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Turning Quantum Science into Quantum Business: Entrepreneurial Narratives in Deep Tech

A case study in quantum computing

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Abstract

Previous research in strategy and entrepreneurship underscores the pivotal role of narratives as a means for entrepreneurs to establish legitimacy and secure support for their ventures. The significance of narratives becomes particularly evident when validated facts are lacking, a common scenario for start-ups in nascent industries. Despite the growing body of literature, limited attention has been paid to examining the role and utilization of narratives in the field of deep tech. To address this gap, this thesis conducts a detailed case study in quantum computing.

Applying qualitative methods, the study reveals three main benefits of entrepreneurial narratives in the early stages of venturing. First, narrative accounts enhance the accessibility of complex innovation by employing analogies, metaphors, and visualizations. Second, they instill confidence in the abilities of the entrepreneurs and their mission through suggestion and identification, and third, provide direction by establishing expectations. Additionally, the study illuminates the interplay between entrepreneurial capital and expectations as the focal content of narratives.

The study provides insight on effective science communication and public engagement strategies in the initial phases of venturing in deep tech. The research contributes to academic knowledge by synthesizing approaches to narratives in venturing.

Keywords Entrepreneurship, strategy, narratives, deep tech, quantum computing

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Tiivistelmä

Tämä opinnäytetyö käsittelee tarinankerrontaa syväteknologian yrityksessä. Aiempi tutkimus korostaa tarinoiden keskeistä merkitystä keinona, jolla yrittäjät rakentavat uskottavuutta ja varmistavat tukea yrityksilleen. Tarinoiden rooli korostuu, kun todennettuja väitteitä ei vielä ole. Tilanne on tyypillinen uusille yrityksille. Syväteknologian yrityksissä tarinankerronnan rooliin ja sen hyödyntämiseen liittyvää tutkimusta on toistaiseksi tehty rajallisesti. Tämä työ vastaa puutteeseen tapaustutkimuksella kvanttilaskennassa.

Tutkimus soveltaa laadullisia menetelmiä ja selventää tarinankerronnan kolme keskeistä hyötyä liiketoiminnan alkuvaiheessa. Tarinoiden vertauskuvat parantavat monimutkaisten innovaatioiden ymmärrettävyyttä. Viittaukset ja tarinat yrityksen identiteetistä vahvistavat luottamusta yrittäjään ja yrityksen missioon. Odotukset puolestaan viitoittavat tekemistä. Lisäksi tutkimus valaisee yrittäjäpääoman ja odotusten vuorovaikutusta kertomusten keskeisenä sisältönä.

Tutkimus lisää ymmärrystä tiedeviestintään ja sidosryhmien sitouttamiseen yrittäjyyden varhaisessa vaiheessa. Samalla se edistää teoriaa yhdistämällä eri lähestymistapoja tarinankerrontaan yrittäjyydessä.

Avainsanat Yrittäjyys, strategia, tarinankerronta, syväteknologia, kvanttilaskenta.

Contents

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In gratitude,

In Espoo, 27 November 2023.

Christa Schauman

Quantum computing terminology

Qubit	A quantum bit, or qubit for short, is the basic building block of a quantum computer. It is analogous to a classical bit, but able to exist in multiple states simultaneously due to quantum superposition.
Logical qubit	Logical qubits can be defined as multiple physical qubits that are manipulated in a manner that ensures preserving their information without errors.
Superposition	The fundamental quantum principle that allows a quantum particle, like a qubit, to simultaneously exist in multiple states until observed or measured. When observed, the particle collapses into one of those states, contrasting with classical bits, which can only be in either a 0 or 1 state.
Entanglement	When two or more particles become connected in such a way that their states are interdependent, even when separated by a large distance. A measurement of one particle instantaneously affects the state of the other particle. As a result, each additional qubit exponentially increases the potential states a quantum computer can inhabit.
Coherence	The ability of qubits to maintain their quantum states. This is fundamental for the reliability and efficiency of quantum computing
Noise	Unwanted disturbances or fluctuations that can disrupt or introduce errors in quantum states or qubit operations, challenging the reliability and accuracy of quantum computations.
Modality	Refers to the various hardware approaches used in quantum computing development, each with its own strengths, challenges, and potential applications. More common approaches include building quantum processor based on superconducting qubits, trapped ions, photons, and quantum annealing.
Cryogenics	The science and technology of extremely low temperatures, typically below -150 degrees Celsius. Cryogenic temperatures are crucial in quantum computing, particularly for technologies like superconducting qubits, because they help suppress thermal noise, maintaining qubit stability and preventing decoherence, which is essential for reliable computation.
Quantum supremacy	The point at which a quantum computer can perform tasks that go beyond the capabilities of the most advanced, current computers.
Quantum advantage	The point at which quantum computers can solve a practical problem faster, cheaper, or more efficiently than current computers.
Noisy Intermediate Scale Quantum (NISQ)	A class of quantum computers with a small number of qubits and limited error-correction capabilities, making them an intermediate stage in quantum computing development.
Fault-Tolerant Quantum Computing (FTQC)	A class of quantum computers that have built in the needed quantum error-correction that prevents quantum errors, or faults originating from qubits, from spreading throughout the quantum circuits.

1 Introduction

How does a new venture capture attention, generate interest, and secure vital funding and support? In academic research, it has been argued that narratives can play a pivotal role (see for instance, Aldrich & Fiol, 1994; Fenton & Langley, 2011; Garud et al., 2014a, 2014b; Lounsbury & Glynn, 2001; Martens et al., 2007; Navis & Glynn, 2011). When the venture is still unknown and lacks a proven track record, obvious asset value, and profitability, narrative accounts can help explain, rationalize, and promote it in a way that reduces uncertainty. Narration operates through suggestion and the creation of identification between the audience and the narrative, providing compelling reasons for belief (Aldrich & Fiol, 1994). Ranging from smaller story fragments to grand narratives (Fenton & Langley, 2011), entrepreneurial narratives coherently address who the company is, why it is qualified, what it wants to achieve, and why it is likely to succeed (Fenton & Langley, 2011; Martens et al., 2007). According to Lounsbury and Glynn (2001), creating an appealing and coherent story may be one of the most crucial assets for a nascent venture to confront the low legitimacy arising from a lack of externally validated arguments. Yet how can entrepreneurial narratives support in providing direction, establishing legitimacy, and securing support when the venture is simultaneously navigating the uncharted waters of an emerging industry?

In nascent industries, technologies, products, and processes are often unproven or poorly understood (Navis & Glynn, 2010). Pre-existing market structures and meanings are either absent or exist in a limited capacity, primarily among highly specialized audiences (Hilkamo & Granqvist, 2022). The lack of established norms makes the emerging category inherently ill-structured and ambiguous. Uncertainty compounds when the ventures themselves are new, lacking the resources and clear identities enjoyed by their more established counterparts. Building credibility becomes an even more formidable challenge when both the venture and the industry grapple with legitimacy issues. (Aldrich & Fiol, 1994; Navis & Glynn, 2010)

Within emerging industries, the domain known as deep technology, often referred to as *deep tech*, offers a particularly intriguing arena for investigating the role of narratives in establishing new ventures. This is chiefly attributed to the profound complexity inherent in deep tech, making it exceptionally challenging for non-experts to comprehend and compare approaches, especially in the early stages of industry formation. As portrayed by De La Tour et al. (2017) and Portincaso et al. (2019, 2021), deep tech companies set themselves apart from traditional tech companies by pursuing innovations that genuinely push the boundaries of science and technology. They rely on a robust research base and require advanced skills and infrastructure. Consequently, adapting swiftly to changing circumstances can be a formidable challenge.

Typically driven by start-ups, these companies pursue solutions arising from unique, protected, or hard-to-reproduce technological or scientific advances in fields such as aerospace, biotechnology, artificial intelligence, robotics, and quantum computing. Deep tech ventures entail high technology risk and uncertain commercial application while requiring substantial upfront and long-term investment. Yet the promise is a significant improvement in, for instance, speed, efficiency, precision, or cost savings compared to existing solutions. These innovations have the potential to disrupt entire value chains and industries. (De La Tour et al., 2017; Portincaso et al., 2019, 2021) The transformative impact of deep tech ventures is exemplified by companies such as Tesla, revolutionizing the automotive industry with electric vehicles, and NVIDIA, reshaping graphics processing and high-performance computing.

This study delves into entrepreneurial narratives within quantum computing, an emerging deep technology poised to revolutionize computation. The potential of quantum computing lies in solving complex problems exponentially faster and addressing challenges currently beyond the capabilities of conventional computers, with applications spanning various industries and scientific fields (Islam et al., 2023; Ruane et al. 2023). However, at the present stage of development, quantum computing is still shrouded in uncertainty. Hilkamo and Granqvist (2022) emphasize how the technology still lacks a definitive design despite the numerous solutions currently under development. Similarly, its operating principles, potential applications, and timeline for widespread availability remain unclear.

New ventures, therefore, must make both quantum computing and their unique approach within it understandable and appealing. This dual challenge offers rich material for the study of entrepreneurial narratives. Initially, these ventures must adeptly convey the significance and importance quantum computing to early stakeholders, including financiers. Simultaneously, the ventures must articulate how they can translate the highly complex science into a viable business, elucidating why their specific approach holds greater appeal than the many competing alternatives. Achieving this is no small feat, considering that quantum computing exceeds the comprehension of most individuals outside the expert community. In this context, narratives, presented as stories, metaphors, and visualizations, emerge as a powerful means to render the subject more approachable, understandable, and appealing.

Yet, research focusing on the role of narratives in quantum computing remains scarce. Notably, Hilkamo and Granqvist's work in 2022 stands out as an exception. Their study delves into the role of figurative language, specifically analogies and metaphors, in shaping perceptions and understanding of quantum computing as an emerging market category. However, their study does not delve into how ventures utilize narratives to transition their scientific endeavors into viable businesses. Moreover, although contemporary approaches in strategy and entrepreneurship studies increasingly recognize the significance of practices, there is a notable scarcity of empirical research elucidating how the practices available to strategists and entrepreneurs translate into tangible resources and subsequently shape behaviors (Jarzabkowski & Spee, 2009; Thompson et al., 2020). Consequently, there is a gap in understanding the role and usage of narratives in venturing into quantum computing, which this study aims fill.

Through an in-depth case study of the quantum computing start-up SemiQon Technologies Oy (referred to as SemiQon), this study aims to answer *how* *entrepreneurial narratives can guide and advocate for a new deep tech venture in an emerging industry?* It explores the narratives produced by the company and its founders during the initial 18 months of operations, spanning from June 2022 to November 2023. By analyzing interviews and company documentation, the study sheds light on the role of narratives in building legitimacy and attracting support in the earliest stages of venturing, uncovering the processual mechanisms at work. Drawing upon previous research on narratives, relevant frameworks and methodologies are adjusted and applied to investigate these narratives. This exploration yields valuable insights into the development of effective science communication as well as capital and customer acquisition strategies for new deep tech ventures. Simultaneously, this study contributes to academic knowledge by synthesizing approaches to narratives in venturing.

The study begins with an overview of quantum computing, introducing essential concepts, developments, and prevailing challenges. This is followed by a more detailed introduction to the case company, SemiQon. The focus then moves to an exploration of contemporary literature on entrepreneurial narratives. By synthesizing various approaches, a theoretical framework is constructed for the subsequent analysis. The following section outlines the methodology employed to analyze narratives produced by SemiQon, with the primary focus of this paper dedicated to a thorough examination. In conclusion, the study discusses the implications of its findings, emphasizing their relevance for establishing new ventures in deep tech and their contribution to management research.

2 Introduction to quantum computing

Before delving into the theory of entrepreneurial narratives, this chapter provides an overview of quantum computing. The introduction clarifies why comprehending this rapidly evolving field can be particularly challenging for non-experts. Following the industry overview, the focus shifts toward a more in-depth introduction of the case company, SemiQon Technologies.

2.1 Supercharging computation

Quantum computing is an emerging technology that uses the laws of quantum mechanics to exponentially improve the performance of specific types of calculations. While conventional computers, often referred to as classical computers, rely on bits with only two possible states (0 or 1), quantum computers use quantum bits or *qubits* that can exist simultaneously in multiple states. This property is known as *superposition*. Moreover, quantum *entanglement* links particles so their states are interdependent, even when far apart. Measuring one particle instantly impacts the state of the other. In this way, every added qubit exponentially increases the potential states achievable by a quantum computer. These properties contribute to the promise of quantum computing to significantly accelerate certain types of computations and to address problems that are currently beyond the capabilities of classical computers. The potential of quantum computing can be likened to unlocking a code lock. In traditional computing, a sequential approach is employed where codes are tested one after another, which is time-consuming and resource intensive. In contrast, by allowing all possible combinations to be tested at once, a quantum computer can drastically reduce the time required to unlock the code. (Ezratty, 2022; Islam et al., 2023; Lerner et al., 2023; Ruane et al., 2022)

Quantum computers are probabilistic machines. Results are obtained by conducting multiple measurements, yielding outcomes that represent probabilities. Statistical analysis of repeated measurements provides valuable insights despite the inherent randomness. In contrast, classical computers are deterministic, performing precise calculations using binary code (0s and 1s) to provide exact answers. While quantum computers may excel at specific problem types, they will collaborate with classical computers to collectively address a broader spectrum of computational tasks. Integrating quantum computers is anticipated to significantly enhance the existing computing infrastructure. (Islam et al., 2023)

Quantum technologies began gaining notable attention in the 2010s as advancements started capturing the imagination of researchers, investors, governments, and industries. Figure 1 by CitiGPS (Islam et al., 2023, p. 23) shows the growth in venture capital investment in quantum computing since 2010. Moreover, the public sector has shown sustained interest, with the United States and the EU announcing investments of $1.8 billion and $1.2 billion in 2022. Even without a recent update, China retains the world's highest public investment in quantum computing at $15.3 billion. (Mohr et al., 2023) The race is fueled by the immense transformative potential, commercial prospects, and geopolitical rivalry associated with quantum technologies.

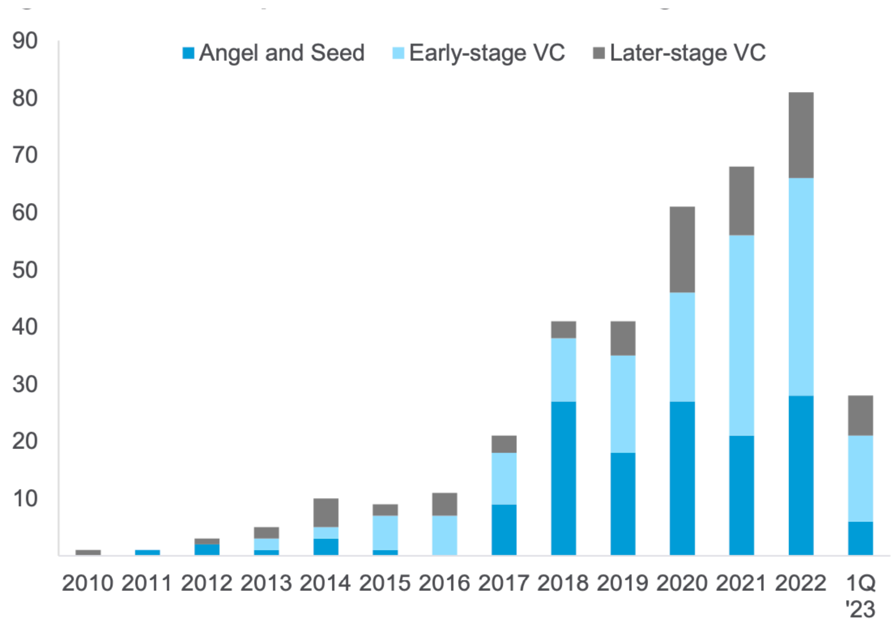


Figure 1: Venture capital invested in quantum computing companies from 2010 (Islam et al., 2023, p. 13)

As the technology matures, quantum computing is projected to excel over classical computing in four key domains: optimization, machine learning, simulations, and cryptography (Biondi et al., 2021; Islam et al., 2023; Langione et al., 2023). Even basic quantum technology can supercharge optimization, benefiting industries like manufacturing, logistics, artificial intelligence, healthcare, finance, energy, and climate. Based on an analysis of third-party projections by CityGPS (Islam et al., 2023), the anticipated total addressable market (TAM) for quantum computing is projected to range from $700 million to $8.6 billion by 2027. The assessment implies a compound annual growth rate (CAGR) of up to 50%. Furthermore, McKinsey & Co (Mohr et al., 2023) emphasize how the early economic impacts from quantum computing are anticipated across sectors like automotives, chemicals, finance, and life sciences, potentially yielding up to $1.3 trillion in value by 2035.

Despite significant advancements in recent years, quantum computing is still in its early stages of development. Various hardware platforms are currently being developed, with no consensus on the optimal solution. The two main types of architectures are gate-based quantum computers, versatile for multiple applications, and quantum annealers, specialized in optimization through annealing. Currently, the gate-based model is the most extensively researched approach. Additionally, quantum computers are based on different types of physical qubits, such as trapped ions, cold atoms, superconducting and electron spin qubits, and photons. (Dargan, 2023; Ezratty, 2022; Islam et al., 2023; Mohr et al., 2023) According to McKinsey & Co

(Mohr et al., 2023), the development is currently dominated by the major technology players and selected start-ups. Technology giants focus mainly on superconducting qubits, whereas start-ups explore more varying approaches. Adapted from Olivier Ezratty (2022, p. 12), Table 1 provides an overview of some of the more prominent qubit technologies, including examples of vendors and research laboratories involved in developing the technology. Each hardware approach has its own advantages, yet none of them are fault-free at this stage. Ezratty emphasizes how future systems may in fact combine multiple technologies.

Table 1: Key industry vendors and research laboratories by qubit technology, adapted from Ezratty (2022, p. 12)

	Atoms		Electrons				Photons
	Trapped ions	Cold atoms	Quantum annealing	Super-conducting	Semi-conducting	Spin vacancies	Photons
Vendors	• IonQ • Quantinuum • AQT • Ofxord Ionics • eleQtron	• Pasqal • ColdQuanta • Atom computing • QuEra • PlanQc	• D-Wave Systems • Qilimanjaro quantum tech • NEC • Fuijitsu	• IBM • Amazon • Google • Alibaba • BaiDu • Rigetti • IQM	• Intel • Quantum motion • Quobly • Diraq • **SemiQon**	• Turing • Quantum Brilliance • Photonic • XeedQ	• PsiQuantum • Quandela • Xanadu • ORCA Computing • Duality
Labs	• IQST • University of Maryland • MIT • Karlsruher Institut für Technologie • IQI	• CNRS • Institut d'Optique • Harvard University • Caltech • Forschungs-zentrum Jülich	• NEDO • Stanford University • MIT • Karlsruher Institut für Technologie • MCQST	• CEA • CNRS • MIT • INRIA • University of California, Santa Barbara	• CEA • CNRS • University of Bristol • University of Oxford • Yale University	• CEA • CNRS • MIT • University of Maryland • Delft University of Technology	• CNRS • University of Bristol • University of Oxford • Sapienza Università di Roma • Universität Wien

One of the main challenges in quantum computing is *decoherence*, where quantum systems lose coherence over time due to interactions with their environment. This is why most prototype computers require stringent environmental control, resulting in hardware systems roughly the size of a car. These systems primarily comprise of cooling mechanisms dedicated to maintaining the processor at its ultra-cold operating temperature. Consequently, today's quantum computers are often referred to as *Noisy Intermediate-Scale Quantum (NISQ)* devices. While more advanced than classical computers in certain ways, these devices are not yet fully error-corrected or fault-tolerant. They are characterized by having a relatively small number of qubits, typically in the range of tens to a few hundred, and their operations are affected by quantum noise and errors. Even though they cannot solve the large-scale, complex problems that fully *Fault-Tolerant Quantum Computers (FTQC)* are envisioned to handle, the quantum properties of NISQ devices can provide an advantage in, for instance, simulation, optimization, and cryptography. To achieve useful results with NISQ devices, careful consideration of error mitigation techniques is still required. (Bogobowicz et al., 2023; Islam et al., 2023; Lerner et al., 2023)

Quantum computers in the NISQ era are often evaluated based on their count of physical qubits rather than logical qubits. *Logical qubits* consist of several *physical qubits* that are connected in a manner that ensures error-free information retention. Therefore, Islam et al. (2023) argue that comparing quantum computers solely by physical qubit count is insufficient, as qubit quality matters equally. The authors exemplify how a quantum computer with 50 high-quality (low-noise) qubits can outperform one with 5,000 low-quality (high-noise) qubits. However, to contextualize the state of the quantum computing market, Table 2 compiled by Islam et al. (2023, p. 31) highlights qubit counts from various companies based on publicly available information.

Table 2: Qubit counts by selected quantum computing companies as of June 2023 (Islam et al., 2023, p. 31)

Qubit technology	Company	Number of qubits
Superconducting	IBM	433
Cold atom	Pasqal	324
Cold atom	QuEra	256
Photonic	Xanadu	216
Superconducting	Rigetti	84
Superconducting	Google	72
Trapped ion	IonQ	32
Trapped ion	Quantinuum	32

Today, the IBM Osprey with 433 qubits, is widely regarded as the most powerful quantum computer developed thus far. Many, however, believe that fully harnessing the potential of quantum technology will require at least one million qubits and that realizing that level of advancement may still be a decade away. Advancements are essential: increasing qubit count, reducing error rates, scaling up processors, and evolving algorithms and software tailored to quantum principles. (Islam et al., 2023; Lerner et al., 2023) In the evolving quantum industry, companies pursue various paths. Some aim to build full-stack computers, while others specialize in hardware components like qubits and gates or quantum software and algorithms. Many adopt hybrid strategies. (Mohr et al., 2023)

Publications from reputable organizations like McKinsey & Co (Biondi et al., 2021; Mohr et al., 2023; Pautasso et al., 2021), the Boston Consulting Group (Langione et al., 2023) as well as Citi Group (Islam et al., 2023) argue that quantum computing is quickly moving from theory to reality. McKinsey experts highlight that the acceleration of technological breakthroughs, increased investment inflows, the proliferation of start-ups, and projections of capable quantum systems by 2030 collectively signal the need for businesses to commence formulating their quantum computing strategies. Big companies such as Alibaba, Amazon, IBM, Google, and

Microsoft have already launched cloud services providing commercial quantum computing access. (Biondi et al., 2021; Pautasso et al., 2021) Similarly, BCG experts indicate that enterprise-grade quantum computing is on the horizon, potentially delivering business value by 2025. This is contingent on hardware companies meeting their technology development milestones and software effectively using the hardware better. (Langione et al., 2023) Lastly, and in alignment with this, a recent report by Citi GPS (Islam et al., 2023) suggests that the rapid strides in quantum computing imply the possibility of a sudden shift to *quantum advantage*—the phase at which quantum computers can solve practical problems faster and more cost-efficiently than the most advanced classical computers. This transition is, however, expected to unfold variably across industries and applications, given the specialized nature of quantum computers.

Recent assertions regarding the future capabilities and commercial applications of quantum computing have been notably grandiose, ranging from solving global warming (Cooper et al., 2022) to revolutionizing drug discovery (Accenture Labs, n.d.) and breaking current encryption protocols (Pflitsch, 2023). However, some advocate for more cautious expectations, citing the early stage of the technology. The renowned physicist Sankar Das Sarma (2022), for instance, underscores the current absence of compelling evidence for substantial real-world optimization with today's quantum computers. According to Das Sarma, even the task of cracking RSA encryption using current technology would necessitate millions, if not billions, of noisy physical qubits. The prevailing hype presents a challenge for non-experts, making it difficult to accurately assess the potential of quantum computing and distinguish between credible claims and exaggerations.

