
This is an electronic reprint of the original article.
This reprint may differ from the original in pagination and typographic detail.

Hilkamo, Oona; Barbe, Anne Sophie; Granqvist, Nina; Geurts, Amber

Temporal work by consultants in nascent market categories: constructing a market for knowledge in quantum computing

Published in:
Technology Analysis and Strategic Management

DOI:
[10.1080/09537325.2021.1931098](https://doi.org/10.1080/09537325.2021.1931098)

Published: 01/01/2021

Document Version
Publisher's PDF, also known as Version of record

Published under the following license:
CC BY

Please cite the original version:
Hilkamo, O., Barbe, A. S., Granqvist, N., & Geurts, A. (2021). Temporal work by consultants in nascent market categories: constructing a market for knowledge in quantum computing. *Technology Analysis and Strategic Management*, 33(11), 1303-1316. <https://doi.org/10.1080/09537325.2021.1931098>

Temporal work by consultants in nascent market categories: constructing a market for knowledge in quantum computing

Oona Hilkamo, Anne-Sophie Barbe, Nina Granqvist & Amber Geurts

To cite this article: Oona Hilkamo, Anne-Sophie Barbe, Nina Granqvist & Amber Geurts (2021) Temporal work by consultants in nascent market categories: constructing a market for knowledge in quantum computing, Technology Analysis & Strategic Management, 33:11, 1303-1316, DOI: [10.1080/09537325.2021.1931098](https://doi.org/10.1080/09537325.2021.1931098)

To link to this article: <https://doi.org/10.1080/09537325.2021.1931098>



© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 26 May 2021.



Submit your article to this journal [↗](#)



Article views: 2570



View related articles [↗](#)



View Crossmark data [↗](#)







Citing articles: 2 View citing articles [↗](#)



OPEN ACCESS



Temporal work by consultants in nascent market categories: constructing a market for knowledge in quantum computing

Oona Hilkamo ^a, Anne-Sophie Barbe ^a, Nina Granqvist ^a and Amber Geurts ^{a,b}

^aDepartment of Management Studies, Aalto University, Espoo, Finland; ^bTNO, The Netherlands Organisation for Applied Scientific Research, The Hague, Netherlands

ABSTRACT

The literatures on market categories and temporal work pay limited attention to the agentic role of intermediaries in nascent market categories. Through an inductive analysis of quantum computing, we explore how management consultancies perform temporal work in such settings. We find that management consultancies construct a market for knowledge by engaging in three types of temporal work. First, they bring the future market category into present existence and thus make it an object for action. Second, they construct ultimate uncertainty and ambiguity and therefore a need for external knowledge. Third, they create a sense of urgency for immediate market engagement. Our findings shed light on the active intermediating role of management consultancies in nascent market categories, allowing them to capitalise on novel markets very early on.

ARTICLE HISTORY

Received 1 October 2020

Revised 12 April 2021

Accepted 13 April 2021



KEYWORDS

Market categories; emergence; temporal work; quantum computing; market for knowledge

Introduction

Market categories are shared socio-cultural sets of meanings that guide assessments of the similarity of firms and products belonging to a category or attempting to enter it (Kennedy and Fiss 2013; Khaire and Wadhvani 2010). While established markets have relatively clear boundaries and member identities, emerging categories are characterised by a lack of prototypes and categorical structures and unclear actor roles and identities (Durand and Khaire 2017; Granqvist, Grodal, and Woolley 2013). Unknown user needs and a lack of standards lead to a high degree of divergence in the available technical solutions and evoke sensemaking processes. In such settings, multiple possible technologies compete for dominance through community-level meaning-making and contestation (Grodal, Gotsopoulos, and Suarez 2015).

Emerging settings are thus characterised by open-endedness, which implies both ambiguity and uncertainty. Ambiguity refers to the simultaneous existence of multiple meanings regarding the boundaries of a category with respect to the kinds of products and services it encompasses, as well as the potential range of valid identities for category members (Granqvist, Grodal, and Woolley 2013; Santos and Eisenhardt 2009). Uncertainty is a temporal construct referring to multiple possible future developments – it is very difficult, for instance, to determine how a new market category is developing and to identify the right timing for engagement. Due to such ambiguity and uncertainty, market category emergence is characterised by individual and collective processes in which category participants – customarily defined as producers, intermediaries and audiences –

CONTACT Oona Hilkamo  oona.hilkamo@aalto.fi  Department of Management Studies, Aalto University, PO Box 21210, Espoo 00076, Finland

© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

construct the category boundaries and expectations. In so doing, they are influenced by their perceptions, interests, and prior knowledge (Durand and Paoletta 2013; Granqvist and Ritvala 2016).

Temporal work, in particular, is central to market category emergence. The concept refers to how market participants both make sense of temporal structures and also produce them (Granqvist and Gustafsson 2016; Kaplan and Orlikowski 2013). Studies have looked at expectations regarding future market category developments (Garud, Schildt, and Lant 2014; Granqvist, Grodal, and Woolley 2013), how actors construct understandings about the right timing for market entry (Granqvist and Gustafsson 2016), and how the experiences of actors ‘over the temporal horizons of the past, present, and future (...) endow them with uniquely crafted identities and action repertoires, as well as dreams and visions for the future’ (Pontikes and Rindova 2020, 150). Importantly, temporal work is impacted by the particular community-specific temporal frames held by actors (Barley 1988). Early actors negotiate and invest in what they *expect* will be relevant in a potential, future industry – with the very real risk that this market may never emerge (Helfat and Lieberman 2002; Moeen and Mitchell 2020).

While previous studies have looked at the role of audiences and producers during market category emergence, the role of intermediaries has received less attention. This is a major shortcoming because intermediaries often join the nascent category early on (Granqvist, Grodal, and Woolley 2013; Grodal 2018) and play an important role in the process of market-making (Brès and Gond 2014). Management consultants, in particular, have a major role in nascent markets as they act as key brokers of knowledge and networks in the early stages (Granqvist, Grodal, and Woolley 2013; Grodal 2018). They also have a long-standing interest in developing business opportunities and tradable services around new issues or knowledge (Brès and Gond 2014). The focus of this study is to explore how management consultancies, as key intermediaries, construct a nascent market category, and particularly, how they engage in temporal work.

