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Self-sovereign identity adoption: Antecedents and potential outcomes

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ABSTRACT

Self-Sovereign Identity (SSI) technology is transforming digital identity management by enabling individuals and organizations to control personal data securely. Its adoption promises enhanced privacy, data security, and trust in digital ecosystems. However, despite its rising importance, the key drivers and broader impacts of SSI adoption remain unclear. Understanding these factors is essential to support informed decision-making by organizations and policymakers, ensuring successful implementation and widespread adoption. This study addresses this critical research gap. We employed a qualitative field study, gathering data through interviews with senior SSI practitioners, participatory observations, and document analysis. This multi-method approach facilitated a comprehensive exploration of factors shaping SSI adoption. Our findings identify four categories of adoption antecedents. Organizational factors include leadership attitudes and financial stability. Societal and environmental drivers involve regulatory frameworks and public sector involvement. Ecosystem dynamics cover governance models and technological readiness. Individual traits such as risk tolerance and technical expertise also play a central role. We also highlight significant outcomes of SSI adoption. These include enhanced organizational efficiency, strengthened data privacy, and expanded ecosystem collaboration. Additionally, SSI adoption improves trust and scalability within digital ecosystems. Theoretically, this study advances technology adoption research by integrating ecosystem governance and individual-level factors into established frameworks. Practically, it provides actionable insights for organizational leaders and policymakers.

1. Introduction

Digital identity management has become a critical pillar of modern digital economies (Digital Identity[Book]). However, existing identity infrastructures often fail to meet evolving demands for privacy, security, and trust (Masiero & Arvidsson, 2021). As economist David Birch aptly noted, "We cannot build services for the post-industrial age using the identity infrastructure of the industrial age," (Birch, 2018). This challenge underscores the urgent need for new digital identity systems that can adapt to contemporary societal and technological contexts.

The widespread adoption of digital technologies has delivered significant societal benefits, including enhanced connectivity, financial inclusion, and access to essential services such as healthcare and public administration (Beynon-Davies, 2018; Caputo et al., 2021; Steiber et al., 2020; Wong et al., 2021). However, this progress has come at a cost. The increasing reliance on digital ecosystems has exposed individuals and organizations to serious risks such as identity theft, financial fraud, data breaches, and exploitative surveillance practices (Schlackl et al., 2022; Zuboff, 2015). Addressing these concerns requires a new approach to digital identity management.

Self-Sovereign Identity (SSI) technology has emerged as a promising solution. It offers secure, decentralized identity management by granting individuals and organizations control over their personal data without reliance on intermediaries (Wang & De Filippi, 2020; Naik and Jenkins, 2020; Soltani et al., 2021). SSI can mitigate key digital identity challenges while improving trust and privacy across various contexts, including business, healthcare, and public administration (Abramson et al., 2021).

Governments, businesses, and civil society have begun collaborating globally to enable SSI adoption. Initiatives include health passports (IATA Travel Passport, 2021; Good Health Pass, 2021), secure healthcare data management (Lumedic Connect), and digital identity protocols for legal entities (GLEIF, 2023). For instance, the Kiva protocol has improved financial inclusion in Sierra Leone by providing portable digital credit histories (KIVA, 2024; Wang & De Filippi, 2020). The European Union's plan to introduce a unified digital identity for all

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member states by 2026 highlights the increasing institutional support for SSI adoption (European Commission, 2021, 2023).

Despite its potential, SSI adoption presents complex organizational challenges. Many organizations struggle with SSI's technical complexity, early-stage ecosystem development, and the lack of standard solutions (Lacity & Carmel, 2022). Addressing these barriers requires a deeper understanding of SSI adoption from an organizational perspective, including how it influences and is influenced by organizational structures, regulatory frameworks, and ecosystem dynamics (Lacity & Carmel, 2022).

While prior research has explored the technical aspects of SSI (Wang & De Filippi, 2020) and the benefits of decentralized ecosystems (Laatikainen et al., 2021), the organizational drivers and consequences of SSI adoption remain underexamined. Existing studies often overlook how ecosystem governance, individual-level characteristics, and societal factors jointly shape adoption decisions. This leaves critical questions unanswered: What motivates various entities to adopt SSI? What happens when they do so? Addressing these gaps is essential for developing comprehensive adoption models that guide both research and practice.

Against this backdrop, the purpose of this study is to investigate the antecedents and potential outcomes of SSI adoption. We focus on how organizational, environmental, and ecosystem dynamics interact with individual-level characteristics to influence adoption decisions. This holistic perspective should extend beyond technical considerations to explore the broader drivers and consequences of adoption.

Our contributions are threefold. First, we advance the technology adoption literature by integrating ecosystem governance and individual-level factors. This synthesis expands traditional technology adoption models by highlighting the co-evolution of technological, organizational, and societal forces. Second, we provide a comprehensive model of SSI adoption antecedents and outcomes that encompasses organizational, societal, and environmental dimensions. Our model bridges theoretical gaps by incorporating multi-level determinants often omitted in prior studies. Third, we offer actionable insights for managers and policymakers, supporting strategic decision-making and reducing adoption-related risks. By presenting a structured framework, our findings serve as a practical guide for organizations navigating the complexities of SSI adoption.

The rest of the paper is structured as follows. In the next section, we provide an overview of recent relevant research on SSI and its adoption. In the third section, we describe the research methodology employed in the study. The fourth section presents the key findings, highlighting both antecedents and outcomes of SSI adoption. Finally, the fifth section discusses the study's theoretical and managerial contributions, acknowledges its limitations, and suggests promising avenues for future research.

2. Literature review

In this section, first, we give an overview of the concept of SSI. Next, we briefly describe the theories of technology adoption. Then, introduce the analytical framework of the study.

2.1. Self-sovereign identity

While there is no consensus on the definition of SSI among researchers and practitioners, it can be simultaneously considered as a human-centric paradigm, a set of technologies and standards, and a commodity (Zwitter et al., 2020). First, according to this human-centric paradigm, the users own and control their own identity and the personal data associated with their identity (Naik and Jenkins, 2020; Glöckler et al., 2024). Second, from a technology perspective, SSI enables human-centric identity management by providing the users with a digital identity in a decentralized manner without relying on intermediaries (i.e., trusted third parties; Ferdous et al., 2023; Guggenberger et al., 2023). Third, in some contexts, it can be viewed as a digital identity infrastructure, a commodity that provides private, secure, and trustworthy data storage and communication (Zwitter et al., 2020). In this paper, we refer to SSI as a technology following the human-centric paradigm that facilitates a new, post-industrial digital identity infrastructure.

The key components of SSI include a digital wallet (i.e., an application for storing digital assets, and/or identity information; Kuperberg, 2020; Sedlmeir et al., 2021), verifiable credentials (i.e., a tamper-evident, cryptographically verifiable credential that has authorship; W3C VC, 2022), decentralized identifiers (i.e., references to data about the owners' public keys and associated metadata; W3C DID, 2022) and a verifiable data registry (a role of a system that mediates the creation and verification of identifiers, verification material, and other relevant data; W3C VC, 2022). Many SSI implementations rely on distributed ledger technologies that refer to a type of blockchain-inspired technology (Zachariadis et al., 2019).

The successful implementation of SSI requires an ecosystem of three distinct types of actors with specific roles that form "the digital trust triangle": the holder, issuer, and verifier (Davie et al., 2019). The holders request credentials (i.e., the digital representation of information) from issuers and hold them on their local devices or in the cloud (Lacity & Carmel, 2022). When requested by the verifier, holders can approve the request and present the credentials for verification. The issuers define the credentials, their meaning and method for verification. Verifiers request the credentials they need and then follow their own policy to verify their authenticity (Schlatt et al., 2022).

In SSI ecosystems, the trust among actors is established through peer-to-peer interactions assured by: (1) technology that provides immutable and secure data storage, data exchange and communication (Lacity & Carmel, 2022; Satybaldy et al., 2024), and (2) governance frameworks; consisting of business, legal, and technical rules and policies for managing the ecosystem, in particular business, legal, and technical policies for issuing, holding, and verifying the credentials (Joosten et al., 2021; Bochnia, Richter, & Anke, 2024). The interrelation of the technological architecture and governance framework is further reinforced through the use of machine-readable governance, i.e., automatized governance mechanisms (Joosten et al., 2021).

Given the intertwining of social and technological elements, understanding SSI necessitates a holistic perspective that considers both the technological infrastructure and governance structures. This socio-technical approach recognizes that SSI ecosystems function at the intersection of technology and institutional governance, shaping trust, interoperability, and adoption dynamics (Laatikainen et al., 2021; Giannopoulou & Wang, 2021).

