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A valorization framework to strategically manage data for creating competitive value

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ABSTRACT

Today's big challenge is to use data for informed decision-making. Despite the multitude of data definitions, managers should manage this digital resource strategically to create a competitive value. Previous studies accounted for data technically, either as technology, analytical process, or information system advancement, opening new avenues for management studies on data valorization in multiple industries. Among industries, Insurtech merges the leadership of information and the adoption of data-driven technologies that enable the creation of value. Based on a systematic literature review in the insurtech context, the research identified the pivotal role of data as a strategic business asset and emphasizes the need for data orchestration in insurtech companies to attain a competitive edge. The findings produced a theoretical data valorization framework and four data competitive advantages (enhanced risk assessment, optimized operations, customer engagement, and openness) to position in the market. Managers are enhanced to decide the practices for a competitive value. Policymakers could drive strategies for fostering corporates' data journey toward innovation and competition. The novelty of the study is the comprehensive view that enables valorizing data.

1. Introduction

In today's digital era, data-driven decisions prevail (Yu et al., 2021), and leaders who embrace this excel, while firms combining domain expertise with data practices gain an edge, making data a powerful resource to bet (McAfee and Brynjolfsson, 2012). For instance, insurers capturing a competitive advantage use data management to commit to scaling up large use cases across the value chain on a domain-by-domain basis (McKinsey, 2023). Despite data gaining a burgeoning interest (Schulte and Lee, 2019), the significance of data and data management and the management practices and decisions that can bring firms to use data competitively have been poorly investigated.

Notwithstanding scholars' interest in data, there is limited research that has explored data as a valuable resource that can lead to creating competitive value. Most previous studies investigated data in a scattered manner, spanning from data algorithms to information systems or supply chains (Agarwal et al., 2022; Cao et al., 2021; Elgendy and Elragal, 2014; Gandomi and Haider, 2015; Munawar et al., 2020). Data has been recently identified as a valuable economic resource (Farboodi et al., 2022; Farboodi and Veldkamp, 2021; Jones and Tonetti, 2020) that managed strategically can inform organizational decisions and enhance firm competitiveness (Sheng et al., 2017).

Within the insurance context, insurers are recognized for being large users of data for identifying risks, determining premiums, and evaluating claims (Cappiello, 2018; Corea, 2019; Njegomir et al., 2021) and are foreseen to become data-centric powerhouses (Schulte and Lee, 2019). Nowadays, the proliferation of data has allowed insurance companies to embrace advanced technologies, from which Insurtech, enabling them to harness unique selling propositions and competitive advantage over other market participants (Cortis et al., 2019). Insurtech solutions mainly propose "pursuing data to make smarter decisions and accurately reflect risk, while simultaneously reducing costs" (Sosa and Montes, 2022, p. 36). Ultimately, insurers investing in data improve solutions such as underwriting and may enjoy better operating results and performance (Akter et al., 2016; McKinsey, 2021) while also financially including lower-income bracket and the less developed markets (Rawat et al., 2021).

The paper addresses the challenge of data-driven decision-making and the deficient use of data resources to gain competitive value. The topical area is timely and valuable as the understanding of data is deficient in many areas while the opportunities are vast. The paper proposes a systematic literature review of data in the insurtech context

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to connect the significance of data as a resource to management practices, and decisions for using data competitively. The identified research question is:

RQ. How can data be strategically managed to create competitive value in the insurtech context?

The paper aims to enlarge the data management literature by identifying the pillars that turn data into a valuable resource for gaining a competitive positioning. Further, it would comprehensively build a theoretical valorization framework for illustrating decision-makers the steps for turning their companies into successful data-driven firms, while depicting future avenues of research. Indeed, managers may gain insights into management practices and decisions to gain competitive value, and policymakers may drive initiatives to drive firms' innovation and competitiveness.

The paper follows by providing an overview of the literature on data resources and their management. Then, the steps of the systematic literature review are clarified. The successive sections summarize results and discuss theoretical and managerial implications. Finally, conclusive thoughts on the research are stated.

2. Literature review

2.1. Data resources

Today, the existent data are doubling every 18 months (Schumann, 2018). A similar growth occurred in the 15th century with Gutenberg's printing press, which revolutionized society. This growth continued through the era of analog documents, lasting until the beginning of the 21st century when digital data took over (Schumann, 2018). Data have become an indispensable commodity, leading companies to transform their business processes and value chains into data-driven ones (Cortis et al., 2019). It's important to note that data is essentially information (Farboodi et al., 2022). Looking ahead to the future, information would expect to process a volume of data of brontobyte or 10 to the power of 27 bytes, dimension after gigabyte, terabyte, petabyte, exabyte, and zettabyte. It would be like if each person in the world owned 12,500 copies of the US Library of Congress (Wuermeling, 2022). Since 2016, we have been in the zettabyte era, and banks and insurance companies are invited to think about the enormous opportunities generated by data and innovative technologies (Wuermeling, 2022).