Based on an inductive study of the role of management consultants in quantum computing, we identify three forms of temporal work in which consultants engage during market category emergence: bringing the future market category into present existence, which makes it a relevant object for action; constructing ultimate unpredictability, thereby creating a need for audiences to obtain external knowledge; and creating a sense of urgency regarding market engagement in order to immediately engage audiences with the new market. Drawing on these findings, we discuss how consultants constitute new markets through temporal work.

Management consultancies as key intermediaries during market category emergence

Previous studies on market categories have focused on agency in categorisation, with an emphasis on producers and audiences, rather than on intermediaries. Market intermediaries are defined as all the ‘third parties’ that attempt ‘to facilitate market exchanges between producers (i.e. sources of supply) and clients (i.e. sources of demand)’ (Boulongne, Cudennec, and Durand 2019, 68). These middlemen (Biglaiser 1993), who intervene at the interface between the producers and consumers of a market, encompass a variety of actors, such as critics at the interface between wine producers and wine consumers (Hsu, Roberts, and Swaminathan 2012), ranking providers situated between schools and students (Espeland and Sauder 2007), and employment agencies acting between labour supply and labour demand (Stigler 1962). Market intermediaries are acknowledged to play key roles in market categories; they enforce existing categories by providing sanctions or rewards to producers according to their category positioning (Zuckerman 1999) or participate in the (re)categorisation of existing market producers (Durand and Khair 2017), for instance through development of new labels (Curchod, Patriotta, and Neysen 2014) or new classifications (Ruef and Patterson 2009).

However, market category emergence is characterised by ambiguity and uncertainty (Suarez, Grodal, and Gotsopoulos 2015). In such contexts, which lack a shared understanding of what constitutes market supply and demand, the role of market intermediaries within established market

structures appears problematic. Thus, despite growing recognition that ‘most extant research on market intermediaries has been conducted in the context of established markets’ (Lee, Hiatt, and Lounsbury 2017, 3) and that ‘future work should continue to explore how intermediaries create and shape boundaries of nascent market categories’ (Zhao et al. 2018, 607), there is a lack of research on market category emergence that addresses the role of market intermediaries. Although some recent studies have started to address this gap, they focus on contexts where products are already traded even if ‘weakly entrenched’ (Zhao et al. 2018, 1) or lacking standards (Lee, Hiatt, and Lounsbury 2017). In this paper, we thus explore the role of market intermediaries in the very early phases of category emergence, with a particular focus on management consultancies.

The focus on management consultancies is warranted as they often join the nascent category early on (Granqvist, Grodal, and Woolley 2013; Grodal 2018). Indeed, there is growing recognition that management consultants have a ‘visible hand’ (Brès and Gond 2014, 1347) in the process of market-making. Thus, a burgeoning literature explains how management consultants have an interest in ‘translating’ new issues or knowledge into tangible business opportunities (Brès and Gond 2014). Management consulting firms also engage in construction of social-symbolic meanings (Pontikes and Rindova 2020) and in forms of temporal work whose influence on the agency of category members has not yet been captured by either market category research or research on management consultancies.

In the early stages of market category emergence, management consultancies engage in such activities in two ways. First, they develop and sell reports and analyses (Bloomfield and Vurdubakis 1994) about the nascent category. Although the consultants may not have first-hand knowledge of the science and technology involved, especially when they are complex in nature, this may provide them with a learning opportunity. Also, consultants are well-known for their skill in translating knowledge between different parties (Bres and Gond 2014), producing compelling narratives about the growth of the markets (Granqvist, Grodal, and Woolley 2013), and by such means foregrounding demand for knowledge. Thus, the reports often have a prospective, future-oriented tone. This has a major impact on market formation especially when consultants portray the market as fast-growing and ground-breaking.

Second, during the early emergence of a category, there is also a demand for networking – getting to know others who are active in the market. In this vein, consultancies help shape emerging categories by organising events. This provides another early business opportunity as it allows them to position themselves in an emerging market while also being among the first to generate income. Events are trans-organisational structures with the potential to configure and reconfigure a market category by bringing together potential participants around common interests and issues (Anand and Jones 2008). For example, events such as conferences and trade shows can act as venues for participants to signal membership in the field (Granqvist, Grodal, and Woolley 2013) and as forums for interaction and contestation (Lampel and Meyer 2008). Events thus provide temporal discursive spaces that are not normally available, thereby facilitating multiple and conflicting discourses that may lead to new narratives about the field (Garud 2008). For emerging market categories conferences are particularly important, as these are occasions for members to ‘define and redefine the field in dynamic ways’ (Garud 2008, 1085). For example, in his study on the emergence of cochlear implants, Garud (2008) found that conferences provided stakeholders with a venue for enactment of competing technologies, collective sensemaking, and consensus building.

In sum, although management consultancies may be somewhat peripheral in the emerging category with respect to their knowledge and development activities, they are active participants in category construction; they shape its social and symbolic boundaries by authoring reports and organising events (Grodal 2018). Due to their future-orientated narratives and growth forecasts, they play a major role in shaping the expectations and understandings of category members regarding the right timing for engagement. Nevertheless, the literature remains unclear on the role of management consultancies in construction of temporal structures during the emergence of a market

category. Hence we set out to answer the following question: *How do consultants engage in temporal work during market category emergence?*

Methodology

Our investigation aimed to enhance knowledge on the role of consultants in an emerging market category. For this purpose, we studied quantum computing as an emerging domain of science and technology (Rotolo, Hicks, and Martin 2015) that provides a research context with ample material on consultants' activity. We used a data-driven, inductive approach (Langley 1999) to investigate what consultants do during market category emergence when quantum futures are brought into present existence.