2.2. Theories of technology adoption

To build a comprehensive understanding of SSI adoption, we draw on several established technology adoption theories, summarized in Table 1. The Technology-Organization-Environment (TOE) framework (Tornatzky & Fleischer, 1990) and the Diffusion of Innovations (DOI) theory (Rogers, 2003) are often used in combination to provide a more complete view of technology adoption (Oliveira & Martins, 2011). In particular, the TOE framework posits that technology adoption is affected by technological, organizational and environmental factors, and several studies include the five innovation characteristics suggested by DOI (relative advantages, compatibility, complexity, trialability, and observability) into the TOE framework as part of the technological factors. However, these two theories do not consider the human characteristics and behaviors playing a role in technology adoption (Svendsen, Johnsen, Almås-Sørensen, & Vittersø, 2013).

Research that focuses on individual technology acceptance, adoption behavior, behavioral intention or attitude often rely on some, or a combination of the following theories: Theory of Reasoned Action (Ajzen & Fishbein, 1980), Theory of Planned Behavior (Ajzen, 1991), the Technology Acceptance Model (Davis, 1989) and the Unified Theory

Table 1
Key theories in studying technology adoption.

Theory	Main argument	Key references
Technology-Organization-Environment	Technology adoption is affected by factors related to the technological context (technology characteristics), the organizational context (organizational structure, processes, and resources) and the environmental context (e.g., industry, competitors, laws and regulations).	Tornatzky and Fleischer (1990)
Diffusion of Innovations	Innovation diffusion is seen as a process by which innovation is communicated over time among the participants in a social system.	Rogers (2003)
Technology Acceptance Model	Technology adoption is affected by the perceived usefulness, perceived ease of use, and behavioral intention.	Davis (1989)
Theory of Reasoned Action	The theory aims to explain the relationship between attitudes and behaviors within human action.	Ajzen and Fishbein (1980)
Theory of Planned Behavior	A theory originating from psychology that aims to explain individuals' behavioral intentions with attitude, subjective norms and perceived behavioral control.	Ajzen (1991)
Unified Theory of Acceptance and Use of Technology I and II.	A theory that aims to explain individual users' intentions and behaviors with the key constructs of performance expectancy, effort expectancy, social influence, and enabling conditions.	Venkatesh et al. (2003, 2012)

of Acceptance and Use of Technology I and II. (Venkatesh et al., 2003, 2012). Factors that explain individuals' technology acceptance, intentions and behaviors include the perceived usefulness, perceived ease of use and behavioral intention (Davis, 1989), and performance expectancy, effort expectancy, social influence, and enabling conditions (Venkatesh et al., 2003, 2012).

2.3. Analytical framework for SSI adoption

Given the complexity of SSI, an adaptive and context-sensitive approach to technology adoption is required (Gstrein & Kochenov, 2020; Hickman, 2022). Drawing on the above theories and inspired by established factor-based models (e.g., Pitkänen et al., 2003), we propose an analytical framework encompassing four interrelated categories of adoption factors: individual, organizational, ecosystem-related, and environmental factors.

Individual factors play a central role in technology adoption, as decisions are ultimately made by individuals within organizations. Attributes such as risk-taking behavior, openness to innovation, and technological expertise influence how managers evaluate and decide on adopting SSI solutions (Benlian & Hess, 2011). Organizational factors significantly impact technology adoption by shaping internal readiness and strategic priorities. Drawing on the TOE framework and DOI theory, elements such as organizational culture, the openness of leadership to innovation, and the availability of financial and technical resources are critical determinants of SSI adoption (Tornatzky & Fleischer, 1990; Rogers, 2003; Laatikainen et al., 2021).

Ecosystem-related factors encompass both technological and governance dimensions, reflecting the interconnected nature of SSI adoption. Successful implementation requires active participation in a network of issuers, verifiers, and holders who collectively enable secure identity transactions. Technological complexity, a core consideration in DOI theory, affects how organizations perceive SSI's feasibility, while governance structures establishing rules and responsibilities remain an underexplored area in the existing literature (Laatikainen et al., 2021; Guggenberger et al., 2023). Environmental factors play a crucial role in SSI adoption by shaping the external conditions under which organizations operate. Industry competition can drive innovation by encouraging firms to adopt advanced technologies like SSI to gain a competitive edge. Regulatory frameworks establish the legal and compliance boundaries, ensuring that SSI implementations meet data protection and privacy standards. Additionally, market dynamics such as customer demand, technological trends, and economic conditions influence organizations' readiness and urgency to adopt SSI (Tornatzky & Fleischer, 1990; Laatikainen et al., 2021).

SSI adoption affects three primary levels: organizational, ecosystem, and societal. At the organizational level, SSI can enable companies to innovate by offering privacy-enhanced services that prioritize data security and user control (Soltani et al., 2021). Further, organizations adopting SSI can improve service efficiency while reducing data management risks through decentralized identity protocols.

At the ecosystem level, joining an SSI network can trigger network effects, scaling the user base and enhancing interoperability between participants. As more organizations, service providers, and users adopt SSI, the overall ecosystem becomes more robust, facilitating seamless identity verification and data sharing between platforms (Henfridsson & Bygstad, 2013).

From a societal and environmental perspective, SSI adoption can digitize paper-based processes and reduce the reliance on physical identity documents, minimizing environmental footprints associated with traditional identity management methods. By giving individuals greater control over their personal data, SSI promotes privacy, security, and data ownership while improving sustainability through reduced resource consumption (Glöckler et al., 2024).

By integrating multi-level factors and impacts, our framework addresses critical gaps in the existing literature and provides a comprehensive perspective on SSI adoption. This approach highlights the interconnected nature of technological, organizational, and societal dimensions, offering valuable insights into the potential of SSI in cultivating a more secure and sustainable digital environment.

3. Research method

Given the emergent nature of the SSI phenomenon and its limited examination in the existing literature, we adopted an exploratory research approach. This method allowed for the flexibility and openness necessary to investigate SSI through empirically rich and detailed qualitative data (Edmondson & McManus, 2007; Yin, 2009). We conducted a field study to observe SSI adoption in its real-world context, enabling a deeper understanding of the phenomenon. To broaden the scope of our findings, we supplemented the field study with in-depth interviews.

3.1. Data collection

To ensure a comprehensive understanding of the SSI phenomenon, we collected data from multiple sources. First, we collaborated closely with field experts and observed their professional activities. This

approach provided a broad understanding of the subject while yielding rich observational data (Myers & Newman, 2007). Second, we conducted semi-structured interviews with experienced SSI practitioners to gain deeper insights into specific aspects of SSI adoption (Myers & Newman, 2007). These two primary data sources are detailed further in the following subsections.

3.1.1. Data collection through field study

To ensure comprehensive data collection, we collaborated with practitioners who are subject matter experts in SSI technologies. These experts were selected based on their active engagement in SSI development and their long-term expertise in digital identity systems. We used purposive sampling, targeting individuals and organizations directly involved in SSI-related projects to capture diverse perspectives.

Our data collection activities for the field study, summarized in Table 2, involved working with an organization developing an SSI infrastructure, contributing to standard development organization (SDO) initiatives such as the TrustOverIP Foundation[1], engaging in discussions with industry experts, and facilitating collaboration between students and an SSI infrastructure provider. These engagements helped us explore the antecedents and outcomes of SSI adoption in real-world contexts.

During the fieldwork, we gathered observational data through detailed field notes documenting dates, sources, participants, and key insights. We captured presentation slides, saved chat transcripts, recorded meetings with consent, and extracted relevant content from webinars, lectures, and industry presentations. Supporting documents such as white papers and spreadsheets were also collected.

We conducted 40 meetings, totalling approximately 36 h. This included 11 meetings of about 60 min and one meeting of 120 min with an IT service provider contributing to the development of an SSI infrastructure in Finland. This collaboration offered insights into governance and interoperability challenges. As part of this engagement, we did research on blockchain governance and started to develop the "Ecosystem Governance Compass," a tool helping practitioners design and operate blockchain ecosystems.

Our collaboration with the TrustOverIP Foundation involved five 30-min meetings, a 90-min professional workshop, and seven 60-min meetings. These activities included studying SSI adoption and contributing to a governance framework for an SSI ecosystem incubated by UNICEF, offering critical insights into governance challenges (Sroor, Hickman, Kolehmainen, Laatikainen, & Abrahamsson, 2022). Throughout these engagements, we participated in workshops, email discussions, and Slack conversations with global SSI experts.

We also participated in industry meetings with SSI experts, including six 60-min meetings and six 30-min brainstorming sessions. Key discussions involved defining core SSI concepts such as digital wallets, trust, and technology acceptance while exploring ecosystem governance and user adoption. Moreover, SSI practitioners from a firm in the SSI infrastructure business participated in three 60-min university course meetings where SSI was a core learning objective. They provided real-world project themes for student assignments, offering valuable industry insights and hands-on SSI experience.

Beyond these engagements, we monitored industry news, social media updates, and discussions on the TrustOverIP community Slack channels. We also attended webinars and university lectures. To broaden our understanding, we analyzed 41 podcast episodes from the "SSI Orbit" series (Glaude, 2024), where global SSI professionals discussed various aspects of SSI adoption. We reviewed websites of relevant companies, non-profits, and standard-setting organizations.