Despite there is not a common definition of data resources, data might be defined as measurements or observations that are collected as a source of information (Australian Bureau of Statistics, 2023). Data, datasets, big data, or alternative data often interpret different traits of the same digital resource. Although data could refer to the piece of a unit of information, the dataset as a set of data, big data as a large amount and/or enriched data, and alternative data if collected from multimedia, mobile, and sensors, the present paper comprehensively refers to these as synonymous "data". This approach maximizes sensitivity and concentrates on the value that data bring to the world. The definitions of data encompass certain characteristics, grouped into 3Vs (volume, velocity, and variety) (Laney, 2001), 10Vs (volume, velocity, variety, veracity, variability, virality, viscosity, validity, visualization, and value) (Faroukhi et al., 2020) or similar combinations (Cortis et al., 2019; Munawar et al., 2020; Opresnik and Taisch, 2015; Ylijoki and Porras, 2019). These characteristics, together with data sources, data types, and data technologies (Curry, 2016; George et al., 2014; Lim et al., 2018; McGilvray, 2008; Naik et al., 2008; Ylijoki and Porras, 2019) have been addressed in a technical manner and limiting their contribution to decision-making for enhancing the business value.

Beyond the taxonomy, data can be used as a business asset (Opresnik and Taisch, 2015; Russom, 2011; Ylijoki and Porras, 2019). When speaking of data as assets, Sen (2004) referred to pieces of useful items products, or by-products of applications development process that can be tangible or intangible. Tangible data assets are designs and software code with patterns and algorithms. Intangible data assets are knowledge and methodologies including programming knowledge, programming plans, software system architectures, project plans, design documents, user documents and other relevant knowledge sources (Sen, 2004). Indeed, data can be referred to as informational assets (De Mauro et al., 2015) that combined with data management and analytical process provide companies with value (Ylijoki and Porras, 2016). However, as highlighted by scholars, data and data management aspects (like the Vs definition) shall be studied as a new phenomenon (Ylijoki and Porras, 2016), such as data valorization, that can generate tangible benefits for companies.

2.2. Data resources management

Previous research recognized data as significant corporate resources and underscored the importance of its management (Jain et al., 1998). Resource management is a process that structures, bundles, and leverages firm resources like data (Zeng and Khan, 2019) to create competitive value (Sirmon et al., 2007). Data resource management requires firms to use data to support the needs of the firms (Goodhue et al., 1988), by planning processes and methods strategically (Martin, 1982) that link the acquisition and use of data with business objectives (Goodhue et al., 1988). "Despite considerable recent advances in big data analytics, there is substantial evidence that many organizations have failed to incorporate them effectively in their own decision-making processes" (Tabesh et al., 2019, p. 347).

As data are increasingly admitted as a business asset (Russom, 2011), the strategic management literature resumes that resources need to be assembled and utilized to help companies make quality future and long-term decisions (Hitt et al., 2017; Wernerfelt, 1984). Specifically, strategic management englobes the set of managerial practices and decisions for allowing firms to achieve a sustainable competitive edge and earn above-average returns (Amit and Schoemaker, 1993; Hitt et al., 2017). The orchestration of business assets parallelly develops to the resource management literature and comprehends the processes that managers shall purposely follow. With asset orchestration, managers shall fit between the search and selection and configuration and deployment of resources for creating competitive value (Helfat, 2010). Despite the growing attention by scholars and practitioners, the full benefits from asset orchestration and strategic data management have not been accrued yet, requiring studies on theoretical guidance and data uses for achieving superior performance (Ciampi et al., 2020; McAfee and Brynjolfsson, 2012; Sheng et al., 2017; Zeng and Khan, 2019; Zhang et al., 2021). Mazzei and Noble (2017) framed that data can be used strategically to develop new business models, leaving the space to further explore the managerial practices and decisions that valorize data resources to develop new business models and gain competitive value.

Several scholars agree that resource orchestration is a promising area of research (Kristoffersen et al., 2021a) that explores how firms bundle and orchestrate informational assets arising from data for competitive performance and value creation (Kristoffersen et al., 2021a; Zeng and Khan, 2019). Within the strategic management literature, resource orchestration is an extension of the resource-based view theory and complements the frameworks of resource management and asset orchestration. The resource-based view primarily states that a firm achieves a competitive edge by managing both tangible and intangible resources (Barney, 1991). The resource orchestration theory affirms that firms' performance is influenced not only by possessing resources but also involved managerial action regarding structuring the firm's portfolio of resources, bundling those resources into capabilities, and leveraging the capabilities to realize competitive advantage (Sirmon et al., 2011). However, little advancements have been made in the orchestration process required to leverage data resources into firm-wide resources (Kristoffersen et al., 2021b; Mikalef et al., 2018; Saidat et al., 2023). Thus, despite the orchestration of data-related practices and data management being essential for creating competitive value, these have not been explored comprehensively and are needed to support decision-making.

