied to products, services, processes, and business models. To develop a digital strategy, the company and its environment have to be analyzed as a basis for several future scenarios. The digital strategy consists of a vison, mission, strategic objectives, strategic success factors, values, and measures. It also includes the design of ecosystems and networks.

Part digital strategies includes the following contributions: (1) "Same but different—An exploration of alternative business model disruptions across German industries" based on a qualitative analysis, keyword analysis, and literature review; (2) "Productivity paradox in digital innovation for SMEs—A participatory inquiry" based on action research; (3) "Five topics for which industry needs innovation managers—A job advertisement analysis," which includes a qualitative examination of job advertisements in Germany; (4) "Connecting the corporate brain: How digital platforms accelerate digital transformation and cultural change," which includes survey data of listed companies' corporate incubators; and (5) "Development process for smart service strategies problem structuring to enable innovation in business IT projects" based on case study research.

The digital transformation of business models is conducted on a tactical level. This digital transformation concerns itself with individual business model elements, the entire business model, value chains, and the networking of different actors into a value network. It serves to define the digital strategy more clearly within business models. It is based on an approach with a sequence of tasks and decisions that are logically and temporally related to each other.

In this part, we address the following contributions: (1) "Systematic review of the literature on SME digitalization—Multi-sided pressure on existing SMEs"; (2) "Identifying barriers for digital transformation in public sector," which includes a case study as a basis for a constructivist grounded approach and a qualitative research method; (3) "Crisis-driven digital transformation—Examining the online university triggered by COVID-19" with an explorative case study; (4) "Selecting, combining, and cultivating digital deep-tech ecosystems," applying an explorative early stage action research process; and (5) "The pro-poor digitalization canvas—Shaping innovation towards SDGs 1 & 10" based on focus groups, expert interviews, and literature review.

Within the digital implementation, the digital strategy is implemented, and the digital transformation of business model is supported. In general, the following areas are relevant for digital implementation: Organization (e.g., definition of structures and responsibilities, establishment of departments, and the definition of processes); technical implementation (e.g., use of sensors, creation of databases, and networking of components), skills (e.g., IT know-how, use of collaboration tools, development of leadership and collaboration skills, and acquisition of methods), and culture (e.g., cultural anchoring in the company, sensitization of employees, and communication within the company).

This part includes the following contributions: (1) "Digital needs diversity—Innovation and digital leadership from a female managers' perspective" based on a literature review and semi-structured interviews; (2) "Developing creative leaders

learner's reflections on methodology and pedagogy," which includes a literature review and experiential learning cycle theory with empirical study in qualitative design; (3) "An integrated approach to digital implementation—TOSC-model and DPSEC-circle" based on a literature review and the development of their own approach; (4) "Challenges, lessons and methods for developing values-based intrapreneurial culture" with several case studies; (5) "A practitioner-oriented toolkit to foster sustainable product innovation" with a case study survey examining a set of 196 consumer product innovations; (6) "Success factors when implementing innovation teams" based on interviews and the observation of real life innovation teams; and (7) "Fly the flag—How to innovate management practices for the best in the world" based on the design thinking approach.

We hope that this special issue stimulates an intensive discussion among scientists, lecturers, and students from the fields of digitalization, digital strategy, digital transformation, and digital implementation and that the contents are used in research and teaching. Our aim is that practitioners from the areas of management, strategic planning, and business development can apply the insights to successfully practice digitalization and, thus, take advantage of its potential within their business model or an industry.

The editors would also like to thank the team of Springer and everyone who was involved in the typesetting and design. In particular, we would like to thank Mr. Prashanth Mahagaonkar and Ms. Ramya Prakash from Springer and our research assistant at the University of Applied Sciences Neu-Ulm, Mr. Daniel Hasler, for their valuable input and their willingness to be at our side with advice and action at any time.

On behalf of all authors, we wish the readers of the compilation a great deal of knowledge and success in their work on digitalization.