In summary, quantum computing holds significant potential to revolutionize numerous industries, yet the realization of expectations remains uncertain. Although numerous challenges remain, quantum computing will likely continue to develop and evolve, just like classical computing has done. By the time quantum computers provide tangible business benefits, the gap between early adopters of quantum technology and conventional computing users will widen quickly. This acceleration can be attributed to the exponential scaling potential intrinsic to quantum computers and the limited access to such technology in the early days. (Islam et al., 2023; Langione et al., 2023)

2.2 SemiQon Technologies

The case company in this study, SemiQon Technologies Oy, was established in 2022 by Himadri Majumdar (CEO), Janne Lehtinen (CSO), Mika Prunnila (CRO), and Markku Kainlauri (Fabrication Lead). The company emerged as part of the VTT Technical Research Centre of Finland Launchpad incubator, announcing independent operations on March 14, 2023. SemiQon's core mission is to unlock the potential of quantum computing by delivering scalable, cost-effective, and sustainable quantum processors. The company specializes in developing a new type of quantum processor chip utilizing silicon semiconductors. The innovation focuses on integrating classical control electronics and silicon spin cubits on the same processing chip, which is expected to save space as well as reduce wiring complexity and noise levels. Building a processing chip made from standard materials makes it more cost-effective and suitable for mass production compared to other approaches under development. The innovation also enables quantum computers to function at higher temperatures, reducing the energy required. (SemiQon Technologies, n.d.-a) In their own words, the technology expands upon “VTT’s ground-breaking demonstration of monolithically integrated on chip quasi-dissipationless cryogenic multiplexers based on proprietary CMOS technology and devices with extremely low noise levels” (SemiQon Technologies, n.d.-b).

SemiQon leverages the extensive expertise of its four founding members, boasting decades of research experience in quantum and microelectronics and a deep understanding of the European and global quantum industries (SemiQon Technologies, n.d.-c). Located at the Micronova Centre for Applied Micro and Nanotechnology in Espoo, Finland, the company gains a strategic advantage by accessing state-of-the-art research and fabrication facilities and advanced measurement infrastructure. The company employs eight experts primarily dedicated to technology development, covering various roles in R&D, production, and measurement. (Majumdar, personal communication, November 2, 2023) As the objective is specialized technology development rather than becoming a full-stack producer, a smaller team is sufficient for the purpose. Furthermore, existing fabrication facilities are projected to meet requirements in the foreseeable future. (Majumdar, personal communication, April 27, 2023)

The team currently focuses on developing their product and intellectual property. By August 2023, the company had already submitted applications for three patents (Kainlauri, personal communication, August 1, 2023). In its pre-seed stage, the primary objective is to create a minimum viable product to demonstrate the technology’s potential and to attract further investments. While the long-term strategic direction is still under consideration, the company envisions several pathways to commercialization. One approach involves becoming a component producer, which may entail setting up its own manufacturing facilities or outsourcing production. Alternatively, SemiQon could monetize its intellectual property through licensing agreements. Lastly, the company might consider being acquired by a larger organization possessing the resources and capabilities needed to expand sales and production. (Majumdar, personal communication, April 27, 2023)

Today, SemiQon operates in the Business-to-Research (B2R) sector, primarily engaging with universities and research organizations. The goal is encouraging research groups to test and validate the initial product. However, as the technology matures, SemiQon foresees a transition to a Business-to-Business (B2B) model, with system integrators and supercomputer manufacturers becoming its target customers. (Majumdar, personal communication, April 27, 2023)

The company faces competition from both indirect and direct actors in the quantum computing landscape. Indirect competitors encompass developers focusing on other quantum modalities, as the industry still lacks a definitive design. In direct competition, various entities are working on similar quantum processors. This includes the established giant, Intel and newer university spin-offs like Quantum Motion, Dirac, and Quobly. While Intel possesses significant resources and state-of-the-art facilities, smaller ventures benefit from greater agility. Notably, SemiQon holds an advantage over its smaller competitors with access to in-house manufacturing, streamlining its development process compared to competitors relying on third-party foundries. (Majumdar, personal communication, June 21, 2023)

The company secured €2 million in its initial funding round, with Voima Ventures, a Helsinki-based deep tech investor, leading the investment. Other notable investors include Lunar Ventures, Dhyan Ventures, Tiny Supercomputer VC, the Atomico Angel program, and strategic angel investors (SemiQon Technologies, n.d.-a). Moreover, in July 2023, the European Innovation Council granted €2.5 million for a 30-month collaborative project between SemiQon and Qblox, a company specializing in quantum control stacks. The project aims to develop high-quality silicon-based spin-qubits and the accompanying tools for sustainable control and operation, all within a scalable quantum computing control stack framework. (SemiQon Technologies, 2023c)

3 Literature review

This review centers on the scholarly discourse surrounding the establishment of new ventures within nascent industries. While research on venturing into deep tech, especially in the context of quantum computing, remains limited, the explored literature pertains to venturing into innovation science and technology and emerging industries in general. It synthesizes insights from various theoretical perspectives, each offering unique insights into the process. For instance, scholars in entrepreneurship, institutional theory, and organizational identity, such as Lounsbury and Glynn (2001) and Martens et al. (2007), take a more internal perspective. They focus on how an organization's features and actions contribute to its legitimacy. On the other hand, others examine the role that expectations play in driving innovation and entrepreneurship, as seen in the works of Brown and Michael (2003), Borup et al. (2006), van Lente (2012), Garud et al. (2014b) and Beckert (2021). This review contends that both perspectives provide valuable insights into the narrative practices that are becoming increasingly institutionalized in the context of venturing into emerging industries.

This thesis seeks to contribute to scholarly literature by providing a clearer understanding of entrepreneurial narratives and examining how the theoretical insights materialize in the context of SemiQon's pursuits. The exploration holds significance given the argument by Jarzabkowski and Spee (2009) that empirical research on how the practices available for strategists' function as resources and influence behaviors is still relatively limited. According to Fenton and Langley (2011), a focus on narratives delves into how narrative elements are expressed through speech and writing and how they shape an individual's understanding of their actions, identities, roles, and the organization's present and future (i.e., its trajectory or strategy). When these narrative understandings are shared, generalized, and treated as concrete, they actively contribute to constructing the world they depict. In this way, narratives imbue significance into the practice that arises from sensemaking, form a sense of direction or objective for the organization, realign organizational identity, and facilitate and limit the continuous actions of the individuals involved. (Fenton & Langley, 2011)

Similarly, entrepreneurship studies have seen an increasing incorporation of practice-focused research (see, for instance, Thompson et al., 2020). However, Thompson et al. (2020) assert that its impact remains primarily on the periphery. Consistent with the observations of Jarzabkowski and Spee (2009), they contend that empirical work focusing on the interplay between institutionalized practices in entrepreneurship and the actions of practitioners is limited. This study aims to bridge this gap by investigating the significance, application, and impact of narratives within the domain of entrepreneurship, with a specific emphasis on innovation in deep technology.

Through a comprehensive review of contemporary literature, the following subchapters will first explore the challenges of venturing into emerging industries. Following this, attention is given to using narratives to address these difficulties. The chapter then defines entrepreneurial narratives and explores their focal content in venturing. Here, the literature diverges into two primary directions, explored in more detail. Lastly, the review examines the cognitive tools used in creating entrepreneurial narratives and the means for sharing them. Although many of the included studies do not explicitly refer to the domains of strategy or entrepreneurship studies, this study contends that their focus on narratives in venturing renders them relevant for constructing the theoretical framework.

3.1 Venturing in nascent industries

Within scholarly literature, a growing consensus has emerged regarding the intricate legitimacy challenges that newly established businesses routinely encounter when being assessed by relevant stakeholders (Aldrich & Fiol, 1994; Garud et al., 2014b; Lounsbury & Glynn, 2001; Martens et al., 2007). New ventures are typically unknown to relevant stakeholders and lack a proven track record, tangible asset valuation, and immediate profitability (Lounsbury & Glynn, 2001). Characteristically, they are in nascent stages of development, constrained by limited resources, and frequently lack clear and distinct identities (Navis & Glynn, 2010). The challenge of building a resource base arises from two key factors: information asymmetry and uncertainty (Brown & Michael, 2003; Garud et al., 2014b; Martens et al., 2007). Resource providers typically have less information than entrepreneurs regarding specific opportunities and the strategies proposed for their exploitation. Additionally, the actual value of these opportunities often remains obscured until they are actively pursued. In sum, these shortcomings pose significant obstacles to establishing legitimacy, consequently making it more difficult for ventures to attract support and secure the essential resources needed to launch and sustain operations.

Establishing legitimacy becomes particularly formidable for new ventures operating within nascent markets. Navis and Glynn (2010) highlight that emerging markets are characterized by uncertainty, with technologies, products, and processes largely untested and not comprehensively understood. Furthermore, product definitions often remain vague or entirely unknown, while the market categories themselves lack well-defined structures. This context underscores the distinct challenges faced by ventures in emerging industries compared to start-ups in established ones. Aldrich and Fiol (1994) highlight that entrepreneurs in established industries have the advantage of pre-existing trust and industry recognition. However, in emerging sectors, the authors suggest that entrepreneurs must rely on their personal and interpersonal resources when dealing with skeptical stakeholders, including resource providers, customers, and suppliers. Without a proven track record of success, these entrepreneurs face the challenge of persuading potential partners to trust in their vision and commitments.

A significant challenge for innovation in science and technology is that these novel technologies and paradigm shifts in scientific understanding lack substantial existence prior to their actualization (Borup et al., 2006; Brown & Michael, 2003; Garud et al., 2014b; van Lente, 2012). Instead, their actualization relies heavily on future-oriented abstractions or the ideas, expectations, and visions that actors have.

In other words, how these innovations are envisioned or imagined is critical in guiding their development and bringing them into existence. (Borup et al., 2006) Establishing legitimacy for such expectations is a challenging task. It requires both cognitive and pragmatic legitimacy-building efforts (Garud et al., 2014b). When entrepreneurs anticipate a future significantly different from the past, stakeholders may struggle to understand the innovation, undermining its cognitive legitimacy. Future benefits, like investor returns, career opportunities, and valuable customer products, are also important. These expectations are intricately tied to pragmatic legitimacy, where stakeholders believe they will gain from their support of the venture. Given these distinctions, Garud et al. (2014b) argue that attempting to provide detailed specifics about an uncertain future may not necessarily enhance stakeholders' understanding of it.

In summary, to address the challenge of establishing a credible knowledge base when external validation is lacking, Aldrich and Fiol (1994) were one of the first to contend that founders turn to alternative communication methods, such as narratives, to persuade others of their ventures' alignment with established norms. While rational argumentation relies on logic and careful reasoning, narratives operate through suggestion and identification, both offering reasons for belief. The authors highlight how the credibility of a narrative is not dependent on external evidence; instead, it relies on its internal consistency and avoidance of contradictions. While Aldrich and Fiol (1994) emphasize the role of narratives in establishing legitimacy, their definition of what constitutes an entrepreneurial narrative remains vague. Consequently, the concept will next be explored in greater depth.

3.2 Entrepreneurial narratives

Martens et al. (2007, p. 1109) define entrepreneurial narratives as "the stories that are told about entrepreneurs and/or their firms." An entrepreneurial narrative serves several crucial purposes: it communicates a cohesive venture identity and establishes legitimacy (Lounsbury & Glynn, 2001; Navis & Glynn, 2010), captures attention and aids stakeholders in comprehending the opportunity (Garud et al., 2014a, 2014b; Martens et al., 2007) and provides essential direction for the venture and the industry under formation (Borup et al., 2006; Brown & Michael, 2003; Garud et al., 2014b; van Lente, 2012). Stories conveyed through verbal or written language, follow a structured approach with a beginning, middle, and end. The temporal transitions are driven by plot lines and twists, while also being shaped by key characters. (Lounsbury & Glynn, 2001) Both Martens et al. (2007) and Lounsbury and Glynn (2001) highlight the three essential elements of narratives: a narrative subject, an object or goal that the subject seeks, and a set of forces that either facilitate or hinder the subject in achieving the desired object or goal. Applying this framework to the entrepreneurial context, Lounsbury and Glynn (2001) emphasize how the individual entrepreneur or new venture can represent the narrative subject. The goal of the narrative can encompass various aims, such as establishing a successful enterprise, attaining profitability, securing venture capital funding, or cultivating a positive reputation among potential stakeholders. The facilitating or hindering forces manifest within the corporate and societal environment in which the subject operates. While entrepreneurial narratives typically are about achieving a goal, they are not static but evolve as the entrepreneurial journey unfolds (Garud et al., 2014a, 2014b; Lounsbury & Glynn, 2001).

Multiple levels and forms of narrative are inherent to strategic practices (Fenton & Langley, 2011). Narrativity is a matter of degree (ranging from smaller story fragments to grand narratives), and narrative elements (such as sequential elements, distinct grammar, coherence, and recognizable plot) may be detected in multiple forms (Fenton & Langley, 2011; Garud et al., 2014b; Martens et al., 2007). Fenton and Langley (2011) find the presence of narratives in the brief anecdotes shared by managers and individuals during their daily work interactions, in the overarching institutionalized practices utilized for strategy development, in the descriptions provided of their own and others' work as strategy practitioners, and in the tangible outputs generated through the activities involved in strategizing. While institutionalized strategy practices such as SWOT analysis or different forecasting techniques are not inherently rooted in narrative techniques, they can be seen as containing underlying macro-level "grand narratives" or broader discourses that generate local narratives, thereby serving as valuable resources for every day, strategic praxis by practitioners. (Fenton & Langley, 2011)

Coherence and resonance are key to building a comprehensible and plausible narrative for stakeholders (Garud et al., 2014b; Lounsbury & Glynn, 2001). Garud et al. (2014b) emphasize how creating a plot that orders the intermediary steps toward the desired end goal into a comprehensible account creates coherence. Intertextual linkages to more familiar and accepted developments in technologies, markets, and regulations create resonance. Hilkamo and Granqvist (2022) expand on the concept of resonance in developing new market categories in their study of prospective sensemaking and sensegiving in emerging market categories, particularly focusing on quantum computing. They argue that figurative language plays a vital role in bridging the gap between quantum phenomena and the understanding of non-experts. This includes the use of naturalizing, temporal, and mystifying tropes, which simultaneously characterize quantum computing as both familiar and unique. Naturalizing analogies, such as comparing quantum computing to everyday objects like coins and phone books, enhances familiarity and simplifies understanding by drawing on shared cultural resources. Temporal tropes establish rapport by emphasizing the early stage and future potential of quantum computing, for instance, likening quantum computing to the development of conventional computing or the internet. Additionally, Hilkamo and Granqvist (2022) note that using mystifying tropes maintains the boundaries between the scientific community and the general public. While reinforcing power disparities, these tropes also enhance the allure of quantum computing.

3.3 Content of entrepreneurial narratives

The focus now turns to a more thorough exploration of the content of entrepreneurial narratives. Within this domain, the literature falls into two primary categories. The first direction focuses on how new ventures shape narratives around their internal sources of entrepreneurial capital. It additionally delves into how entrepreneurial narratives evolve as the market category matures. Conversely, the second direction stresses the role of expectations in driving entrepreneurial innovation. These categories are next examined in greater detail to gain a more comprehensive understanding.

3.3.1 Emphasis on entrepreneurial capital

Lounsbury and Glynn (2001) have played a pivotal role in advancing early theories regarding the influence of entrepreneurial narratives on building legitimacy and facilitating resource acquisition for new ventures in emerging industries. Their contributions have enriched the understanding of the content of entrepreneurial narratives, particularly when compared to earlier research, such as the work of Aldrich and Fiol (1994). According to Lounsbury and Glynn (2001), narratives serve the crucial purpose of identifying and validating new businesses. Compelling entrepreneurial narratives must align with the audience's interests and normative beliefs to ensure favorable interpretations. The authors argue that these narratives draw on two forms of entrepreneurial capital: firm-specific, *resource capital* (both tangible and intangible) and industry-level, *institutional capital*, encompassing legitimacy, infrastructure norms, and rules. Entrepreneurial stories shape and legitimize the identity of a venture in two fundamental ways. Firstly, they highlight the distinctiveness of the new venture by emphasizing its resource capital. Secondly, they underscore its alignment with established organizational norms and beliefs by emphasizing its institutional capital. While briefly discussing the founder's vision as a source of intangible resource capital, Lounsbury and Glynn (2001) give minimal attention to the innovation's promises, such as technological improvement or financial projections, as the central content of entrepreneurial narratives.

A fundamental assertion is that entrepreneurial narratives wield their most substantial influence in facilitating capital acquisition during the inception stages of venture creation (see, for instance, Borup et al., 2006; Lounsbury & Glynn, 2001). In this period, entrepreneurial legitimacy tends to be the most pressing issue, and narratives can help make the new venture more familiar, understandable, and acceptable. Lounsbury and Glynn (2001) propose that in nascent industries, entrepreneurial narratives tend to emphasize the industry's normative appropriateness over highlighting the venture's distinctiveness. Yet, when the inventions pursued are competence-destroying rather than enhancing, identity stories should accentuate the venture's uniqueness to attract attention and convince it will lead to wealth creation. Competence-destroying inventions bring drastic technological advancements, disrupting organizations lacking the expertise to adapt. Competence-enhancing inventions, in contrast, lead to gradual improvements in a field.

Applying these ideas to the context of quantum computing presents an inherent contradiction. Entrepreneurial narratives should underscore normative appropriateness as the market category is still in its early stages. Yet, aiming for ground-breaking advancements in computing guides quantum ventures to highlight their distinctiveness. Nonetheless, Lounsbury and Glynn's (2001) propositions carry two critical implications for new ventures. First, they underscore the importance for entrepreneurs in developing the acumen to discern whether emphasizing similarity or distinctiveness will lead to resource acquisition and wealth creation. This notion is reinforced by Navis and Glynn (2010), who stress that resolving the identity conundrum—balancing sameness and differentiation—is critical because identities wield substantial influence over legitimacy. Second, Lounsbury and Glynn (2001) suggest that entrepreneurs should build their storytelling skills to effectively convey their identity, resources, and potential benefits to stakeholders. The propositions Lounsbury and Glynn (2001) developed are summarized in their process model of cultural entrepreneurship, depicted in Figure 2.

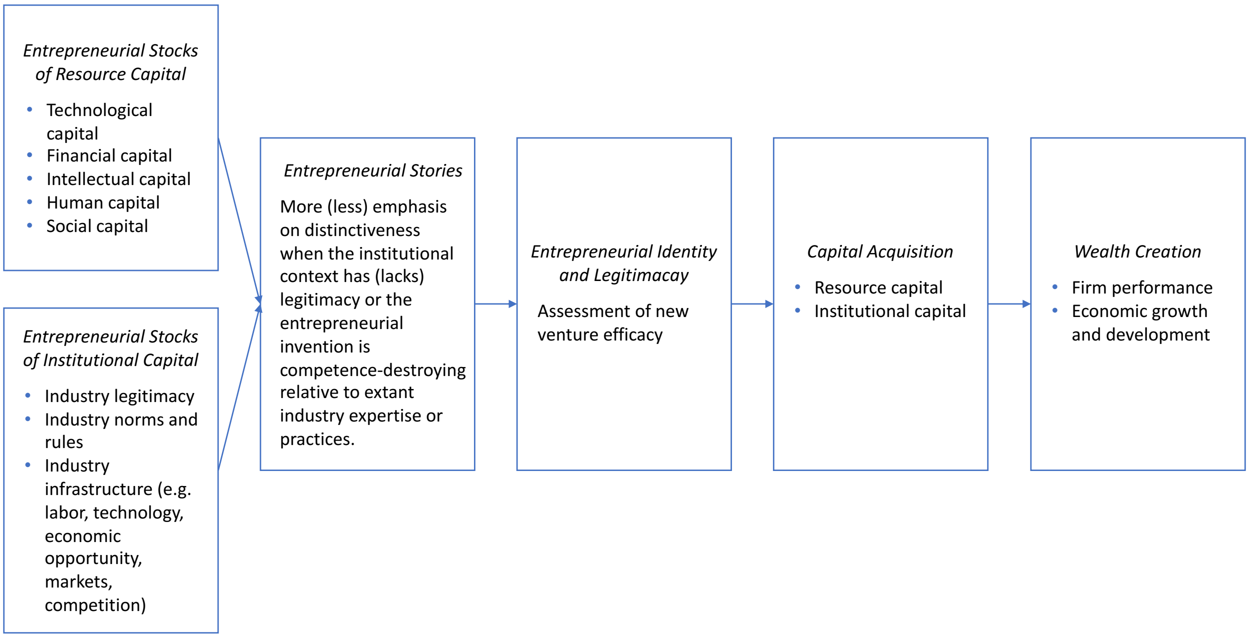


Figure 2: Model of cultural entrepreneurship, adapted from Lounsbury and Glynn (2001, p. 547)

Also focusing on resource acquisition, Martens et al. (2007) conducted one of the first systematic, large-sample tests of the overarching claim that effective storytelling can facilitate external resource acquisition. Through a comprehensive qualitative and quantitative analysis of initial public offering prospectuses from 1996 to 2000 in three high-tech industries, the authors demonstrate that well-constructed narratives can help entrepreneurs secure funding to capitalize on identified opportunities. Like Lounsbury and Glynn (2001), Martens et al. (2007) underscore how the level of information asymmetry and uncertainty is larger in de novo start-ups than in IPO firms.

Effective narratives convey a clear venture identity, explain how the proposed methods of opportunity exploitation can mitigate risk without getting into overly complicated details, and incorporate familiar elements to provide context to the unfamiliar. In this context, what was categorized as either familiar or unfamiliar were strategic initiatives that were either commonly or infrequently articulated. Martens et al. (2007) find that the impact of such narratives on resource providers exceeds that of purely factual information about a firm's resource endowments. Interestingly, these findings challenge the proposition by Lansbury and Glynn (2001) that stories emphasizing a venture's objective resources, such as track record, connections, and credibility, are always more influential. This indicates, according to Martens et al. (2007) that entrepreneurial narratives possess the freedom to interpret and present facts in distinct ways, adding further complexity to their influence on resource acquisition.

The propositions by Lounsbury and Glynn (2001) have additionally been subjected to empirical testing by Navis and Glynn (2010). In their study spanning the initial sixteen years (1990–2005) of the U.S. satellite radio market's evolution, Navis and Glynn (2010) illustrate how nascent market categories become institutionalized through the sensemaking and sensegiving activities of the actors involved. Creating a new market category is a dynamic, social process involving both ventures and interested audiences (see also Hilkamo & Granqvist, 2022). While maintaining a focus on entrepreneurs' identity claims and linguistic framing of activities, the authors place greater emphasis than Lounsbury and Glynn (2001) and Martens et al. (2007) on the influence of external factors. These factors encompass the interested audiences who critically evaluate the venture's credibility and appropriateness. Their study supports Lounsbury and Glynn's (2001) claim that firms shift from emphasizing similarity to highlighting distinctiveness as a market category matures and gains legitimacy. An illustration of this shift is how affiliations with established actors that serve as quality indicators become less common to the industry and more exclusive to the ventures claiming affiliations. Additionally, as a market category matures, the reliance on metaphors and analogies to make the unfamiliar more familiar decreases, and the audience's attention shifts from focusing on the category itself to scrutinizing individual firms. These insights underscore the challenges for stakeholders to evaluate the prospects of individual firms in the early stages of an emerging industry. (Navis & Glynn, 2010)

3.3.2 Emphasis on expectations

In contrast to the studies that primarily emphasize entrepreneurial capital as the central content of entrepreneurial narratives, other scholars have directed their attention to the significance that expectations play in entrepreneurship and innovation and, consequently, in the narratives about such endeavors. According to the Merriam-Webster Dictionary (n.d.), an expectation is "the act or state of looking forward to some occurrence." When viewed through the lens of the sociology of expectations, which examines the informal generation and dissemination of expectations in science and technology, expectations transcend mere descriptive statements about potential realities. Instead, they actively contribute to the shaping and realization of new realities (as discussed by Brown & Michael, 2003, Borup et al., 2006; Garud et al., 2014b; van Lente, 2012). In this way, expectations, like the previously explored concept of narratives, are performative in nature, as they actively influence and create change.

Expectations contribute to creating self-fulfilling prophecies by providing legitimation, heuristic guidance, and coordination (van Lente, 2012; see also Borup et al., 2006; Garud et al., 2014b). Firstly, expectations garner attention and legitimize investments, as promising futures are used to defend a project or program. Secondly, expectations provide a sense of direction for the research processes in science and technology. Lastly, expectations have a coordinating effect, as technical development involves collaborative efforts among networks of companies and research institutions. In the absence of central control, expectations play a crucial role by identifying specific tasks and defining roles. However, Harro Van Lente (2012) stresses that expectations alone will not instigate change; it requires that others act in alignment. What holds significance is the extent to which expectations are mutually shared. Expectations are particularly relevant in the early stages of innovation and industry formation when multiple visions of the future compete, roles are unclear, and regulation is commonly seen as lacking. In this phase, Borup et al. (2006) stress that expectations work through defining roles, clarifying responsibilities, and providing a shared framework for anticipating and preparing for both opportunities and risks.