[1] The TrustOverIP Foundation aims to combine the SSI-related open standards, architectures, and protocols developed in other SDOs and technical development partners. Currently, the steering members include IBM, British Columbia, Accenture, Avast and Futurewei.

3.1.2. Data collection through interviews

Our continuous participation in the field research allowed us to build a strong conceptual foundation for this study. To deepen our understanding of the phenomenon, we conducted additional in-depth interviews. In total, we conducted 16 online interviews, comprising two group interviews and twelve individual interviews. The interviews followed an open-ended structure (Darke, Shanks, & Broadbent, 1998), with durations ranging from 36 to 68 min, averaging 56 min. No financial compensation was provided to the interviewees. We adhered to the ethical guidelines of the Finnish National Board on Research Integrity (TENK, 2020) throughout the data collection process. Formal ethical approval was not required, as the research involved voluntary participation by professionals in their professional roles and did not involve sensitive personal data. All interviews were recorded and fully transcribed for subsequent analysis.

Sample selection: In our sampling, we targeted interviewees who are actively involved in the SSI field and hold senior positions capable of offering detailed and relevant insights for our research. We selected individuals who are active, contributing members of one or more standard-setting organizations (SDOs) or other communities focused on digital identity. Given that SSI adoption is a global phenomenon evolving rapidly across regions, we purposefully selected participants from diverse cultural and geographic backgrounds.

Table 3 provides an overview of the informants. Our interviewees represent Finland, Sweden, Germany, the U.K., the U.S., Canada, and India. They hold senior titles related to SSI development, including Head of Innovation Center, Executive Director, Chief Trust Officer, Founder, CEO, Principal Technology Strategist, Chief Strategy Officer, Senior Consultant, Chief Information Officer, and Advisory Board Chairman. Two interviewees are founders of the TrustOverIP Foundation, while most are active contributors to one or more SDOs or digital identity-related communities. The diversity in professional backgrounds enabled us to gather well-rounded insights from multiple perspectives.

We discontinued the interviews after reaching theoretical saturation, where additional interviews no longer provided new information or altered our overall understanding of the phenomenon.

Conducting the interviews: We structured our interviews around key themes outlined in Table 4. While we used a standardized interview guide, we customized the questions based on each interviewee's professional background to ensure relevance and depth. This approach allowed us to explore specific organizational contexts and individual experiences more comprehensively.

This thematic structure ensured consistency throughout the interviews. At the same time, it allowed flexibility to adjust questions based on interviewee expertise. This approach led to richer, context-specific discussions. As a result, we captured diverse perspectives and uncovered detailed insights.

3.2. Data analysis

To manage the complexity and diversity of the collected data, we compressed and synthesized field data from various formats, including video and images, into concise text representations (Miles & Huberman, 1994; Eisenhardt, 1989). We conducted the data analysis using ATLAS.ti, following a three-phase process involving open, axial, and theoretical coding. This iterative process is illustrated in Fig. 1.

In the first phase, open coding, we identified key aspects relevant to SSI adoption by labelling text segments using concise summary codes (Locke, 2002). We applied the constant comparative method, frequently using terms directly from the text (Strauss & Corbin, 1994), while ensuring that codes captured broader contextual meanings.

During the axial coding phase, we established patterns, relationships, and causal links among the codes. We grouped related open codes into broader categories that reflected different aspects of the SSI adoption phenomenon. This process resulted in a hierarchical code structure, enabling a deeper understanding of interrelated factors.

Table 2
List of events included in the field study.

Activity	Events	Duration	Participants	Topic of key insights	Time period
1. Working with an organization developing an SSI infrastructure	Project meetings with a collaborative partner and one meeting related to another project with another organization working on SSI.	11 meetings of approx. 60 min. and 1 meeting of approx. 120 min.	Our research group and our collaborative partner companies.	General understanding on SSI technology and ecosystem. Governance. Business models. Challenges and benefits.	2020–2021
2. Contribution to SSI-related SDOs: research activities, YOMA governance framework development	Studying the current state of SSI, research as a collaborative effort with some TrustOverIP members.	5 meetings of approx. 30 min.	One SSI practitioner and occasionally some other TrustOverIP member.	Various SSI definitions, actors and roles. Diversity of mental models. SSI benefits, challenges, payment methods, measuring the level of adoption.	2021–2022
	Presenting and leading the discussion on the benefits and challenges of SSI at Internet Identity Workshop XXXII.	1 meeting of approx. 90 min.	Attendants of the IIW32, mostly digital identity practitioners.	Various SSI definitions, actors, and roles. Diversity of mental models. SSI benefits, challenges, payment methods, measuring the level of adoption.	Spring 2021
	Active participation in SSI-related SDO meetings: TrustOverIP meetings (All members meetings, Ecosystem Foundry Working Group meetings, YOMA Task Force Meetings) and a DIF meeting.	7 meetings of approx. 60 min.	Members of SSI-related SDOs: TrustOverIP Foundation members and DIF members.	SSI in global, cross-industrial context. Interoperability issues. Diversity of use cases. Regulatory issues. Challenges in developing the governance framework.	2020–2021
3. Active participation in SSI-related discussions with SSI experts	Brainstorming meetings related to different aspects of SSI: pricing model development, human experience, holders' technology acceptance, blockchain governance.	1 meeting of approx. 60 min. and 6 meetings of approx. 30 min.	Every topic has been discussed with different SSI experts from the TrustOverIP community.	Three-sided markets of holders, verifiers and issuers. New business models. User experience. Guardianship. Custodianship. Blockchain governance. Diversity of mental models.	2020–2021
	Discussions related to SSI technology acceptance of privacy-aware organizations together with some SSI practitioners	5 meetings of approx. 60 min.	One SSI consultant and one additional SSI expert on one of the meetings.	Privacy-awareness. Transparency. Data control. Regulations such as GDPR and Data Governance Act.	2021
4. SSI-related education	Facilitating SSI-related collaboration between students and an organization providing an SSI infrastructure.	3 meetings of approx. 60 min.	Some of the employees of the organization, students.	Hands-on SSI experience. User interface. Immaturity of the technology.	2021
	Summary	40 meetings, altogether 36 h.			

Table 3
List of informants.

Interviewee	Organization/ Institution Type	Role of the organization related to SSI	Position at the Organization/ Institution	Open-source communities and SDOs	Country	Number of interviews	Year of interviews
Interviewee 1	IT Service Provider, Organization A	Building an SSI infrastructure and orchestrating SSI ecosystems	Senior Blockchain Consultant	MyData and TrustOverIP member	Finland	2 group interviews and 1 individual interview	2020 and 2021
Interviewee 2	IT Service Provider, Organization A	Building an SSI infrastructure and orchestrating SSI ecosystems	Head of Innovation Center	MyData and TrustOverIP member	Finland	2 group interviews and 1 individual interview	2020 and 2021
Interviewee 3	Public Digital Trust Service Provider (government), Institution B	Providing a public SSI solution for the citizens (service in production)	Executive Director	Executive Director of the TrustOverIP Foundation	Canada	1 group interview	2020
Interviewee 4	Provider of Platform for Verifiable Credentials, Organization C	Providing platform and tools for SSI	Chief Trust Officer	TrustOverIP Steering Committee Member, W3C DID Co-editor, Sovrin Co-Chair, OpenID Foundation Founding Board member, Identity Commons Steward	U.S.	1 group interview	2020
Interviewee 5	Innovative Consultant Services Provider, Organization D	Providing SSI-consultant services	Founder and CEO	TrustOverIP member	Canada	2 individual interviews	2020
Interviewee 6	Innovative Consultant Services Provider, Organization E	Providing SSI-related consultant services	Consultant and Advisory	TrustOverIP member, DIF contributor, Identity Defined Security Alliance Member, Sovrin Board Member	U.S.	1 individual interview	2020
Interviewee 7	–	–	–	TrustOverIP member, Sovrin member	Canada	1 individual interview	2020
Interviewee 8	Certified Public Accountant, Cybersecurity Audits Organization F	Providing SSI-related consultant services	Cybersecurity Consulting Audit and Governance Executive	TrustOverIP Working Group Co-Chair, Sovrin member, CULedger Board of Advisors member, Credential Master, Board of Advisors member	U.S.	1 individual interview	2021
Interviewee 9	Service and Infrastructure Provider, Bank G	Building an SSI infrastructure and orchestrating SSI ecosystems	Principal Technology Strategist	MyData member	Finland	1 individual interview	2021
Interviewee 10	SSI-related Consultant Services Provider, Organization H	Providing an SSI infrastructure, SSI-related tools, and consultant services	Chief Strategy Officer	TrustoverIP and Hyperledger member	India	1 individual interview	2021
Interviewee 11	Privacy-related Consultant Services Provider, Organization I	Providing SSI-related consultant services	Founder and CEO	Member of the Swedish Institute of Standards, ISO, Kantara Initiative, Trust over IP and Hyperledger Aries	Sweden	1 individual interview	2021
Interviewee 12	Consultant services provider, Organization J	Providing SSI-related consultant services	Senior Consultant	Member of Sovrin, TrustOverIP Foundation, All-party parliamentary group on digital identity in U.K., APPG for AI	U.K.	1 individual interview	2021
Interviewee 13	Consultant Services Provider, Organization K	Providing SSI-related consultant services	Owner and CEO	Open Identity Exchange member	U.K.	1 individual interview	2021
Interviewee 14	Information Security Consultant Services Provider, Organization L	Providing SSI-related consultant services and solutions	Chief Information Officer	Member of TrustOverIP, Sovrin, Data Trust, German IT Security Association, MyData	Germany	1 individual interview	2021
Interviewee 15	Digital Services Provider, Organization M	Building an SSI infrastructure and orchestrating SSI ecosystems	Advisory Board Chairman	Founding and Steering Member of MyData, Senior Advisor for Finnish Council of Regulatory Impact Analysis	Finland	1 individual interview	2021

Table 4
Key themes of the interviews.