Neu-Ulm, Germany — Daniel R. A. Schallmo
Sussex, UK — Joe Tidd
December 2020

Contents

Part I

Digital Drivers

Unchartered Territories: Treat Your Innovation as a Disaster

Mattia Vettorello, Boris Eisenbart, and Charlie Ranscombe

1 Introduction

The complexity of today's society is exponentially growing and requires firms to generate new processes to approach and deliver innovation. Organizations have to transform how they conduct business venturing and produce innovation toward a more adaptable and anticipatory practice (Landoni et al. 2016). In addition to this, organizations should become more futures literate in order to deal with complex dynamics (UNESCO n.d.). In such situations, there are uncertainties around risk evaluation, possible consequences, and long-term implications of decision-making (Lipshitz and Strauss 1997; Brunsson 1985; Kahneman et al. 1982; Corbin 1980). Scholars define two classifications for uncertainty: the first relates to whether or not the longed-for outcome will materialize. The second classification, also known as *ambiguity*, regards the lack of information regarding the probabilities of a desired outcome to occur (Liu and Colman 2009; Frisch and Baron 1988; Curely et al. 1986; Ellsberg 1961). Such decision instances where outcomes are uncertain and there is ambiguity of probabilities are commonly classified as *extreme uncertainties* (Diebold et al. 2010) The lack of information and extreme uncertainty are inhibitors of effective choice (Shane 2009; Teece 2007; Camerer and Weber 1992; Tversky and Kahneman 1974; Sherman 1974) and can cause bias in decisions (Dobelli 2013; Baron 1998; Kahneman and Tversky 1979, 1981; Tversky and Kahneman 1974). Similarly, the *analysis paralysis* bias, which is known for obstructing people to make a clear decision due to the many uncertainties (The Economist 2020; Snowden and Boone 2007) or the *confirmation bias*, which is the tendency to base decisions on previous experience that resulted in success (Dobelli 2013; Tversky and Kahneman 1974). These can also be described as the *framing bias*, *forecast illusion,* and *availability heuristic*. In order to overcome the lack of information and these biases,

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crisis-driven innovation demands new organizational capabilities such as the ability to think in a future-oriented manner, to be comfortable with uncertainties, to scan for weak signals, to make sense of the future, and to deaverage the organization portfolio (See also Reeves et al. 2020; Vettorello et al. 2019; Dong et al. 2016). Larsen et al. (2020) describe future thinking as the ability to generate assumptions about the future and to observe extreme uncertainties as opportunities to discover, rather than constraints or barriers to overcome.

In response to environments of rapid and unexpected change, organizations then have to shift their practices to manage innovation and focus on developing these new dynamic capabilities to support decision-making, which are a viable competitive advantage in the long term (See also Teece 2011; Xu et al. 2007; Assink 2006; Verganti 2003; Eisenhardt and Martin 2000; Pesendorfer 1995; Dumas and Mintzberg 1991). For this, inspiration may come from Disaster Management (DM) because of its nature to deal with unforeseen occurrences and decision-making under extreme uncertainty. Interestingly, Tighe (2019) presents analogies between IM and instances of emergency (i.e., situation of high-risk and uncertainty) (See also Ardeshir and Jahangiri 2018; Neale and Weir 2015; Walker et al. 2013; Bell 2002). These are summarized as:

- Involve multidisciplinary experts
- Deal with emergencies and system
- Deal with people
- Have phases
- Deal with extreme uncertainty