In discussing the content of expectations, van Lente (2012) highlights that expectations encompass technical, commercial, and societal aspects, often in combination. He further specifies that expectations can be either positive (promises) or negative, differing in level, content, and modality, ranging from broad, abstract visions of the future (macro) to specific, detailed expectations (micro). Likewise, Garud et al. (2014b) emphasize that entrepreneurial narratives should aim to establish cognitive and pragmatic legitimacy by emphasizing the future characteristics of a venture and its environment, such as developments in markets, technologies, and competition, as well as the benefits for stakeholders such as return on investment, career prospects, and valuable products for stakeholders. One prominent example in science and technology illustrating this phenomenon is Moore’s Law, which states that integrated circuit complexity and processing power tend to double approximately every 18-24 months (Islam et al., 2023). This expectation has acted as a self-fulfilling prophecy through serving as “a temporal institution to facilitate the orchestration of field actors” (Garud et al., 2014a, p. 1182) and influencing companies’ R&D goals, investment sizes, and tactics to meet the expectation of Moore’s Law in their own development (van Lente, 2012). The example additionally shows how expectations, over time, may exhibit material and social path dependencies, becoming foundational for future envisioning (Borup et al., 2006).

A central argument posits that in situations where future scenarios are complex and ambiguous, and fundamental uncertainty looms large, narratives play a pivotal role in rendering these expectations more comprehensible and convincing (Beckert, 2021; Garud et al., 2014b). Expectations can be viewed as narratives about what the future will look like, the envisioned positioning of the venture, and the decisions required to attain a desired future or prevent an undesirable one. This framing by Jens Beckert (2021) underscores the narrative structure involving a protagonist, events, and a plot. Similarly, Garud et al. (2014b) emphasize how the projected outcome imbues significance into both the beginning and intermediate events, rendering the content comprehensible. Therefore, narratives are especially valuable for conveying the future, as the narrative structure itself, rather than its factual accuracy, wields the power of persuasion. Furthermore, Beckert (2021) asserts that the efficacy of projective narratives is also closely tied to the legitimacy of the methods employed in their construction. The aspect of constructing expectations and narratives will be subjected to a more in-depth examination in chapter 3.4.

Borup et al. (2006) stress how novel technologies and fundamental scientific changes do not exist in a substantive sense before their conceptualization. Hence, innovations are heavily influenced by actors' imaginations, expectations, and visions. While expressing an expectation does not automatically establish accountability, it does provoke reactions and the anticipation that the speaker will substantiate their forward-looking statement. In this context, the potential offered by technology imposes a "mandate" upon technologists, granting them the freedom to explore and advance while simultaneously placing a societal responsibility on them to ultimately deliver. (Borup et al., 2006; see also van Lente, 2012). Garud et al. (2014b) extend the relevance of expectations to entrepreneurship in a broader sense. They posit that expectations are not inherently true or false; rather, their significance depends on their connections with relevant and credible actors, meaningful data, and ongoing developments (see also van Lente, 2012). As a result, scholars in this field frequently direct their research toward understanding the creation, dissemination, growth, development, and changes in prominence of expectations in the realm of science and technology (van Lente, 2012).

Expectations play a pivotal role, especially during the initial phases of innovation by assisting pre-market applications in capturing attention, garnering support, and generating essential momentum (Borup et al., 2006; Brown & Michael, 2003). Studying the development of expectations in clinical biotechnology, Brown and Michael (2003) find that early-stage technologies often generate high promise and optimistic, even naive, expectations compared to innovative concepts with a longer track record (see also Borup, 2006). High uncertainty prompts the need for organized coordination in unstable networks, often achieved through discussions about ground-breaking advancements or revolutionary potential. According to Brown and Michael (2003), elevated or optimistic expectations in discourse signal the emergence of new networks and activities as emerging fields attract investment. Interestingly, the authors note a contrast: while those directly involved in knowledge production, such as scientists, often have higher levels of uncertainty regarding expectations for new innovations, in their entrepreneurial role, these same scientists display strong confidence in asserting the potential and promise of their innovation (see also Borup et al., 2006; van Lente, 2012). The performance of projecting uncertainty or confidence about future expectations will vary depending on the audience. The flexibility in interpretation and communication arises from inequalities in access to the information upon which these expectations are built. This tendency in the scientific market investment system results in limited constraints on generating hyperbolic expectations by entrepreneurial innovators. (Brown & Michael, 2003)

A fundamental argument made by scholars focusing on expectations is that innovation cannot work in isolation (Borup et al., 2006; Navis & Glynn, 2010; van Lente, 2012). Borup et al. (2006) emphasize how expectations and visions are pivotal for resource mobilization across different levels: the macro (i.e., regulations and research funding), the meso (i.e., innovation networks), and the micro (i.e., research groups and individual scientists). Doganova and Eyquem-Renault (2009) offer a pragmatic perspective on how this dynamic operates through their case study exploring the role of the business model in venturing. When entrepreneurs engage with potential partners for their innovation, whether successful or not, it transforms the network they are building. If partners are not interested, the entrepreneurs are unable to continue pursuing their vision with their current business plan. However, when partners do express interest, it results in the reconfiguration of the innovation network, requiring the creation of new connections and the cutting of existing ones. Any change in the social relationships of the innovation also influences its technological aspects, and vice versa. The process of encountering and enrolling partners puts the entrepreneur's business model to the test, often leading to costly changes in technology and alliances. If the business model withstands these challenges, the associations it forms become stronger, gradually transforming the business model into a viable business. (Doganova & Eyquem-Renault, 2009)

The challenge associated with expectations is that the eventual reality frequently deviates from the initial vision. The successful realization of projected outcomes depends on developments in multiple factors, such as technologies, markets, and regulatory frameworks. Yet, inherent uncertainties and unforeseen obstacles can cause the actual outcome to deviate from the envisioned one. As expectations typically peak in the early stages, disappointment seems inherent to how expectations operate in science and technology. (Borup et al., 2006; Brown & Michael, 2003; Garud et al., 2014b) Yet actors must embrace and commit to future expectations to assess their feasibility, underlining the significance of investing in and buying into these expectations (Garud et al., 2014b). Borup et al. (2006) contend that expectations typically follow a temporal pattern over time, characterized by alternating hype and disappointment cycles. Distancing themselves from the more linear progression of technological development in the Gartner (n.d.) hype cycle, illustrated in Figure 3, the authors stress how many scenarios either end in disillusionment or continue with a renewed surge of expectations. A key argument Borup et al. (2006) put forth is that technologies undergo ongoing and practical reconfigurations over time, influencing both their development and utilization.

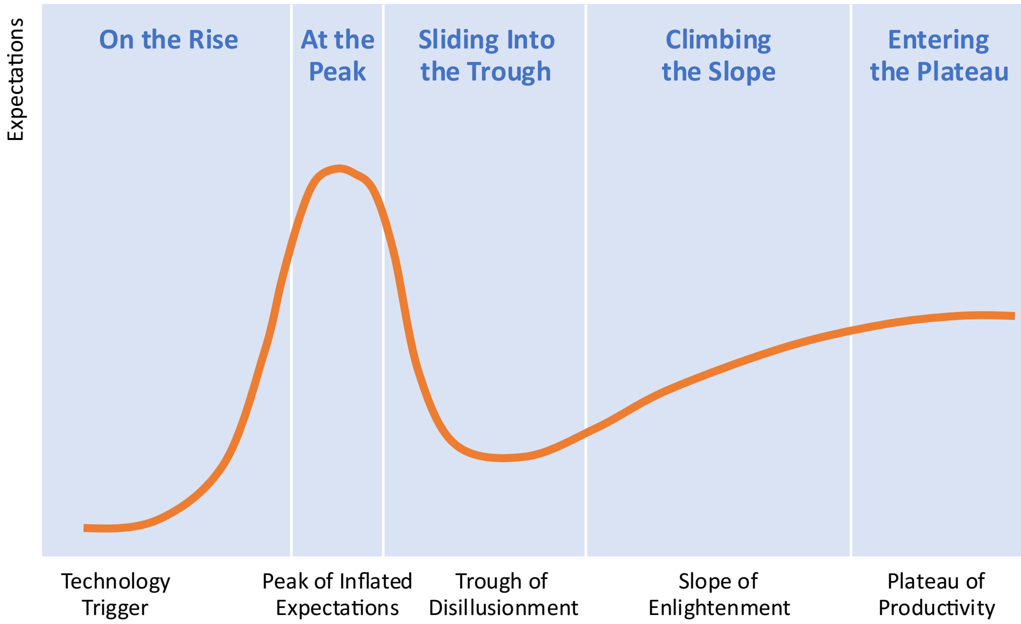


Figure 3: The Gartner Hype Cycle, adapted from Gartner (n.d.)

As setting expectations carries an inherent sense of obligation, projective narratives simultaneously set the stage for challenges, as highlighted by Garud et al. (2014b). When circumstances change, a venture may fail to meet expectations. Consequently, its legitimacy may be jeopardized. To address this challenge, entrepreneurs should continuously frame and reframe future aspirations and past events in response to evolving conditions, a process the authors have labeled ongoing storytelling. Two strategies are proposed. One approach involves replotting, meaning modifying ambitions for the future. When the foundation for setting pragmatic expectations diverges from the approach used in early narratives, a venture can transition from focusing on distant future benefits to concrete, measurable achievements in the near term. Alternatively, it can harness its resources to achieve a different but relevant goal. The second strategy involves reconfiguring relational links, especially when existing relationships become unfavorable. Garud et al. (2014b) provide an example from the late 1980s when AI ventures distanced themselves from the label "artificial intelligence" while still using the technology. The authors summarize their model for ongoing storytelling by adapting the process model for cultural entrepreneurship developed by Lounsbury and Glynn (2001), as depicted in Figure 4.

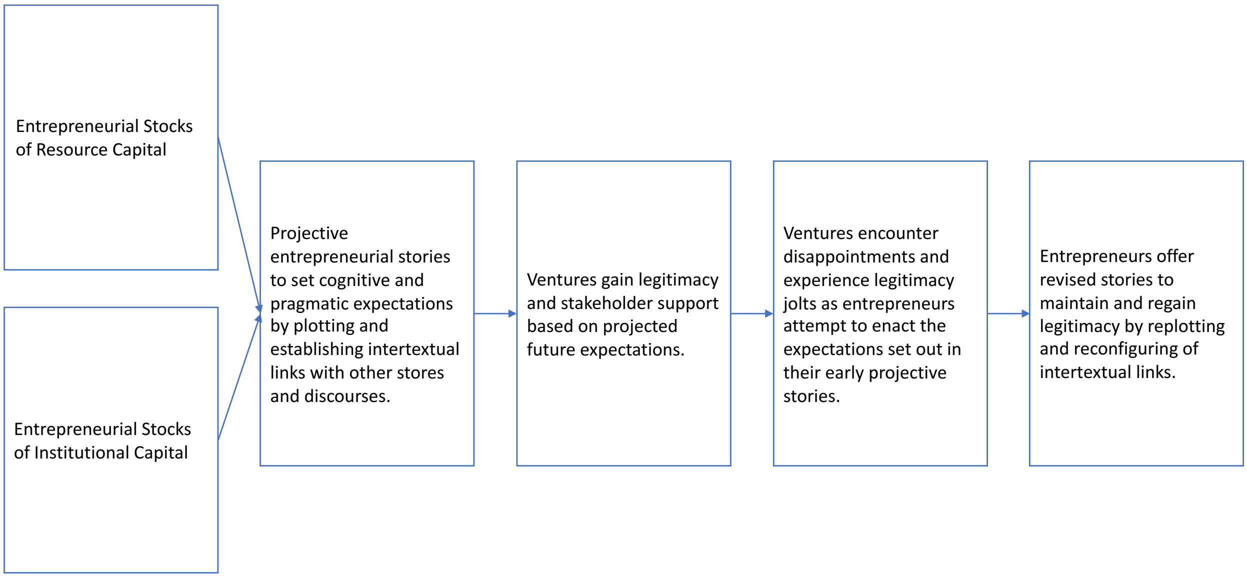


Figure 4: Model for ongoing storytelling to set, maintain, and repair expectations and legitimacy adapted from Garud et al. (2014b, p. 1483).

Originally based on the model for cultural entrepreneurship developed by Lounsbury and Glynn (2001, p. 547)

3.3.3 Comparison of approaches

While the explored approaches vary in their emphasis on the central content of entrepreneurial narratives, they share a consensus that narratives serve as effective tools for persuasion, especially in the absence of external validation. Additionally, both approaches recognize the constitutive or performative role of narratives, actively shaping and influencing actions within the venture and its environment. However, the two approaches diverge in addressing why the venture should be regarded as legitimate. Narratives that focus on entrepreneurial capital primarily address *why the venture is qualified* to pursue the desired opportunity. On the other hand, narratives centered on expectations emphasize building legitimacy by answering *what the company aims to achieve and by when*. Expectations-focused narratives demonstrate a heightened concern for commercial viability, providing more precise temporal and numerical insights.

In the context of quantum computing, this distinction in legitimacy-building efforts can be illustrated in the following way. Firstly, narratives centered on *entrepreneurial capital* highlight either venture-specific resource capital, or industry-level institutional capital to rationalize why the venture is relevant. Narratives could, for instance, focus on the founders' expertise in quantum physics (human capital), recognition from innovation accelerators (social capital), or secured funding (financial capital). Alternatively, such narratives could underscore the potential of quantum computing to address some of the world's most pressing challenges or share media coverage of achievements by other quantum companies to establish collective legitimacy for the quantum industry (industry legitimacy).

Secondly, entrepreneurial narratives can build legitimacy by setting expectations, i.e., highlighting the company's objectives and the timeline for achieving them. In the context of quantum computing, this might involve the venture sharing projections for qubit count development or specifying the anticipated timeframe for achieving quantum advantage. Both examples reflect expectations regarding technological progress. Alternatively, the venture could outline its plans for revenue growth or the prospects of an initial public offering (IPO), exemplifying narratives about commercial expectations. Before summarizing the insights in a coherent theoretical framework, the focus shifts to exploring the creation and dissemination of entrepreneurial narratives.

3.4 Creating entrepreneurial narratives

The impact of entrepreneurial narratives is not solely dependent on their coherence and resonance. According to Beckert (2001), it also hinges on the legitimacy of the methods used to construct them. He emphasizes that entrepreneurs often rely on cognitive tools like technology projections, strategic planning, and capital budgeting to predict the future. These widely accepted tools in management use visual imagery, numerical data, and mathematical models to support their predictions. Beckert suggests that investigating these tools and methods offers an effective approach to understanding how organizations envision their future. This section explores common cognitive tools for creating expectations before delving into a more detailed examination of how narratives are shared.

Technology projections are central to entrepreneurial innovation in science and technology. Projections of innovations are promissory stories that serve as a script for the future, initially existing only as vague promises (Beckert, 2021; Deuten & Rip, 2000). By influencing the expectations and decisions of multiple stakeholders, technology projections broadly impact the overall ecosystem in which they operate (Beckert, 2021; Borup et al., 2006). *Technology roadmaps*, more specifically, are a management tool that systematically maps these projections. These roadmaps represent imaginative links between anticipated advancements in technical expertise, progressions in product sequences, and potential future market opportunities (van Lente, 2012). According to Kerr and Phaal (2020), roadmaps are characterized by a visual representation and the use of the "why-what-how-when" framework. They provide a structured approach to align market perspectives, product definitions, technological capabilities, and timing considerations. This framework involves understanding market drivers and opportunities (why), defining desired products or offerings (what), determining the necessary technologies for development (how), and establishing the implementation timeline (when). Creating the roadmap facilitates decision-making, consensus-building, and synchronization among stakeholders. Kerr and Phaal (2020) emphasize how technology roadmaps, without the why-what-how-when framework, lose their distinctiveness and resemble other strategic plans and business cases.

Strategic planning serves as the predominant tool for guiding resource allocation decisions (Beckert, 2021). Strategic planning creates a framework for interpreting situations and anticipating future developments to guide decisions and shape the organization's environment. Strategic plans inherently include fictional elements, as they rely on assumptions about the future that may or may not materialize. Fenton and Langley (2011) emphasize how such plans provide legitimacy to organizational members, guiding them toward pursuing specific objectives while neglecting others. When connected to quantifiable goals and management incentives, strategic plans function as binding commitments, influencing subsequent strategic action and shaping the organization's trajectory, roles, and identities. Strategic plans can also serve more nuanced purposes, such as inspiring belief, commitment, and justifying past decisions. (Fenton & Langley, 2011)

Lastly, *financial planning* is an element in strategic planning that entails projecting the anticipated financial performance of an investment in the future (Beckert, 2021). This enables firms to assess the viability of funding the project and prioritize among competing investment opportunities. Capital budgeting, more specifically, relies on evaluating future cash flows and other relevant financial indicators. This depicts a situation that does not yet exist. Yet if the projections are considered credible, they inform decision-making as if they accurately represent the future. (Beckert, 2021)

These tools can help entrepreneurs create compelling entrepreneurial narratives by structuring their thought processes and bringing attention to potential inconsistencies. Technology projections achieve coherence by presenting a logical sequence of expected advancements, considering dependencies. Coherence in strategic plans results from aligning actions and objectives logically with anticipated future scenarios. Additionally, resonance is achieved by addressing stakeholders' concerns, priorities, and goals, making the narrative more meaningful and impactful. For example, integrating financial considerations will likely appeal to stakeholders concerned about economic viability, such as investors. Together, these tools enhance the credibility of entrepreneurial narratives by structuring logical progressions that are familiar and appealing to the target audiences.

Lastly, the reviewed tools can either be shared directly with selected audiences, or the outcome may be presented independently of the tools. For example, a quantum computing startup seeking investment for its groundbreaking technology may share its full technology roadmap with potential investors to provide a detailed overview of how their technology will evolve over the next few years. The founders might also share a more condensed version in a pitch deck or during a presentation. They could use simplified language and visuals to convey the main points of the larger storyline in the roadmap. The condensed version serves as a quicker and more easily digestible way to communicate key points to a broader audience. Both contribute to building a persuasive narrative for their target audiences. The following section explores how entrepreneurial narratives are shared with key audiences.

3.5 Sharing entrepreneurial narratives

Entrepreneurial narratives are shared through various modes, including oral and written forms (Martens et al., 2007). Ad hoc narratives are often spontaneous, responding to immediate needs, and delivered in informal settings, while planned narratives are prepared in advance for specific purposes. Spontaneous, smaller narratives are shared in everyday conversations with employees, customers, and suppliers, while planned and scripted narratives are delivered in for instance formal presentations to audiences like bankers, venture capitalists, and media representatives. Entrepreneurial narratives appear in written form as story segments on promotional materials such as brochures, websites, and product packages, as well as fuller narratives in documents like business plans, IPO prospectuses, and annual reports. (Martens et al., 2007; see also Fenton & Langley, 2011) Furthermore, Garud et al. (2014a) highlight that narratives also encompass the entrepreneurial action that contributes to making the innovation understandable for stakeholders, such as prototyping, securing funding, and cultivating customer relationships. Informed by the literature, Table 3 summarizes different modes for sharing entrepreneurial narratives.

Table 3: Modes for sharing entrepreneurial narratives

	Oral	Written	Actions
Ad hoc Small stories or story fragments	*Informal narratives* shared via everyday conversations with employers, customers, suppliers, or investors.	*Informal narratives* shared via email or chat for day-to-day communication with stakeholders such as employees, customers, suppliers, or investors.	Prototyping Cultivating stakeholder relationships Product demonstrations, pilot programs Participating in industry events or exhibitions
Planned Small stories or story fragments to grand narratives	*More formal and prepared verbal communication,* such as team presentations, investor pitches, industry conference presentations, panel discussions and interviews.	*More formal and prepared forms of communication*, such as business plans, pitch decks, funding applications, marketing material, annual reports, whitepapers and research reports, social media, and blog posts.	

Note. The table was built on insight from Martens et al. (2007), Garud et al. (2014a) and others.

Compelling entrepreneurial narratives present appealing and believable scenarios that align with the interests of different stakeholders (Beckert, 2021; see also Lounsbury & Glynn, 2001). Beckert (2021) highlights two key means for sharing such narratives: *marketing* to engage customers and *business plans* to attract investors. In marketing, future expectations play a dual role. First, they shape a compelling vision of future customer satisfaction through symbolic product or service value typically communicated via advertising. Second, they anticipate future consumer desires to identify lucrative market positions facilitated by market research. Conversely, the business model, often shared as a plan, serves as a vital tool to communicate the expected profitability of an investment (Beckert, 2021; Doganova & Eyquem-Renault, 2009). It conveys future expectations based on careful assessments of market trends, competitive positioning, product development timelines, cost structures, and more. The business plan serves both as a narrative and calculative tool for entrepreneurs to navigate the market and persuades investors to believe in the envisioned success. Business plans represent commitments that hinge on securing funding, playing a pivotal role in shaping perceptions. Their effectiveness relies not only on the document but also on their dynamic presentation in meetings.

Both Beckert (2021) and Doganova and Eyquem-Renault (2009) underscore that the business plan plays a key role for early ventures in enticing potential investors. While Doganova and Eyquem-Renault (2009) place greater emphasis than Beckert (2021) on the performative role and evolving nature of the business plan, it remains, as argued by Latifi et al. (2023), a static document. Latifi et al. (2023) establish a clearer distinction between the business plan and the pitch deck. The business plan leans towards analytical depth and textual substance. It involves meticulous projections about the venture's future, catering to both internal and external stakeholders. Conversely, the pitch deck takes a much shorter and visually more engaging format. It is specifically targeted to potential investors with the primary goal of captivating interest and prompting further exploration. In a study exploring the role of business plans in venturing, Latifi et al. (2023) reveal a diminishing appeal of comprehensive business plans among financiers. The decline is attributed to factors such as investor time limitations and an uncertain and rapidly evolving market landscape, which raises doubts about detailed, long-term projections (see also Brown & Michael, 2003; Garud et al., 2014b).

Latifi et al. (2023) contend that a broader shift in social norms in venture capital is underway, moving the focus from traditional business plans toward adopting digital tools for communicating and evaluating prospective performance. New methods for presenting business ideas encompass various modalities, including concise PowerPoint presentations, the business model canvas, lean prototyping, pilot experiments, and brief videos. The authors unveil an intriguing paradox by examining 301 nascent ventures. Whereas founders frequently believe that business plans are indispensable for obtaining external equity funding, investors, in contrast, lean towards utilizing alternative tools to assess the viability of investing in a new venture.

3.6 Theoretical framework

This literature review has delved into the multifaceted challenges faced by new ventures stemming from their inherent obscurity, lack of an established track record, profitability, and a clear identity. These challenges are further compounded when ventures operate within nascent industries characterized by competing visions of the future. In such contexts, the emerging market category itself lacks established structures and demonstrable viability, resulting in a deficit of trust and recognition among external stakeholders. This review has shown how narratives emerge as a powerful means for new ventures to address these challenges. Operating through suggestion and identification, narratives provide compelling reasons for belief when external validation is lacking.

Amidst a growing body of literature, the definition of an entrepreneurial narrative and its focal content remains elusive and occasionally yields contradictory interpretations. This review has synthesized input from multiple perspectives to address the ambiguity. In essence, narratives encompass the stories told about entrepreneurs and their companies. An entrepreneurial narrative serves several essential purposes: it communicates a coherent venture identity, enhances the accessibility of the opportunity, captures attention, fosters legitimacy, attracts support, and serves as a catalyst for action geared toward evolving goals. Narratives manifest in a spectrum of forms, ranging from smaller story fragments to grand narratives, and are thereby ingrained in the everyday practices of strategy and entrepreneurship. A compelling narrative possesses internal coherence and external resonance with the norms and beliefs of its intended audience. Narratives typically comprise three essential components: a narrative subject (the entrepreneur or the new venture), a goal (encompassing objectives such as securing funding or achieving profitability), and a set of influential forces within the business and societal environment that either facilitate or hinder progress. Metaphors, analogies, and visualizations serve as rhetorical tools to enhance comprehension, especially within nascent market categories. In summary, the literature highlights how narratives influence and mold entrepreneurial action, providing valuable insights into the dynamics of venturing into emerging industries.