2.3. Data in insurtech companies

The value and importance of data in business decisions, particularly within the context of insurtech companies, are paramount (Gupta and Tham, 2018). The relevance of using data and the call for information technology investments in the insurance industry dates back to the early 2000s (Pressman, 2003) when the insurtech term did not exist yet. Insurtech is an insurance-specific branch of fintech and indicates a "phenomenon comprising innovations of one or more traditional or non-traditional market players exploiting information technology to deliver solutions specific to the insurance industry" (Stoeckli et al., 2018, p. 289). Data have transformed the way insurance companies deal (Cortis et al., 2019; Rawat et al., 2021), have acquired strategic importance (Hussain and Prieto, 2016), and have led insurtechs to create products based on received data (Hussain and Prieto, 2016; Rawat et al., 2021). Historically, insurance companies developed actuarial and underwriting models calculating risks (Cevolini and Esposito, 2020) with structured data such as age, location, and education (Cortis et al., 2019; Hussain and Prieto, 2016; Saidat et al., 2023). Today, insurtechs integrate unconventional data such as social media (Cortis et al., 2019; Hussain and Prieto, 2016; Saidat et al., 2023), and use them to gain sophisticated analyses of customer trends to strengthen solutions, offer highly personalized solutions and online experiences (Thompsett, 2023) while enhancing firms' competitiveness (Saidat et al., 2023). Insurtechs that manage data strategically can provide value to customers in a timed and accurate manner (Pressman, 2003) while increasing their competitiveness (BCG, 2013; Cappiello, 2018). Saidat et al. (2023) recently demonstrated that data and Insurtech may promote the expansion of financial companies' services. Finally, as demonstrated also by several calls for papers worldwide, limited research works exist on the applications of data in the evolving finance sector and specifically Insurtech (Paul and Sadath, 2021) and the state-of-the-art of how data valorization provides insurtech companies a competitive advantage. For these reasons, Insurtech is a relevant context to address our study.

3. Research methodology

The paper's research question was investigated with a systematic literature review methodology. The choice of this methodology responds to several reasons. First, the call for an evidence-based examination of how firms should strategically use data (Sheng et al., 2017) and the relevance of the insurtech as a data rich context. The work gathers evidence-based results systematically (Tranfield et al., 2003) to organize and convey extant knowledge of data and understand how academic research can support practitioners' needs. Second, it avoids overlapping with existing studies and provides the ground for the academic discussion on the data and insurtech domains. Third, although past reviews on data exist, this focuses on how to manage data strategically to create competitive value, starting from industry-leading data usage in order to provide foundations in the data management literature, as suggested by Zhang et al. (2021). Fourth, the urgency to provide the state-of-the-art of how firms can use data strategically (De Vet et al., 2005), given the lack of practical concepts and methodologies for valuing information assets (Spiekermann et al., 2018). Therefore, the work assesses previous studies and grey documents (e.g., reports, regulatory documents) to deliver an output of high academic and managerial relevance, context-sensitive (Aken, 2004) on gaining insights on how to manage data strategically for competitive positioning.

In terms of document collection, previous studies often assessed data in conjunction with "big" or "social" resulting in technical or ethical discussion and limiting the extractable evidence on the digital resources "data". As a research protocol, we identify to search the data fundamentals that allow insurtech companies to manage data resources and gain a competitive advantage. The review started by collecting evidence based on the research protocol involving documents on (i) data-related topics, and (ii) insurtech context. The initial keywords were "data" and "insurtech", then expanded to "insurtech" because of the reasonable number of papers.

For the data analysis, the systematic review followed Tranfield et al. (2003)'s approach. All types of documents were captured from Scopus and Web of Science, both considered to contain a large number of documents in social science and qualifying for reliability, validity, and timeliness (Gomezelj, 2016; Law et al., 2016; Mariani et al., 2018; Vieira and Gomes, 2009). To obtain a more comprehensive overview of extant research, the work searched for management journals across areas including strategy (Roehrich et al., 2020), and integrated grey studies such as practitioners and regulatory reports (Godin et al., 2015). The research was refined to economics and management subject areas (Xu et al., 2019) and English language, capturing results until September 22, 2023. Positing on the research protocol, the selection of studies was run double-blind. One author assessed titles, keywords, and abstracts, and the other author randomly verified the correctness of the process. Then, one author read the full texts, and the other author randomly verified the selected papers. Disagreements were checked until a final agreement was achieved. Further, the selection captured relevant papers by backward approach referring to insights on data and Insurtech. As reported in the PRISMA framework (Fig. 1), the final database included 88 documents. The database excluded 14 documents because 10 did not contain data related contents, 3 did not contain insurtech related contents, and 1 was in Russian. Concepts were organized in an extraction table for processing evidence-based results. Thus, we organized results in tables, summarized findings with illustrative figures, and developed a conceptual framework in the discussion.