By exploring the DM literature, we have observed that foresight theory and hypothesizing scenarios have been used effectively for many years in supporting strategic decision-making during operation management in disastrous events (Kauffman 1994). Whether prior to or during a disastrous event, this entails characteristics such as readiness in case something suddenly changes (for example, wind carries chemical and chances direction), time-to-action (for example, acting quickly and sharply because "plans/consequences" have already been hypothesized), opportunity and weak-signals scan (e.g., scanning a particular environment/cause to generate anticipatory actions) (Ardeshir and Jahangiri 2018; Neale and Weir 2015; Walker et al. 2013; Bell 2002). Thus, by researching future thinking/abductive reasoning and contingency planning in DM and their correlation with innovation processes, this chapter seeks to add insight to the IM literature by proposing an approach to operationalize capabilities such as future thinking, being comfortable with uncertainties, weak signals scanning and sense-making of those. We propose the *Future-Led Innovation (FLI)* framework as a tool for reasoning. The proposed framework aims to stimulate future thinking and hypothesizing, contingency mapping, alertness to changes, and call-to-action to shape future-ready innovations. By doing so, organizations can drive innovation in a more deliberate and target-oriented manner in situations characterized by extreme uncertainty—as is the case in DM. The main contribution of FLI is in hypothesizing and contingency

mapping. These entail the generation of future scenarios and abducting innovation roadmaps (thinking for contingency) to connect the present to the future (Vettorello et al. 2020). This in turn gives richer hypotheses and can guide strategic decision-making in situations of extreme uncertainty, high risks, and eventually reduce the analysis paralysis bias (See also Kleinsmann et al. 2017; Cross 2011; Dorst 2011; Brown 2009; Kelly 2005). Scholars such as Dong et al. (2015, 2016) and Kolko (2010) suggest that abductive reasoning and the action of thinking about "what might be" (rather than "what is") increases the likelihood of innovation in high-risk and high-performance scenarios. The reason being this is proactive thinking that requires hypothesizing preferable future-states and consequently orient actions to design toward it. By doing this, undesired consequences and external factors must be taken into consideration in outlining innovation strategic trajectories as elements to avoid in achieving that very vision. Inayatullah (2008) also indicates companies that look into alternative futures can plan for adjustments as uncertainties unfold. On this note and strictly related to DM, Kunz et al. (2014) advise that investing in preparedness capabilities—being ready, planning for, and knowing what to do in case something changes—results in lead time reduction of up to 67%. This means conscious actions are taken faster and more accurately. Transferring this to innovation and IM could mean that by being ready for unforeseen events—for example, new entrants, new technologies, or political change—organizations and innovation managers can evaluate the scenario at hand more easily and create flexibility by representations or proximity of alternatives. This would thus contribute to increasing dynamic capability.

The remainder of this chapter presents the procedural thinking behind DM as a source of inspiration. Learnings on how to manage a crisis are mapped to IM to improve dynamic capability to tackle complexity, unforeseen events, increase preparedness, and leverage flexibility that are significant elements of IM. In other words, it is recommended to roadmap innovation by hypothesizing scenarios and consequences in order to increase preparedness and enhance performance. Section 2 highlights the learning from DM with a focus on the effectiveness of developing strategic innovation roadmaps. Starting from the comparison between DM and IM, Sect. 3 provides a reason why future thinking is an important innovation capability to seize opportunity and tolerate uncertainty. Then, Sect. 4 focuses on the definition of abductive reasoning and connects DM into IM, thus presenting the proposed future-oriented approach and the argument for the positive impact of thinking about "what might be" during decision-making. Conclusions and further work are presented in Sect. 5.

2 Disaster Management: A Source of Inspiration for Innovation

Nowadays, we are observing a drastic change all over the globe (i.e., large-scale migration, nonstop urbanization, climate change, and pandemic) which results in a higher degree of danger, unknown consequences, and uncontrollability influencing

the economy and humanity. In the context of innovation, extreme uncertainties rise significantly for organizations as the society has dramatically change work- and lifestyle, and therefore needs (Harari 2020). As we investigate DM, we observe similarities with IM in the need of managing uncertainties:

- Both DM and IM entail aspects of being prepared for the unknown future, which is likely to rely on or at least benefit from foresight techniques (Tighe 2019; Ardeshir and Jahangiri 2018).
- And both must address risks associated with that possible scenarios and probabilities of knowns/unknown consequences to occur (Lipshitz and Strauss 1997; Brunsson 1985; Kahneman et al. 1982; Corbin 1980).