Empirical setting

Quantum computing is a young discipline at the interface between computer science and quantum physics (Paraoanu 2011). The field focuses on development of universal *quantum computers*, i.e. computing devices that instead of classical bits use quantum bits, or qubits, to store and process information. Although current quantum computers still underperform classical computers, they promise major increases in processing capacity that would enable solutions to problems deemed unsolvable with classical computers within any reasonable time frame (Vermaas 2017). Decades of laboratory work and the growing ability to manipulate quantum effects are now paving the way towards the first, near-market-ready quantum computer (Mohseni et al. 2017). Quantum computing is expected to create a new paradigm in computing and have a real, game-changing practical impact for science, business, and society in ways we cannot yet foresee. As a result, several players have announced their interest in the emerging market of quantum computing, among them big tech companies such as IBM and Google, smaller startups such as Rigetti and IonQ, and consulting firms such as McKinsey, Deloitte, and Accenture. The speed of industrial activity has surprised scientists (Preskill 2018) and many recognise that quantum computing is at present surrounded by hype, especially since a prototypical design and use cases are yet to emerge. Hence this setting, characterised by extreme ambiguity and uncertainty, provides an excellent context for studying the dynamics of market category emergence.

Data sources and analysis

Our exploration of the role of consultants in the emerging market category of quantum computing is part of a larger, long-term project. The data for this project encompass interviews with industry players, substantive archival material consisting of news stories and reports, and observations of numerous events and conferences. Using insights from this larger project, we observed that the role of management consultants during early market formation comprised two main activities: producing industry reports and organising networking events.

Accordingly, our primary data for this paper are reports and events. We systematically collected all the published *consultancy reports* on quantum technologies in general and quantum computing in particular. These reports numbered 24 and comprised 464 pages of material for analysis. Additionally, we collected data from eight *quantum computing events* organised or sponsored by consulting firms. We collected publicly available event materials, including presentation slides, agendas, and press releases, as well as presentations of speakers when available and took observation notes during the events. A summary of our data is provided in Table 1.

We began our analyses by writing a historical narrative about the key scientific and industry advancements in quantum technologies and quantum computing. For this, we used secondary sources from our project, including archival data and interviews. The narrative developed continuously as we integrated new information emerging from the on-going data collection.

Table 1. Summary of data.

Reports published by management consultancy firms					
N	Authoring firm		Year	Pages	Title
1	Accenture		2017	16	Innovating with Quantum Computing
2			2017	20	Think beyond ones and zeros. Quantum computing. Now
3	BCG		2020	18	In Quantum we trust
4			2018	19	The Coming Quantum Leap in Computing
5			2018	30	The Next Decade in Quantum Computing and How to Play
6			2019	19	Where Will Quantum Computers Create Value and When?
7			2019	6	Will Quantum Computing transform Biopharma R&D?
8	CB Insights		2019	31	What Is Quantum Computing?
9	Deloitte		2017	10	From fantasy to reality: Quantum computing is coming to the marketplace
10			2019	20	Quantum computers: The next supercomputers, but not the next laptops
11			2020	20	The realist's guide to quantum technology and national security
12	Inside Quantum Technology		2019	7	Quantum Computing Strategies: 2019
13	KPMG		2019	2	Quantum Computing 101
14	McKinsey		2016	3	The growing potential of quantum computing
15			2019	7	The next big thing? Quantum computing's potential impact on chemicals
16			2020	8	The next tech revolution: quantum computing
17			2020	9	A game plan for quantum computing
18	Patinformatics		2017	65	Practical Quantum Computing: A Patent Landscape Report
19	PwC		2017	6	Information Security in the Age of Quantum Technologies
20			2019	44	Advancing a strategy for quantum computing that will inspire, support and safeguard economic growth in the Middle East
21			2019	22	Quantum Computing: A technology of the future already present
22	The Hutch report		2018	44	Quantum Computers: The game changers?
23	Wavestone		2019	23	Quantum Computing: Ready for the Huge Leap?
24		Yole Development		2020	22
			Total	464	
Events materials					
N	Name of the event	Related consultancy firm	Year (s)	Place	Data details
1	The Quantum Countdown	Z/Yen	2018	Webinar	Materials publicly provided
2	Quantum Computing Business Conference	McKinsey	2019	Paris, France	Materials publicly provided
3	Inside Quantum Technology Europe	Inside Quantum Technology	2019	The Hague, the Netherlands	Event attended
4	Inside Quantum Technology New York Online	Inside Quantum Technology	2020	Online	Event attended
5	BCI Summit Quantum	Social Venture Circle	2019	New York, USA	Materials publicly provided
6	Getting Ahead in the Quantum Economy: A Deep Dive into the Hardware	e2i	2019	Singapore, Singapore	Materials publicly provided
7	Quantum Tech Congress	Several	2019	London	Materials publicly provided
8	Quantum Computing Summit	KPMG	2020	London, Silicon Valley	Materials publicly provided

Following inductive, data-driven analyses of our primary data, we started the analysis with a close reading of the data, with each of the authors independently analysing part of the material (Glaser and Strauss 1967). We then discussed and compared our initial findings and decided on more focused themes for deeper analysis. Our second round of analysis focused on three broad themes that emerged as the key actions taken by the consultants: *bringing the future into present existence, constructing unpredictability, and creating a sense of urgency*. We analysed our data to uncover how meaning is constructed around these complex topics. At the final stage, we focused our analysis on the motivations and claims of the consultants regarding the emerging market of quantum computing.

Temporal work by consultants to create a market for knowledge

In this section, we present our findings. First, we show how the consultants bring ‘a quantum future’ into present existence. Second, we show how they sketch a path between present and possible futures, thereby constructing ultimate unpredictability, and third, we show how they create a sense of urgency for market engagement. Taken together, our findings shed light on the role of the consultants during market category emergence by creating a ‘market for knowledge’.

Bringing an emerging market category into present existence

By authoring reports and organising events around quantum computing, consultants bring this novel market category into present existence. First, they engage in temporal and technological demarcation by presenting quantum computers as a profoundly different, disruptive technology that will lead society into a new era. Second, they depict the future existence of quantum computers as inevitable by providing estimates of the future market.