4. Results

The following sections evidence the components that establish data as a business asset within the insurtech context. The findings address data with a managerial approach studying the contribution of data to decision-making for enhancing competitive value. Specifically, the paper identifies how data become business assets within insurtech firms, encompassing aspects such as data sources, types, and characteristics. It further identifies the orchestration of these data components into strategic decision-making through the selection of data technologies and data management practices, thereby contributing to a competitive edge through data enhanced activities. In subsequent sub-sections, we delve into the presentation of these six pillars, encompassing what we refer to as data sources, data types, data characteristics, data technologies, data management practices, and data activities.

4.1. Data sources

Insurtech companies acquire data from a broad spectrum of sources, namely private data, public data, self-quantification data, community data, and data exhaust (Appendix A). Private data are proprietary data owned by the insurer (e.g., historical transactions) or single entities such as individuals (e.g., driving data, vitality data, and nutrition data - Stoeckli et al., 2018) or corporations (e.g., real estate, products). Public data allow insurtech companies to collect valuable information (e.g., demography, mobility, energy, space) served by public institutions or public agencies (e.g., Eurostat, World Bank Open Data, IMF Data, National Bureau of Statistics of China). Insurers can also gather self-quantified data preferences of single entities or crowdsourced data collection (Rawat et al., 2021) to evoke specific traits. Further, community data, and data exhaust involve data from dynamic networks (e.g., social media, consumer reviews, and online voting interactions), and data passively collected or synthetically created with zero value unless connected with other sources (e.g., log files, cookies, temporary files) (Cortis et al., 2019). These possess limited intrinsic value unless integrated with other data sources (e.g., log files, cookies, or temporary files).

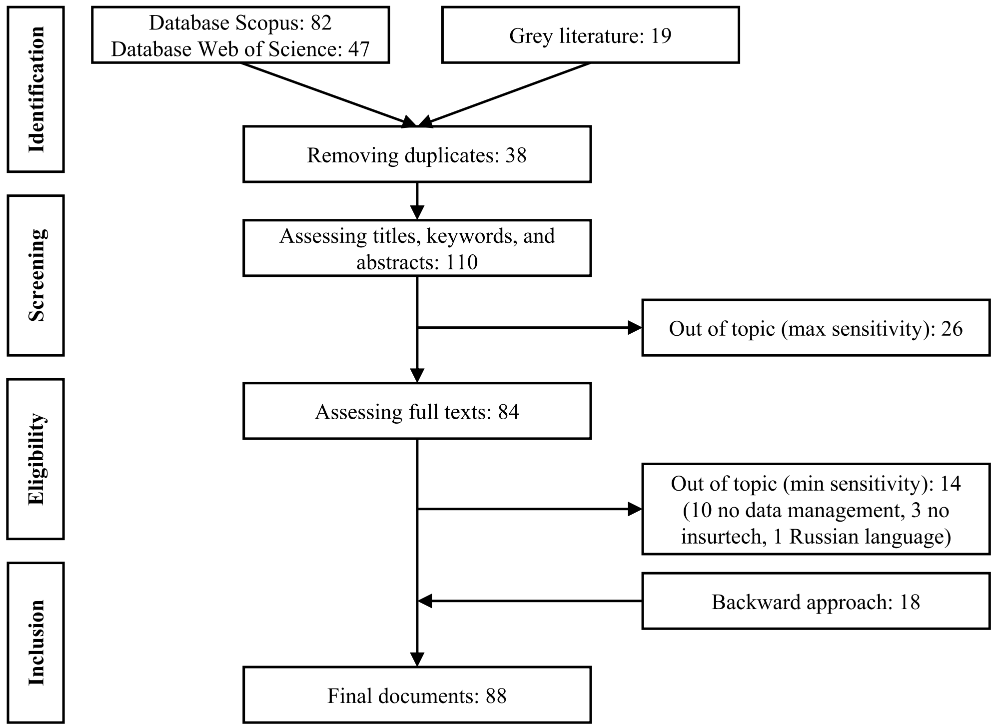

Fig. 1. PRISMA framework.

Based on the business objective, the insurtech companies have two strategic sourcing methods to store data: internal, or external (Appendix A). They can source data from internal infrastructures (Mai, 2018; Stoeckli et al., 2018; Yu and Yen, 2020), sourcing them externally from public or private collaborations (e.g., partnerships, data vendors, third parties, service providers - Mai, 2018; Rawat et al., 2021; Standaert and Muylle, 2022; World Economic Forum, 2015; Yu and Yen, 2020) or jointly building databases from private-public partnerships (OECD, 2016).

In the competitive landscape, insurtech companies' strategy is to consolidate multiple data sources in one data lake to unlock data analytics and facilitate informed decision-making (Fintech Global, 2023; PwC, 2022). This allows to gather risk data in a single repository for proactive risk management and improved customer interactions (Fintech Global, 2023). Based on specific products and services, insurtech companies must choose what, how, and at which cost to source data.