Viewpoint	Key themes
Background of the interviewee	Experience related to SSI and digital identity, and to SSI-related open-source communities Personal incentives, objectives, and expectations related to contributing to SSI standardization
Background of the organization of the interviewee	The role of the organization related to SSI Benefits, drivers, risks, and barriers of the organization to adopting/orchestrating SSI Organizational factors impacting SSI adoption Customers and partner companies' perceptions of the value of SSI
SSI technology and ecosystem, and their adoption	Defining SSI and its key components SSI ecosystem actors, their roles, ecosystem orchestration, and governance Perceptions related to the roadmap toward mass adoption The role of open-source communities and SDOs in shaping the SSI market and their impact on the organization/the SSI ecosystem

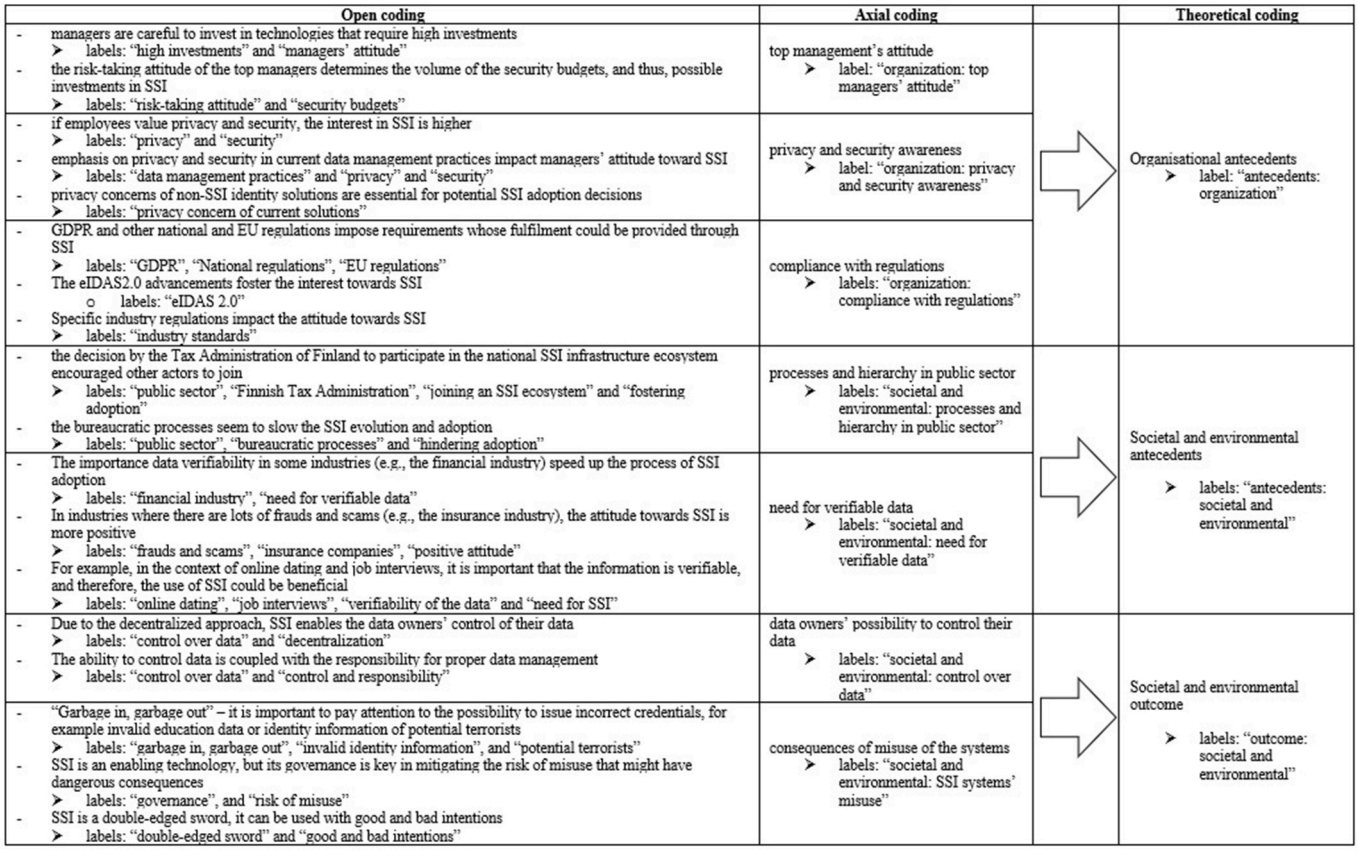

Fig. 1. Illustrative examples of the coding process of the study.

In the final theoretical coding phase, we formulated a conceptual model offering a comprehensive understanding of SSI adoption. Drawing on existing research frameworks such as the Antecedents and Outcomes model (e.g., Chen et al., 2021), we iteratively categorized themes into two primary groups: (1) Antecedents and (2) Potential Outcomes.

Throughout the analysis, we regularly refined the codes by renaming, merging, and eliminating duplicates to maintain logical coherence. We also conducted multiple validation discussions within our research team and with SSI community experts. This collaborative effort ensured that our final model reflected both theoretical robustness and practical relevance.

4. Findings

Our findings suggest that SSI adoption is a multifaceted co-creationary process characterized by continuous interaction between organizations and the broader ecosystem. Based on our analysis, we identified key antecedents and potential outcomes of SSI adoption. These categories are summarized in Fig. 2 and discussed in greater detail in the following subsections.

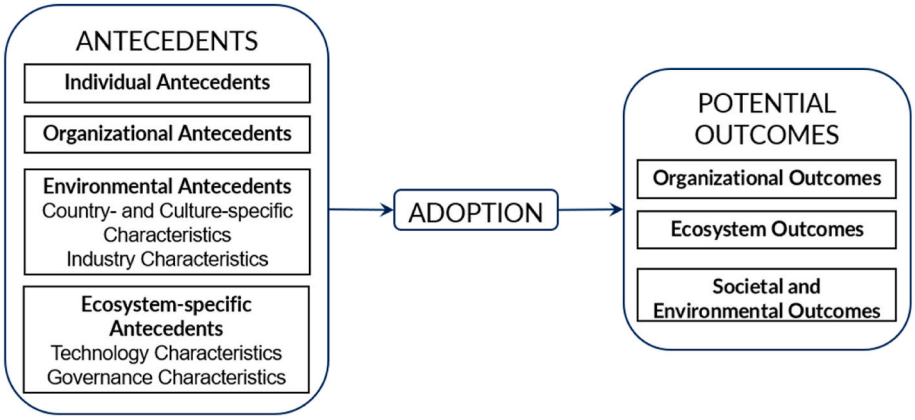

Fig. 2. Antecedents and potential outcomes of SSI adoption.

4.1. Antecedents of the adoption

The adoption of SSI is influenced by multiple interrelated factors that determine the readiness and capacity of organizations, ecosystems, and individuals to adopt the technology. Based on our empirical data, we identified four main types of antecedents shaping the adoption process: organizational antecedents, societal and environmental antecedents, ecosystem-specific antecedents, and individual-level antecedents. Table 5 summarizes these categories, which we discuss in detail.