Parallels of Anticipatory Practice

We built our analysis on extent literature that focuses on the application of foresight methods, frameworks and tools to DM (Jahangiri et al. 2017; Turoff et al. 2013, 2015; Watson et al. 2015; Lopez-Silva et al. 2015; McAllum and Egerton 2014; Aubrecht et al. 2013; Birkmann et al. 2013; Constantinides 2013; FEMA 2013; Beddington and McLean 2012; Prochazkova et al. 2012; Hellmuth et al. 2011; Scawthorn et al. 2006). In DM, whether in an instance of prevention from or in a situation of recovering from a disastrous event, possible damages are likely to be anticipated and dramatic consequences are reduced or fully mitigated. Pinkowski (2008, p. xxi) succinctly summarizes the benefit of future thinking in DM:

> Even if we cannot control all of the causes of disasters, we can prepare and respond based on the present state of development in the science of disaster management.

In order to prepare a response to unfolding circumstances, scenario planning is used by DM teams to quickly generate immediate alternative futures while taking into consideration as many cause–effects as possible (Turoff et al. 2013, 2015; FEMA 2013; Birkmann et al. 2013). This requires to rapidly formulate mental contingent scenarios that inform decision-making in high-stake and highly uncertain situations. As a witnessed example, during the COVID-19, suddenly unexpected behaviors have happened causing significant consequences—i.e., evacuating "red zone" causing a quicker spread of the virus or simply hoarding essential goods. These "unforeseen" circumstances could have been thought a priori, the DM teams could have proactively taken actions and adjust them as uncertainties unfold. In IM, foresight is intended to give richer information about "what an idea might be" and influence decision-making. For example, Firm A is pursuing an innovative idea. While still in the development phase, a competitor, Firm B, launches a product that fulfills the same need ending in occupying that market. Yet, because Firm A has already hypothesized different futures, they can quickly realign the innovation trajectory of that very idea. This analogy permits to determine how in both situations initially we work on one aspect, healthcare crisis, and business opportunity,

respectively, but then changes of circumstances require adapting direction and adjustment of strategy.

The use of future thinking and anticipatory practices, therefore, influences decision-making as successful ideas are unlikely to not be dropped out. This refers to what Mounarath et al. (2011) call Type-I Error. In such decision situations, projects are rejected based on an underestimation of their potential success and not pushed forward to the next phase. Underestimating is also affected by the lack of analytical information, which halts decision-maker in paralysis. However, these ideas contain many potentials and are likely to yield successful business opportunities. With respect to anticipatory practice, as early as 1995, Martin (1995) lists four elements of anticipation and realignment that are of interest in this context of crisis-driven innovation: pre-foresight, foresight, post-foresight (consequent assessment), and implementation evaluation. He highlights different stages of foresight. As certainties come to light and there is a need to strategically readjusting the before taken trajectory. Simply put, developing contingency models aid strategic realignment and time-to-action due to representativeness or proximity of alternatives. As parallels related to the need for future thinking and contingency planning are drawn between DM and IM, we now focus on integrating these into IM dynamic capabilities.

3 Strategic Foresight as a Dynamic Capability in Crisis-Driven Innovation

Teece and Pisano define dynamic capabilities as (1994, p. 538):

> The term "dynamic" refers to the shifting character of the environment; certain strategic responses are required when time-to-market and timing is critical, the pace of innovation accelerating, and the nature of future competition and markets difficult to determine. The term "capabilities" emphasises the key role of strategic management in appropriately adapting, integrating and reconfiguring internal and external organisational skills, resources, and functional competences toward changing environment.

From this definition and related literature, it is possible to infer that dynamic capabilities required an ability at the individual and the organization level to deal well with the exposure to exogenous change, uncertainty, and unforeseen events. As described above, we read how future thinking is a significant capability to have in DM. It supports navigating uncertainty and unknown in decision-making instances. Drawing from DM parallels, Table 1 highlights in bold the "dimension" considered fundamental to foster innovation and embrace proactiveness, uncertainty, and risks. It is noted however that future thinking and contingency mapping lack mentions in the list.