Temporal and technological demarcation

The consultants present quantum computers as a new market category that differs profoundly from earlier computing technologies; the emergence of quantum computers creates a boundary between what is now and what will be in the future. The technology behind the devices is described as ‘fantastical’ (Schatsky and Puliakodil 2017, 2) and quantum computing is envisioned to have ‘the potential to be both transformative and disruptive.’ (Hazan et al. 2020, 3). Quantum computers are presented as paradigm-breaking and revolutionary: ‘The very nature of quantum physics creates opportunities to completely disrupt existing technologies, and break the paradigms of classical computation’ (Ward et al. 2020, 4) and ‘[i]ts disruptive potential exceeds that of the internet, smartphones and cloud computing combined’ (Vernacchia 2019, 9). The emergence of quantum computing demarcates the beginning of a new era: ‘[w]e’re at the dawn of the quantum-computing age’ (Brownell and Chui 2016, 1). This temporal demarcation suggests that there will be a post-quantum world with new opportunities and threats. Even though the timeline for this future is uncertain, consultants propose that executives ‘begin to prepare their enterprises for *the era of quantum computing*’ (Schatsky and Puliakodil 2017, 5, emphasis added).

To demarcate the new technology, quantum computers are described as offering ‘an entirely new model of computing’ that is as far from classical computing as light bulbs are from candles (Carriere et al. 2019, 10). In a more modest discourse, quantum computing is portrayed as a continuation of the computing paradigm, enabling ‘the fifth generation of computers’ (Carrel-Billiard, Garrison, and Dukatz 2017, 5). Quantum computers are differentiated from classical computers by explaining that their abilities extend beyond those of classical computers. Quantum computers ‘will be able to perform certain kinds of calculations exponentially faster than the fastest computers currently known’ (Schatsky and Puliakodil 2017, 2) and solve ‘certain problems far faster than conventional machines’ (Quantum Business Conf. Paris programme leaflet, 2019). As a general-purpose quantum computer is yet to be built, there is uncertainty about what such a device could do: ‘In

fact, researchers don't yet know all the types of problems at which quantum computing could excel' (Schatsky and Puliakodil 2017, 3). However, despite such a high level of uncertainty, the consultants contend that quantum computing will have a bright future: 'In the long term, such machines will very likely shape new computing and business paradigms by solving computational problems that are currently out of reach' (Gerbert and Ruess 2018, 3).

Narrating the future existence of quantum computers

Though current quantum computers are early prototypes, the consultants portray the future presence of a universal quantum computer as certain. It is not a matter of if, but rather of when, in fact they maintain that the 'quantum countdown' (Z/Yen, 2018, event brochure) has already started. The only future available to actors is the one in which the emergence of quantum computers leads to more disruptive change than that instigated by previous technologies. Indeed, consultants state that 'we believe that this technology is within our reach and will be available in the next coming years' (Haddad and Chinasi-Halet 2019, 19).

This future existence or even imminent reality of quantum computing are portrayed in the titles of reports produced by consultants: for example 'A technology of the future already present' (Haddad and Chinasi-Halet 2019) and 'From Fantasy to Reality: Quantum Computing is coming to the marketplace' (Schatsky and Puliakodil 2017). Even though their much-vaunted superiority over classical computers has not yet been verified, the consultants state that 'such a demonstration is deemed imminent' (Gerbert and Ruess 2018, 9). Ambiguity around the emergence of the novel market category is dispelled by evoking images of other successful technologies: 'Remember that deep learning, which today dominates the fast-growing field of AI, was also once a purely experimental success' (Gerbert and Ruess 2018, 19).

Consultants also categorise market participants and make forecasts about the future size of the market. The technology is deemed developed enough 'for an ecosystem of hardware and software architects and developers, contributors, investors, potential users, and collateral players to take shape' (Gerbert and Ruess 2018, 6). Moreover, some consultants provide estimates on the potential value of the market; Hazan et al. (2020, 4) estimate a '+\$1 trillion value potential by the mid-2030s in 5 industries' and Lee et al. (2019, 5) a future market 'about the size of today's supercomputer market – around US\$50 billion'.

Constructing ultimate unpredictability

To create demand for their 'knowledge services', consultants frame the path from the present to the inevitable quantum future as extremely open-ended and difficult to foresee. In essence, they construct ultimate unpredictability. Our data show that the consultants devise a complex narrative of *uncertainty* about future developments and *ambiguity* about the forms of quantum computers to describe how the market will evolve and create demand for their knowledge services.

Uncertainty in the timeline

The consultants portray a timeline that separates the present (in which quantum computers are not available) from the future. They infuse the latter with uncertainty by emphasising that the nature of this technology is still unknown, especially because it is evolving at an unpredictable pace. They make fuzzy claims such as 'it isn't far away' (Vernacchia 2019, 12), predict 'upcoming real-world applications' (Quantum Computing Business Conference, 2019), or on the contrary argue that 'none of this will happen overnight' (Ménard et al. 2020, 1). The overall tone of the consultants' reports is one of uncertainty – 'there is no exact timeline for commercial availability of a general-purpose universal quantum computer' (Buchholz et al. 2020, 7). While some reports provide a '*likely* timetable for development' (Russo, Thaker, and Adam 2018, 4, emphasis added), others emphasise that 'experts are divided on the timing of quantum computing's impact' (Langione et al. 2019b, 13).

As the consultants portrayed the pace at which the timeline is developing as unpredictable, the ultimate horizon appears even more uncertain; indeed ‘the progress in recent years is hard to overstate’ (Gerbert and Ruess 2018, 3) given that such technologies ‘can emerge at unpredictable speed’ (Ménard et al. 2020, 9). Thus, if some consultants highlight the surprising speed of its development – outlining for instance that ‘quantum computer development is progressing at a faster pace than expected’ (PwC and Russian Quantum Center 2017, 2) – others warn of its probable slowness – ‘since the technology is nascent, progress *might* be slow’ (Hazan et al. 2020, 6, emphasis added). The latter group explains that the technologies underlying development of quantum computers – such as those enabling operation in a ‘vacuum environment or at cryogenic temperatures’ (Gerbert and Ruess 2018, 3) eventually reaching known physical limits such as ‘the lowest temperature that’s physically possible in the universe’ (Brownell and Chui 2016, 2) – are ‘technical hurdles that quantum computing faces’ (Gerbert and Ruess 2018, 3). Thus, the consultants contend that ‘maturity in quantum computing will not follow a smooth, continuous curve. Instead, a *precipitous breakthrough* that may come at any time’ (Langione et al. 2019b, 2, emphasis added), with the ‘ultimate pace and roadmap [being] still uncertain’ (Gerbert and Ruess 2018, 24).