Acknowledging the pivotal role of narratives, the literature diverges on their central content. This review compares two predominant approaches: one focusing on entrepreneurial capital and the other emphasizing expectations. This thesis contends that the two approaches address different aspects of why a venture is likely to succeed in its intended endeavor. Narratives that emphasize entrepreneurial capital focus on explaining *why* a venture is qualified. Conversely, narratives highlighting expectations aim at gaining legitimacy through shedding light on *what* the venture aims to achieve and *by when*. Furthermore, the literature explored has shown that entrepreneurial narratives develop over time, evolving in tandem with the maturation of the venture and the industry. As the level of maturity increases, the focus of the entrepreneurial narrative shifts from emphasizing industry-level legitimacy to highlighting the distinctive characteristics of the venture. Similarly, narratives about expectations become more precise as knowledge about the industry and opportunity accumulate. Figure 5 synthesizes these insights, illustrating the evolution of entrepreneurial narratives over time. It is an adaptation of the original model on cultural entrepreneurship developed by Lounsbury and Glynn (2001).

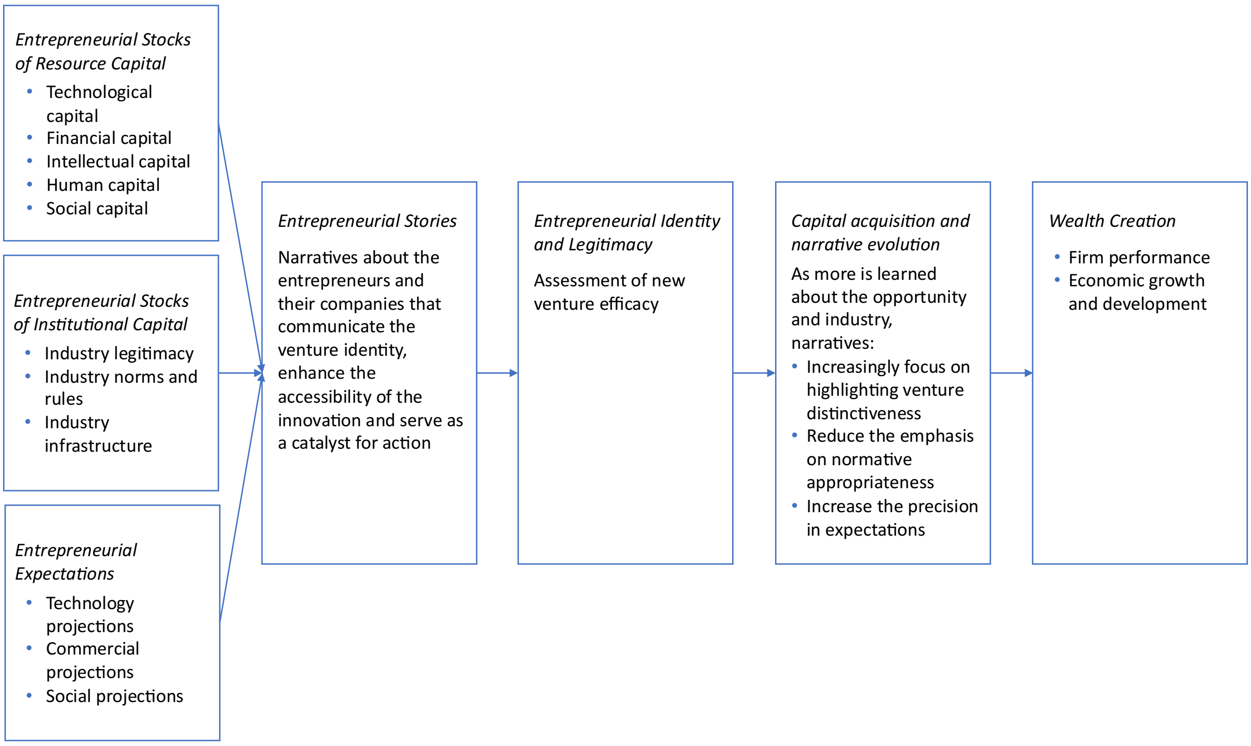


Figure 5: Model for the development of entrepreneurial narratives as the venture journey unfolds

Originally based on the model for cultural entrepreneurship developed by Lounsbury and Glynn (2001, p. 547)

Next, this thesis aims to provide a rich understanding of entrepreneurial narratives through an empirical study of a nascent, deep tech venture. The focus turns to an in-depth exploration of how SemiQon Technologies creates and employs narratives to establish its presence within quantum computing. The inherent complexity and uncertainty surrounding quantum computing offers an ideal backdrop for a thorough exploration of narrative dynamics in the entrepreneurial process.

4 Research methods and material

This case study is set in the context of developing a new business in the emerging market category of quantum computing. The featured company, SemiQon Technologies, is a component producer for quantum computers operating on superconducting qubit technology. The study aims to uncover the processual mechanisms at work through an in-depth, analysis of the company narratives. The approach is somewhat exploratory, as previous research on the use and impact of entrepreneurial narratives in venturing into deep tech is limited. This chapter will delve into the research approach, elaborating on the research focus, data collection approaches, and methods of analysis.

4.1 Research focus

The focus of this study is on the narratives crafted by SemiQon and its founders, targeting specifically the company's two primary stakeholders during the pre-seed stage: *investors* and *the research community*. Investors are pivotal in providing funding and guidance for the company's development and growth. Exploring the narratives crafted for investors shows how the company strives to establish its commercial credibility and secure necessary financial support. Conversely, the research community represents potential early partners and customers. Examining narratives tailored for this group offers insights into how SemiQon aims to establish technical credibility and legitimacy in its customers' eyes. The knowledge level in quantum computing will likely vary between these stakeholder groups, with researchers typically having deep technical expertise and investors relying more on commercial and strategic insight. This inherent contrast provides a unique opportunity to explore how narratives are adjusted to suit the audience's level of expertise, interests, and normative frameworks.

With these limitations, many stakeholder groups remain outside the direct focus of this study. Excluded stakeholders include, amongst others, employees, regulatory bodies and prospective customers beyond the research community, including manufacturers of quantum computers or supercomputers. However, much of the examined public content also caters to broader audiences. It is noteworthy that, for a more comprehensive understanding of the narratives at play, the investigation could encompass a wider spectrum of stakeholders.

Lastly, the study is limited to exploring planned entrepreneurial narratives in contrast to exploring more spontaneous narratives (to revisit forms, see Table 3: Modes for sharing entrepreneurial narratives). This restriction focuses the study mainly on documented narratives shared in writing as opposed to field observations. Limiting the scope allows for a more in-depth analysis of the chosen forms of communication to uncover nuances, characteristics, and implications of how these narratives have formed, shaped actions, and influenced different audiences. The study does, however, not account for real-time contextual variations and dynamics that could be observed through direct field engagement.

4.2 Research data

To explore the narratives at work, this study relies on semi-structured interviews with internal and external stakeholders held between March and November 2023, alongside documentation produced by SemiQon and its founders from June 2022 to August 2023. The explored documentation includes the company webpage, press releases, presentations, social media content, and email exchanges. Additionally, the study examines the evolution of entrepreneurial narratives over time. Combining an analysis of interview data with documentation helps reduce bias introduced by retrospective accounts. This approach enables the study to compare various manifestations of the company narrative to gain a more comprehensive perspective. With these restrictions, the analyzed content is summarized in Table 4.

Table 4: Data and materials

Data	Amount	Focus	Additional information
Interviews	11	Internal interviews with the founding team External interviews with investors and scientists	Semi-structured interviews were conducted from February to November 2023. External interviewees included individuals who have evaluated the SemiQon opportunity.
Internal company documents	6	Business plan presentation to investors	Six versions of the same document introducing the company's business plan, created between June 2022 and March 2023.
	1	SemiQon technology presentation	Version 2.1. of the SemiQon Technology presentation, mainly targeted to the research community.
	1	Email conversation	An email discussion consisting of seven messages between SemiQon and a quantum computing research group.
Press releases	1	Initial press release	The initial press release announcing the launch of operations.
Website	Entire website	www.SemiQon.tech	The main focus is on the *About SemiQon* section, which outlines the company's grand narrative and its evolution, as confirmed using the Wayback Machine Internet Archive.
LinkedIn posts	181 posts	All company and founder posts on LinkedIn	Data includes posts made by the SemiQon account and its founders from March to the end of August 2023.

4.3 Data analysis

The research employs an inductive approach to analyzing entrepreneurial narratives by SemiQon and its founders. Given the stated limitations, the study examines narratives from four distinct angles. Firstly, it examines *the expectations* set by the company regarding its future, investigating the founders' use of cognitive tools in shaping these projections and how these expectations have impacted the company's overall trajectory, and consequently, also its narrative. Secondly, the research delves into the *intended narratives* for investors and the research community based on interviews with the founders. Thirdly, it analyzes the *actual narratives* shared, drawing from internal and external company documentation. Lastly, it explores the *information needs* for opportunity evaluation as perceived by the interviewed investors and scientists.

The primary emphasis of the analysis is on a detailed examination of the narratives actively disseminated by the company. This encompasses a thorough review of both private and public documentation. Private material includes the company's business plan for investors and the technology presentation targeted to scientists. Given the confidential nature of these documents, the findings are presented on a general level, with the primary objective of identifying how narrative structures, content, and practices have evolved during the early stages of the entrepreneurial journey.

Conversely, the scrutiny of public documentation involves a more meticulous review. Passages are systematically coded and categorized based on the type of content that lends legitimacy to the narrative. This categorization tracks how the content of entrepreneurial narratives has developed in the first six months after the public launch of operations in March 2023. A qualitative assessment aids in identifying the principal arguments advanced by the company, enriching the categories and narrative developments with deeper significance. In addition to unveiling the processual mechanisms of narratives in deep tech venturing, this analysis seeks to validate the theoretical framework.

While this methodology for investigating narratives holds its merits, it is crucial to acknowledge its limitations. For instance, involving additional researchers in content categorization could have ensured a more robust outcome. It is also important to note that the focus is mainly on planned and documented communications. Other forms of communication, such as informal discussions or unscripted interactions, are outside the scope of this analysis. These limitations will be considered when interpreting the findings of the study.

5 Findings

This chapter delineates and analyzes the narratives produced by SemiQon from four distinct viewpoints: the establishment of expectations, the intended narrative, the actual narrative, and the information requirements of their key stakeholders. The study focuses on narratives specifically oriented towards two primary target audiences: investors and the scientific community.

5.1 Creating expectations

To understand the formation of the SemiQon narrative, the analysis begins by reviewing the future expectations set by the founders. It is crucial to comprehend the formation and impact of these expectations on the company's overall trajectory, as they play a defining role in shaping its narrative. These insights have been gathered through interviews with the founding team.

The idea of pursuing SemiQon started as an unstructured conversation between the founders in the spring of 2022. Around this time, Voima Ventures, an early-stage venture capital firm specializing in deep tech, expressed an interest in investing in quantum computing hardware. This interest catalyzed Himadri Majumdar, Janne Lehtinen, and Mika Prunnila to focus on actively defining and pursuing their identified opportunity. The first version of a concrete company narrative took shape in the summer of 2022 when the founders documented their business plan exclusively for Voima Ventures. The resulting PowerPoint presentation added structure to their exploratory efforts. It emerged as their primary tool for clarifying ideas, setting objectives, identifying key stakeholders, and outlining anticipated deliverables. Additionally, the founders used Excel to create an expenditure estimate and a rudimentary Gantt chart to visualize tasks and timelines. In the initial planning phase, the founders received valuable guidance from an external advisor with a proven track record in building companies.

The founders constitute the core decision-making group for the company's strategic direction. Thus far, their consensus-building process has been emergent and straightforward. Despite early clarity regarding the technological approach, the founding members encountered a series of pivotal decisions in the initial phases of the company's establishment. Their first significant decision was to opt for specialization over a full-stack approach, made to prevent excessive funding needs. This choice aligned with their personal interests and enabled the team to stay focused on technology development rather than succumbing to investor pressure due to the high operational costs associated with a full-stack approach. The second critical decision centered on actively seeking public funding. Recognizing that specialization required partnerships and that these partnerships made SemiQon eligible for public funding, the founders leveraged their in-depth knowledge of the European policy landscape to position themselves favorably for securing public funding. Lastly, the founders deliberately positioned SemiQon as a product-oriented company rather than a service-oriented one. This decision was grounded in recognizing that early customers in the research community were likely to demand customized products, potentially leading the company toward a service-oriented model. However, SemiQon consciously prioritized standardization and scalability as their strategic direction. These decisions formed the foundation for setting early external expectations and have become central to the company narrative.

Moreover, the founding team decided to participate in the VTT LaunchPad program as a strategic move to streamline their access to valuable intellectual property and, more importantly, to leverage the institutional credibility of the Technical Research Centre of Finland. The association with VTT signifies a commitment to research-driven innovation and adherence to rigorous scientific standards attributes highly esteemed among their target audiences.

While SemiQon has a well-defined initial direction, the founders acknowledge that their approach may evolve based on obtained results. Their exploratory product development approach aligns with the inherent nature of deep tech, a dynamic they argue is familiar to deep tech investors. Collectively, the founders have adopted a pragmatic and realistic approach to expectation-setting, avoiding excessive hype and recognizing that their most informed estimates remain educated guesses. Except for defining commercial milestones, setting expectations has been marked by a high degree of consensus among the founders.

Expectations have, with some exemptions, mainly been expressed in qualitative terms, lacking support from numerical data or specific timelines. The subsequent sections offer a more in-depth description of SemiQon's primary operational expectations, as conveyed to both investors and scientists.

SemiQon's expectations regarding technology development

SemiQon's pre-seed goals are set within a two-year timeframe. During this period, the company aims to make incremental yet steady progress in both qubit count and quality. As one of the founders emphasized, "We are not making any quantum leaps to thousands of qubits in this period." These expectations have evolved organically and in consensus, grounded in the founders' extensive subject matter expertise and their strategic insights into industry dynamics, including competitor abilities and limitations.

Although not publicly disclosed, the company has communicated selected milestones in technology development to investors. The primary expectations include generating intellectual property, conducting efficient fabrication iterations, addressing the performance of spin qubits, and demonstrating qubit count advancements (see Figure 6). Their technological commitments also encompass quality benchmarks, including setting minimum thresholds for qubit coherence (the duration a qubit retains information) and noise levels. These projections serve as guidance, influencing prioritization and decision-making within the team.

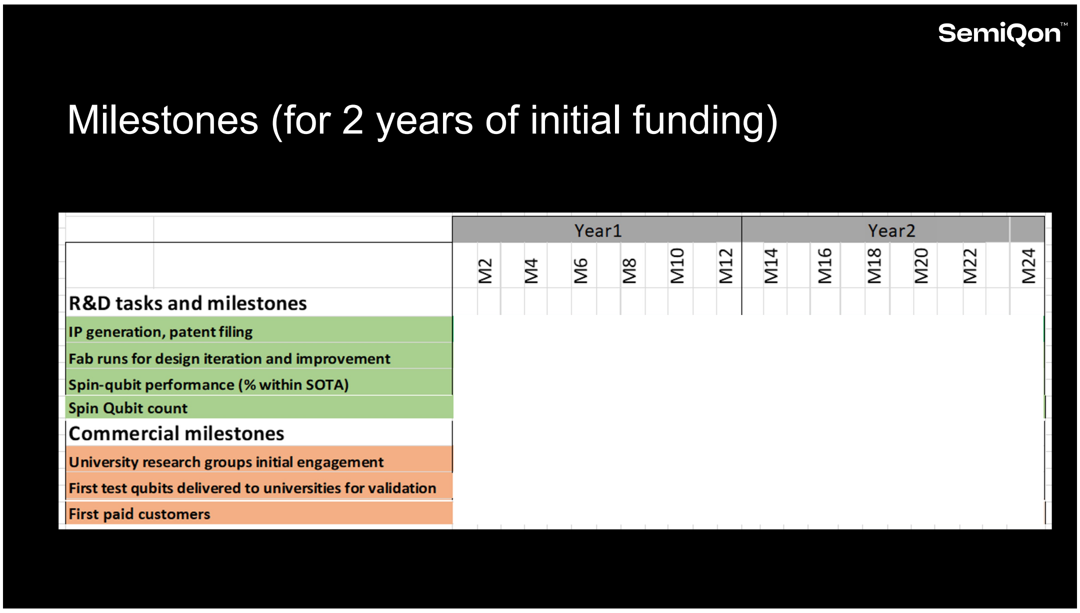


Figure 6: Milestones set by SemiQon for the first two years of operations from the latest business plan presentation to investors. *SemiQon Technologies.*

Note that the timeline to the right of the image has been redacted to ensure the confidentiality of sensitive information.

SemiQon's foremost commitment to its early customers within the research community is the timely delivery of dependable devices. The company recognizes that its future success relies on gaining validation from the scientific community—such validation results in word-of-mouth endorsements, which, in turn, builds traction for its technology. Since scientists rely on SemiQon's processors for their research, meeting their expectations is paramount.

SemiQon's expectations regarding commercial development

The founding team initially disagreed about commercial milestones, preferring to concentrate solely on technological development and to communicate commercial prospects on high-level, qualitative terms, as exemplified in the below PowerPoint slide included in both the company's business plan presentation to investors and its technology roadmap shared with the expert community (see Figure 7).

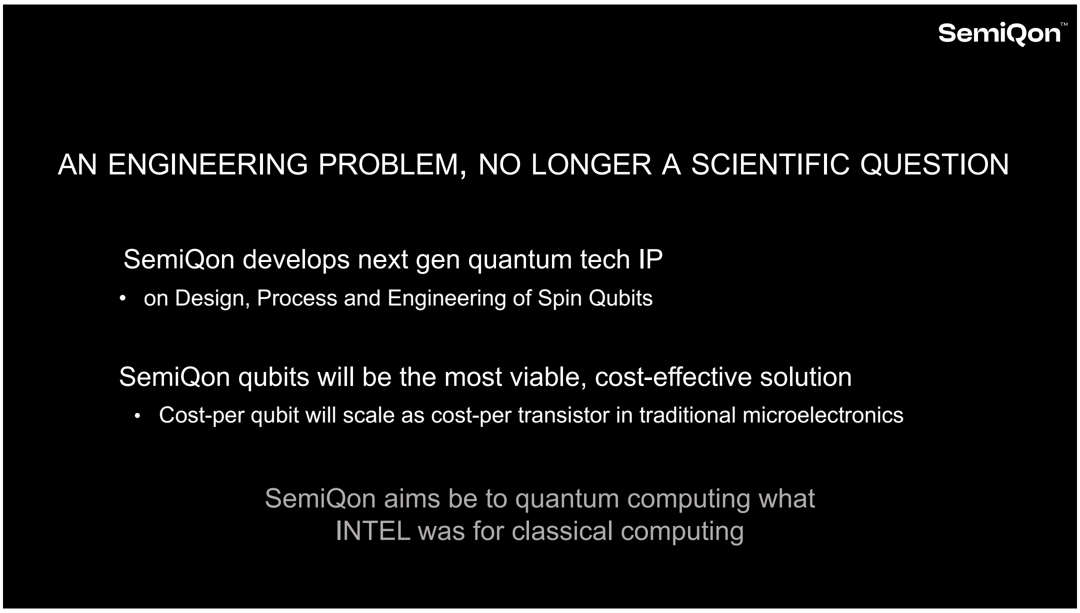


Figure 7: Slide five from the latest business plan presentation to investors. *SemiQon Technologies.*

The founders, however, acknowledge the significance of setting commercial milestones to attract investors. Initially, the CEO proposed a more aggressive timeline, which faced opposition from the more technically oriented team members. The founders have intentionally maintained pragmatic expectations regarding commercial milestones. As one founder stated, "We have made commitments, but we have not overpromised." The agreed-upon milestones are non-numerical, including a timeline for tasks including identifying collaborating universities, conducting initial validation and testing, and estimating when the company can acquire its first paying customers, similarly shown in Figure 6 on the previous page.

The team is uncomfortable making revenue projections due to the inherent uncertainty in market predictions for early-stage deep technologies. According to one of the founders, "Revenue projections become clearer only after obtaining the first paying customers." The primary revenue source will continue to be predicated on the promise of successfully developing the leading-edge technology. Transitioning beyond scientific research depends on reaching a critical qubit quality threshold for practical computing. Until this milestone is achieved, the product primarily serves the specific needs of the scientific community.

While scientists are not particularly interested in SemiQon's commercial prospects, the founders emphasize that scientists still require information about the company's expected revenue development. Receiving the first devices for free, customers will eventually have to share the development expenses. Thus, scientists need precise data on technology costs for their research proposals.

Commercial projections are intentionally excluded from the public narrative. Nevertheless, the founding team acknowledges the growing need to incorporate revenue projections in investor communications in response to investor requests.

Additionally, changing circumstances, such as forming new partnerships, could suddenly and significantly affect their outlook, prompting the need to incorporate revenue expectations.

SemiQon's expectations regarding the benefits of its product

> "Our technology allows us to fabricate quantum processors in a way that supports scaling up manufacturing efficiently while also lowering costs. The chips we manufacture also enable the quantum computer to operate at warmer temperatures – thus requiring only a fraction of the energy needed for alternative solutions." (SemiQon Technologies, n.d.-a)

The central promise of silicon-based quantum processors communicated across channels is their competitive advantage over competing technologies achieved through greater scalability, affordability, and sustainability. These arguments are supported in public channels solely by qualitative reasoning. Scalability and cost-effectiveness are accomplished using standard materials and existing manufacturing processes. Additionally, sustainability is enhanced by developing processors capable of operating at higher temperatures than competing alternatives.

Numerical data on the competitive advantage of the SemiQon processors have been included only in later versions of private documentation shared with investors and scientists (explored in more detail in chapter 5.3). This data consists mainly of comparisons with other qubit technologies on scalability and operational temperatures. These comparisons have been included as the founders have learned more about the opportunity as well as of the information needs of their target audiences.

SemiQon's expectations regarding team size development

The focus on specialization enables SemiQon to achieve its initial objectives with a compact team. Consequently, the company anticipates that its team size will experience limited growth in the initial two years; see Figure 8, which outlines the team growth narrative. A key element of this strategy is the active engagement of external partners, which effectively serves as a form of outsourcing. This approach allows SemiQon to concentrate on developing the semiconducting processor while relying on partners to handle complementary tasks, such as developing read-out electronics.

Figure 8: Slide 22 from the latest business plan presentation to investors. *SemiQon Technologies.*

SemiQon's expectations regarding industry development

SemiQon has refrained from speculating about achieving quantum advantage, which denotes when quantum computers can outperform classical computers in solving practical problems faster, more affordably, or more efficiently. Expectations regarding the achievement of commercial use of quantum computing have primarily been shared with investors in private discussions for educational purposes.

SemiQon's expectations regarding funding needs

The team has opted not to specify a total development cost for their technology, aligning with deep tech's exploratory nature and extended development timeline. Instead, they have chosen to convey expectations regarding the burn rate of funding for the initial two years, which is vital for their internal understanding and planning. The team has, however, firmly established its intent to pursue public funding as a pivotal element of the company's funding strategy, effectively extending its financial runway before additional private capital is needed.

5.2 The intended narrative

This section will first shortly focus on how the labor division has evolved within the team concerning communication with key stakeholders. Subsequently, the focus shifts to what the Semiqon team aims to share with investors and scientists, respectively, and how the intended narrative has evolved since the early narrative set in the summer of 2022. This overview has similarly been gathered through interviews with the founding team.