Assink (2006) and Francis and Bessant (2005) define innovation capabilities to be an aptitude or a driving force to explore new ideas, to understand and calculate risks of investment. Furthermore, uncertainties should be seen as opportunities rather than not considering them or becoming inhibited by them (Larsen et al. 2020; Fayolle

Table 1 Innovation dynamic capabilities

Level	Characteristic	Dimension
Individual	Personality	*Tolerance of ambiguity*; *Self-confidence*; *Openness to experience*; *Unconventionality*; Originality; Rule governed (negative relation); Authoritarianism (negative relation); *Independence*; *Proactivity*
	Motivation	Intrinsic (vs. extrinsic); *Determination to succeed*; Personal initiative
	Cognitive ability	*Above average general intellect*; Task-specific knowledge; Divergent thinking style; Ideational fluency
	Job characteristics	*Autonomy*; Span of control; Job demands; Previous job dissatisfaction; *Support for innovation*; Mentor guidance; Appropriate training
	Mood states	Negative moods
Team	Structure	Minority influence; Cohesiveness; Longevity
	Climate	Participation; *Vision*; *Norms for innovation*; Conflict; *Constructive controversy*
	Membership	Heterogeneity; Education level
	Processes	*Reflexivity*; Minority dissent; Integration skills; *Decision-making style*
	Leadership style	Democratic style; Participative style; *Openness to idea proposals*; Leader–member exchange; Expected evaluation
Organization	Structure	Specialization; Centralization (negative relation); Formalization (negative relation); *Complexity*; Stratification (negative relation)
	Strategy	"*Prospector*" *type*
	Size	Number of employees; Market share (negative relation)
	Resources	Annual turnover; Slack resources
	Culture	Support for experimentation; *Tolerance of idea failure*; *Risk-taking norms*

Source: Adopted from Anderson et al. (2004)

et al. 2014). As the world becomes more complex and interconnected (Chesbrough 2003; Rothwell 1992), Hunt (2019, p. 127) states:

> To design in the context of complex system one must be attuned to the perverse and unintended consequences that might emerge. It is not a question of taming or solving the unknowns but modelling how they may play out and anticipating widely divergent futures. Designing to solve complex system is impossible. But that doesn't mean we shouldn't strive to model heuristically their tendencies, potentialities and misbehaviours.

In IM, organizations have to adapt to and explore the changing environment through technological, geopolitical, organizational, and strategic lenses (Helfat et al. 2007). In support of this, Tighe (2019) suggests the need to conduct an analysis of drivers—usually developed from STEEPLE: Social, Technological, Economic, Environmental (natural), Political, Legal, and Ethical factors—to inform the scenario planning. Noticeably, there are several instances that can enable innovation, and

having solid dynamic capabilities is likely to support firms to improve the innovation process. This is highly analogous to the DM literature where people are encouraged to look at uncertainties, unknowns, and risks, and hypothesize alternative scenarios. In other words, people in DM have to be comfortable with ambiguity and not knowing likely or unlikely consequences. This is further supported by Eisenhardt and Martin (2000) who add to the above definition the importance of preparedness. The ability to be ready if an unexpected occurrence happens. Additionally, Flyvbjerg et al. (2009) state that in IM culture there is a lack of incentives to seek out uncertainties and risks. People strive for certainty. While in DM looking for uncertainty is essential to generate possible consequential scenarios upon which strategic decisions are made. Interestingly, *tolerance for ambiguity* is discussed in IM literature as the most pertinent to drive innovation (Barron and Harrington 1981, see Table 1) as well as in DM. Eisenhardt and Martin (2000), and Teece (2007) take a strong position toward the benefit that dynamic capabilities bring to an organization that has the knowledge and resources to handle them. Future thinking can be supportive in situations of uncertainty, complexity, and decision-making. In very high-velocity markets, recognizing changes has become very challenging and arduous due to the non-linearity or unpredictability of uncertainty. Different studies (i.e., Dong et al. 2016; Wally and Baum 1994; Judge and Miller 1991; Eisenhardt 1989) show that creating multiple alternatives—which are also supported by real-time information—results in an increase of successful strategic decision-making in high-velocity market and extreme uncertainty. In this discourse, we focus on the individual level to introduce the cognitive aspect of abductive reasoning. This is centered on the ability to think diversely and generate alternatives in situations of extreme uncertainty and possibly harsh consequences. In order words, future thinking helps mapping changes and working around them in order to influence the hypothesized future (Bishop and Hines 2012). The next section elaborates on this combining with the learnings from DM literature and dynamic capability suggesting FLI framework to drive innovation in times of great uncertainties.