4.1.1. Organizational antecedents

Our empirical analysis reveals that several organizational factors critically influence the adoption of SSI. First, the attitude of top management emerged as a decisive factor. Early-stage adoption of SSI entails significant investment with uncertain returns, requiring top management's awareness its potential value. A consultant from an SSI consultancy firm emphasized this:

> *"If [organizations] include decentralized solutions in their organization, then they have to get approvals from their executive leadership to get their security budgets […] It's a problem when there's a lack of specific technology knowledge and lack of support from their executive leadership."* – Consultant and Advisory, Innovative Consultant Services Provider, Organization E (Interviewee #6)

Our findings also indicate that an organization's financial condition plays a crucial role. Financially robust organizations are better positioned to invest in emerging technologies despite inherent risks. Conversely, financially constrained organizations may delay SSI adoption due to limited budgets. The Head of the Innovation Center at an organization orchestrating an SSI ecosystem explained:

> *"There are alternative means to solve the problem, even if they are not as effective. In the short term, these alternative solutions require less investment but don't necessarily deliver the same level of value in the long term. […] The solutions we propose require high upfront investments while delivering higher value only after a few years, like three to five years. That's quite challenging for many organizations to justify this investment."* – Head of Innovation Center, IT Service Provider, Organization A (Interviewee #2)

Additionally, our findings suggest that organizational culture, innovativeness, and size influence SSI adoption. Organizations with a culture of innovation are more likely to adopt new technologies. Larger organizations with dedicated R&D budgets can absorb higher risks. However, even within large organizations, SSI adoption often depends on budgetary allocations. The Head of the Innovation Center further highlighted this challenge:

> *"Even though many large organizations are involved in various innovation-related activities, the innovation budgets are often relatively small compared to their business budgets. Business owners are the ones who really decide if they are jumping into the game fully. Sometimes, you see press releases claiming that a company is involved in a blockchain ecosystem. However, it does not mean their business owners have actually signed up. It can just mean that their innovation group or blockchain team has a budget to test things out."* – Head of Innovation Center, IT Service Provider, Organization A (Interviewee #2)

Table 5
Antecedents of SSI adoption.

Organizational antecedents	Societal and environmental antecedents		Ecosystem-specific antecedents		Individual-level antecedents
Organizational characteristics	*Country and culture-specific characteristics*	*Industry characteristics*	*Technology characteristics*	*Governance characteristics*	*Human characteristics*
• Top management's attitude • Financial condition • Organizational culture • Innovativeness • Size • Age • Technological competence • Privacy and security awareness • Compliance with regulations	• Regulations and legislation • The government's attitude towards the technology • Processes and hierarchy in public sector • Social norms and culture • Trust in government	• Level of digitalization • Need for verifiable data • Industry regulations and standards	• Relative advantage • Compatibility • Complexity • Immaturity • Lack of standards • User experience • Security and privacy concerns • Interoperability	• Business, legal and technical policies and rules • Incentives (monetary/non-monetary) • Governance principles • Actors' credibility	• Skills and competencies • Risk-taking attitude • Power or agency to create change • Sensitivity towards societal problems • Belief in human-centric principles

Our observations indicate that the age and size of an organization further shape SSI adoption. Younger, smaller organizations often have fewer legacy systems, making SSI adoption less complex. In contrast, older, larger organizations face challenges due to entrenched legacy systems. An experienced SSI consultant explained:

> *"Identity impacts every part of the customer service, retail, all the customer touchpoints, and every product or service where there's access control, data management, and marketing. […] In [an old and large organization], it took me a year and a half to get buy-in across the business for the whole identity management upgrade. It was a five-year program, with no commercial benefits in the first two years – just opportunity, cost, and risk reduction. We had to do this first; otherwise, we couldn't do the juicy bit at the end."* – Senior Consultant, Consultant Services Provider, Organization J (Interviewee #12)

Technological competence also plays a critical role in SSI adoption. Organizations with advanced technical skills can build custom solutions when ready-made tools are unavailable, integrate SSI into legacy systems, and contribute to technology development. Organizations lacking technical capabilities may struggle with these challenges.

Given SSI's potential to enhance privacy and security, privacy awareness and regulatory compliance emerged as important adoption drivers. Organizations prioritizing privacy and adhering to relevant regulations, such as GDPR, are more likely to adopt SSI, recognizing its potential to simplify data management. A privacy expert stated:

> *"Many companies are scared of using private data. However, if you have the right implementation and give the right motivation for individuals—such as giving them control of their user data—then people are more willing to share their data. Thus, the organization's attitude matters in how they handle private data."* – Founder and CEO, Privacy-related Consultant Services Provider, Organization I (Interviewee #11)

However, the immaturity of SSI technology raises concerns about its security-related advantages compared to existing identity solutions. Emerging technologies like quantum computing may eventually undermine current encryption methods, requiring continued vigilance.

4.1.2. Societal and environmental antecedents

Our empirical analysis underscores the significance of societal and environmental antecedents in influencing the adoption of SSI. Through systematic coding, these antecedents were categorized into two major groupings: country and culture-specific characteristics and industry characteristics.

Country and culture-specific characteristics include regulations and legislation, such as the General Data Protection Regulation (GDPR), the Data Governance Act, eIDAS 2.0 (European Digital Identity Regulation: Regulation EU 2024/1183), and national laws, which impose stringent requirements on data management and sharing. These mandates encompass principles such as fair and lawful processing, purpose limitation, data minimization, and data retention, introducing complexities in organizations' approaches toward data governance. To mitigate these challenges, SSI enables customers to securely control their data, while possibly reducing the burden of data storage and management for organizations. However, depending on the implementation details and the rules set in the governance framework, organizations may store customer data despite of using some components of SSI.

The government's attitude toward SSI plays a pivotal role. Supportive governments can stimulate SSI innovation through financial aid, legislative initiatives, and involvement in standardization efforts. For example, Germany and Finland have funded SSI advancements, while British Columbia pioneered early SSI initiatives. However, slow bureaucratic processes can hinder innovation. This perspective was emphasized by a chief information officer providing SSI-related services:

> *"We see in Germany how an investment by the government can be the catalyst. If we can get to a pure version of SSI all across Europe, this would be a real economic advantage."* – Chief Information Officer, Information Security Consultant Services Provider, Organization L (Interviewee #14)

Public institutions' roles in identity and data management are critical. For instance, Finland's Tax Administration's participation in a national SSI infrastructure encouraged other organizations to follow suit. However, bureaucratic inertia and independent public organizations have also delayed adoption, as explained by a senior consultant:

> *"It's challenging … because [in our country] public organisations are independent. The tax administration has been one of the key players from the very get-go, but because they cannot join by themselves, they need to join as a government or as a nation. [Another public institution] is really interested but is unsure how it works in accordance with their other things yet."* – Senior Blockchain Consultant, IT Service Provider, Organization A (Interviewee #1)

Social norms and cultural factors also significantly impact SSI adoption. Individuals with high digital proficiency are more inclined toward adopting SSI, while those with limited digital literacy face greater barriers due to unfamiliarity with digital tools and concerns about privacy and security.

Citizens' trust in their governments affects organizational decisions about joining SSI ecosystems. In regions where trust in governmental institutions is low, organizations may prefer private-sector-driven ecosystems over government-led initiatives. Thus, public trust directly influences organizational engagement in collaborative SSI projects.

Industry characteristics also play a decisive role. The "level of digitalization and the need for verifiable data" determine SSI adoption. Industries benefiting from data digitization or requiring trustworthy, verifiable data, such as banking and public services, show a higher inclination toward SSI adoption. The Head of the Innovation Center at an SSI ecosystem orchestrator explained:

> *"SSI is more relevant … in certain industries where the customers are end consumers. Like for example in banking or in public sector services. If you think about social insurance institutions, for example, where a lot of their processes still rely on paper documents, unstructured data, and there's a lot of fraud involved. Or insurance companies … or healthcare welfare. SSI solutions will have there a huge impact."* – Head of Innovation Center, IT Service Provider, Organization A (Interviewee #2)

Additionally, industry-specific regulations and standards strongly influence SSI adoption. In healthcare, compliance with standards such as the National Safety and Quality Health Service (NSQHS, 2024) standard shapes how health data is managed, promoting the adoption of interoperable, privacy-preserving solutions. These regulatory pressures create a compelling incentive for adopting SSI technologies in multiple sectors.

Despite these positive drivers, certain societal challenges persist. Resistance to change, data sovereignty concerns, and fragmented regulatory environments between countries can complicate global adoption efforts. Furthermore, industries with entrenched legacy systems may face significant hurdles in transitioning to an SSI-driven model, necessitating comprehensive ecosystem collaboration and policy alignment.

4.1.3. Ecosystem-specific antecedents

Our analysis of empirical data reveals several ecosystem-specific antecedents that influence SSI adoption, categorized into *Technology Characteristics* and *Governance Characteristics*.

Among the *Technology Characteristics*, the relative advantage of the emerging technology plays a critical role. In regions with established digital identification services, such as the Nordic countries, the comparative value of SSI-enabled identification services is reduced. As a senior consultant involved in developing the national SSI infrastructure explained:

"The value of the core systems in [my country] is high, is very high. We have a very good technical infrastructure. And we have such high value there that […] in order for [our system] to be more valuable than the existing infrastructure, we need to offset that by providing additional features." – Senior Blockchain Consultant, IT Service Provider, Organization A (Interviewee #1)

Compatibility with legacy systems is another decisive factor. Integrating SSI into established systems can be resource-intensive and time-consuming, posing significant adoption barriers. One interviewee highlighted that for some customers, adopting SSI would necessitate a complete technological overhaul, complicating its feasibility:

"There are use cases where SSI does not fit. […] Some of those customers who need to make huge changes in the specific ecosystem. […] Their systems are so desperate that in order to move or change their ecosystem a complete technology shift definitely has to happen." – Consultant and Advisory, Innovative Consultant Services Provider, Organization E (Interviewee #6)

The complexity of the technology was also frequently mentioned. SSI adoption demands the coordination of multiple actors and components, including various user interfaces for issuers, verifiers, and holders, as well as data registries, backup mechanisms, and data schemas. This multifaceted structure can make the technology challenging to understand and deploy effectively.