The allocation of responsibilities within the company has evolved naturally through discussions, reflecting the founding team's expertise, relationships, and interests. The CEO Himadri Majumdar oversees management, external communication, and commercial relationships, drawing from his established connections and thought leadership in science communication predating SemiQon. Janne Lehtinen and Mika Prunnila are primarily engaged with the scientific community, with Lehtinen focusing on technical expertise and Prunnila on securing potential public funding. Markku Kainlauri, an expert in cleanroom operations, concentrates on that domain. The team maintains clear boundaries, with the CEO focusing on business aspects while avoiding technical discussions. When approaching new stakeholders, the CEO initiates discussions with broad concepts, bringing in the team for technical matters. All team members nurture connections with their existing relationships, involving the CEO when starting partnership discussions.

According to the founders, the company narrative has evolved and become more refined through interaction with the audience. This development is attributed to learning about the expectations and information needs of the audience and adjusting the narrative accordingly. The founders highlight that the dynamics of engagement differ between investors and researchers, the two main stakeholder groups in this study.

The intended narrative for investors

According to the founders, attracting attention to quantum computing is no longer a challenge, but sustaining interest is difficult. The difficulty arises because investors generally lack a scientific background in quantum and related technologies, making it challenging to comprehend intricate details and compare different approaches within quantum computing. As a result, one of SemiQon's main objectives is to make both the quantum industry more accessible and the company's particular approach within it more attractive. As semiconducting approaches trail behind other modalities in qubit count, analogies and simplified visual representations of SemiQon's approach to technology development have become crucial for distinguishing the company favorably from the competition. The CEO underscores the importance of simplifying concepts, as overly complex explanations can deter investors and lead to unnecessary delays in development, as exemplified by the quote: "Sometimes scientists can be their own worst enemy by scaring people off". A growing part of the company's narrative to investors revolves around reducing information asymmetry using technical and market analogies, explored in more detail in the following subchapter. Although obtaining real-life examples related to quantum computing is challenging, the founders make inventive efforts to bridge this gap.

In its early narrative, SemiQon drew a comparison to Intel to enhance the accessibility of its opportunity. "We are the Intel of quantum computing. Intel manufactures chips, as do we. Just like Intel changed the game for classical competing, we are trying to change the game for quantum computing." However, as Intel is also involved in developing semiconducting qubits, SemiQon must simultaneously clarify how the company differs from Intel. This has led to a new comparison with the automotive industry, particularly between Tesla and incumbent car manufacturers. Tesla adopts a vertical integration strategy, constructing the car from the ground up and controlling various stages of the production or distribution process. In contrast, traditional car companies often acquire necessary components, concentrating on the assembly, including the integration of batteries. SemiQon aligns itself with Tesla in this analogy, emphasizing its ground-up technology development and integration of batteries and powertrain as the more disruptive approach.

Another objective in investor communications is to manage expectations within the broader quantum field, particularly considering the soaring expectations prevalent among many industry players. This requires educating investors about the industry's current state and what is realistically achievable in the near to midterm. According to the founders, investors are primarily interested in the technology's commercial potential. While this approach differs from the funding members' preferences, the team has included commercial milestones in its objectives and communication. The overarching goal is to balance optimism and realism regarding the company's path to industry leadership and to shape expectations for when it achieves a prominent position. The narrative aims to present an attractive vision of the future while acknowledging the associated risks. In routine communications, the emphasis is on highlighting step-by-step progress.

Over time, the importance of public funding in the context of the quantum industry and the role of geopolitics have evolved into central themes in the company's intended narrative, not just for investors but also for policymakers. Firstly, the narrative provides insight into funding structures for deep tech, recognizing that government support in Europe is crucial for sustaining deep tech development, especially in the absence of private funding comparable to that in the US. As active participants in the European quantum industry, the founders acknowledge Europe's drive to expand the exploration of quantum modalities to gain a competitive edge. SemiQon's approach aligns well with these objectives. This narrative additionally highlights the essential role of entities such as the European Innovation Council in fostering the creation of research-based companies in Europe and the funding injection into semiconductor development through the European Chips Act.

Secondly, the geopolitical narrative underscores Europe's efforts to catch up with Southeast Asia in semiconductors for traditional computing while simultaneously emphasizing Europe's potential leadership in quantum technologies. The synergy created by combining both technologies offers a robust competitive advantage and a significant market opportunity. Gaining the attention of policymakers is beneficial as it can encourage the allocation of public funds to European institutions supporting quantum development, for which SemiQon is eligible.

According to the CEO, building trust among investors relies 90% or more on the technical credibility of the team. He underscores how the main building block for trust is past actions and a robust track record within the scientific community. Since many investors lack the knowledge to thoroughly assess the feasibility of different approaches to quantum computing, they often rely on their advisory networks, which commonly consist of university professors and other scientific experts and investors. Personality and confidence also play an important role in building trust. These aspects are more related to the communicative and narrative efforts of the entrepreneurs. For example, the CEO emphasizes the significance of confidently discussing the commercial roadmap in investor communications as a key element in building belief in the opportunity.

Effective communication with investors encompasses various methods, such as dialogue, meetings, email correspondence, and active involvement in scientific conferences. The documentation shared primarily includes presentations and emails. LinkedIn is the primary channel utilized to reinforce the company's narrative and generate excitement, given its prevalence among investors and policy professionals. While acknowledging that X (formerly Twitter) is a channel that this audience follows, it remains a channel of limited focus and sporadic use for awareness creation. In addition to the SemiQon company profile, only the CEO is present on X.

The intended narrative for researchers

The target audience within the scientific community consists of a few hundred researchers worldwide who focus on SemiQon's chosen approach. These scientists are affiliated with universities and research institutions globally. Many of these scientists have longstanding connections with the founders or, at the very least, are aware of its ongoing initiatives. Their primary interest revolves around understanding SemiQon's technological approach and commitment to addressing specific challenges. Of particular concern is the quality and capabilities of the qubits, as they form the foundation for conducting research using SemiQon's processors. Additionally, the readout electronics or control stack responsible for governing and manipulating qubits assumes a vital role in scientific assessments.

SemiQon's significance to this audience lies in its access to semi-industrial production facilities, its commendable CMOS capabilities, and the potential for scalable production. According to the founders, substance holds more weight for scientists than grand promises or financial figures. Therefore, prioritizing fact-based communication is essential. Maintaining transparency when information is unavailable is fundamental for building trust. While the company openly communicates its milestones to investors, scientists are informed on a need-to-know basis. The content varies depending on the partnership; for instance, some researchers receive information about fabrication runs, while others are updated on the performance of spin qubits. The communication strategy with scientists is rooted in pragmatism, emphasizing the importance of disseminating information only when substantial updates are available. This approach avoids premature hype and ensures that actual results are presented as significant achievements.

Similarly to investors, establishing trust among scientists is heavily contingent on the past track records of team members. Trust plays a pivotal role, especially within the small community of researchers focusing on the modality SemiQon is developing. Word of mouth from fellow scientists is essential in instilling confidence in SemiQon's capabilities before the company has a proof of concept. To advance to the next level of experiments in quantum computing, scientists require stable devices. Therefore, maintaining the trust is further contingent upon delivering reliable devices within the communicated timeline. As scientists often support local technologies, receiving recommendations is critical to gaining a foothold in competitor regions. Interest and excitement among scientists are generated by highlighting the technological progress that has been made.

Effective communication with scientists involves a variety of approaches, including, amongst others, dialogue, meetings, emails, and active participation in scientific conferences. The materials shared with researchers come in various formats, from informal emails to presentations and measurement data. While LinkedIn is an important channel to reinforce the company narrative, the founders acknowledge that scientists are generally inactive on the platform, and some may even be absent. Hence, relationship building remains the most impactful way to influence both existing and new connections.

In summary, the intended narratives for investors and scientists vary based on the founders' comprehension of the information needs and normative frameworks specific to each target audience. The primary emphasis in the investor narrative is on effectively communicating the commercial potential and competitive advantage. It seeks to mitigate information asymmetry, enhancing the opportunity's appeal by simplifying complex topics and educating investors about both the industry and the pursued opportunity. In contrast, the intended narrative directed at scientists is fact-based and primarily centered on the technology, with fewer elements of suggestion and identification typical to narratives. This communication seeks to inform, with a focus on transparency and the avoidance of hype. To conclude, these findings suggest that the founders aim to convey higher confidence when engaging with investors than with the expert community, aligning well with Brown and Michael's (2003) emphasis on how the entrepreneur's performance of projecting uncertainty or confidence about future expectations will vary depending on the audience.

Within SemiQon, the internal dynamics align more closely with the scientific dialogue. Achievements that might capture investor interest, such as increased LinkedIn followers, hold minimal significance within the company's internal workings. Instead, the primary source of enthusiasm stems from technological advancements. Although uncomfortable with promotional activities, the founders acknowledge their necessity in the business landscape. Two illustrative quotes exemplify this attitude: "We have had to agree that this type of nonsense [referring to social media] must be included to ensure that our message gets across. We need the awareness and brand building to attract partners." Another acknowledgment is that "If we begin to communicate only when we actually have something to show, then we are already too late. When people think about silicon-based processors, they should think about SemiQon". The CEO, however, stands out as an exception, displaying a predilection for external communication and opinion building that predates SemiQon.

5.3 The actual narrative

This chapter delves into the planned and documented narratives disclosed by SemiQon and its founders. As the focus is on exploring the narrative targeted specifically at investors and the scientific community, this chapter initially delves into internal company documentation, including SemiQon's investor and technology presentations. Images and quotes from internal documentation have been incorporated to the extent possible in the subsequent analysis. However, sensitive content has been described rather than shared to omit business-critical information. Subsequently, this chapter examines public documentation in the form of the initial press release announcing the launch of operations and the company website. These channels have been utilized to establish public recognition and support for the company, catering to broader audiences. This analysis yields more concrete examples of the actual narrative. Finally, this chapter examines how the founders have strengthened their public narrative using social media, specifically LinkedIn. This investigation provides insights into the communicative tactics and strategic narratives actively employed by SemiQon.

5.3.1 The investor narrative

The early investor narrative is encapsulated in the first version of the SemiQon business plan, documented as an investor presentation explicitly tailored for Voima Ventures. This plan was introduced face-to-face in June 2022 and consisted of a concise presentation comprising 24 slides. The initial and subsequent versions of the business plan primarily consist of text in bulleted format, complemented by icons, images, and illustrations to enhance comprehension. The presentation offers an overview of SemiQon as a company, explaining its goals, the relevance of its objectives, and outlining how the company plans to achieve them. It addresses key elements such as industry relevance, the estimated quantum computing market size, core concepts, the team, target customers, the competitive landscape, and milestones to be achieved.

The early narrative primarily substantiates the investment opportunity by highlighting the broader potential of quantum computing in qualitative terms. This potential is showcased on a polished slide positioned at the outset of the presentation. It features well-crafted arguments supported by icons that highlight how quantum computing can enable significant advances across diverse applications and industries, including amongst others cryptography, logistics optimization, and molecular modelling. The slide also includes a brief description of the current global landscape in quantum computing, underscoring its relevance for technological sovereignty and national security.

The first version of the business plan, however, lacks contextual information that would help the investor to comprehend the scale of the SemiQon opportunity or to compare the company's approach with that of other companies. The only indication of the size of the opportunity is documented as a footnote on the Mission Statement slide stating: "INTEL of Quantum Computing." Examining the written presentation independently from the verbal pitch suggests that it is specifically crafted for an audience with expertise in the subject. The founders, however, knew that Voima Ventures already possessed a certain level of understanding, given their prior investments in quantum computing.

Voima Ventures provided valuable input that contributed to developing successive presentation versions. Adjustments were made to accommodate that not all prospective investors had prior experience with quantum computing technologies. The second version of the same presentation already places a greater emphasis on analogies to enhance investors' understanding of the opportunity. Firstly, it improves the placement, font size, and wording of the Intel comparison, stating, "Semiqon will be the INTEL of quantum computing." Furthermore, it introduces a clarifying two-slide analogy, drawing parallels between the historical progression of classical computing and the evolution of quantum computing. These slides are enriched with visuals that vividly illustrate the size challenges faced during the early stages of classical computing, both in physical dimensions and capacity. Similarly, it incorporates a timeline showing various approaches to developing quantum computing, helping the audience comprehend and compare different technological approaches. These new comparisons in the company's investor narrative contribute to clarifying both the overall potential of the quantum computing industry (while still highlighting its early stage of development) and SemiQon's unique approach within it in easily understandable terms that do not require expert knowledge.

While the third version features only minor changes, the fourth iteration introduces further parallels to emphasize the strengths of the SemiQon business model. The company's value proposition is now bolstered with a two-slide illustration of the speed advantage of SemiQon's business model. This is achieved through a visual comparison between SemiQon's approach, and the current global standard of iteration runs. In the example, SemiQon can complete multiple rounds of iterations during the same time it takes others to conduct just one. Emphasized through arrows and brief text snippets, this advantage is easily understandable, requiring no specialized industry knowledge. Moreover, the fourth version incorporates a slide highlighting achievements by the SemiQon team, underscoring their human capital and justifying why the team is qualified. However, evaluating the significance of these accomplishments does require in-depth expertise, as exemplified by the achievement "Integrated on-chip quasi-dissipationless cryo-CMOS".

The fifth version incorporates additional updates that enhance the understanding of proportions, making more arguments accessible without requiring technical expertise. For instance, the achievements introduced in the previous version are now presented as world records. Additionally, the concept of operating at warmer temperatures is now contextualized by illustrating the equipment sizes required for quantum computers using different modalities, demonstrating a distinct advantage for

SemiQon. The technical comparison of quantum modalities to achieve this benefit is visually enhanced with an illustration, directly contrasting equipment size with that of a human body. This demonstrates how SemiQon's approach significantly reduces the size of the physical infrastructure needed for quantum computing.

In its fifth version, the presentation also extends the development timeline from the initial two years to ten. A new, ten-year timeline slide visually illustrates the development of qubit count and pricing, introducing specific revenue expectations for the first time. This expansion was triggered by completing the term sheet between SemiQon and one of its initial investors, mandating the inclusion of revenue projections. Acknowledging their significance for other potential investors, these projections were subsequently integrated into the business plan as well.

The most recent iteration of the business plan, Version 6, dated March 2023, consists of 26 slides, a slight expansion from the initial 24. This updated version incorporates the newly established branding of the company. Notably, it introduces three additional slides that, for the first time, present not only visual but also numerical comparisons between SemiQon's approach to developing semiconducting qubits and the more widely adopted competing approach using superconducting qubits. These comparisons distinctly showcase the advantages of SemiQon's approach in qubit control scalability, qubit scalability, and operational temperatures. While these slides remain anchored in complex, scientific descriptions, the inclusion of tangible images and numerical comparisons aids a non-expert audience to understand proportions and compare the approaches under development. Consequently, these slides play a significant role in enhancing the accessibility of the opportunity.

During the interviews about the intended narrative, the founders stressed two core enabling forces: attaining public funding and geopolitical relevance. However, despite the founders' emphasis on public funding, this enabling force held relatively limited significance in the early documentation. The argument is initially introduced only towards the end of the investor pitch, presented as one of several bullet points on the financial roadmap, indicating that expected public funding will commence from the third year. In subsequent updates of the financial roadmap slide, the argument gains prominence as the team provides examples of secured public grants.

On the other hand, the geopolitical relevance of quantum computing is introduced right from the beginning, making this argument a central part of the company's grand narrative. The argument is placed on the first content slide outlining why quantum computing as an emerging market category is of interest. The primary focus of the slide is, however, on highlighting the potential of quantum computing, as previously explored. Arguments related to global rivalry, technological sovereignty, and safety considerations are placed in the lower right corner, indicating secondary importance. The argument resurfaces towards the end of the presentation in a slide labeled "Why Invest".

In line with the literature review, especially referencing the works of Hilkamo and Granqvist (2022) and Lounsbury & Glynn (2001), the successive iterations of the business plan increasingly rely on analogies to clarify the intricacies of the quantum industry and the opportunities it offers. The use and importance of these analogies expand with each version, spanning from June 2022 to March 2023. The founders attribute this evolution to their engagement with the audience, which enabled them to understand the specific information needs of investors and adjust their pitch accordingly. They also emphasized that the ability to craft analogies and visualizations is a skill that has matured and improved over time.

However, in contrast to the findings of Beckert (2021) and Doganova and Eyquem-Renault (2009), the business plan presented during the investor pitch leans more toward being a narrative rather than a calculative tool. It primarily conveys promises through suggestion and identification, offering only limited numerical and financial insight in the form of revenue, cost, or profitability projections. Notably, the commercial milestones are not specified in terms of monetary values, and revenue projections only enter the storyline in the sixth version of the business plan presentation. This approach aligns better with the findings of Latifi et al. (2023), who argue that careful projective calculations have limited relevance for investors in an increasingly volatile and unpredictable market environment. It is important to note that delving into the specifics of the entrepreneurial capital underlying the narratives in the business plan is beyond the scope of this discussion, as this document serves as a strategic and non-public asset for the company.

Summarizing the evolution of documented investor narrative reveals three key insights. Firstly, the role of educating the audience about the broader quantum industry and the SemiQon opportunity becomes more prominent with subsequent iterations. This is achieved by introducing both technology and market analogies. Secondly, during the initial stages of deep tech venturing, detailed numerical and financial projections seem to hold limited significance in securing financial support. This is evident in the predominantly qualitative descriptions of the benefits and potential of the SemiQon opportunity. Thirdly, identity development is a continuous process. This is exemplified by the founders placing greater emphasis on the importance of public funding and geopolitical relevance for pursuing the SemiQon opportunity than what is explicitly indicated in the documentation. This also highlights the limitations of relying solely on retrospective accounts.

5.3.2 The scientist narrative

SemiQon engages with other quantum scientists for two primary objectives: establishing partnerships for joint development and conducting thorough testing on their early products. The SemiQon narrative is communicated to quantum scientists in casual conversations or meetings and presented at relevant industry forums. When SemiQon seeks to partner with a research entity for product validation, the founders typically follow up on discussions with email proposals. The objective is to establish a partnership where SemiQon offers its early processing chip to the research group in question and, in return, receives test results from experiments conducted on the processors. The initial email outreach serves as a brief introduction to SemiQon's approach, often accompanied by a concise company presentation, suggesting a joint meeting to delve deeper into the subject. The subsequent meeting further explores the technology and outlines the following steps, including signing a non-binding letter of intent to formalize the partnership. When successful, the CEO follows up with a request to sign the letter of intent. Based on the analyzed email conversation, this process is straightforward, focused on the practical aspects of arranging meetings and progressing in the partnership development process.

Like the business model presentation for investors, the technology presentation has evolved as both the technology and the company have matured. Version 2.1 already incorporates the company's new branding. The presentation begins with a slide dedicated to a one-sentence introduction outlining the company's overarching goal: "To build Quantum processors from semiconductors and targeting the million qubit era, with SCALABILITY promise." The presentation, however, refrains from specifying timelines for delivering on the ambitious promise or any intermediary steps. While investors receive some insights into the timeline and ambition for qubit count development in written materials, this information is omitted from researchers.

The primary purpose of the technology presentation is to explain *why* the SemiQon team is qualified and *how* they plan to achieve scalability in quantum processors. This involves highlighting the founders' intellectual and human resource capital, such as prior art, including patents, publications, critical know-how (see Figure 9), and achievements thus far, as explored earlier. Furthermore, the presentation provides a detailed overview of SemiQon's technological approach. For instance, one specific slide outlines SemiQon's strategy for addressing what the company has labeled "the interfacing bottleneck". This slide is dedicated to describing *how* SemiQon will solve the bottleneck. In contrast to the investor presentation, limited attention is paid to the substantial benefit of solving the problem achieving lower infrastructure costs. In this way, the technology presentation refrains from stating the obvious to subject matter experts. The storyline centers exclusively on outlining the technological approach, with no inclusion of arguments related to commercial potential, geopolitical relevance, or the company's funding structure. Nevertheless, delving into the accompanying email conversation reveals that public funding is a pivotal element that underscores why SemiQon is an attractive and relevant partner.

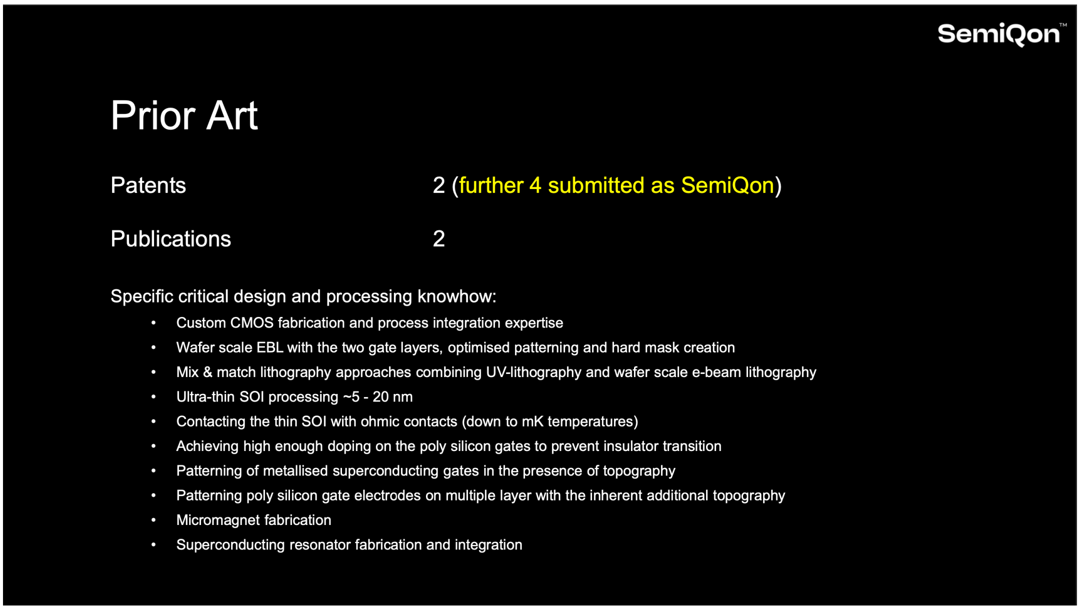


Figure 9: Slide 4 highlighting the founding team's intellectual and human capital from SemiQon's technology presentation. *SemiQon Technologies.*

The technological approach is often demonstrated with illustrations or images, providing a conceptual clarification or comparison to competing approaches. Although the content is concise, presented in bullet points, and the illustrations are simplified, a comprehensive understanding beyond the conceptual level requires subject matter expertise. While the presentation does provide some educational content, especially when comparing different modalities, the primary focus remains on informative rather than educative material.

In summary, when comparing the key documents targeted at the two primary stakeholder groups, it becomes evident that they address different questions. The investor presentation primarily focuses on answering questions about what the company aims to achieve, why this is relevant, and by when. On the other hand, the technology presentation centers around how the team will achieve their mission and why they are qualified. Both rely on analogies, illustrations, and comparisons to enhance the accessibility of the content and the attractiveness of the approach. However, the technology presentation exclusively employs technology-related analogies, while the investor presentation also incorporates market analogies. Again, in line with the reviewed literature (see Brown & Michael, 2003), the communication to quantum experts refrains from projecting substantial certainty, as exemplified by avoiding detailed or long-term projections. Instead, this communication prioritizes substance and technical content, conveying minimal additional or emotional elements.

5.3.3 The public narrative

This chapter examines two crucial sources to establish the company's primary public narrative: the company's initial press release announcing the start of operations in March 2023 and the company website, www.semiqon.tech. The initial press release marks the launch of efforts to establish public recognition and support for the company, including attracting more investors and potential customers. Before its publication, information about the company was notably scarce, as the website provided limited insights into SemiQon as a company (confirmed through the Wayback Machine[1]). Therefore, the press release can be seen to present the first version of the company's overarching, public narrative. On the other hand, the website has seen progressive enhancements and updates. An investigation into the press release alongside the website can thus illuminate the evolution of legitimizing narratives used by the company.

Initial press release

The press release announcing the launch of operations was published on March 14, 2023 (SemiQon Technologies, 2023a). The announcement was picked up by a handful of industry news outlets, including the Quantum Insider and Innovation News Network. Moreover, dissemination was facilitated by key stakeholders, including VTT Technical Research Centre of Finland, the institution from which SemiQon has emerged, and Voima Ventures, its primary financier. The press release comprised a 640-word article and supplemental information, such as a link to the media kit and details about the involved entities: VTT, SemiQon, Voima Ventures, and the VTT Launchpad spin-off incubator.