Ambiguity about the potential technological designs and market structures

The consultants not only portray an uncertain timeline separating the present (in which quantum computers are not available) from the future, but also connect this present to several possible futures (in which some quantum computers will be available). To do so, they envisage a multiplicity of possible technological designs for quantum computers and provide blurred categorisations of eventual market providers, thereby giving rise to ambiguity.

Several technological designs coexist in the emerging market category. The consultants depict the different existing designs for qubits and their related technological challenges and acknowledge that there are currently ‘several approaches to building quantum computers’ (Carrel-Billiard, Garrison, and Dukatz 2017, 8), that ‘there is no consensus to date on how to physically create qubits’ (Carriere et al. 2019, 22), and that ‘nobody knows what will be the right technology, that’s gonna work’ (Quantum Computing Business Conference (2019) roundtable moderator). The consultants also acknowledge the uncertainty regarding the future forms of qubits: ‘who knows, new types of qubits might ease [one] constraint in the future’ (Carriere et al. 2019, 22). Since there are a number of potential technological designs, the ultimate form of the underlying architecture remains unclear (Gerbert and Ruess 2018). With respect to technological design, the final computers could be hybrids (Gerbert and Ruess 2018).

Furthermore, the consultants suggest a multiplicity of possible futures by providing blurred categorisations of eventual quantum computer providers, by for instance distinguishing between ‘end-to-end providers’, ‘hardware players’, ‘services players’ and ‘specialists’ (Gerbert and Ruess 2018, 7) or ‘worldwide tech giants’ and ‘start-ups’ (Vernacchia 2019, 11) or even ‘components’, ‘software’ and ‘hardware’ providers (Carriere et al. 2019, 32). However, they also note that ‘the lines between layers [are] easily blurred or crossed, in particular by maturing hardware players extending into the higher-level application, or even service layers’ (Gerbert and Ruess 2018, 8).

Thus, while the consultants envision the inevitability of the new market category, they also build fundamental uncertainty and ambiguity into their narratives about the timeline and nature of the market category’s emergence to convince participants that they need new knowledge and networks.

Creating a sense of urgency for market engagement

Finally, the consultants argue strongly for immediate market engagement with quantum computing as a condition for future market success and highlight the steps that others have already taken. This is exemplified in a rhetorical question we found on the website of the Quantum Computing Summit,

‘Quantum is a thing of the future, right? No, you can take advantage of this right now!’ Hence the consultants contend that there is a current need for their services in the area.

Framing early engagement as a condition for keeping up with the competition

The consultants frame present or near-future market engagement as a condition for future success. They describe early engagement with quantum computing as essential efforts by businesses to achieve top performance in their market categories. As exemplified in a report published by BCG (Langione et al. 2019a, 5) for the category of biopharma, the consultants state that ‘a quantum-advantaged world will probably witness *a race* to find and patent the best molecules for a given target’ and that biopharma firms ‘should take the necessary steps *now* to prepare for quantum computing’s role in R&D’ (emphasis added). For almost every existing market category, the consultants assert that ‘early movers will almost certainly gain advantages that followers will have a tough time matching’ (Langione et al. 2019a, 1). Overall, the consultants urge their readers to ‘act now’ (Budde and Volz 2019, 1) because it will soon ‘be too late to develop a strategic position and investment plan’ (Vernacchia 2019, 12) given that ‘the time to look at options for a quantum-safe architecture is at a minimum 10 years ahead of the expected need date’ (Ward et al. 2020, 17).

Highlighting steps already taken by possible competitors

Another way to urge actors to take part in constructing the market is to highlight how other actors already have a quantum strategy and are taking the action needed to become industry leaders in the new market. For example, in the financial industry, where quantum computing will supposedly bring early benefits, the consultants emphasise that ‘major banking actors are already involved in this initiative’ (Haddad and Chinasi-Halet 2019, 13). In another report, they call for investments in talent management, as ‘companies such as Airbus already offer quantum training programmes to prepare their engineers for the future’ (Langione et al., 2019a, 5). The consultants also point to the consequences of not preparing for the coming quantum age: ‘In an extreme scenario, biopharma companies risk being relegated to focusing mainly on clinical development, medical affairs, and sales’ (Langione et al., 2019a, 5). By showing what others have done, the consultants establish that actions have already been taken and thereby create potential benchmarks.

Temporal work by consultants to build a market for knowledge during category emergence

According to our analyses, the consultants perform three types of temporal work during category emergence: (1) they bring the future market category into present existence, thereby making it subject to actions taken by their audiences; (2) they construct ultimate unpredictability, which implies that audiences need external knowledge to engage with the future; and (3) they create a sense of urgency around market engagement, which implies that the audiences need to take action now.

Through this temporal work, the consultants construct a ‘market for knowledge’ as displayed in Figure 1. This market designates a space where they portray a knowledge shortage on the demand side and then then urge their audiences to engage immediately with the future technology. The forms of temporal work we have identified are all necessary yet independently non-sufficient. By bringing the future into present existence, the consultants enable their audiences to envisage the necessary action. Only by portraying such action as urgent and complex can they convince their audiences of the existence of a ‘knowledge shortage’ and the need for concrete steps to address it.