The immaturity of SSI, compounded by the lack of universally accepted standards, further complicates adoption. A chief strategy officer from an SSI consultancy noted that organizations struggle with continuously evolving technological components, creating uncertainties about long-term investments:

"One challenge is whether the technology is mature so that they can invest and not necessarily keep upgrading the technology as it seems to have been a moving target for the last couple of years. Although we have quite stable versions nowadays, there have been continuous upgrades. If the clients are implementing such a moving target technology, then they need to spend more effort, time, and money to maintain the latest version. The technology maturity is a concern to some of the clients." – Chief Strategy Officer, SSI-related Consultant Services Provider, Organization H (Interviewee #10)

The user interface, especially digital wallets, should be intuitive, simple, and tailored to specific users' needs and hide "the dance of the protocols", which refers to the complex interaction of various technological components. Developing digital wallets and other user interfaces requires lots of communication with the target user group during development. A chief strategy officer of a startup providing SSI consultancy services summarized the importance of user experience as follows:

"The user experience is going to be a key factor in terms of large-scale adoption. Whether we can make it so intuitive that my grandma can use it." – SSI-related Consultant Services Provider, Organization H (Interviewee #10)

Security and privacy concerns also stand out. Since users' personal data and identities are secured with private keys, maintaining robust security measures is critical. However, emerging threats, such as quantum computing's potential to break current encryption methods, raise long-term security concerns:

"Security is where concerns come up. Quantum computing is one area: how easy it would it be for quantum computers to break the encryption? We'll see how we deal with that later." – Chief Strategy Officer, SSI-related Consultant Services Provider, Organization H (Interviewee #10)

Interoperability between various SSI solutions is essential due to the technology's cross-industry and cross-border applications. Government-issued digital identities, for example, must function seamlessly across sectors like healthcare, education, taxation, and travel.

In terms of *Governance Characteristics*, business, legal, and technical policies significantly influence adoption decisions. Organizations must consider regulations, compliance requirements, and contractual terms. For example, Finnish companies are more inclined to join the national SSI ecosystem due to its alignment with Finnish legal and regulatory frameworks.

Incentives, both monetary and non-monetary, further shape adoption. These include ecosystem reputation, networking opportunities, and potential financial returns. Governance principles such as transparency, portability, consent, and data minimization also guide adoption decisions. Organizations aiming to provide transparent and privacy-preserving services are likelier to join ecosystems with similar guiding principles.

Lastly, actors' credibility emerges as a crucial factor. Ecosystems involving reputable public institutions and major corporations inspire greater trust and encourage wider participation. Conversely, ecosystems led by less established players may struggle due to perceived risks related to sustainability and reliability. Thus, actors' credibility strongly shapes the success and expansion of SSI ecosystems by influencing organizational trust and commitment.

4.1.4. Individual-level antecedents

Our analysis of empirical data highlights several individual-level antecedents influencing SSI adoption, categorized under human characteristics such as skills and competencies, risk-taking attitude, power or

Table 6
Potential outcomes of SSI adoption.

Organizational outcomes		Societal and environmental outcomes		Ecosystem outcomes	
Potential positive outcomes	Potential negative outcomes	*Potential positive outcomes*	*Potential negative outcomes*	*Potential positive outcomes*	*Potential positive outcomes*
• more secure and private services • reduced risks (e.g., money laundering, cyber-attacks) • increased customer' satisfaction • improved brand and reputation • learning and innovation • increased financial performance • competitive advantage • regulatory compliance • resource and process efficiency • cost saving	• losing business partners	• better living conditions • trustworthy, private and secure digital interactions • data owners' possibility to control their data • digital transformation • increased job performance • digital and financial inclusion	• losing jobs due to automatization • dangers for vulnerable groups • consequences of misuse of the systems	• economic advantage • strategic alliances • co-learning • increased collaborative performance • new markets and market structures	• credibility loss

agency to create change, sensitivity toward societal problems, and belief in human-centric principles.

Skills and competencies play a critical role in SSI adoption. A deep understanding of both technological and governance aspects is essential, as highlighted by a head of an innovation center orchestrating an SSI ecosystem:

> *"When we have talked to customers … and we organized one training session, the person who was organizing said: 'There are people who are only interested in the technology, and then we have people who are interested in the governance.' I told him that when you think about the people who hear about either of these things it is like watching dancing without music. That's going to be funny and you're not going to understand how the whole thing works unless you see the dance and hear the music at the same time."* – Head of Innovation Center, IT Service Provider, Organization A (Interviewee #2)

A risk-taking attitude also emerges as a crucial antecedent due to the immaturity of the technology. Early adopters face uncertainty about whether the technology will gain enough traction to provide long-term value. A senior consultant developing the national SSI infrastructure elaborated:

> *"With blockchain and identity, there is always a comparison between the potential gain of innovation and the cost of transitioning to it. Blockchain requires a foundational rethink from the bottom up, which challenges companies accustomed to established processes. Even with clear long-term benefits, shifting from centralized to decentralized approaches remains a significant business risk."* – Senior Blockchain Consultant, IT Service Provider, Organization A (Interviewee #1)

Additionally, individuals with power or agency within organizations significantly influence the adoption process. Leaders and managers can champion SSI by allocating resources and driving organizational change. This was exemplified by a head of an innovation center:

> *"We have been very lucky that we have been able to develop these concepts over quite a long period of time without really needing to, reason to anybody that why we are doing this."* – Head of Innovation Center, IT Service Provider, Organization A (Interviewee #2)

However, the adoption process can face resistance from leaders with competing priorities or risk-averse attitudes, potentially delaying SSI integration.

Sensitivity toward societal problems often motivates early adopters, especially those engaged in open-source communities focused on privacy and security. An advisory board chairman from a non-profit organization shared his perspective:

> *"My mission has always been … society at large. That is why we do this. Not because it is good for anybody's particular business or whatever but it's so important for society at large."* – Advisory Board Chairman, Digital Services Provider, Organization M (Interviewee #15)

Finally, belief in human-centric principles underpins many practitioners' efforts to promote SSI adoption. They see the technology as a way to enhance digital trust by giving users control over their personal data, aligning closely with broader societal goals for a more trustworthy digital environment.

Despite these motivations, some practitioners express concerns that the complexity of the human-centric model might deter organizations focused solely on financial returns, highlighting the tension between social impact and profitability in SSI adoption.

4.2. Potential outcomes of self-sovereign identity adoption

SSI adoption entails a broad range of potential outcomes. While many of these outcomes are favourable, such as enhanced security, improved customer satisfaction, and greater digital inclusion, certain challenges persist. These include risks like job displacement due to automation and the possibility of reduced ecosystem credibility. Drawing from our empirical findings, we categorized these outcomes into three distinct dimensions: organizational, societal and environmental, and ecosystem-level effects. Table 6 summarizes these outcomes.

4.2.1. Potential organizational outcomes

SSI adoption has several potential organizational outcomes, both positive and negative. The primary promise of SSI lies in enhancing the privacy and security of services offered by organizations while reducing risks such as fraud and service misuse. This is particularly relevant in the financial industry, where banks aim to mitigate cybercrimes and identity fraud. Another pertinent example involves organizational wallets: SSI-based organizational identities improve the privacy and security of digital representations when employees act on behalf of their employers.

For example, the verifiable LEI concept refers to an SSI-enabled automatically verifiable legal identifier that has been developed by the Global Legal Entity Identifier Foundation with the objective to establish a chain of trust for organizational identity.

One of the speakers of the SSI Orbit podcast series (Glaude, 2024) finds the organizational identity to be one of the most important SSI innovations:

> *"Organizational identity will be the largest identity market you've never heard of. Think about all the interactions that a business does with other organizations – all the contracts, all the onboarding of suppliers, all the supply chain stuff. Employees are at the heart of that. I need a proof of employment, a proof of identity, is this individual authorized to act on behalf of the company? Think about all the contracts it signs, all the payments it makes, all payments it receives … so organization identity is going to be a very very big deal."* – one of the speakers of the SSI Orbit podcast series (Glaude, 2024)

Our analysis reveals that adopting SSI systems can significantly enhance customer satisfaction. This stems from organizations affording customers greater control over their personal data while embedding stronger privacy features into services. Privacy-conscious customers who are wary of sharing personal data with service providers benefit from this approach. Specifically, SSI enables customers to manage and share only the necessary data attributes, reducing unnecessary data collection and minimizing privacy concerns.