The press release adeptly establishes a cohesive narrative framework, as explored by Lounsbury and Glynn (2001) and Martens et al. (2007). It introduces the central subject, delineates its ultimate objective, and identifies the catalysts and obstacles at play. In essence, SemiQon is positioned as the protagonist, embarking on developing a novel quantum processor chip utilizing silicon semiconductors. The overarching goal encompasses mitigating the limitations of current quantum computers, rendering them more scalable, cost-effective, and environmentally sustainable. The main enabling forces propelling this pursuit include ground-breaking technology and the social and human capital of the founders, referring to their notable social connections and specialized expertise. Simultaneously, the endeavor grapples with challenges like prevailing constraints in quantum computing and inadequate financial support.

Applying the framework established by Lounsbury and Glynn (2001) to investigate the construction of narratives fostering legitimacy and credibility, the analysis explored the *focal content* of the narratives within the press release. By meticulously examining the press release, all passages were categorized based on the focal content

[1]The Wayback Machine, maintained by the Internet Archive, is an online digital archive that captures and stores snapshots of web pages at various points in time. It allows users to access historical versions of websites and track their evolution over time.

of the argument, following the categorization first introduced by Lounsbury and Glynn in their model for cultural entrepreneurship (revisit Figure 2 on page 23). Next, the word count of each category was totaled to illustrate the distribution of wording and, consequently, the emphasis given to each argument category. Analyzing the proportion of words within each respective category in relation to the total word count yields the following outcomes: The largest proportion of wording, 59%, is allocated to narratives built on the *firm-specific resource capital*. These narratives highlight the distinctiveness of SemiQon. Within this category, the largest emphasis is placed on narratives that delve into the *technological capital*, mainly detailing the potential of the company's innovative approach. However, the actual technical approach is described in very limited and high-level terms. The second largest emphasis is dedicated to highlighting SemiQon's social capital, mainly through credentialing, accentuating SemiQon as a VTT spin-off, and emphasizing notable social connections. Furthermore, the third largest category within firm-specific-resource capital underlines the importance of human capital, namely the expertise and experience of the founders. For a more detailed breakdown of word counts and key arguments within each category of entrepreneurial capital, please refer to Table 5 on the following page.

Table 5: Type of entrepreneurial capital highlighted in SemiQon's initial press release launching operations (SemiQon Technologies, 2023a)

Type of entrepreneurial capital	Secondary category	Sum of words	Share of words	Main arguments	Times repeated
Resource capital	Technology capital	240	37 %	**Potential of innovation**: Develops an alternative to conventional quantum computer chips, making future quantum computers more affordable, scalable, and sustainable.	8
				Features of innovation: Silicon quantum dot-based technology	3
				Physical resources Pilot manufacturing facility	1
	Social capital	69	11 %	**Credentialing:** VTT spin-off	3
				High status network connections: Quoting network connections to VTT and Voima Ventures	2
				(Additional credentialing in supporting materials, through introductions to VTT, Voima Ventures and VTT Launchpad)	
	Human capital	59	9 %	**Key personnel**: Leading experts	4
				Vision: Building quantum processors with millions of qubits	1
	Financial capital	5	1 %	**Funding:** Voima Ventures backs the development	2
Resource Total		**373**	**59 %**		
Institutional capital	Industry infrastructure	115	18 %	**Limitations** Quantum hardware and scalability limitations	6
				Physical infrastructure Existing, large scale manufacturing processes for silicon	1
	Industry legitimacy	110	17 %	**Potential:** Quantum computers to solve some of the world's greatest challenges	3
	Industry norms and rules	36	6 %	**Quantum investment**: Silicon semiconductor qubit technology is underfunded	1
Institutional Total		**261**	**41 %**		
Non-categorized		**8**	**1 %**		
Grand Total		**642**	**100 %**		

Conversely, narratives drawn from *industry-level institutional capital* account for 41% of the total wording. This aspect primarily focuses on highlighting the normative appropriateness of the quantum computing industry. These narratives encompass efforts to bolster the industry's legitimacy (by showcasing quantum's potential to address global challenges), underscore the importance of industry infrastructure (highlighting current limitations in quantum computing and the existing manufacturing capabilities of silicon), and address industry norms and standards (with an emphasis on funding priorities). Similarly, Table 5 presents the breakdown of word counts and key arguments also for this category.

The company website

The company website, www.semiqon.tech, launched in February 2023 and features six sections: *About SemiQon, Team, Technology, News & Insights, Careers,* and *Get in Touch*. While the website remains light, it offers more comprehensive information than the initial press release. Notably, it delves into two additional aspects: the founding team and the technology. The most relevant source for understanding the grand narrative of the company, as presented on the website in August 2023, is the *About SemiQon* section (SemiQon Technologies, n.d.-a). This page serves as the critical reference point for analyzing how the company's narrative has evolved during its inaugural six months of operations.

To start with, the About SemiQon section introduces largely the same narrative framework, as the initial press release. Essentially, SemiQon, the protagonist, aims to improve scalability, efficiency, and sustainability with a novel quantum processor. Enabling forces, such as groundbreaking technology, specialization, and the social and human capital of the founders, are at play, while hindering forces include constraints in quantum computing and geopolitical rivalry.

However, utilizing the same approach as in the previous section to analyze the focal content of the arguments in the *About SemiQon* section, reveals a different breakdown: 77% of the wording emphasizes firms-specific, resource capital, while the remaining 23% concentrate on industry-level, institutional capital. This shows a change in focus, directing attention more towards the unique attributes that distinguish SemiQon as a company rather than emphasizing the normative appropriateness of the quantum computing industry. In contrast, the initial press release, displayed a more even, 59%-41% division between narratives highlighting resource versus institutional capital. This contrast becomes even more pronounced when considering the entire website's content. A substantial 90% of all narratives on the website[2] are rooted in highlighting SemiQon's resource capital, or the "firm-specific value-enhancing assets and capabilities (rare, inimitable, tangible, and intangible assets) that shape the fortunes of organizations" (Lounsbury & Glynn, 2001, p. 548). Table 6 provides more detail on the share of wording emphasizing resource or institutional capital as well as the main arguments under each secondary category.

[2]This excludes webpages headers, footers and news articles

Table 6: Type of entrepreneurial capital highlighted in the About section on the company website on August 30, 2023 (SemiQon Technologies, n.d.-a)

Type of entrepreneurial capital	Secondary category	Sum of words	Share of words	Main arguments	Times repeated
Resource	Social capital	165	23 %	**Credentialing:** VTT spin-off	3
				Network connections: Backed by influential investors	1
	Technological capital	165	23 %	**Potential of innovation** Making future quantum computers more affordable, scalable, and sustainable	4
				Features of innovation Silicon-based quantum processor	4
				Physical resources Pilot manufacturing facility	1
	Human capital	114	16 %	**Vision:** Realize the promise of quantum computing	3
				Key personnel: Experienced experts	3
	Organizational capital	70	10 %	**Business model:** Specialization	2
	Financial capital	28	4 %	**Funding:** 2MEUR in funding secured	1
Resource Total		**542**	**77 %**		
Institutional	Industry infrastructure	64	9 %	**Limitations** Quantum hardware and scalability limitations	2
				Physical infrastructure Existing, large scale manufacturing processes for silicon	1
	Industry legitimacy	52	7 %	**Potential of quantum:** Quantum computers to solve some of the world's greatest challenges	1
				Uniting with others: Featured on Quantum podcast	1
	Political and social landscape	45	6 %	**Geopolitical relevance**: Boosting European technological sovereignty and competitiveness	2
Institutional Total		**161**	**23 %**		
Grand Total		**703**	**100 %**		

It is however worth nothing, that individuals visiting the SemiQon website are likely to do so because they have already encountered information about the company or quantum computing through other sources. Consequently, it is reasonable to assume that visitors to the website possess a certain level of familiarity with quantum computing, reducing the need to establish the legitimacy of the industry. To derive more substantiated conclusions regarding a shift in the focal content of narratives, an extended investigation into press releases and website development over a more extended period is warranted.

Compared to the press release, the About SemiQon webpage introduces two new narratives: a business model centered around specialization (an example of human capital) and the geopolitical relevance of strengthening quantum capabilities in Europe. The following quotes illustrate these arguments (SemiQon Technologies, n.d.-a):

> On specialization: "We see that specialization is speeding up in the quantum field and believe that the entire industry and ecosystem will benefit from more companies doing fewer things."

> On geopolitical relevance: "We benefit from an existing industry, which will support the scale-up and commercialization of our technology and boost the European competitiveness and technological sovereignty in quantum."

Emphasizing how SemiQon can enhance European competitiveness and technological sovereignty introduces a new form of institutional capital stemming from broader political and societal developments—a concept not covered by the categorization developed by Lounsbury and Glynn (2001). This geopolitical narrative was introduced to the About SemiQon page in May 2023 (as confirmed by the Wayback Machine internet archive). On May 8, the company additionally dedicates an entire CEO opinion piece to the narrative, published under *News and Insights* (Majumdar, 2023b). One explanation for this shift can be traced to contemporary societal dynamics at the time, marked by escalating geopolitical competition, the war in Ukraine, energy crises, and semiconductor chip shortages. Additionally, the influence of key stakeholders within the SemiQon network may have played a focal role in steering the narrative development. This reasoning is supported by a news article covering the company's May 8, 2023 launch event (SemiQon Technologies, 2023b). According to the article, prominent speakers, including a member of the Finnish parliament and the CEOs of VTT and Murata Electronics Finland, highlighted the growing significance of quantum and critical technologies for Finland and Europe. The speakers emphasized the impact of political and societal developments such as The European Chips Act, Finnish NATO membership, and the increasing focus on geopolitical competition and technological sovereignty.

Expectations in the public narrative

Lastly, the focus shifts from exploring the focal content of the narratives to shortly analyzing the expectations set within them. Comparing the expectations set by SemiQon in the initial press release to the expectations set on the website reveals the following narrative evolution. Firstly, the confidence level projected in the company's vision is markedly stronger on the website than in the initial press release. In the press release, the vision is vaguely articulated with the phrase: “This could ultimately enable the building of quantum processors that will require millions of qubits for fault-tolerant operation”(SemiQon Technologies, 2023). In contrast, the website presents a more assertive vision: “At SemiQon, we build quantum processors for the million-qubit era”(SemiQon Technologies, n.d.-a). Notably, this bold vision was already prominently featured on the website at its launch in February, as confirmed by the Wayback Machine.

Considering these expectations from a problem-solution perspective, SemiQon’s solutions effectively promise to address three significant challenges that currently hinder the global development of quantum computers: scalability, affordability, and sustainability. This message is consistently conveyed in both sources, and they also explain how these challenges will be tackled, primarily using standard materials, existing manufacturing capabilities, and innovative technology. Similarly, both sources make clear and concise statements about the technological advancements that the company is aiming to achieve. The new processors are easier to manufacture and capable of functioning in warmer temperatures, thereby enhancing sustainability and operational efficiency compared to existing solutions.

However, when addressing the technology’s potential impact and benefits, the argument is centered around supporting revolutionary advancements in other industries, such as pharmaceuticals and climate-related endeavors. Notably, the size of the target market and potential customer segments are mainly left unaddressed. While the press release indirectly alludes to a current market size of fewer than 100 quantum computers, it does not provide insight into the number of manufacturers or the number of processing chips relevant or intended for this market. The question of addressing the market size, both current and future, remains unanswered. Similarly, despite SemiQon setting the ambitious vision of entering the “million-qubit era,” neither the initial press release nor the website, including news updates, offers any indication of how and by when this objective will be realized. Expectations are summarized in Table 7.

Table 7: Expectations set by SemiQon

	Press release from March 14, 2023	Company website on Sept 1, 2023
Title	SemiQon, a spinout from VTT, to develop more affordable and scalable quantum computers with new semiconductor qubit technology	About SemiQon
Vision and mission:	**Vision:** This could ultimately enable the building of quantum processors that will require millions of qubits for fault-tolerant operation. **Mission:** …making future [quantum] computers more affordable, scalable, and sustainable.	**Vision:** At SemiQon, we build quantum processors for the million-qubit era. **Mission:** Our mission is to power the scale-up of quantum computing with silicon-based quantum processors.
Problem-solution framing:	Our solution responds to three major challenges currently slowing down the development of quantum computers globally – their scalability, price, and sustainability.	Our semiconductor-based solution responds to three major challenges that are currently slowing down the development of quantum computers globally – their scalability, price, and sustainability
Technology advancement:	The new semiconductor quantum processor chips are scalable and easier to manufacture. They can also function at warmer temperatures, making them more operable and sustainable	Our technology allows us to fabricate quantum processors in a way that supports scaling up manufacturing efficiently while also lowering costs. The chips we manufacture also enable the quantum computer to operate at warmer temperatures – thus requiring only a fraction of the energy needed for alternative solutions.
Impact and benefits	…quantum computers could one day accurately model viruses and drugs, or come up with climate solutions	…from developing life-saving drugs to achieving climate neutrality
Market potential:	Due to scalability issues, there are currently less than 100 quantum computers in the world, and they can cost EUR 10,000,000 or more to build.	

In summary, when comparing the initial press release with the current website, both targeted at general audiences, one can again observe an evolution in the SemiQon identity. Firstly, the confidence level is higher on the website, as exemplified by bolder claims about building quantum processors for the million-qubit era. Secondly, SemiQon is placing a greater emphasis on its European identity and geopolitical relevance on the website, aspects not evident in the initial press release. The argument of geopolitical relevance introduces a new form of institutional capital, broadening the categorization by Lounsbury and Glynn (2001).

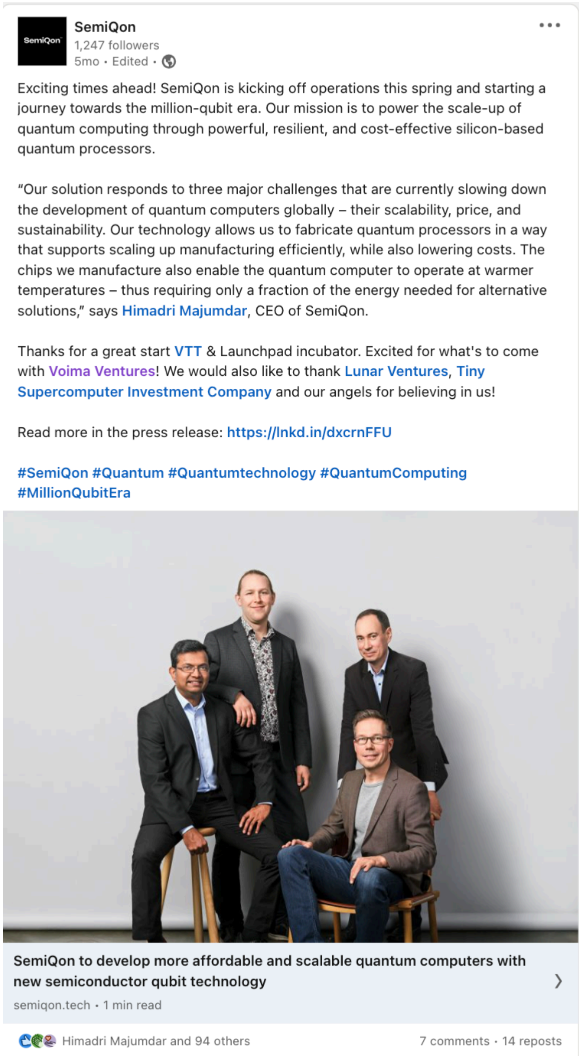
Yet, similarly to the investor and expert narrative, the expectations set by the company remain vague and ambiguous in the public channels. Both the initial press release and the company webpage omit numerical and commercial projections, including timeline estimates. While the overarching mission is to develop processors capable of handling millions of qubits, neither the initial press release nor the company website gives any indication of the potential market size, current state of development or a timeline for when the promised qubit counts are expected to materialize.

5.3.4 Bolstering the public narrative

Next, attention turns to examining SemiQon's and its founders' LinkedIn activity, as this platform serves as the primary channel for actively promoting the company narrative. SemiQon is also present on X (formerly Twitter); however, this platform is excluded from the review, as it, according to the founders, holds limited significance and is only used sporadically.

The exploration proceeds in four stages: First, it examines the entities sharing SemiQon's stories, addressing the critical question of who participates in this narrative ecosystem. Subsequently, the analysis narrows down on the content itself, focusing on discerning the core themes and messaging that drive SemiQon's narrative efforts. Like the previous chapter, the analysis probes into the entrepreneurial capital embedded within these narratives and the promises these narratives make. The chapter then studies the temporal dynamics, covering the initial six months of SemiQon's operations. This sheds light on how the company narrative has evolved. Ultimately, the chapter concludes by exploring the audience's response to SemiQon's communication on LinkedIn, as the responses received can influence the type of stories told in the future.

To start with, the main entities reinforcing the company narrative on LinkedIn include the company profile and the founders. From the beginning of March until the end of August 2023, a total of 181 posts were shared. Most (90%) posts are directly related to SemiQon (see Figure 10). The remaining 10% are indirectly associated with the company. The indirect posts provide perspectives on the quantum and other scientific industries or offer insights into the values of the CEO and, by extension, the company, as evidenced in the screen captures in Figure 11.



SemiQon
1,247 followers
5mo • Edited •

Exciting times ahead! SemiQon is kicking off operations this spring and starting a journey towards the million-qubit era. Our mission is to power the scale-up of quantum computing through powerful, resilient, and cost-effective silicon-based quantum processors.

"Our solution responds to three major challenges that are currently slowing down the development of quantum computers globally – their scalability, price, and sustainability. Our technology allows us to fabricate quantum processors in a way that supports scaling up manufacturing efficiently, while also lowering costs. The chips we manufacture also enable the quantum computer to operate at warmer temperatures – thus requiring only a fraction of the energy needed for alternative solutions," says Himadri Majumdar, CEO of SemiQon.

Thanks for a great start VTT & Launchpad incubator. Excited for what's to come with Voima Ventures! We would also like to thank Lunar Ventures, Tiny Supercomputer Investment Company and our angels for believing in us!

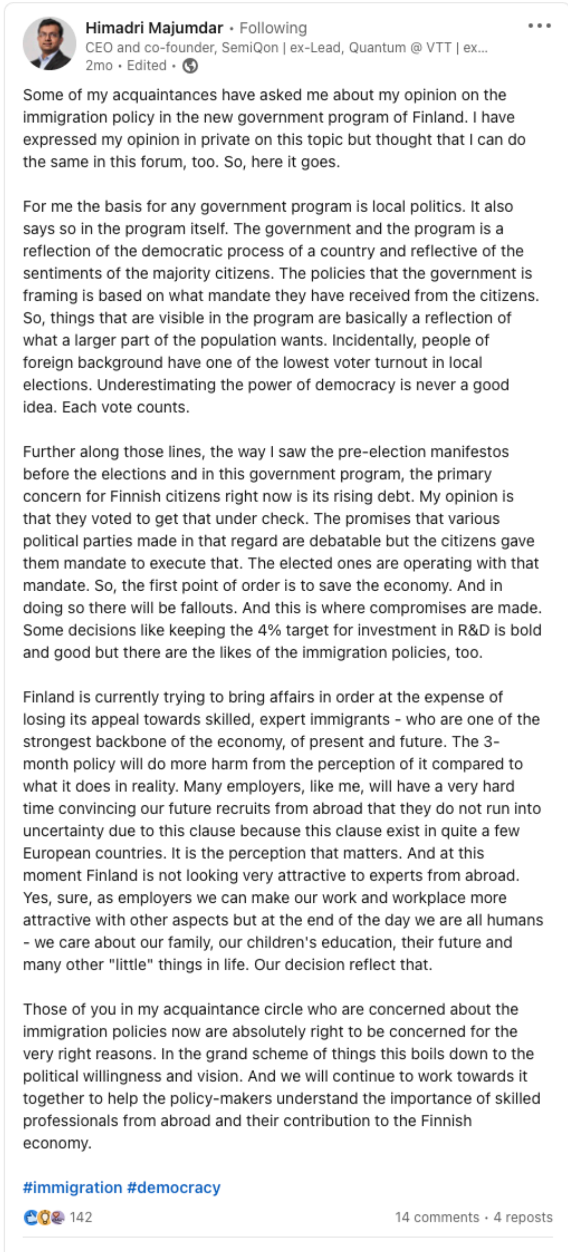
Read more in the press release: https://lnkd.in/dxcrnFFU

#SemiQon #Quantum #Quantumtechnology #QuantumComputing #MillionQubitEra

SemiQon to develop more affordable and scalable quantum computers with new semiconductor qubit technology
semiqon.tech • 1 min read

Himadri Majumdar and 94 others 7 comments • 14 reposts

Figure 10: Example of a LinkedIn post by the SemiQon company profile (SemiQon, 2023a)



Himadri Majumdar • Following
CEO and co-founder, SemiQon | ex-Lead, Quantum @ VTT | ex...
2mo • Edited •

Some of my acquaintances have asked me about my opinion on the immigration policy in the new government program of Finland. I have expressed my opinion in private on this topic but thought that I can do the same in this forum, too. So, here it goes.

For me the basis for any government program is local politics. It also says so in the program itself. The government and the program is a reflection of the democratic process of a country and reflective of the sentiments of the majority citizens. The policies that the government is framing is based on what mandate they have received from the citizens. So, things that are visible in the program are basically a reflection of what a larger part of the population wants. Incidentally, people of foreign background have one of the lowest voter turnout in local elections. Underestimating the power of democracy is never a good idea. Each vote counts.

Further along those lines, the way I saw the pre-election manifestos before the elections and in this government program, the primary concern for Finnish citizens right now is its rising debt. My opinion is that they voted to get that under check. The promises that various political parties made in that regard are debatable but the citizens gave them mandate to execute that. The elected ones are operating with that mandate. So, the first point of order is to save the economy. And in doing so there will be fallouts. And this is where compromises are made. Some decisions like keeping the 4% target for investment in R&D is bold and good but there are the likes of the immigration policies, too.

Finland is currently trying to bring affairs in order at the expense of losing its appeal towards skilled, expert immigrants - who are one of the strongest backbone of the economy, of present and future. The 3-month policy will do more harm from the perception of it compared to what it does in reality. Many employers, like me, will have a very hard time convincing our future recruits from abroad that they do not run into uncertainty due to this clause because this clause exist in quite a few European countries. It is the perception that matters. And at this moment Finland is not looking very attractive to experts from abroad. Yes, sure, as employers we can make our work and workplace more attractive with other aspects but at the end of the day we are all humans - we care about our family, our children's education, their future and many other "little" things in life. Our decision reflect that.

Those of you in my acquaintance circle who are concerned about the immigration policies now are absolutely right to be concerned for the very right reasons. In the grand scheme of things this boils down to the political willingness and vision. And we will continue to work towards it together to help the policy-makers understand the importance of skilled professionals from abroad and their contribution to the Finnish economy.

#immigration #democracy

142 14 comments • 4 reposts

Figure 11: Example of a LinkedIn post by the CEO indirectly promoting company values (Majumdar, 2023a)

The most prolific content creator is the company CEO, Himadri Majumdar, who accounted for 45% of all posts. Mr. Majumdar also boasts the most extensive follower base among the contributors, with nearly 2 900 connections or followers on LinkedIn (as registered on September 1, 2023). His active presence in sharing industry insights and personal reflections pre-dates the launch of SemiQon. The company profile, on the other hand, has been responsible for 31% of all posts. The SemiQon account has attracted 1,300 followers during the company's initial six months of operation. The three other founders have contributed the remaining 23% of posts. In summary, LinkedIn plays a pivotal role in promoting the SemiQon's narrative, with a concerted effort to establish a positive image led by the CEO and company profile supported by other founders through both direct and indirect content.

Delving deeper into the content shared, it is important to note that 33 posts, comprising 18% of the total, are exclusively generated by SemiQon or its founders. These posts typically include text, links to internal content, and hashtags and often incorporate images to enhance their impact. Nevertheless, the majority of posts, amounting to 148 posts or 82%, involve reposting content from internal or external sources. This reposted content is relatively evenly divided between two categories: the redistribution of internal content created by SemiQon or the other founders (53%), and the sharing of third-party content (47%), see example in Figure 12. By resharing internal content, SemiQon effectively triples the number of posts by the company. The CEO's extensive following, in particular, significantly amplifies each post's reach and engagement metrics. Yet when it comes to posting original content, the key contributors are either SemiQon or the CEO. In contrast, the other founders are primarily involved in reposting without adding personal introductions or commentary.