4.2. Data types

Data types allow insurtech companies to strategically organize and structure collected data into useable information. Data can be found in structurally diverse formats, notably structured, unstructured, or semi-structured (Appendix B). Structured data, primarily encompassing tabular data, allow to exhibit interconnected variables, attributes, subjects, and temporal aspects. Unstructured data, in their digital forms (e.g., text, photo, audio, video, clickstream, sensor data), are sourced from diverse origins, including social media, satellites, drones, and devices, serving multifaceted purposes such as behavioral analysis, preference profiling, weather forecasting, disaster prediction, road network analysis, and accident risk assessment, among others (Cevolini and Esposito, 2020; Ching et al., 2020; Cortis et al., 2019; Kaigorodova et al., 2021; Mai, 2018; Njegomir et al., 2021; Schulte and Lee, 2019; Sosa and Montes, 2022; Volosovych et al., 2021; World Economic Forum, 2015; Xu et al., 2019). Semi-structured data (e.g., XML files, HTML documents, log files) incorporate user-defined data tags to facilitate machine-driven analysis (Cortis et al., 2019; OECD, 2020).

Given the large volume of data, insurtech companies must scan unstructured and semi-structured data to identify patterns and trends (Gupta and Tham, 2018) to structure relevant data - reducing dimensionality and speeding up computation (Cao et al., 2021; Rawat et al., 2021) - for developing or enhancing successful products and services. Thus, insurtech companies structure data types with common standards in master data, transactional data, reference data, and metadata to strategically manage data (Appendix B). Insurtech master data include information on people (e.g., policyholders, employees), context (e.g., places, postcodes, weather), and things (e.g., risk profile, policies, accounts, road status) to be used for claim processing and IT system. For example, insurtech companies calculate the risk of having a car accident and the policyholder's profile with structured data such as drivers' age, gender, postcodes, car model, and claim historical and unstructured data such as driving behaviors (e.g., location, time of day, mileage, driving frequency, behavior around hazardous zones, speed, rates of acceleration and braking habits) for reducing information asymmetry and adverse selection (Cortis et al., 2019; Marafie et al., 2018). In addition, insurtech companies organize transactional data (e.g., policy orders, premiums payments, claims) held along the business operations to learn customer lifetime value and react to targeted services. Insurtech companies also refer data with values, code lists, product types, and hierarchy to facilitate sharing and reporting of information, for example, to help provide recommendations (Marafie et al., 2018). Finally, insurtechs' metadata encompasses data about data on technical, business, and audit trail information and facilitates discovery, using rules to manage data (European Commission, 2018; Wilkinson et al., 2016). Data themselves become a strategic asset to be organized and structured for governing data management of firms structured digital resources to gain a competitive edge.

4.3. Data characteristics

As insurtech companies integrate digital resources into their operations, specific data characteristics, as identified by Saidat et al. (2023), play a pivotal role in gaining an informative advantage. These characteristics, previously discussed by scholars, notably shape insurtech activities in their daily operations, encompassing volume, velocity, variety, veracity, accessibility, granularity, sharing, ownership, privacy, compliance, and mutability (Appendix C). Decision-makers within insurtech companies systematically assess these characteristics to strategically leverage their data assets, ultimately enhancing their competitive advantage. Each characteristic contributes significantly to augmenting the overall value of these data assets.

Volume. Insurtech companies deal with an enormous amount of data (Rawat et al., 2021) that enable them to develop policies, evaluate, predict, understand, visualize, personalize and price services and products, engage with customers, extract information, explain products and services, and detect early signals (Al-witwit & Ibrahim, 2020; Ching et al., 2020; Cortis et al., 2019; Njegomir et al., 2021; Tereszkiewicz and Południak-Gierz, 2021). Insurers detaining large amounts of data have an edge in the competitive market (European Commission, 2020). With the help of advanced technologies, insurtech companies build large amounts of data and relevant information for running their businesses and competing with more traditional players.

Velocity. Insurtech companies capture data at a certain data pace to continuously interactions such as filter, analyze, and act (Cortis et al., 2019; OECD, 2020). The pace allows these companies to combine multiple types and sources of data in real-time (Cortis et al., 2019; Stoeckli et al., 2018) to personalize products and services at the right time and price, detect frauds, and process claims (Cortis et al., 2019; Gramegna and Giudici, 2020; Mai, 2018; Stoeckli et al., 2018) in a timely manner (Rejda and McNamara, 2014).

Variety. Insurtech companies combine diverse data sources and data types to unveil hidden relationships and inconsistencies (Cortis et al., 2019; Munawar et al., 2020; Njegomir et al., 2021), established by analysis unveiling correlations and phenomena (European Commission, 2018). Further, the high variety of data (OECD, 2020) can be augmented through strategic mergers, acquisitions, and collaborations, exemplified by partnerships and other collaborative initiatives.

Veracity. This data characteristic is pivotal for the insurance business as it encompasses the accuracy, truthfulness, and quality of the raw data for developing any type of product and servicing policyholders (Agarwal et al., 2022; Baker, 2017; Cortis et al., 2019; Malgieri and Custers, 2018; Sosa and Montes, 2022). Several tests and tools, safety procedures (e.g., antifraud algorithms), and technologies (e.g., blockchain) (Al-witwit & Ibrahim, 2020; Cortis et al., 2019; Gramegna and Giudici, 2020; Marafie et al., 2018; Rejda and McNamara, 2014) can contribute to data veracity. Holding more data qualifies for more accurate risk models and informed decisions (Stoeckli et al., 2018; World Economic Forum, 2015).