The supply side of this market for knowledge is partly fuelled by the consultant firms themselves; in the emerging industry of quantum computing, consultants are keen to ‘help [the audience] move forward’ (Haddad and Chinasi-Halet 2019, 17) or to propose working ‘with clients to conduct quantum business experiments’ to assist them in gaining ‘unique insights into how quantum computing can be applied to their enterprises’ (Carrel-Billiard, Garrison,

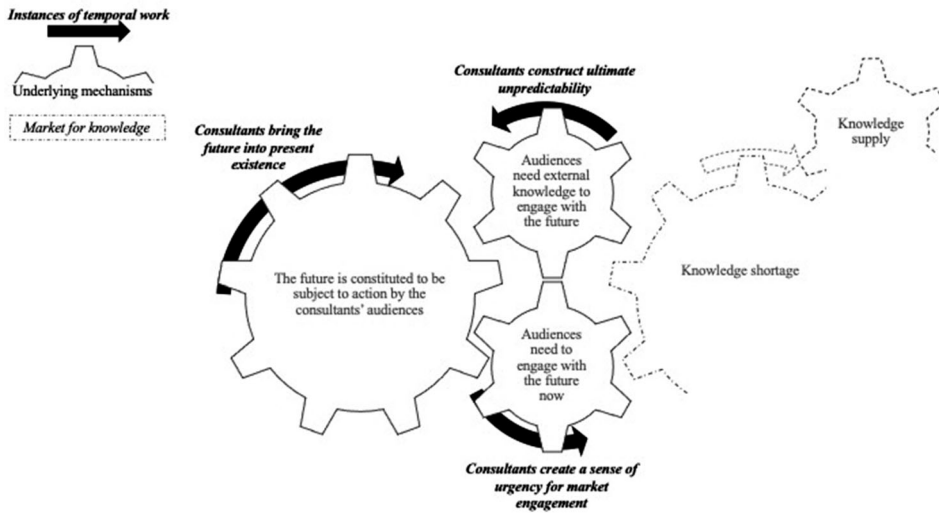


Figure 1. Temporal work and the creation of a market for knowledge.

and Dukatz 2017, 14). However, they also incentivise their audiences to manage ‘partnerships, or patent acquisition opportunities’ (Patinformatics, 2017, 3) especially with start-ups or even to envision a ‘one-off partnership with a quantum community player (a manufacturer, publisher, university, start-up, VC firm, consulting firm, etc.) – to define or prototype a use case specific to the business’s needs’ (Carriere et al. 2019, 37). In sum, the consultants construct a market for their services in the nascent market category through these forms of temporal work.

Discussion and conclusions

Our findings contribute to the literature on market category emergence by showing how consultants acting as market intermediaries actively shape emerging market categories. While positioning themselves in an emerging market through temporal work, they shape the emerging category and thus increase their possibilities to gain a central intermediating position within that market.

Temporal work by management consultants during category emergence

The literature on temporal work refers to how market participants are embedded in and develop new temporal structures that then guide behaviours in markets (Granqvist and Gustafsson 2016; Kaplan and Orlowski 2013; Pontikes and Rindova 2020). While previous studies have looked at how market actors construct expectations and understandings about the timing for market entry (Garud, Schildt, and Lant 2014), there is still little understanding of how such activities constitute novel markets. Our study on the activities of management consultants during the emergence of the quantum computing market category casts light on this issue. First, we find that consultants bring the future market category into present existence, thereby making the category *ontologically real*. By stating that the category will inevitably emerge, they make it a relevant object for action. Second, consultants construct extreme open-endedness, which implies that their audiences may need *external knowledge and networking* to proceed to such actions. The third aspect is that they create *a sense of urgency* to engage with the market category in the present. We show that the inherent combination of extreme open-endedness and the need to engage with the category to keep up with the competition support formation of a market for knowledge where consultants enable their clients to alleviate the ‘knowledge shortage’ between the present market and its

potential future manifestations. Our study thereby provides important insights into the role of management consultancies as key knowledge intermediaries in nascent market categories.

Practical implications and suggestions for future research

Our study also raises relevant practical implications for the role of management consultants in constructing a market for knowledge, thereby foreshadowing a future industry. It shows that while narratives can be used as a tool to translate emerging markets into present action, they also produce equivocality. By narrating markets in this way, management consultants create a sense of urgency that persuades market players to consider undertaking present action towards an inevitable, yet uncertain, future market. Our study also shows that management consultants create a market for knowledge by actively constructing a knowledge shortage, for which they propose to supply their consulting services. While few other organisations can generate revenue in a nascent market category, management consultants can and thus sustain their activities by continuously producing a knowledge shortage and partially supplying the missing knowledge. Policymakers planning interventions to support an emerging market should thus keep in mind that their market-specific insights might be influenced by the stories of market intermediaries who are interested in sustaining a market for knowledge over prolonged periods. While previous research has pointed to this (Granqvist, Grodal, and Woolley 2013), our study identifies the specific types of temporal work that may instigate outcomes such as prolonged hypes.

For future research, our findings direct attention to the novel and interesting insights that can be gained by exploring nascent market categories. Specifically, our findings indicate the need to engage in *real-time empirical research* to explore how emerging technologies and market categories advance – free from the posthoc rationalisation of knowing the future end state of that technology, market, or category. In this paper, such a perspective enabled identification of a market for knowledge in a nascent market category. Future research could extend these findings to include the insights of other market intermediaries to give a more complete picture of the variety of activities and strategies employed by market intermediaries when working on nascent market categories. Moreover, our findings point to the role of management consultants in the construction of temporal structures in the very early phases of market category emergence. In particular, our empirical study emphasises the role of these consultants in convincing end-users of the urgency of engagement in the nascent market. Future studies on the role of management consultants in the emergence of new market categories could focus on cases in which management consultants construct other forms of temporal structures (such as ‘non-urgent’). It could also examine how the temporal work of consultants succeeds (or fails) to enhance engagement by end-users or explore the underlying reasons leading management consultants to undertake such temporal work.

Our study sheds light on how market intermediaries can shape emerging market categories through temporal work. We show how management consultants as market intermediaries construct a market for knowledge that foreshadows the future industry. This market for knowledge allows intermediaries to capitalise on the emerging market early on, before more central actors in the field are able to reap profits.

Disclosure statement

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

Funding

This work was supported by Academy of Finland: [Grant Number 323119].