4 Introducing the Future-Led Innovation Framework

So far, we have explored the DM literature and the effectiveness of hypothesizing alternative scenarios to support making decisions on where and how to plan/act for emergencies. We have also looked at the definition and classifications of dynamic capabilities. Noticing that foresight is not mentioned as a dynamic capability in IM, we now want to close that gap and operationalize this thinking. We focus on how to transfer *abductive reasoning* which is known as per inference and hypothesis (Kolko 2010) to the dynamic capabilities to drive innovation and support decision-making. Reasoning is an individual skill that helps individuals make sense of the surroundings by observing and validating assumptions (Walton 1990). Guenther et al. (2017, p. 392) states:

Fig. 1 Abductive reasoning (adapted from Dorst 2011)

> Abductive reasoning relies on mental capabilities that are also inherent to creativity [. . .] Both creativity and abductive reasoning aim to produce something novel for the future, i.e. something that does not exist yet in the market place in a similar form or proliferation.

Abductive reasoning, therefore, can actively support the generation of hypotheses and make sense of complex situations, the result of which is a better consideration and preparedness of alternatives future chain of actions (Vettorello et al. 2019; Voros 2017; Hiltunen 2010; Alstyne 2010). Following on Inayatullah's (2008) statement that embracing alternative thinking is beneficial to a discovery action, van der Duin and den Hartigh (2009) suggest that future thinking should be knowingly integrated in the design innovation process. Hence, an individual decides a most conforming and meaningful solution until new evidence is brought to discussion which consequently increases certainty (Dong et al. 2016). Maher and Poon (1996) inform how important it is to utilize gained evidence to adapt the trajectory throughout the design journey. This is also featuring in DM as evaluation and decision on the next actions to take are based on high stake and high uncertainty (Ardeshir and Jahangiri 2018). It is literally an explorative process where a certain comfort dealing with uncertainty and risk is required (Vettorello et al. 2019: Maher et al. 1996). Dorst (2011) supports sharing with the community that a *value* is the source of alternative generation and it is used as a guide/metric to make decisions (See also Dong et al. 2015). Dorst (2011) continues to suggest that organizations have to seek innovative approaches to resolve the algorithm (see Fig. 1).

The intricacy of this argumentation is that there is not a clear answer to what to create and this complexity is very related to designerly way of thinking (Roozenburg and Eekels 1995; Roozenburg 1993). In abductive reasoning, a hypothesis is generated to describe the process as per achieving the end-value, which does not exist yet (Vettorello et al. 2019). It is a desired state (i.e., in a disaster the end-value is to minimize and reduce to null the adverse event; in innovation, it is to generate novel solutions that solve [humanity] needs and give competitive advantage). In this scenario, the context in which the outcome is formed and the vehicles to accomplish it are "obscure" (Dorst 2011). For Roozenburg (1993), innovative abduction (abductive reasoning) is the most and only appropriate way of reasoning in design. Kolko (2010) in unison with Dorst (2011) and Dong et al. (2015) state that abductive reasoning allows for the generation of new knowledge through dealing with uncertainty and unknowns. And likely to induction—the result is known or at least expected, however the mechanisms to achieve that outcome are unknown to the individual—the aspired value may not be reached even though the premises were true. There is a clear link that in IM and DM there is a need to deal with uncertainty and generate hypotheses considering the current scenarios and exogenous elements