Accessibility. Data accessibility in the insurtech industry refers to the availability of standardized, free, open, authenticated, findable, portable, authorized, and reusable data. The concept of reusable data also implies the non-rivalry of digital resources. Additionally, data availability plays a crucial role in driving initiatives aimed at enhancing risk assurance, policy affordability, and competition among market participants (Cevolini and Esposito, 2020; Lanfranchi and Grassi, 2022; Yu and Yen, 2020) and some scholars discussed open insurance initiatives to reduce data access barriers to enhance customer profiling and product offering (Standaert and Muylle, 2022). Poor data accessibility can pose a threat to innovation and healthy competition (Njegomir et al., 2021; Savchuk et al., 2021), prompting some regulators to implement measures like open banking, in favor of payments data accessibility (e. g., PSD2), to address these imbalances (European Commission, 2020). Access to relevant data is a valuable source of competitive advantage (Zeier Röschmann et al., 2022).

Granularity. Thanks to the adoption of advanced technologies, insurtech companies are increasingly collecting more granular data, meaning fine-grained details to assess risks along their business and target the contents and products and services for enhanced returns (Cappiello, 2018; Stoeckli et al., 2018; Zeier Röschmann et al., 2022). This extended data about policyholders and risk assessments enables insurers to broaden their services, reaching previously excluded customers (OECD, 2020; Stoeckli et al., 2018; World Economic Forum, 2015).

Sharing. The insurtech companies require policyholders to provide a set of data, leveraged with advanced technologies (Eling and Lehmann, 2018) to access their products and services in the form of a mutual transaction (Standaert and Muylle, 2022). Policyholders are often incentivized to share more data in exchange for rewards or discounts in the premiums (Volosovych et al., 2021) and stimulate the development of innovative products and services (European Commission, 2020). The transactions happen mainly through digital interfaces, as in the case of Lemonade (Cortis et al., 2019). At the same time insurtech companies collaborate and compete with more traditional insurance companies or public institutions (Beraja et al., 2020; Eling and Lehmann, 2018; Mai, 2018; OECD, 2020) often to put in common anonymized data or white labelling forms of services (Stoeckli et al., 2018; Tereszkiewicz and Południak-Gierz, 2021). Lapetus Solutions, for example, developed an analytical system and is partnering with life underwriters to offer quotations with facial analytics to engage in the phase of claims and sales processing (Cortis et al., 2019). Building an ecosystem where data are shared (Yu and Yen, 2020) reduces the asymmetry of information in the transaction processes (Eling and Lehmann, 2018).

Ownership. As the insurance industry is highly regulated, insurance companies shall be careful in understanding the entity producing, storing, and sourcing the data. Insurtech companies may acquire data initially owned by individuals, personal data (e.g., name, surname, health records, email, tax code, IP address, GPS coordinates, navigation cookies), or by other corporations or public institutions, non-personal data. Ethically, data owners shall ask for the consent of their customers to use their data (Cortis et al., 2019) and adopt security checks for data leakage. In general, scholars highlight the concerns that insurtech companies may gather more information than the actual owner knows (Cevolini and Esposito, 2020) from connected devices or aggregated data (World Economic Forum, 2015). Therefore, trust in the usage of data is a pivotal requirement in the insurance industry (Zarifis and Cheng, 2022), and insurtechs can enhance this by giving customers greater control over their data (Standaert and Muylle, 2022; Talonen et al., 2021).

Privacy. Despite differences among countries' data privacy regulations (Baker, 2017; Xu and Zweifel, 2020), all insurtech companies shall closely address the custody of personal information in accordance with the customers' willingness to protect and disclose data. As advanced technologies may capture or enrich more data than customers know, insurtechs can be liable for values and rights violations (Baker, 2017; Rejda and McNamara, 2014). Data enrichment such as data profiling must consider protecting customers (Njegomir et al., 2021) and preventing unfair practices that could infer ethics, ethnicity, gender, religion, and belief discrimination (Rejda and McNamara, 2014; Tereszkiewicz and Południak-Gierz, 2021). Marafie et al. (2018) propose to study customer willingness to pay for preserving their privacy. Customers can be covered with anonymization and processing techniques (Stoeckli et al., 2018; Tereszkiewicz and Południak-Gierz, 2021) that ensure rights and values and preserve trust (Njegomir et al., 2021; Standaert and Muylle, 2022; Tereszkiewicz and Południak-Gierz, 2021). The potential for in-depth investigation of the pivotal role of data privacy and trust in the insurance industry is a compelling avenue for scholarly exploration.