Notes on contributors

Oona Hilkamo is a doctoral candidate at the School of Business at Aalto University, Finland. She has a MSc in Technology from Aalto University School of Science. Her doctoral research focuses on the social-symbolic construction of emerging technologies and markets, focusing on narratives, storytelling and visual sensemaking practices.

Dr. Anne-Sophie Barbe is a post-doctoral researcher at the School of Business at Aalto University, Finland. Her research mobilises organisation theory and economic sociology to investigate the social dynamics underlying the construction of technological markets. Her research has been published in *Technological Forecasting and Social Change*.

Professor Nina Granqvist has engaged with the field of quantum phenomena for well over a decade, with her research on nanotechnology awarded with key prizes in her field. The focus of her research is how new ideas and technologies move from margins to mainstream, with a particular focus on market emergence. Her research has been published in the top management journals, including *Academy of Management Journal*, *Organization Science*, *Organization Studies*, and *Journal of Management Studies*.

Dr. Amber Geurts is a researcher at the department of Strategy & Policy of TNO, the Netherlands Organisation for Applied Scientific Research. Her research focuses on key (enabling) technologies such as AI and quantum as well as mission-oriented policies and data-driven foresight. Before joining TNO, Dr. Geurts conducted her post-doctoral research at Aalto University in Finland. Her research has been awarded several grants, and has been published in various outlets including *Advanced Science*, *Technological Forecasting and Social Change*, *Journal of Cross-Cultural Psychology*, and the *Journal of Economic Issues*.

ORCID

Oona Hilkamo  <http://orcid.org/0000-0002-0459-8172>

Anne-Sophie Barbe  <http://orcid.org/0000-0002-7127-8064>

Nina Granqvist  <http://orcid.org/0000-0001-8603-2908>

Amber Geurts  <http://orcid.org/0000-0003-0478-0713>

References

- Anand, N., and B. C. Jones. 2008. "Tournament Rituals, Category Dynamics, and Field Configuration: The Case of the Booker Prize." *Journal of Management Studies* 45: 1036–1060.
- Barley, S. R. 1988. "On Technology, Time, and Social Order: Technologically Induced Change in the Temporal Organization of Radiological Work." In *Making Time: Ethnographies of High-Technology Organizations*, edited by F. A. Dubinkas, 123–169. Philadelphia: Temple University.
- Bigliaiser, G. 1993. "Middlemen as Experts." *Rand Journal of Economics* 24 (2): 212–223.
- Bloomfield, B. P., and T. Vurdubakis. 1994. "Re-presenting Technology: IT Consultancy Reports as Textual Reality Constructions." *Sociology* 28: 455–477.
- Boulongne, R., A. Cudennec, and R. Durand. 2019. "When do Market Intermediaries Sanction Categorical Deviation? The Role of Expertise, Identity, and Competition." In *Microfoundations of Institutions*, edited by P. Haack, J. Sieweke, and L. Wessel, 67–83. Emerald: Bingley.
- Brès, L., and J.-P. Gond. 2014. "The Visible Hand of Consultants in the Construction of the Markets for Virtue: Translating Issues, Negotiating Boundaries and Enacting Responsive Regulations." *Human Relations* 67: 1347–1382.
- Brownell, W., and M. Chui. 2016. *The Growing Potential of Quantum Computing*. McKinsey and Company.
- Buchholz, S., J. Mariani, A. Routh, A. Keyal, and P. Kishnani. 2020. *The Realist's Guide to Quantum Technology and National Security*. The Deloitte Center for Government Insights.
- Budde, F., and D. Volz. 2019. *The Next Big Thing? Quantum Computing's Potential Impact on Chemicals*. McKinsey and Company.
- Carrel-Billiard, M., D. Garrison, and C. Dukatz. 2017. *Think Beyond Ones and Zeros*. Accenture Labs.
- Carriere, F., R. Gayard, A. Rabayrol, and M. Tordeux. 2019. *Quantum Computing: Ready for the Huge Leap*. France Digitale and Wavestone.
- Curchod, C., G. Patriotta, and N. Neysen. 2014. "Categorization and Identification: The Identity Work of 'Business Sellers' on eBay." *Human Relations* 67: 1293–1320.
- Durand, R., and M. Khaire. 2017. "Where do Market Categories Come from and how? Distinguishing Category Creation from Category Emergence." *Journal of Management* 43: 87–110.
- Durand, R., and L. Paoletta. 2013. "Category Stretching: Reorienting Research on Categories in Strategy, Entrepreneurship, and Organization Theory." *Journal of Management Studies* 50: 1100–1123.
- Espeland, W. N., and M. Sauder. 2007. "Rankings and Reactivity: How Public Measures Recreate Social Worlds." *American Journal of Sociology* 113: 1–40.