In this context, privacy-aware customers highly value services that avoid centralized data storage. Instead, SSI facilitates a more user-centric model where data requests are made on an as-needed basis. This reduces the risks associated with sensitive data exposure, cultivating trust and enhancing customer engagement. A privacy standardization expert from the Swedish Institute of Standards elaborated:

> *"I hope SSI adoption will be driven by a combination of business opportunities and regulations. Now we have the right tools for a better way of handling data that is more individual-centric. Regulators can give a little incentive to push data management in the right direction but the business opportunities are clear due to the privacy benefits for the customer."* – Founder and CEO, Privacy-related Consultant Services Provider, Organization I (Interviewee #11)

Moreover, SSI adoption serves as a catalyst for boosting organizational brands and reputations. Organizations actively participating in SSI research and standard development can enhance their public image and credibility. Standard Development Organization (SDO) logos displayed on websites signals commitment to industry leadership, privacy principles, and best practices. This visible commitment can strengthen relationships with customers, partners, and stakeholders, elevating an organization's reputation within the digital identity ecosystem.

Adopting emerging technologies also enhances innovation, leading to new product and service development, potentially enhancing financial performance and competitive advantage. An example includes lifelong SSI-based reputation systems that allow organizations to issue digital credentials recognizing employees' achievements. These

credentials can enhance employees' value in the job market and motivate them professionally.

SSI can simplify regulatory compliance processes. For instance, when an organization implements Know-Your-Customer (KYC) verification through SSI, it can choose to shift the responsibility of managing sensitive customer data from organizations to the customers. This reduces compliance burdens related to data security and privacy regulations. Additionally, automating processes through digital documents can lead to operational efficiency and cost savings by replacing manual tasks.

However, adopting SSI may also pose negative outcomes. Substantial changes to existing business processes can disrupt organizational routines, particularly affecting partnerships and established identity verification services. The decentralized nature of SSI might eliminate intermediaries, leading to job losses and shifts in business models. A principal technology strategist from a bank emphasized this complexity:

> *"In every single organization the problem is that in [these decentralized SSI solutions] lots of intermediaries disappear. The business models that include these intermediaries disappear. The processes which include intermediaries disappear. Also, there are lots of people who make their money from the old world, and if they don't know how to […] make money in the new world which looks entirely different then that's of course a challenge to overcome."* – Service and Infrastructure Provider, Bank G (Interviewee #9)

Thus, while SSI adoption offers transformative benefits, organizations must navigate potential negative impacts in their ecosystems, adapting strategically to sustain growth and remain competitive.

4.2.2. Potential societal and environmental outcomes

The adoption of SSI holds considerable potential to create positive societal and environmental impacts. A primary driver behind SSI adoption is its social value, particularly its capacity to improve living conditions through secure and private digital interactions. By enabling data owners to maintain control over their data, SSI enhances trusted digital engagements. For instance, in countries lacking formal digital identification systems, SSI can significantly improve access to essential services such as healthcare, education, and voting, thereby enhancing workforce mobility. Similarly, applications like online job interviews and dating services benefit from verifiable data exchanges.

SSI supports digital transformation across various sectors, including education, healthcare, public administration, and tourism, by digitizing documents and automating processes such as identification and authorization. These advancements often result in increased job performance due to streamlined administrative procedures. A notable example includes digital invoices and sales receipts developed in Finland and Europe, which replace paper receipts, automate financial administration processes, and facilitate data sharing between organizations (Finnish Tax Administration, 2022; Real Time Economy, 2023; State Treasury, 2021).

Moreover, SSI promotes digital and financial inclusion. The Kiva solution in Sierra Leone exemplifies this by enabling secure credit history sharing between microfinance institutions. Individuals' credit profiles become portable rather than confined to a centralized bureau, granting citizens broader access to financial services through a government-issued digital identity.

However, SSI adoption also presents certain negative societal outcomes. Some organizations might lose their competitive advantage, while employees in specific roles could face job displacement due to process automation. For instance, digital wallets could render customer profile management systems obsolete by allowing real-time data verification from users' wallets, reducing the need for dedicated customer service personnel.

Vulnerable groups, such as children, elderly persons, individuals with serious illnesses, and those with limited digital literacy, may encounter challenges due to SSI's reliance on digital skills. Experts stressed the importance of designing inclusive SSI solutions to address these concerns. A chief strategy officer from an SSI consultancy firm highlighted this challenge:

> *"I perceive challenges in achieving large-scale adoption of the SSI model. From a user perspective, key concerns include the level of awareness and confidence in managing their digital identity and wallet. Additionally, there is a risk of excluding non-smartphone users, which could hinder broader inclusion."* – Chief Strategy Officer, SSI-related Consultant Services Provider, Organization H (Interviewee #10)

The potential for misuse is another critical consideration. SSI systems can be exploited if incorrect credentials are issued, potentially enabling cybercrimes. This concern underscores the importance of issuer reliability in SSI ecosystems. A senior consultant involved in developing a national SSI infrastructure illustrated this concern:

> *"During a meeting, someone asked whether our SSI infrastructure could issue verifiable identities to terrorists and what responsibility we would bear if it did. While such individuals still have human rights, this raises questions about our operational scope. Our infrastructure provides foundational capabilities, while service providers handle credential issuance within separate ecosystems. Any technology can be misused—not because of its design but because of how it is applied."* – Senior Blockchain Consultant, IT Service Provider, Organization A (Interviewee #1)

Addressing such risks requires robust ecosystem governance. Unlike centralized systems with clear accountability structures, decentralized SSI ecosystems must rely on shared governance frameworks to mitigate misuse risks effectively. The enforcement of these frameworks becomes critical in ensuring the reliability and integrity of the entire SSI ecosystem.

4.2.3. Potential ecosystem outcomes

Organizations' decisions to adopt SSI and join an ecosystem significantly impact the broader ecosystem's structure and dynamics. Several field experts emphasized that the value of SSI ecosystems follows Metcalfe's Law, which posits that a network's value is proportional to the square of its users. This principle suggests that as more organizations adopt SSI, the network effect multiplies, enhancing the ecosystem's overall value. A senior consultant developing SSI innovations explained:

> *"Metcalfe's law states that the more nodes you have in a network, the more valuable the network is. And this is also true here. The more you have issuers, verifiers, and holders in the network, the more valuable it is."* – Senior Blockchain Consultant, IT Service Provider, Organization A (Interviewee #1)

Additionally, organizations joining an SSI ecosystem facilitate the formation of new strategic alliances, encourage co-learning, and boost collaborative performance. For example, in the Finnish national SSI infrastructure development project, several banks collaborate despite being competitors. These strategic alliances advance shared learning and collective performance improvements. Addressing industry-wide challenges collaboratively with competitors was considered crucial, as highlighted by a principal technology strategist from a leading bank:

> *"When the entire ecosystem needs to replace paper with digital formats, collaboration is essential. Industry-wide challenges can be addressed through fully open collaboration, allowing us to transparently share our efforts to solve these problems together."* – Principal Technology Strategist, Service and Infrastructure Provider, Bank G (Interviewee #9)

Moreover, organizations entering an SSI ecosystem can unlock new markets and reshape market structures. For instance, if an organization in an SSI-based organizational identity ecosystem issues SSI-enabled work certificates to employees, it could create new reputation-based service markets. Another example is the implementation of digital product passports (Digital Europe, 2023) in industries like fashion.

Digital product passports store comprehensive product data using QR codes or hardware tags such as NFC, RFID, or Bluetooth. A decentralized, SSI-based approach in the clothing industry could disrupt existing market structures in unforeseen ways.

However, SSI adoption may also yield negative consequences for the ecosystem. A key risk involves incorrect credential issuance, which can undermine the ecosystem's credibility. As highlighted by a chief strategy officer of a startup providing SSI consultancy services:

> *"If we end up with wrong credentials being issued to the users, and they use them for different products and services, I think the entire trust of the system is at stake. And that's where we have to avoid any situation where incorrect data gets into the system."* – Chief Strategy Officer, SSI-related Consultant Services Provider, Organization H (Interviewee #10)

In conclusion, while SSI adoption offers numerous ecosystem-wide benefits, including economic advantages, strategic partnerships, and the creation of new market structures, it also poses risks that need careful governance. Avoiding misuse and ensuring data accuracy are pivotal areas for maintaining trust and sustaining ecosystem growth.

5. Discussion

5.1. General discussion

SSI technology represents a transformative shift in digital identity management. Its impact extends to individuals, organizations, and even Internet of Things (IoT) devices (Lacity & Carmel, 2022; Satybaldy et al., 2024). It addresses longstanding concerns about privacy and security in digital interactions (Wang & De Filippi, 2020). It also promotes trust in digital ecosystems by offering a user-centric approach to identity management (Schlatt et al., 2022). Governments, organizations, and individuals are increasingly preparing for its adoption. This readiness is driven by the goal of empowering individuals with greater control over their personal data (Glöckler et al., 2024).

Despite this promise, the motivations for SSI adoption and its broader implications remain underexplored (Zwitter et al., 2020; Satybaldy et al., 2024). Our research addresses this gap by analyzing extensive qualitative data from field studies. This study identifies antecedents at various levels: organizational, societal and environmental, ecosystem-specific, and individual. Additionally, it categorizes outcomes into three domains: organizational, societal and environmental, and ecosystem-related.