Compliance. Insurtech companies must be data-compliant to own governing rules and public regulations (legal and ethical), by protecting customers from discriminating, unfair practices such as pricing, privacy, sharing, and destruction requests (Al-witwit & Ibrahim, 2020; Cortis et al., 2019; Rawat et al., 2021; Rejda and McNamara, 2014; Standaert and Muylle, 2022; Tereszkiewicz and Południak-Gierz, 2021). Scholars evidence the lack of unified data regulation with consequences on innovation in insurance (Baker, 2017; Standaert and Muylle, 2022). European insurance enterprises are mandated to adhere to the General Data Protection Regulation (GDPR), a framework not exclusive to the insurance sector. The GDPR holds significance as a benchmark, as several nations (e.g., Brazil) have looked to its suggested guidelines while formulating their respective regulations. In contrast, the United States employs a disparate approach, incorporating data policies within certain federal regulations (Rejda and McNamara, 2014). Chinese regulatory authorities, exhibiting heightened vigilance towards potential insurtech-related risks, are actively drafting rules to reinforce oversight over internet-based insurance companies (Baker, 2017). Data compliance also considers potential issues such as accessibility, market power imbalance, data governance, data infrastructures, data literacy, risk assessment, and data security. Poor data compliance leads to financial loss and damage to a firm's reputation (Lee, 2017). Integrating insurance services with services less affected by regulation might be an efficient way to enhance customer engagement (Stoeckli et al., 2018).

Mutability. Insurtech companies collect, store, and maintain data in a centralized (e.g., a single server or cloud) (Eling and Lehmann, 2018) or distributed repository (e.g., peer-to-peer networks) (Cortis et al., 2019), defining the possibility to modify the original data. Decentralized technologies are disrupting the insurance industry enabling distributed and immutable transactions and processing, where smart contracts execute specific commands based on the available data while a few scholars indicate a potential reduction in information asymmetry (Faure and Li, 2020). For example, a decentralized-based solution against delayed flights can automatically trigger compensation upon flight delay (Stoeckli et al., 2018). Further, decentralized technologies such as blockchain ensure immutability and depletion - immutability when data is transparently stored in ledgers and cannot be modified - unless overwriting it, depletion when data is unique, not requiring copies across devices. In Insurtech, this dimension helps in checking legal requirements - according to underwriting purposes to secure information with consensus processes (Ching et al., 2020; Eling and Lehmann, 2018). Through blockchain, insured and insurtechs can see the decisions of all users, and be informed anytime a change happens (Faure and Li, 2020), therefore, reducing complexity and protecting digital identity (Choon Yan et al., 2017).

Decision-makers must evaluate different traits of the data characteristics (Fig. 2) to build valuable data assets to achieve their business goals. The combination of these data characteristics (Malgieri and Custers, 2018) along with data sources and data types delineates the possibility to use data for enhancing the business value, ultimately making them a strategic asset.

4.4. Data technologies

Investing in the right technologies is essential for insurtech to align their digital agenda with a strategy with a clear roadmap (Bohnert et al., 2019; PwC, 2022), thereby gaining a competitive edge (Lanfranchi and Grassi, 2022; Volosovych et al., 2021). Decision-makers should define clear objectives before investing in technologies. Implementing advanced technologies requires a clarification of strategic and tactical development objectives, involving a systematic analysis of business processes and consideration of the existing IT architecture (Kaigorodova et al., 2021; Njegomir et al., 2021; Ventiv Technology, 2023). Advanced technologies, pivotal in digital applications, continually disrupt the insurance industry, fostering innovative operations in the form of insurtech (Ratnakaram et al., 2021). The value of data technology lies in its capacity to enable compliance, transparency, accuracy, monitoring, updating, and identifiability, presenting opportunities to enhance efficiencies, revenues, and customer experiences (Gupta and Tham, 2018).

In the realm of insurtech companies, we summarized scholars' work tackling advanced technologies in data analytics, telematics, immersive technologies, and blockchain (Appendix D). Technological innovations reshape risk parameters by enriching structured data with unstructured data, enabling insurance providers to conduct more fine-grained risk assessments (Standaert and Muylle, 2022). In addition to typical data analytics technologies (e.g., artificial intelligence, machine learning), quantum computing will enable the management of billions of pieces of

Volume	Amount of data
Velocity	Pace of data interactions
Variety	Combination of heterogeneous data sources and data types
Veracity	Accuracy, truthfulness, and quality of raw data
Accessibility	Availability of data
Granularity	Level of fine-grained detail
Sharing	Mutual transaction of data
Ownership	Entity producing, storing, and sourcing data
Privacy	Preserve the protected and disclosed data
Compliance	Follow own data governance and regulatory guidelines
Mutability	Possibility to modify data in a centralized or decentralized repository

Fig. 2. Data characteristics.

data (Schulte and Lee, 2019). As technology continues to evolve, insurtech companies continue to remain at the edge of trends, capturing new business lines (Gupta and Tham, 2018). Telematics devices provide a substantial amount of data, connecting people, while sensor-equipped vehicles, houses, and factories offer programmability, addressability, sensibility, communicability, memorability, traceability, associability, and interoperability (Standaert and Muylle, 2022). Without adequate, relevant, timely, and complete information, it would be almost impossible for insurance companies to provide insurance services on a sustainable basis (Njegomir et al., 2021). Immersive technologies and blockchain are innovatively used for streamlining the claims settling processes to help underwriters estimate the loss in a timely manner, accurately manage claims and reinsurance contracts through smart contracts (Cappiello, 2018; Hoffmann, 2021; Ratnakaram et al., 2021), and enhance policy administration (Ma and Ren, 2023). Blockchain technologies facilitate increased access to and enhanced security of information regarding customer assets, priorities, preferences, and third-party information services (Cappiello, 2018).