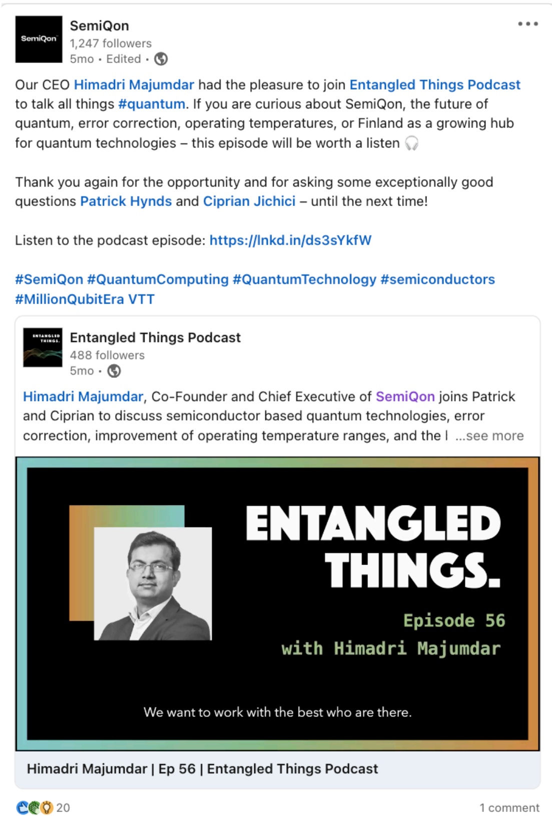


Figure 12: Example of reshared, third-party content (SemiQon, 2023b)

When examining post timing, it is essential to note that LinkedIn provides relative posting times (e.g., 'X days ago') rather than specific dates. Therefore, Table 8 below offers estimated posting dates based on the information provided by LinkedIn at the time of data collection. Analyzing the timing of these posts reveals a pattern of increased activity, mainly centered around the company's launch in mid-March 2023. The initial press release received robust promotion from the founders and key stakeholders, including VTT and company investors. It was pivotal in attracting media attention, primarily in tech and innovation-focused outlets like the Quantum Insider, Innovation News Network, and Computer Weekly, as well as smaller industry newsletters. The high number of mentions right after the launch led to a higher ratio of reshared content compared to original posts. This observation aligns with expectations from the literature review, where the focus typically revolves around generating hype and excitement during a venture's initial stages. In summary, resharing third-party mentions substantially boosted the volume of posts from SemiQon and its founders, as shown below.

Table 8: LinkedIn activity and timing by SemiQon and its founders

Time posted	Time range		Posts		Reposts		Total
			Number	Share	Number	Share	
7 months ago		Feb	1	50 %	1	50 %	2
6 months ago	Feb	Mar	7	39 %	11	61 %	18
5 months ago	Mar	Apr	3	7 %	41	93 %	44
4 months ago	Apr	May	6	22 %	21	78 %	27
3 months ago	May	Jun	4	14 %	24	86 %	28
2 months ago	Jun	Jul	5	24 %	16	76 %	21
1 month ago	Jul	Aug	2	13 %	13	87 %	15
<1 month ago	Aug	Sep	5	19 %	21	81 %	26
Grand Total			**33**	18 %	148	82 %	**181**

Returning to the framework developed by Lounsbury and Glynn (2001), the study explores the predominant focus of entrepreneurial capital in LinkedIn posts. Some posts may introduce multiple types of entrepreneurial capital. However, each post has been categorized based on its primary emphasis. For instance, in a post from summer 2023, the company states: "At SemiQon, we build quantum processors for the million-qubit era. We are on a mission to power the future of quantum computing by delivering scalability through powerful, resilient, and cost-effective silicon-based quantum processors. Join us on our journey towards fulfilling the promise of quantum computing" (SemiQon, 2023d). In this case, the post has been categorized as highlighting the company's vision, representing a form of human capital, as it is the primary argument presented, while the features of the innovation serve as a secondary argument. Instead of counting words, the analysis focuses on the number of posts dedicated to each category, resulting in the distribution shown in Table 9.

Table 9: Entrepreneurial capital highlighted in LinkedIn posts

Type of entrepreneurial capital	Secondary category	Main argument	Count of posts	Share of total
Resource	**Human capital**	Key personnel, expertise	26	14 %
		Vision	21	12 %
	Financial capital	Recruiting	13	7 %
		Funding	10	6 %
	Social capital	High status connections, networks	10	5 %
		Credentialing	7	4 %
	Technological capital	Early progress	7	4 %
		Potential of innovation	2	1 %
	Organizational capital	Values	2	1 %
		Brand	1	1 %
		Physical infrastructure	1	1 %
		Business model	1	1 %
Resource Total			**101**	**56 %**
Institutional	**Industry legitimacy**	Uniting with others	48	27 %
		Using positive industry media coverage	20	11 %
	General political and social landscape	Personal commentary	10	6 %
	Industry norms and rules	European landscape	2	1 %
Institutional Total			**80**	**44 %**
Grand Total			**181**	**100 %**

In alignment with the initial press release and website content, the LinkedIn posts by the company and its founders strongly emphasize establishing legitimacy through non-financial and qualitative factors. The majority (56%) of posts use company-specific resource capital as the primary argument. Still, a significant portion (44%) highlights industry-specific institutional capital as the focal content. In fact, the most prevalent focal content revolves around building *industry legitimacy*, focusing on uniting with industry peers (constituting 27% of all posts) or showcasing positive media coverage within the industry (11%, respectively). LinkedIn posts provide a broad array of stories emphasizing institutional capital. One can see ‘uniting with others’ demonstrations in posts where the company collaborates with industry organizations or participates in relevant events. Posts showcasing ‘positive industry media coverage’ emphasize the successes in the quantum industry and related scientific fields. The second most prominent narrative emphasizes *human capital*, particularly the expertise and experiences of key personnel (14%), followed closely by narratives about the company vision (12%).

Interestingly, ten posts, making up 6% of the total, delve into broader societal and political topics. In these posts, the CEO Himadri Majumdar shares his thoughts on various current matters, spanning talent recognition, gender equality, scientific rigor, social issues, cultural differences, immigration policies, and academic opportunities (revisit previous example, Figure 11 on page 64). While these posts do not directly tie to SemiQon, they can be seen to contribute to the company narrative by sharing its values. Addressing social or political issues can help establish connections with specific audiences and underscore the company's commitment to particular principles. Connecting the company narrative to the broader societal context is an approach not explored by previous literature.

It is intriguing to observe that, in contrast to the increasing focus on company-specific resource capital on the webpage compared to the initial press release, a similar trend is not evident in LinkedIn posts. At first glance, the shift in emphasis between highlighting resource or institutional capital appears random. However, upon closer examination of the months marked with a peak focus on institutional capital, which are labeled as 5 and 2 months ago in Table 10, a possible explanation emerges. During these months, the company actively participated in numerous industry forums, generating valuable content to reshare. This suggests that the randomness in emphasis might be influenced by external forces operating on their own schedules rather than being driven by SemiQon's internal strategy. External events provide ample content for posting on social media, resulting in peaks whenever such opportunities arise. Again, to establish more well-founded conclusions regarding a shift in the focal content of narratives, a more extended investigation is warranted.

Table 10: Split between posts emphasizing resource capital and institutional capital on LinkedIn over time

Time published	Estimated time range		Resource capital Count	Share	Institutional capital Count	Share	Total
7 months ago		Feb	2	100 %		0 %	2
6 months ago	Feb	Mar	17	94 %	1	6 %	18
5 months ago	Mar	Apr	9	20 %	**35**	**80 %**	44
4 months ago	Apr	May	21	78 %	6	22 %	27
3 months ago	May	Jun	19	68 %	9	32 %	28
2 months ago	Jun	Jul	6	29 %	**15**	**71 %**	21
1 month ago	Jul	Aug	10	67 %	5	33 %	15
<1 month ago	Aug	Sep	17	65 %	9	35 %	26
Grand Total			101	56 %	80	44 %	181

While the primary focus of this study is the analysis of the narrative practices of SemiQon, namely how and what narratives are used and shared, it is also worthwhile to briefly explore the impact of these stories, as the responses received can influence the type of stories told in the future. A preliminary examination of audience responses in the form of comments and likes on LinkedIn posts, reveals distinct patterns. Generally, 'liking' emerges as the most frequent mode of engagement with the company. Every post has garnered at least one 'like,' with an average of 60 'likes' per post. While the average number of comments per post stands at 4, almost half of the posts have received no comments at all. While some posts may not have received comments, they can still gain significant popularity through likes, as exemplified by

Figure 13. Reposting as a category of engagement with SemiQon has been excluded from the evaluation, as the overwhelming majority of reposts are initiated by the company profile or the founders themselves.

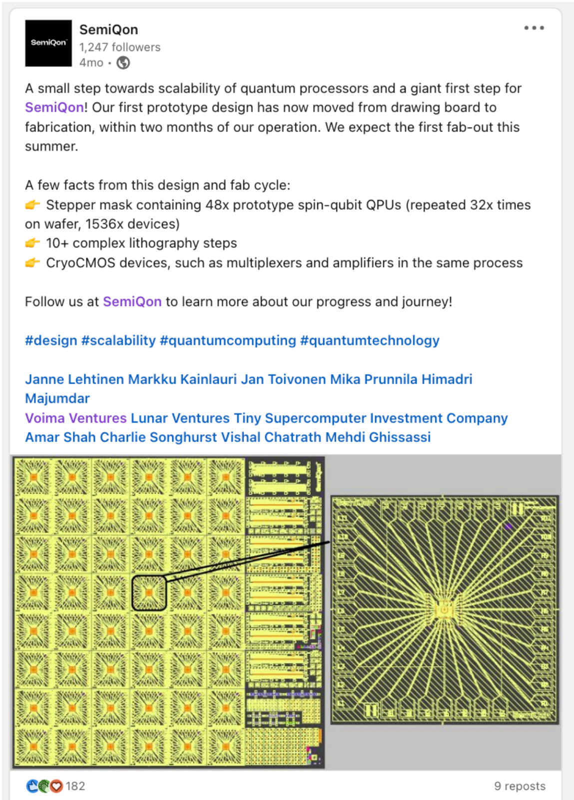


Figure 13: LinkedIn post by SemiQon in April 2023 (SemiQon, 2023c)

Interestingly, a small number of posts have attracted most of the interaction through likes and comments. This phenomenon aligns with the Pareto principle, where 20% of the individual posts account for 80% of all comments. Upon closer examination of the content within the top 20% of commented posts, one finds that topics related to job changes, the company launch, and personal reflections are most conducive to sparking discussion. In contrast, when it comes to ‘likes,’ the distribution is more evenly spread. Here, 20% of the posts contribute to only half of all the likes. Zooming in on the content of the top 20% of liked posts, one notices two additional categories that stand out—highlighting high-status network connections and sharing company success stories. For further details, please refer to Table 11. This implies that highlighting content likely to elicit congratulations, such as job advancements and noteworthy achievements, along with sharing personal reflections, are the categories that garner the highest levels of engagement.

Table 11: Top 20% of LinkedIn posts measured by engagement in form of likes or comments

Description of content	Number of posts	Likes, average	Comments, average
Job change	3	191	60
Company launch	7	142	27
Personal reflection	7	135	12
Success	5	111	5
Network connections	2	176	5
Company vision	1	41	4
Ecosystem building	6	68	3
Open jobs	1	89	2
Founder introduction	1	97	1
Grand Total	**33**	**123**	**15**

The enthusiasm expressed through likes, comments and reshares plays a crucial role in LinkedIn's algorithm. When posts receive higher engagement, they become more visible and reach a broader network of LinkedIn users. Essentially, the more people interact with a post, the more it gets promoted within the platform, leading to increased visibility for both the post and the company it represents. This heightened visibility can attract more engagement and further expand the company's reach on LinkedIn.

In conclusion, SemiQon actively leverages LinkedIn to generate interest in and foster engagement with the company, mainly driven by the activity of the CEO. The target audience includes potential investors, partners, customers, and public policy professionals. Most posts (56%) on LinkedIn emphasize the unique qualities of SemiQon, while a significant portion (44%) still focuses on establishing the legitimacy of the broader quantum industry. Although there may be variations in this distribution from month to month, there is no observable declining trend in emphasizing institutional capital. Audience engagement on LinkedIn predominantly involves actions such as liking and commenting, particularly on posts that offer congratulations or share personal and insightful reflections.

5.4 Stakeholder information needs

The following insights have been extracted from semi-structured interviews with two deep tech investors who have provided funding to SemiQon and two quantum researchers who have evaluated SemiQon's approach. The sections pertain to deep tech investment and quantum research in general while also briefly discussing the SemiQon opportunity. The chapter begins by examining investor expectations before exploring the perspectives of experts. In the conclusion, the findings are compared with the reviewed literature.

Investors

In early-stage deep tech investment, venture capital (VC) firms frequently engage in outbound sourcing. This approach involves VCs actively seeking out opportunities by following up on network referrals, attending industry events, and engaging with academic and research institutions, sometimes even bringing forth the very notion of a business to be developed. Their involvement in promising opportunities, particularly in the earliest stages of venture creation, typically entails close collaboration with the founding team to navigate the complexities of transforming a research concept into a viable business. Discussions and idea refinement can span over a year or longer. During this process, the VC does not expect a meticulously crafted business plan presentation; instead, the opportunity is assessed based on insights gained primarily through interaction with the founding team and the VC's research into the industry and the venture's potential. Business plans assume a more significant role when evaluating inbound opportunities, approaching additional investors, and in later funding rounds when the business idea is generally more mature and comprehensively documented.

This process aptly mirrors how the idea for SemiQon initially took shape. It all began with a network referral from a quantum computing company to a deep tech VC, leading the VC to engage with the research group. This engagement sparked the founding team at SemiQon to explore the potential of pursuing the opportunity. The initial VC assisted in honing the business opportunity, a process outlined previously in chapter 5.3.1. The second interviewed investor was similarly introduced to SemiQon by the CEO of another company in quantum computing, underscoring the significance of networks in industry development.

Investors recognize the inherent challenge of delving deeply into the intricacies of the deep technologies they are exploring. Often lacking extensive technical expertise, investors excel at assessing the technology more conceptually. Investors with advanced technical expertise may turn to research papers and patents for evaluation, while others leverage their networks of experts to validate critical components. Investors primarily concentrate on the commercial and operational aspects, ensuring the venture adds value to their investment. An essential consideration is the ambition level of the founding team. Commitment to excel on a global scale and target large enough markets are imperative for aligning with the investment objectives of the VC. However, it raises concerns if the founding team primarily comprises scientific experts with limited commercial or entrepreneurial experience. Sustained VC involvement often depends on the team's willingness to embrace feedback, enhance their skill sets, or address capability gaps.

This dynamic was also evident in the case of SemiQon. One of the investors, with a Ph.D. in physics, conducted an in-depth review of the company's previous research, while the other investor engaged in more high-level discussions. Both were drawn to the opportunity based on its commercial and operational potential, particularly the scalability of SemiQon's approach and the efficiency of its R&D process. Trust in the founding team was reinforced through two primary means. First, through personal interactions that showcased the team's passion for their cause, ambition to develop world-class technology, and receptiveness to feedback. Second, it derived from the team's previous track record and extensive connections within the emerging quantum computing industry, validated through consultations with expert networks.

VCs advocate early engagement with potential customers to truly understand customer needs rather than relying on assumptions. Yet, in contrast to conventional technology start-ups, revenue expectations hold little sway in the early stages of deep tech ventures. During pre-seed and seed funding rounds, the primary focus is assessing the technology's potential. The key goal is to validate the technology's feasibility and develop a minimum viable product. This approach enables deep tech ventures to secure substantial funding without the necessity of generating revenue, a challenge commonly faced by conventional tech start-ups. Furthermore, as deep tech investments are inherently high-risk and typically require substantial and prolonged investment, deep tech VCs focus on opportunities addressing sizable markets to ensure substantial returns upon success. Although the timeframe extends beyond conventional tech investments, it typically spans the near future, roughly 10-15 years, providing the fund's eventual repayment.

The interviewed investors emphasized that in quantum computing, an exceptionally high level of trust in market development is imperative due to the early stage of technology. They are drawn to the investment opportunity by its potential for ground-breaking success once the technology matures, with the optimistic expectation that the value will materialize during the lifetime of their respective investment funds. One of the investors likened the allure of this opportunity to the prospect of a computing revolution comparable to that of the '60s and '70s.

The interviewed investors, however, held contrasting perspectives on the role of metaphors and analogies in enhancing the understanding of opportunities. While one investor downplays their relevance in the early stages of innovation, the other emphasizes their role in facilitating comprehension. However, retrospective accounts may not fully capture the genuine significance of analogies and metaphors in real-world contexts.

Scientists

In scientific research, partnerships among research groups are common. Partnerships offer various benefits, such as leveraging complementary expertise, resource sharing, and access to critical data and samples. Collaboration is often local or regional and evolves primarily through informal discussion among established connections. International cooperation is more prevalent in more specialized research areas due to the scarcity of relevant entities. Awareness of pertinent research entities, whether in the public or private sector, often comes from industry events, through network referrals or publication references. Collaborative partnerships are formed when independent accomplishment is not feasible or when they mutually benefit the involved entities. Public research partnerships can lack formal agreements, but when partnerships expand to include private companies, the need for contracts arises, introducing complexity to the process. When unfamiliar with the individuals involved, assessing other partners associated with the company proves valuable. Ventures benefit from being connected with individuals whom the scientists already trust.

In quantum computing, most companies still originate from universities or research institutions, and relationships with their academic origins typically remain strong. Due to the niche approach of semiconducting qubit technology, the expert community is small, consisting of a few hundred scientists worldwide. Knowledge about relevant research groups is primarily tacit. Personal relationships play a pivotal role in connecting with the right people, and new partnerships typically arise from informal conversations rather than active solicitation. Historically, partnerships have primarily been formed among public entities. However, there is a noticeable shift towards increased collaborations between research institutions and private companies, as well as between private entities. A more diverse and expansive collaborative landscape can be seen to signal a maturation of the quantum computing industry.

Scientists rely on conversation and published research to understand various approaches. Analogies, metaphors, and visual illustrations are crucial in improving comprehension and are frequently employed in discussions and documentation. They serve a dual purpose: enhancing understanding of the subject at hand and clarifying what is not being discussed. Meanwhile, interest is mainly generated through conversation, while company presentations hold limited significance. Lastly, technical due diligence is instrumental in evaluating prospects for joint development.

Highly ambitious, long-term projections in technology development risk credibility, as experts inherently know what is realistically achievable. One interviewed expert encapsulates this sentiment with the following quote: “I don’t care what anybody says about themselves years in the future. It is too unpredictable anyway.” While confidence in technology is crucial, overconfidence can backfire. Nonetheless, projections a few years into the future remain relevant, given prolonged development times in deep tech. Similarly, while commercial projections hold limited relevance, actual revenue generation solidifies a company’s credibility, indicating widespread recognition of the approach’s value. The trust in a venture’s abilities is primarily built on the founders’ previous achievements in scientific research. Strong cultural alignment between entities further fosters trust. Ultimately, sustaining trust relies on delivering promises and maintaining consistency.

For one of the interviewed scientists, partnering with SemiQon holds significant advantages. It provides access to semiconducting processors, a technology beyond the research group’s independent capabilities. In return, SemiQon gains access to valuable test results. The collaboration between the two entities predates the establishment of SemiQon, and trust has been firmly established through past interaction. This reduces the need for extensive documentation to aid understanding or to generate interest. As the interviewed researcher’s work does not depend on commercial-scale qubit count, cubit development projections are of limited importance. Furthermore, geographical proximity enhances the effectiveness of collaboration.

Similarly, the second interviewee emphasized that the establishment of cooperation was rooted in mutual benefit. SemiQon's high ambition and disruptive approach served as compelling factors for the partnership. Trust in SemiQon's capabilities and the validity of its claims was built on the founding team's previous achievements at VTT. This trust further developed through discussions about the partnership's content, revealing a strong cultural alignment between the two entities. In summary, the collaboration emerged organically.

When comparing the interview findings with the reviewed literature, several observations come to light. Firstly, the results closely resonate with Aldrich and Fiol's (1994) emphasis on the pivotal role of the founder's personal and interpersonal resources in building trust for ventures. The interviews highlight how the most critical factor for building trust is the engagement and discussions with the founding team and their respective networks when assessing opportunities or considering partnerships. This alignment also corresponds with Lounsbury and Glynn's (2001) concept of narratives rooted in entrepreneurial capital, particularly when detailed substantiations about the opportunity remain limited. All interviewees emphasized the founders' expertise, previous track record, and established networks as critical elements in building trust in the team and the opportunity the company is pursuing.

Moreover, the interviews further support the notion developed by Doganova and Eyquem-Renault (2009), highlighting how a business idea evolves through interactions with its audience. This phenomenon becomes particularly evident in the earliest stages of deep tech entrepreneurship when the founders engage with and secure investors. The narratives presented by the entrepreneurs, whether expressed in casual conversation or crafted in structured business presentations, along with the ensuing discussions, play a pivotal role in shaping the realities they convey. Similarly, Semiqon's early engagement with the scientific community for technology validation is integral to the business they are building.

However, contrary to the viewpoints advocated by Beckert (2021) and Doganova and Eyquem-Renault (2009), the interviews emphasize that detailed projections, projective calculations, and well-documented materials have limited significance during the early stages of deep tech investment and development. The findings underscore how meticulously crafted financial or technological projections offer little utility in the initial evaluation of the deep tech opportunity. These projections are often seen as unrealistic or, at best, grounded in speculative guesswork. Scientists, in particular, rely minimally on the cognitive tools typically employed in business when considering partnerships. The documentation scientists find impactful is primarily limited to research publications or other scientific descriptions.

Lastly, while the investors held contrasting perspectives regarding the role of metaphors and analogies in enhancing the understanding of opportunities, the scientist, in contrast, leaned towards using such tropes. Once again, it is essential to recognize that retrospective accounts may only partially capture the genuine significance of analogies and metaphors in real-world contexts. For a more precise assessment of the role and impact of analogies and metaphors in the initial phases of opportunity or partnership evaluation, empirical field observations could have strengthened the study. Additionally, increased reliability might be attained by incorporating a more extensive set of interviews.

6 Summary and discussion

This chapter begins with a summary of the findings in the case study while acknowledging its limitations. It proceeds to explore the theoretical implications and concludes by proposing avenues for further research.

6.1 Summary of findings

Previous research underscores the pivotal role of narratives as means entrepreneurs employ to establish legitimacy and secure support for their ventures. The significance of narratives becomes particularly evident when validated arguments are lacking, a common scenario for start-ups in nascent industries. These ventures confront additional challenges from competing approaches and the absence or limited presence of shared meanings and existing market structures (Hilkamo & Granqvist, 2022). In the context of deep tech, uncertainty is compounded by factors such as high complexity and technology risk, the need for large upfront and long-term investments and uncertain commercial applications.

Through a case study in quantum computing, this study has explored how entrepreneurial narratives can advocate for and guide a new deep tech venture in a nascent industry. The analysis highlights three primary ways in which narratives can help new ventures accomplish this objective, as discussed below:

Accessibility through analogies and metaphors

As observed in the case study, only a few people possess the deep expertise required to truly understand and evaluate the feasibility of approaches within quantum computing. The examination of the intended and actual narrative yields evidence that the use of analogies, metaphors, and illustrations plays a crucial role in enhancing the accessibility of deep technology. Interviews with the founders highlight that creating clarifying comparisons is a skill deep tech entrepreneurs must cultivate, particularly during the initial stages of industry formation when shared understandings are limited. The evolution of the SemiQon business model presentation serves as a practical example showcasing the increasing significance of analogies in educating the audience about the industry, facilitating meaningful comparisons between different approaches to quantum computing, and clarifying the commercial opportunity. While investor interviews provided conflicting evidence regarding the role of analogies and metaphors, interviews with industry experts similarly proved how scientists benefit from analogies and illustrations, particularly when trying to comprehend different technological approaches.