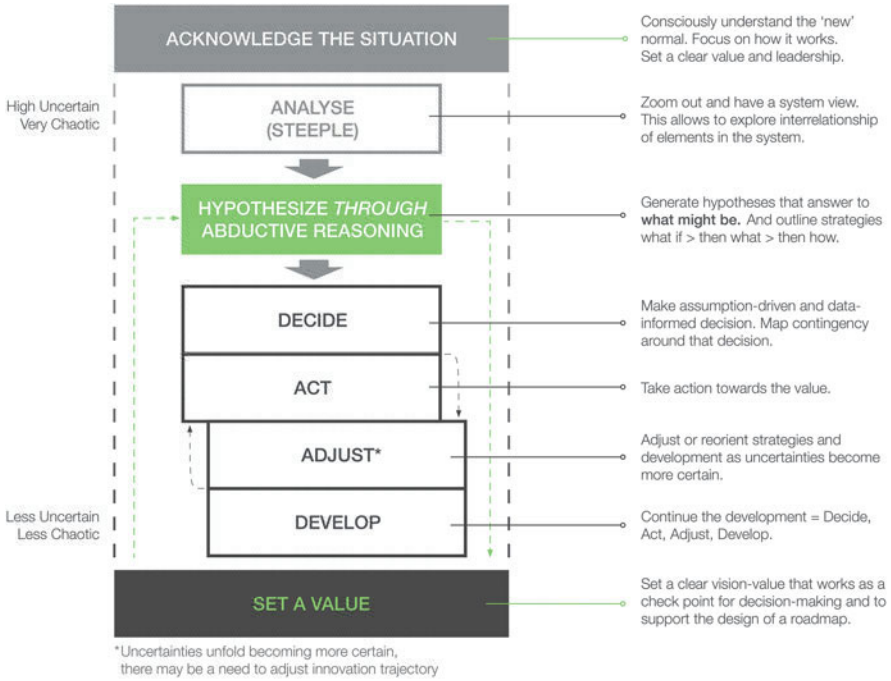

Fig. 2 Future-led innovation framework

that could positively or negatively affect the decision and create undesired consequences. The creation of possible trajectories indeed can help innovation managers to prepare them and the business for what might be. This anticipatory exercise to develop trajectories becomes an asset that is likely to increase adaptability, tolerance for ambiguity, and preparedness. Foresight is used in disaster management to identify possible future risks and generate likely consequences, which are often ignored in IM (Ardeshir and Jahangiri 2018; Flyvbjerg et al. 2009). IM is lacking in this type of contingent thinking (Reeves et al. 2016) and there are no strict incentives in the extent literature to include it (Flyvbjerg et al. 2009) as opposed to DM where by looking at undesirable consequences there is a higher chance to anticipate harsh consequences and increase the number of lives saved. As a result, what we call to be the *Future-Led Innovation* framework (FLI, see Fig. 2) is likely to support innovation managers reasoning through the design process in decision-making under extreme uncertainty. The FLI is a framework to facilitate the generation of alternatives (as emphasized by Dong et al. 2015, 2016; Kolko 2010). It allows flexibility as uncertainties unfold as the idea is moved forward in the developing process and builds for trajectory change when ideas do not work out as planned.