- Garud, R. 2008. "Conferences as Venues for the Configuration of Emerging Organizational Fields: The Case of Cochlear Implants." *Journal of Management Studies* 45: 1061–1088.
- Garud, R., H. A. Schildt, and T. K. Lant. 2014. "Entrepreneurial Storytelling, Future Expectations, and the Paradox of Legitimacy." *Organization Science* 25: 1479–1492.
- Gerbert, P., and F. Ruess. 2018. *The Next Decade in Quantum Computing-and How to Play*. Boston Consulting Group.
- Glaser, B. G., and A. L. Strauss. 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Piscataway, NJ: Transaction publishers.
- Granqvist, N., S. Grodal, and J. L. Woolley. 2013. "Hedging Your Bets: Explaining Executives' Market Labeling Strategies in Nanotechnology." *Organization Science* 24: 395–413.
- Granqvist, N., and R. Gustafsson. 2016. "Temporal Institutional Work." *Academy of Management Journal* 59: 1009–1035.
- Granqvist, N., and T. Ritvala. 2016. "Beyond Prototypes: Drivers of Market Categorization in Functional Foods and Nanotechnology." *Journal of Management Studies* 53: 210–237.
- Grodal, S. 2018. "Field Expansion and Contraction: How Communities Shape Social and Symbolic Boundaries." *Administrative Science Quarterly* 63: 783–818.
- Grodal, S., A. Gotsopoulos, and F. F. Suarez. 2015. "The Coevolution of Technologies and Categories During Industry Emergence." *Academy of Management Review* 40: 423–445.
- Haddad, M., and G. Chinasi-Halet. 2019. *Quantum Computing, a Technology of the Future Already Present*. PwC.
- Hazan, E., A. Ménard, I. Ostojic, and M. Patel. 2020. *The Next Tech Revolution: Quantum Computing*. McKinsey and Company.
- Helfat, C. E., and M. B. Lieberman. 2002. "The Birth of Capabilities: Market Entry and the Importance of pre-History." *Industrial and Corporate Change* 11: 725–760.
- Hsu, G., P. W. Roberts, and A. Swaminathan. 2012. "Evaluative Schemas and the Mediating Role of Critics." *Organization Science* 23: 83–97.
- Kaplan, S., and W. J. Orlikowski. 2013. "Temporal Work in Strategy Making." *Organization Science* 24: 965–995.
- Kennedy, M. T., and P. C. Fiss. 2013. "An Ontological Turn in Categories Research." *Journal of Management Studies* 50: 1138–1154.
- Khaire, M., and R. D. Wadhvani. 2010. "Changing Landscapes: The Construction of Meaning and Value in a new Market Category—Modern Indian art." *Academy of Management Journal* 53: 1281–1304.
- Lampel, J., and A. D. Meyer. 2008. "Field-configuring Events as Structuring Mechanisms: how Conferences, Ceremonies, and Trade Shows Constitute new Technologies, Industries, and Market." *Journal of Management Studies* 45: 1025–1035.
- Langione, M., J.-F. Bobier, C. Meier, S. Hasenfuss, and U. Schulze. 2019a. *Will Quantum Computing Transform Biopharma R and D*. Boston Consulting Group.
- Langione, M., C. Tillemann-Dick, A. Kumar, and V. Taneja. 2019b. *Where Will Quantum Computers Create Value— and When?*. Boston Consulting Group.
- Langley, A. 1999. "Strategies for Theorizing from Process Data." *Academy of Management Review* 24: 691–710.
- Lee, B. H., S. R. Hiatt, and M. Lounsbury. 2017. "Market Mediators and the Trade-Offs of Legitimacy-Seeking Behaviors in a Nascent Category." *Organization Science* 28: 1–18.
- Lee, P., S. Stewart, J. Loucks, and C. Arkenberg. 2019. *Technology, Media, and Telecommunications Predictions*. Deloitte.
- Ménard, A., I. Ostojic, M. Patel, and D. Volz. 2020, February. "A Game Plan for Quantum Computing." *McKinsey Quarterly*.
- Moeen, M., and W. Mitchell. 2020. "How do pre-Entrants to the Industry Incubation Stage Choose Between Alliances and Acquisitions for Technical Capabilities and Specialized Complementary Assets?" *Strategic Management Journal* 41: 1450–1489.
- Mohseni, M., Read, P., Neven, H., Boixo, S., Denchev, V., Babbush, R., Fowler A. Smelyanskiy, V., & Martinis, J. (2017). Commercialize Quantum Technologies in Five Years. *Nature*, 543, 171–174.
- Paraoanu, G. S. 2011. "Quantum Computing: Theoretical Versus Practical Possibility." *Physics in Perspective* 13: 359–372.
- Pontikes, E., and V. Rindova. 2020. "Shaping Markets Through Temporal, Constructive, and Interactive Agency." *Strategy Science* 5: 149–159.
- Preskill, J. 2018. "Quantum Computing in the NISQ era and Beyond." *Quantum* 2: 79.
- PwC, and Russian Quantum. 2017. *Information Security in the Age of Quantum Technology*. PwC.
- Rotolo, D., D. Hicks, and B. R. Martin. 2015. "What is an Emerging Technology?" *Research Policy* 44: 1827–1843.
- Ruef, M., and K. Patterson. 2009. "Credit and Classification: The Impact of Industry Boundaries in Nineteenth Century America." *Administrative Science Quarterly* 54: 486–520.
- Russo, M., A. Thaker, and S. Adam. 2018. *The Coming Quantum Leap in Computing*. The Boston Consulting Group and BCG Henderson Institute.
- Santos, F. M., and K. M. Eisenhardt. 2009. "Constructing Markets and Shaping Boundaries: Entrepreneurial Power in Nascent Fields." *Academy of Management Journal* 52: 643–671.
- Schatsky, D., and R. K. Puliya Kodil. 2017. *From Fantasy to Reality: Quantum Computing is Coming to the Marketplace*. Deloitte University Press.
- Stigler, G. J. 1962. "Information in the Labor Market." *Journal of Political Economy* 70: 49–73.

- Suarez, F. F., S. Grodal, and A. Gotsopoulos. 2015. "Perfect Timing? Dominant Category, Dominant Design, And The Window Of Opportunity For Firm Entry." *Strategic Management Journal* 36: 437–448.
- Vermaas, P. E. 2017. "The Societal Impact of the Emerging Quantum Technologies: a Renewed Urgency to Make Quantum Theory Understandable." *Ethics & Information Technology* 19: 241–246.
- Vernacchia, S. 2019. *Quantum Leap: Advancing a Strategy for Quantum Computing that Will Inspire, Support and Safeguard Economic Growth in the Middle East*. World Government Summit 2019 & PwC.
- Ward, C., Y. Lu, C. Y. Lam, and A. Lamas-Linares. 2020. In *Quantum We Trust*. Accenture Pte Ltd and SpeQtral Pte Ltd.
- Zhao, E. Y., M. Ishihara, P. D. Jennings, and M. Lounsbury. 2018. "Optimal Distinctiveness in the Console Video Game Industry: An Exemplar-Based Model of Proto-Category Evolution." *Organization Science* 29: 588–611.
- Zuckerman, E. W. 1999. "The Categorical Imperative: Securities Analysts and the Illegitimacy Discount." *American Journal of Sociology* 104: 1398–1438.