Confidence through suggestion and identification

The SemiQon narrative implies that the company will become the Intel of quantum computing. Yet the lack of validation in the early stages of technology and market development underscores the crucial role of suggestions and connections in fostering trust and support. The analysis of public company documentation reveals that these suggestions are founded in both venture-specific, resource capital highlighting the distinctiveness of SemiQon and industry-level institutional capital emphasizing the ventures alignment with organizational norms and beliefs in quantum computing. The prevalence of narratives centered around institutional capital highlights how SemiQon operates in an emerging industry striving to establish legitimacy. The initial press release reveals a substantial reliance on institutional capital, constituting 41% of the word count. Similarly, despite month-over-month fluctuations, the proportion of LinkedIn posts highlighting institutional capital remains significant, averaging 44%. To build legitimacy for the company mission, SemiQon also must convince the audience of the appropriateness of the broader quantum computing industry.

Yet, interviews with both founders and key external stakeholders reveal that trust in the opportunity and the team's capabilities is not primarily shaped by *documented* elements closely tied to the entrepreneurs' narrative efforts. While the founders initially relied on PowerPoint and Excel as their main tools to articulate, structure and document their exploratory efforts, the documents created to outline the company's overarching narrative had limited significance in establishing legitimacy and garnering support. On the contrary, trust relied predominantly on the entrepreneurs' past track record, dialogue with stakeholders and established networks. Investors validate these credentials through their own, advisory networks. For domain experts, the evaluation is more direct, relying on personal experience and expertise. These findings underscore the significance of personal relationships and affiliations with other prominent scientists in reaching, attracting, and building trust within the scientific community. These insights imply that founders cannot establish credibility solely through narrative means. Venturing into deep tech hinges on past actions and well-established networks

However, this study still maintains that crafting the company narrative in well-established formats that align with audience expectations and normative frameworks is a crucial step for founders. While the business plan or technology roadmap may not be the primary instruments for building trust, the coherent narrative they have helped to build supports the founders in articulating the story or relevant elements of it in more casual conversation.

Direction through expectations

While scholars like Beckert (2021) and Doganova and Eyquem-Renault (2009) argue that detailed projections are vital for generating interest and support, the analysis of SemiQon's intended and actual narrative, along with an examination of the information needs of key stakeholders, reveals that the value of expectations does not depend on detailed forecasts and meticulous financial modeling. Conversely, interviews with the founders and investors assert that detailed calculations should be cautiously approached, given the inherent uncertainty in the early stages of deep tech development. The absence of revenue projections in the initial iterations of the

SemiQon business plan, coupled with investors expressing a preference for forming opinions through discussions and individual research, suggests that deep tech investors are comfortable with uncertainty and open to exploration, especially in the earliest stages of venture-building. The expert audience takes an even more pragmatic stance, prioritizing present realities over speculative forecasts. In summary, the earlier the stage in technology development and the higher the audience expertise, the less crucial the role of detailed, long-term projections is in attracting interest and support.

Nevertheless, setting expectations remains a foundational and constitutive element in SemiQon operations. The primary role of expectations is to guide internal activities and offer insights to external audiences on how the vision will be achieved. For instance, expectations guide the planning of timely fabrication runs and determine the timing of interactions with potential customers. While projecting confidence in their technology is crucial, this confidence is independent of setting detailed future projections. The scientist-entrepreneurs, however, acknowledge the importance of outlining commercial milestones and underscore a growing need for more specific expectations as more becomes known about the opportunity.

6.2 Limitations

Through a case study of SemiQon, this thesis offers valuable insights on the role and utilization of narratives in the context of early stage venturing in deep tech. However, the distinctiveness of a case study may pose challenges when attempting to extrapolate the results to different situations or settings. While SemiQon exemplifies characteristics typical to deep tech ventures—a scientific spin-off, extended development timelines, and uncertainty about technological and commercial applications—it may not fully represent the diverse landscape of such ventures. Nevertheless, this case study enriches theoretical knowledge with practical application and context.

Furthermore, the categorizations applied in analyzing the central content of narratives heavily rely on the researcher's interpretations, potentially limiting objectivity. The involvement of multiple researchers could bolster the reliability of these categorizations. The study also recognizes that the qualitative insights rely on a limited number of interviews, often based on retrospective accounts. Additional interviews, especially with investors and research group representatives, could have yielded more nuanced results. Similarly, supplementing the study with field observations could mitigate the bias inherent in retrospective accounts. Lastly, to validate the results, it is suggested to replicate the method in another case study in quantum computing or within a different field of deep tech.

6.3 Theoretical implications

This case study empirically validates the assertion that narratives play a pivotal role in garnering attention and fostering support during the initial phases of venturing in an emerging market category, especially when external validation is limited and shared meanings, as well as market structures, are sparse. The study aligns with the insights of Lounsbury and Glynn (2001), demonstrating the construction of narratives based on entrepreneurial capital to build legitimacy and attract support. Furthermore, the findings support extending the categorization of institutional capital developed by Lounsbury and Glynn (2001) to include the broader societal and political environment. The narratives employed by SemiQon demonstrates that adeptly incorporating the broader operational landscape into the company's narrative can attract attention and garner support. The company employs arguments emphasizing global rivalry, safety considerations, and the necessity for technological sovereignty to bolster backing for its initiative. This translates into SemiQon increasingly emphasizing its European identity and geopolitical relevance. Another illustrative example involves the CEO's corporate activism on LinkedIn. Addressing current issues ranging from scientific rigor to immigration policies reflects an extension of the company's values. These posts contribute to heightened visibility, discussion, and, consequently, increased support for the company.

In contrast, the findings challenge the emphasis on detailed future projections as the focal content of narratives in early venturing, opposing the stance of expectation-oriented scholars like Beckert (2021) and Doganova and Eyquem-Renault (2009). Nevertheless, setting expectations remains a foundational and constitutive element in early venturing. These guide internal activities and offer insights to external audiences on how the vision will be achieved. As more information becomes available about the opportunity, the demand for details in expectations grows, encompassing aspects such as more concrete commercial projections.

Hence, the study concludes that the model presented in Figure 5 (p. 35) offers a robust framework for examining entrepreneurial narratives in the context of deep tech ventures. The model has, however, been updated to include the extension of the new subcategory labeled *Political and societal relevance* under institutional capital, as illustrated in Figure 14.

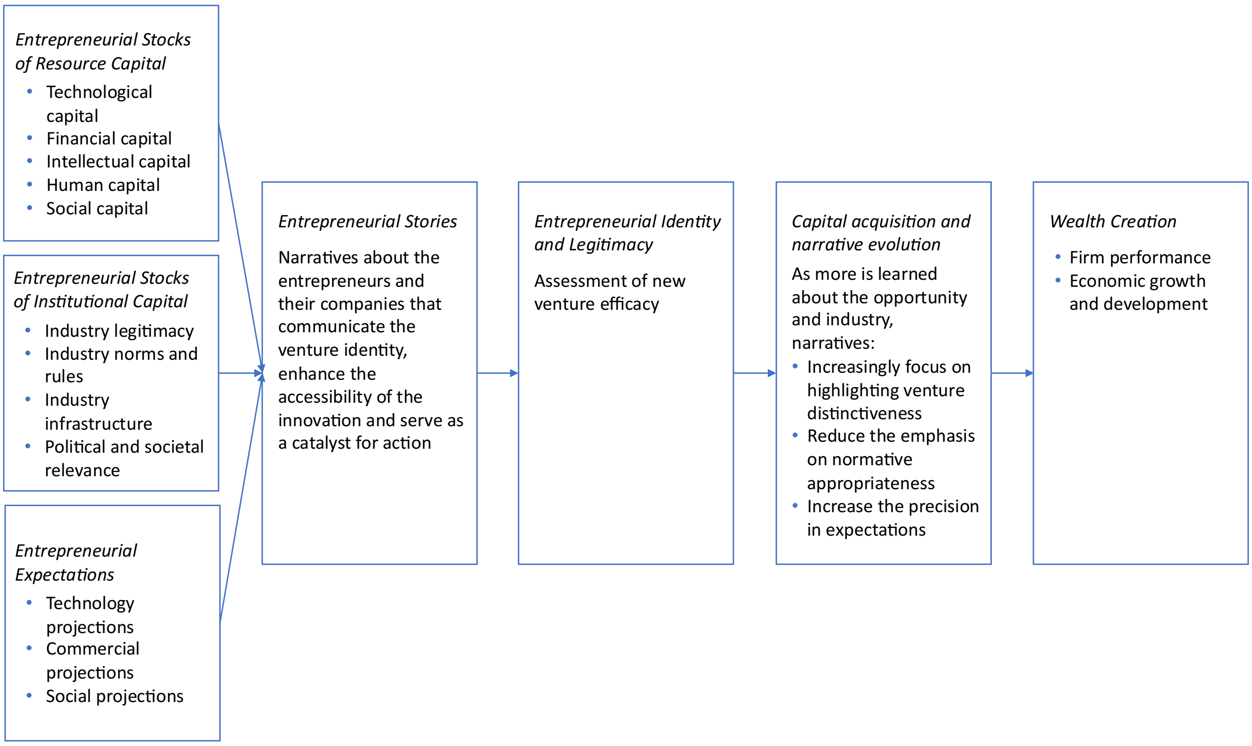


Figure 14: Model for how entrepreneurial narratives develop over time

Originally based on the model for cultural entrepreneurship developed by Lounsbury and Glynn (2001, p. 547)

6.4 Implications for future research

Future research on deep tech venturing and emerging industries has the potential to offer crucial insights for nascent ventures regarding efficient capital and customer acquisition strategies. The findings in this study calls for more attention to exploring how entrepreneurial narratives related to the broader societal and political can attract attention and garner support. Recognizing how societal and political dynamics shape public perception can be relevant for devising effective communication and public engagement strategies, as demonstrated in the SemiQon case. The extension of entrepreneurial capital in the cultural entrepreneurship model developed by Lounsbury and Glynn (2001) suggests opportunities for future research to enhance the generalizability, practical applicability, and comparative understanding of this concept across various settings.

Second, given the somewhat contradicting evidence regarding the role of analogies, metaphors, and visualizations in improving understanding and facilitating support for the venture, this study suggests field observations as an avenue for further exploration. Field observations can enrich the understanding of how linguistic and visual elements foster comprehension and garner support for complex deep tech concepts and opportunities, reducing the bias of retrospective accounts.

Finally, the study encourages additional exploration into the role and relevance of ad hoc and informal company narratives, whether in verbal or written form or expressed through activities such as product/service demonstrations for establishing legitimacy and support for ventures (revisit Table 3: Modes for sharing entrepreneurial narratives, p. 13). While this study reveals evidence questioning the significance of detailed documentation and projections, it does not find support for the idea that other forms of planned documentation or digital tools as suggested by Latifi et al. (2023) would substitute for them. On the contrary, the findings indicate that more informal dialogue with the entrepreneurs and relevant networks, combined with independent research, are critical elements in building trust in the founding team and the opportunity. This underscores the importance of entrepreneurship as a constitutive process, emphasizing how dialogue and networks play a pivotal role in shaping the legitimacy and support of ventures during their early stages.

7 Conclusions

Science-based, cutting-edge innovation will likely play an instrumental role in tackling many of the most pressing challenges of the 21st century. Such advancements are considered critical across various domains, such as developing carbon-negative technologies, ensuring global food security, and creating sustainable urban ecosystems. Considering the formidable dedication and perseverance required to acquire deep, scientific domain expertise it becomes evident that this undertaking may limit an expert's attention to their chosen domain and its corresponding community of peers. The intense focus can result in a noticeable disparity between the skills required for rigorous scientific expertise and those essential for success in the business sphere.

Consequently, it becomes imperative to establish robust support systems to facilitate the success of science-based ventures. This mandate extends beyond public and private financial support for investment-heavy, lengthy, and uncertain deep tech development. It also entails establishing structures that empowers scientist-entrepreneurs to develop the essential commercial acumen needed to express their ideas and opportunities effectively. Furthermore, considering the pivotal role networks play in attracting funding and support, as demonstrated by the findings of this case study, the support should also include fostering relationship and network building.

In conclusion, this thesis not only contributes to academic knowledge on the role and use of narratives in strategy and entrepreneurship, but also provides valuable practical insights into effective science communication and public engagement strategies for deep tech entrepreneurs. It shows how ventures can build narratives around their stocks of entrepreneurial capital to foster interest, comprehension, and support when shared meanings and established market structures are limited, and external validation for their technology is still lacking. The study underscores the significance of narratives as an essential tool in the entrepreneur's toolkit for navigating the challenges inherent in deep tech venturing.

6. References

Accenture Labs. (n.d.). *Pioneering quantum computing in R&D*. Accenture. Retrieved December 12, 2023, from https://www.accenture.com/us-en/case-studies/life-sciences/quantum-computing-advanced-drug-discovery

Aldrich, H. E., & Fiol, C. M. (1994). Fools rush in? The institutional context of industry creation. *Academy of Management Review*, *19*(4), 645–670.

Beckert, J. (2021). The Firm as an Engine of Imagination: Organizational prospection and the making of economic futures. *Organization Theory*, *2*, 1 21. https://doi.org/10.1177/26317877211005773

Biondi, M., Heid, A., Henke, N., Mohr, N., Pautasso, L., Ostojic, I., Wester, L., & Zemmel, R. (2021, December 14). *Quantum computing use cases are getting real—what you need to know*. McKinsey Digital. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/quantum-computing-use-cases-are-getting-real-what-you-need-to-know#/

Bogobowicz, M., Gao, S., Mateusz, M., Mohr, N., Soller, H., Zemmel, R., & Zesko, M. (2023, April 24). *Quantum Technology sees record investments, progress on talent gap.* McKinsey Digital. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/quantum-technology-sees-record-investments-progress-on-talent-gap

Borup, M., Brown, N., Konrad, K., & Van Lente, H. (2006). The sociology of expectations in science and technology. *Technology Analysis and Strategic Management*, *18*(3–4), 285 298. https://doi.org/10.1080/09537320600777002

Brown, N., & Michael, M. (2003). A Sociology of Expectations: Retrospecting Prospects and Prospecting Retrospects. *Technology Analysis and Strategic Management*, *15*(1), 3–18. https://doi.org/10.1080/0953732032000046024

Cooper, P., Ernst, P., Kiewell, D., & Pinner, D. (2022, May 19). *Quantum computing just might save the planet*. McKinsey Digital. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/quantum-computing-just-might-save-the-planet

Dargan, J. (2023, June 6). *What Types Of Quantum Computers Exist In 2023?* The Quantum Insider. https://thequantuminsider.com/2023/06/06/types-of-quantum-computers/

Das Sarma, S. (2022, March 28). *Quantum computing has a hype problem*. MIT Technology Review. https://www.technologyreview.com/2022/03/28/1048355/quantum-computing-has-a-hype-problem/

De La Tour, A., Soussan, P., Harlé, N., Chevalier, R., & Duportet, X. (2017). *From Tech to Deep Tech: Fostering collaboration between corporates and startups*. https://media-publications.bcg.com/from-tech-to-deep-tech.pdf

Deuten, J. J., & Rip, A. (2000). Narrative Infrastructure in Product Creation Processes. *Organization*, *7*(1), 69–93.

Doganova, L., & Eyquem-Renault, M. (2009). What do business models do?Innovation devices in technology entrepreneurship. *Research Policy*, *38*, 1559–1570. https://doi.org/10.1016/j.respol.2009.08.002

Ezratty, O. (2022). *Understanding Quantum Technologies 2022 - Key takeaways 2022* (O. Ezratty, Ed.; 5th ed.). https://www.oezratty.net/wordpress/wp-content/themes/Ezratty5/forcedownload.php?file=/Files/Publications/Understanding%20Quantum%20Technologies%20Olivier%20Ezratty%202022%20Key%20Takeaways.pdf

Fenton, C., & Langley, A. (2011). Strategy as Practice and the Narrative Turn. *Organization Studies*, *32*(9), 1171 1196. https://doi.org/10.1177/0170840611410838

Gartner. (n.d.). *Gartner Hype Cycle - Decide which technologies are crucial to future proof your business*. Retrieved September 25, 2023, from https://www.gartner.com/en/marketing/research/hype-cycle

Garud, R., Gehman, J., & Paco Giuliani, A. (2014). Contextualizing entrepreneurial innovation: A narrative perspective. *Research Policy*, *43*, 1177–1188. https://doi.org/10.1016/j.respol.2014.04.015

Garud, R., Schildt, H. A., & Lant, T. K. (2014). Entrepreneurial Storytelling, Future Expectations, and the Paradox of Legitimacy. *Organization Science*, *25*(5), 1479 1492. https://doi.org/10.1287/orsc.2014.0915

Hilkamo, O., & Granqvist, N. (2022). Giving Sense to de novo Market Categories: Analogies and Metaphors in the Early Emergence of Quantum Computing. *Research in the Sociology of Organizations*, *80*, 57 79. https://doi.org/10.1108/s0733-558x20220000080005

Islam, T. Q., Chana, D., Kornish, S., Krause, H. H., Ghose, R., Josey, R., Garlick, R., Gogioso, S., Edelman, D. W., Dayan, Y., Master, K., Gibson, C., Fei, W., Bose, S., Gangahar, A., Stone, D., & Malik, A. (2023). *Quantum Computing - Moving Quickly From Theory to Reality*. https://ir.citi.com/gps/nh6PRNGut2dR%2BanVBfV8YtiV33RvBKQo3jNLwY-vfjZJlTVKHYMGV3MicyGBcqqwlxVLhv7bO7aBa%2FLLNdXwpIA%3D%3D

Jarzabkowski, P., & Spee, A. P. (2009). Strategy-as-practice: A review and future directions for the field. *International Journal of Management Reviews*, *11*(1), 69 95. https://doi.org/10.1111/j.1468-2370.2008.00250.x

Kerr, C., & Phaal, R. (2020). Technology roadmapping: Industrial roots, forgotten history and unknown origins. *Technological Forecasting and Social Change*, *155*, 1–16. https://doi.org/10.1016/j.techfore.2020.119967

Langione, M., Bobier, J.-F., Cui, Z., Naudet-Baulieu, C., Kumar, A., & Gourévitch, A. (2023, May 4). *Quantum Computing Is Becoming Business Ready*. Boston Consulting Group. https://mkt-bcg-com-public-pdfs.s3.amazonaws.com/prod/enterprise-grade-quantum-computing-almost-ready.pdf

Latifi, G., Grilli, L., & Herrmann, A. M. (2023). Does writing a business plan still matter for searching and obtaining external equity finance? *Venture Capital*, 1 27. https://doi.org/10.1080/13691066.2022.2161969

Lerner, S., Thornhill, J., Joiner, S., & de la Torre Arenas, I. (2023, May 2). Quantum computing could break the internet. This is how. *Financial Times*. https://ig.ft.com/quantum-computing/

Lounsbury, M., & Glynn, M. A. (2001). Cultural Entrepreneurship: Stories, Legitimacy, and the Acquisition of Resources. *Strategic Management Journal*, *22*(6–7), 545–564. https://doi.org/10.1002/smj.188

Majumdar, H. (2023a). *Some of my acquaintances have asked me about my opinion on the immigration policy in the new government program*. LinkedIn.

https://www.linkedin.com/posts/himadrimajumdar_immigration-democracy-activity-7077135518869655552-Fr0X/?trk=public_profile_like_view
Majumdar, H. (2023b, May 8). *Realizing the promise of quantum requires commitment and resources, but creates unlimited opportunities for European industry*. News and Insights, SemiQon Technologies.
Martens, M. L., Jennings, J. E., & Devereaux Jennings, P. (2007). Do the Stories They Tell Get Them the Money They Need? The Role of Entrepreneurial Narratives in Resource Acquisition. *The Academy of Management Journal*, *50*(5), 1107 1132. https://www.jstor.org/stable/20159915
Merriam-Webster Dictionary. (2023, September 25). *Expectation, noun*. https://www.merriam-webster.com/dictionary/expectation?utm_campaign=sd&utm_medium=serp&utm_source=jsonld
Mohr, N., Zemmel, R., Soller, H., Bogobowicz, M., Gao, S., Gschwendtner, M., Heid, A., Masiowski, M., & Zesko, M. (2023). *Quantum Technology Monitor April 2023*. https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/quantum%20technology%20sees%20record%20investments%20progress%20on%20talent%20gap/quantum-technology-monitor-april-2023.pdf
Navis, C., & Glynn, M. A. (2010). How New Market Categories Emerge: Temporal Dynamics of Legitimacy, Identity, and Entrepreneurship in Satellite Radio, 1990–2005. *Administrative Science Quarterly*, *55*, 439–471.
Pautasso, L., Pflanzer, A., & Soller, H. (2021, February 19). *The current state of quantum computing: Between hype and revolution*. McKinsey Digital. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/tech-forward/the-current-state-of-quantum-computing-between-hype-and-revolution
Pflitsch, M. (2023, May 4). *Quantum Computers Could Make Today's Encryption Defenseless*. Forbes. https://www.forbes.com/sites/forbestechcouncil/2023/05/04/quantum-computers-could-make-todays-encryption-defenseless/?sh=3e2628a58556
Portincaso, M., de la Tour, A., & Soussan, P. (2019). *The Dawn of the Deep Tech Ecosystem*. The Dawn of the Deep Tech Ecosystem
Portincaso, M., Gourévitch, A., Arnaud de la Tour, A., Legris, A., Salzgeber, T., & Hammoud, T. (2021). *The Deep Tech Investment Paradox: a call to redesign the investor model*. https://hello-tomorrow.org/wp-content/uploads/2021/05/Deep-Tech-Investment-Paradox-BCG.pdf
Ruane, J., McAfee, A., & Oliver, W. D. (2022, January). Quantum Computing for Business Leaders - Will the reality live up to the hype? *Harvard Business Review*, *January-February*, 112 122.
SemiQon. (2023a). *Exciting times ahead! SemiQon is kicking off operations this spring and starting a journey towards the million-qubit era. Our mission*. LinkedIn. https://www.linkedin.com/posts/semiqon_semiqon-to-develop-more-affordable-and-scalable-activity-7041395345922142208-7VtK/?trk=public_profile_like_view
SemiQon. (2023b, March). *Our CEO Himadri Majumdar had the pleasure to join Entangled Things Podcast to talk all things #quantum. If you are*. LinkedIn. https://www.linkedin.com/posts/semiqon_himadri-majumdar-ep-56-

entangled-things-activity-7043982955412623360-5G2j/?trk=public_profile_like_view
SemiQon. (2023c, April). *A small step towards scalability of quantum processors and a giant first step for SemiQon! Our first prototype design has*. LinkedIn. https://www.linkedin.com/company/semiqon/posts/?feedView=all
SemiQon. (2023d, June). *At SemiQon, we build quantum processors for the million-qubit era. We are on a mission to power the future of*. LinkedIn. https://www.linkedin.com/posts/semiqon_semiqon-building-quantum-processors-for-activity-7084418535770210304-5Ali?utm_source=share&utm_medium=member_desktop
SemiQon Technologies. (n.d.-a). *About SemiQon*. N.d. Retrieved September 27, 2023, from https://www.semiqon.tech/about-semiqon
SemiQon Technologies. (n.d.-b). *SemiQon's Technology*. Retrieved September 27, 2023, from https://www.semiqon.tech/technology
SemiQon Technologies. (n.d.-c). *Team*. Retrieved September 27, 2023, from https://www.semiqon.tech/team
SemiQon Technologies. (2023, March 14). *SemiQon, a spinout from VTT, to develop more affordable and scalable quantum computers with new semiconductor qubit technology*. https://www.semiqon.tech/news-insights/press-release-march-2023
Thompson, N. A., Verduijn, K., & Gartner, W. B. (2020). Entrepreneurship-as-practice: grounding contemporary theories of practice into entrepreneurship studies. *Entrepreneurship and Regional Development*, *32*(3–4), 247–256. https://doi.org/10.1080/08985626.2019.1641978
van Lente, H. (2012). Navigating foresight in a sea of expectations: Lessons from the sociology of expectations. *Technology Analysis and Strategic Management*, *24*(8), 769–782. https://doi.org/10.1080/09537325.2012.715478