The FLI framework is suggested to design for innovation (as emphasized by Dong et al. 2015; Dorst 2011; Kolko 2010; Roozenburg 1993), scan the broader system (as emphasized by Tighe 2019; Eisenhardt and Martin 2000), generate

hypotheses of new product development (as emphasized by Dong et al. 2015, 2016; Kolko 2010), increase adaptability (as emphasized by Kuosa 2016; Pinkowski 2008), and incentivize the tolerance for ambiguity (as emphasized by Barron and Harrington 1981), decisions are therefore based on short- and long-term strategy. It also asks and infers the development of a culture of innovation (see also Anderson et al. 2004). The innovation manager should analyze the ideas and mentally hypothesize in terms of what these ideas could be and what the consequences and interactions within the eco-system could be as an innovation chain reaction. This will inform possible future actions, the strategy to pursue, or indeed flexibly adapt the strategy. In addition, as a way to reduce the "time-to-action," this mental generation could be transferred in written form. Foresight then will enter the dynamic capability list because it is meant to increase agility, at the individual and at organizational level, enhancing future thinking, in turn inviting individuals to embrace uncertainty and seek for them in order to generate competitive advantage. Finally, we contend that this could further reduce analysis paralysis.

5 Discussion and Conclusion

In this chapter, we bring forward the impact of future thinking on decision-making under extreme uncertainties, high-stakes, and unknowns. DM is a source of inspiration for contributing to the IM literature where we combine knowledge of the former in the latter. The review highlights analogies between DM and IM hypothesizing how DM might support readiness in fast-paced environment and strategic decision-making. The FLI framework expands on current literature by integrating current IM knowledge and practices (i.e., Dong et al. 2015, 2016; Dorst 2011; Kolko 2010; Assink 2006; Barron and Harrington 1981) with new contributions as per abductive reasoning and continency mapping. Our aim was to explore a discipline that deals with crisis, emergency, and fast-changing circumstances. As societal complexity rises, it is no longer enough to focus on an individual innovation opportunity, but now it is necessary to manage the whole portfolio (Kahneman and Lovallo 1993). The ultimate desired dynamic state for an organization is to manage complexity, processes, and agility (Keim 2011). The framework is offered to any organization wishing to innovate, but more specifically to innovation managers. The FLI framework is thus more likely to guide to more accurate decisions around new ideas and take into account risks, unknowns, and uncertainty, to ultimately foster innovation. Biases can be mitigated and uncertainty can be reduced by hypothesizing future states and abducting pathways to reach said states. Specifically, *analysis paralysis* and *confirmation bias.* Organizations and managers should firstly acknowledge the situation which allows help evaluation and alertness of the context. It should be noted that this chapter is limited to crisis-related topics and that the suggested framework is based on a literature review. Future research, therefore, is targeted to substantiate this analogy by bringing more evidence from DM experts, evaluate the FLI framework, and test its effectiveness as a way to better inform innovation managers in the process of decision-making. We thusly offer as a conclusion that

future thinking steps in the FLI framework should enter the dynamic capability list as a means to support design and decision-making processes.

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Future-Oriented Technology Analysis: A Classification Framework

Valeria Maria Urbano, Marika Arena, and Giovanni Azzone

1 Introduction

"We live at a time of technological change that is unprecedented in its pace, scope and depth of impact." This is the opening of the Technology and Innovation Report presented in 2018 at the United Nations Conference on Trade and Development. According to this report, the speed of technological development is expected to grow even more in the next decades driven by the opportunities provided by digital platforms and by the combination of different technologies (United Nations 2018). The same view emerges also from Butler (2016) who claims that technological change is accelerating at unprecedented speed following an exponential trend. In this context, anticipating future technologies and assessing their impacts became crucial for both business and governmental entities. The former can exploit the possibility of spotting new technologies as an important source of competitive advantage. The latter can leverage practices related to the analysis of future technologies to reduce uncertainties and to rapidly adapt to technological change.

Although first studies related to practices that aim at anticipating future technologies date back to the second half of the twentieth century, before 2004 no systematic approach was adopted to develop the field as a whole (Madnick and Cisl 2014). Different forms of process dedicated to the analysis of future technologies were, indeed, developed as individual topics, probably as a result of the fact that the different tools and approaches were developed in diverse contexts by different communities of practitioners (Eerola and Miles 2011).

Setting an important milestone, in 2004 Alan Porter and the Technology Futures Analysis Methods Working Group (TFAMWG) provided for the first time a framework regarding the different coexisting forms used to analyze future technologies

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