A key finding reveals that SSI adoption is not merely a technological process. It also requires active participation within broader ecosystems and adherence to shared governance principles (Laatikainen et al., 2021). This insight contributes to the technology adoption literature by highlighting the co-creative dynamics intrinsic to SSI adoption (Lacity & Carmel, 2022; Nohutlu et al., 2023). Our study provides a comprehensive understanding of the antecedents and potential outcomes of SSI. It also establishes a foundation for future research in this evolving field. For practitioners, the findings offer actionable insights to guide SSI adoption and validate its value in digital ecosystems.

On the positive side, SSI demonstrates the potential to enhance privacy and security. It reduces risks such as money laundering and cyber-attacks. Customer satisfaction is likely to increase due to improved data control and transparency. SSI also supports regulatory compliance and facilitates digital inclusion. Organizations see opportunities to improve brand reputation, advance innovation, and gain competitive advantages. SSI enables resource efficiency, cost savings, and the digitization of paper-based processes.

However, SSI adoption is not without challenges. Its implementation may result in job losses, harm vulnerable groups, or lead to the misuse of systems. For example, replacing traditional customer management systems with digital wallets may reduce certain jobs. Vulnerable groups, such as those with low digital literacy, face barriers to using SSI-based solutions. Technological immaturity is another concern. Issues such as low levels of standardization, complex interfaces, and private key management need further refinement. Security concerns, including phishing attacks and private key theft, warrant further investigation. Additionally, SSI adoption requires all three roles – issuers, holders, and verifiers – to function collaboratively. This dependency can complicate adoption processes.

While SSI shows significant promise, its benefits must be weighed against potential risks and limitations. These insights emphasize the need for a balanced and informed approach to adopting this technology.

5.2. Conceptual contributions

This research offers several theoretical contributions to the study of technology adoption, digital identity management, and ecosystem governance. First, it introduces a multi-dimensional framework of antecedents and outcomes for SSI adoption. This framework addresses gaps in the literature by providing a comprehensive foundation for exploring adoption dynamics across organizational, societal, and ecosystem levels, moving beyond generic models to context-specific insights (Laatikainen et al., 2021).

Second, the study highlights the co-creative nature of SSI adoption, showing how stakeholders collaborate within ecosystems governed by shared principles and rules. This builds on the literature on ecosystems and governance (Adner, 2017; Jacobides et al., 2018), demonstrating that successful SSI adoption depends not only on internal organizational readiness but also on alignment with broader ecosystem dynamics. The emphasis on governance mechanisms adds depth to existing discussions by illustrating how they mitigate risks such as misuse or credibility loss.

Third, this research incorporates individual- and societal-level antecedents, areas that have been less explored in digital identity management studies. By addressing drivers such as individual skills, competencies, and societal influences such as regulations, cultural norms, and public trust, the study extends existing technology adoption frameworks (e.g., TAM, DOI). These additions enhance the understanding of how adoption processes operate across multiple levels and contexts.

Additionally, the study positions SSI as both a driver and outcome of digital transformation. The findings reveal how SSI adoption can reshape market structures, create new forms of value, and influence competitive dynamics. These insights respond to the call for research that examines the role of emerging technologies in transforming industries and ecosystems (Nambisan et al., 2017).

Finally, this research acknowledges the dual nature of SSI adoption outcomes, including both positive and negative consequences. By taking a balanced view, it highlights the benefits of SSI while recognizing potential challenges, addressing a need in the technology adoption literature for a more nuanced perspective. This approach provides a richer understanding of the unintended consequences and complexities associated with adopting disruptive innovations.

In summary, this research advances theoretical discussions by offering a multi-level framework for SSI adoption, emphasizing co-creation in ecosystems, and addressing both benefits and challenges. These contributions aim to enhance understanding and provide a foundation for future research in digital identity ecosystems and beyond.

5.3. Practical implications

This study provides practical insights for stakeholders navigating the adoption of Self-Sovereign Identity (SSI) technologies, including innovators, organizations, governments, and regulatory bodies. The findings offer actionable guidance for integrating SSI into existing infrastructures while addressing its inherent challenges and opportunities.

The insights are particularly valuable for innovators and technology developers. By identifying key drivers and challenges of SSI adoption,

the study enables these stakeholders to align their solutions with the specific needs of adopters. For instance, innovators can focus on user-centric design, especially the development of intuitive digital wallets and interfaces, to ensure broad accessibility, even for users with limited digital literacy. Additionally, addressing technological concerns such as interoperability, security, and privacy can lead to more competitive and robust solutions.

Organizations stand to benefit by understanding both the opportunities and risks associated with SSI adoption. The research highlights how SSI can enhance data security, improve customer satisfaction, and drive operational efficiency. Practical applications, such as implementing SSI-enabled Know-Your-Customer (KYC) processes, can simplify compliance with data protection regulations while reducing the risks linked to centralized data storage. At the same time, this study identifies potential challenges, such as disruptions to existing business models and resource demands. Armed with this understanding, organizations can perform comprehensive cost-benefit analyses to assess the strategic value of SSI.

For governments and regulators, the findings offer guidance on developing balanced policies that promote the secure and ethical adoption of SSI while addressing critical concerns. Policymakers can focus on governance frameworks that mitigate risks, such as the issuance of incorrect credentials, while ensuring that SSI adoption remains inclusive. The study also emphasizes the importance of government involvement in funding SSI initiatives and promoting digital literacy to maximize societal and economic benefits.

The research further provides a foundation for organizations to communicate the value of SSI adoption to their stakeholders, including upper management, partner companies, and customers. By outlining both the benefits, such as improved brand reputation and enhanced customer trust, and the challenges, the findings equip organizations with well-rounded arguments to build consensus and gain support for adoption efforts.

In summary, this research connects academic insights with practical applications, offering stakeholders the tools to make informed decisions about SSI adoption. By addressing the opportunities and challenges, it enables stakeholders to navigate the complex landscape of digital identity technologies with clarity and confidence.

5.4. Limitations and suggestions for future research

This study makes both theoretical and practical contributions, yet some limitations must be acknowledged. The qualitative research design limits the generalizability of the findings. However, diverse data sources, including expert interviews, field observations, and grey literature, enhance the study's depth and reliability.

The study reflects the perspectives of SSI experts and practitioners, but it does not directly capture end-users' views. Indirect insights into user attitudes and behaviors were obtained through discussions with interviewees who engage with users professionally. Additionally, many interviewees were involved in SSI development, which led to a greater emphasis on positive outcomes.

Several promising research avenues stem from the study's findings and limitations. First, most of the data for this study was collected between 2020 and 2022. As SSI initiatives are evolving, the results of this study could be triangulated with the outcome of a different study based on newer data. For example, the European Digital Identity Framework entered into force in May 2024 and each member state is obliged to offer an EU Digital Identity Wallet by 2026 to their citizens. These regulatory obligations, being one of the most important antecedents of SSI adoption, have substantially forwarded the SSI evolution by mobilizing various entities to invest in developing SSI innovations. Further studies could investigate the antecedents and the outcome of the adoption of the European digital wallets and compare the findings with the outcome of this study.

One key direction is to explore SSI adoption as a co-creation process between organizations and ecosystems. This study emphasizes the importance of ecosystem-specific antecedents, such as governance and interoperability, in influencing adoption. Future studies could examine how innovation characteristics, ecosystem dynamics, and organizational strategies interact. Longitudinal case studies would help reveal how these interactions evolve over time.

Future research should also investigate ecosystem-related antecedents and outcomes of SSI adoption. Governance mechanisms are crucial in mitigating risks such as credential misuse, as highlighted in this study. Researchers could explore how decentralized accountability frameworks impact technology adoption and ecosystem performance. Additionally, studies could examine how SSI ecosystems create new markets and reshape existing ones, offering insights into their economic and strategic implications.

Another critical avenue is the role of social value as a driver of SSI adoption. This study shows that social value, such as empowering individuals to control their data and reducing societal injustices, is a key motivator. Future research could explore how social value perceptions vary between cultures and regulatory environments. Integrating this dimension into existing technology adoption theories would further enrich the field.

Lastly, multi-method research approaches could address the limitations of qualitative studies. Quantitative surveys could validate and generalize the antecedents and outcomes identified here. Comparative studies between regions and industries could examine contextual differences, especially as the European Digital Identity initiative progresses.

These directions highlight the complexity of SSI adoption and its interplay with technological, organizational, societal, and ecosystem factors. Addressing these topics would expand our understanding of SSI's transformative potential in the digital economy.

CRediT authorship contribution statement

Gabriella Laatikainen: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Formal analysis, Data curation, Conceptualization. **Mekhail Mustak:** Writing – review & editing, Writing – original draft, Methodology. **Nicky Hickman:** Writing – review & editing.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT 4o and Gemini Advanced in order to improve the readability and language of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed, and take full responsibility for the content of the published article.

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Data availability

Data will be made available on request.

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