For the scope of data management, technologies are typically used in synthesis and combination (Gupta and Tham, 2018), where some of them are the development of earlier technologies (Kaigorodova et al., 2021). Adopting technology is a key success factor that requires decision-makers to embrace a scaling mindset to manage investment costs (PwC, 2022; Zeier Röschmann et al., 2022). Technologies encompassing data analytics, telematics, immersive technologies, and blockchain, when used in combination with a streamlined data flow, can create competitive value.

4.5. Data management practices

The proliferation of data allows insurtech companies to harness a unique selling proposition and competitive value over other market participants by transforming historical insurance models with innovative practices (Cortis et al., 2019). Specifically, insurtech companies aggregate data assets and technologies to make quality business decisions (Rawat et al., 2021) that incorporate multiple data management practices. In this context, data management practices refer to the strategic activities involved in acquiring, organizing, storing, processing, and maintaining data throughout its lifecycle within an organization. We systematically identified the data management practices (Appendix E) and we then grouped by similar content.

Insurtech companies' objectives are significantly shaped by a variety of strategic data management practices, which play a pivotal role in enhancing risk management, business operations, customer interaction, and collaborative practices. Data enhance risk management practices allowing to better manage eligibility, underwriting, and rating of individuals (Cappiello, 2018). These practices also enhance security by implementing automated fraud detection, automated verification, and compliance monitoring, while issuing proactive warnings maintaining data integrity through digital signing and identification practices, and mitigating losses. Considering the IT architecture, business operations practices target improvements in digital transactions and processing, ensuring accuracy, integrity, and efficiency. These are enhanced through secure digital submission, data augmentation and enrichment, automated processing, predictive assessment (e.g., shifting the loss compensation to risk prediction and prevention), behavioral policy evaluation, automated verification, digital matched demand and supply, automatic recommendations, and digital advisory. Insurtech companies also employ compliance monitoring in conjunction with effective planning and digital administration to ensure proactive governance and strategic decision-making in their operations. However, insurtech companies shall evaluate an extreme digitalization of business operations with respect to human interaction to preserve customer loyalty (Cappiello, 2018). Customer interaction practices focus on the more frequent and personalized exchange between the insurtech companies and the customers. They encompass detecting customer profiles to deliver personalized offers, digital conversation and notifications also with push-notification or location-, activity- or context-based (Zeier Röschmann et al., 2022), automated feedback as scores, alerts, or monetary rewards (Marafie et al., 2018), situational and flexible insurance offers. These practices allow customers to avoid high-risk situations and improve their behaviors by "moving from price to advice" (Bharal and Shapiro, 2016, p. 9). However, an excess of personalization through targeted marketing may invalidate customer privacy and the final decision of the potential customer (Cappiello, 2018). Finally, as identified by Standaert and Muylle (2022) improved customer experiences are also related to collaborative practices by opening data, product, and ecosystem dimensions to third-party data, beyond insurance products, and on platforms. For example, by centralizing data and detecting customer needs, insurtechs can complement traditional products and services with new ones such as services of plumbers, electricians, locksmiths, and painters. In addition, through the establishment of peer-to-peer networks, insurtech companies increase customer engagement, information exchange, and reduce intermediation costs bringing an innovative dimension to traditional insurance servicing (Li et al., 2023).

Decision-makers shall build a strategic digital agenda to valorize data for new directions of growth and development as suggested in the study by Bohnert et al. (2019). Data orchestration leads to new business lines, where insurtech companies gain a competitive edge over more traditional companies by enabling or extending extant products and services (Njegomir et al., 2021) with data management practices. Using a strategic approach in undertaking risk management strategies, persistency of business operations, customer engagement, and collaborative initiatives can ultimately boost market share and profitability (Pressman, 2003). Insurtech companies interrelate these data management practices based on the context and the strategic goals they aim to achieve to gain a competitive edge.

4.6. Data activities

By using data, insurtech companies were able to transform the value chain of insurance (Cappiello, 2018; Ching et al., 2020; Cortis et al., 2019; Gupta and Tham, 2018; Njegomir et al., 2021). Data-driven activities have enhanced the insurance traditional business model, and give insurtech companies the potential to expand and change business models along with gaining a competitive advantage (Ching et al., 2020).

Looking at the value chain, data have impacted both primary and support activities in the insurtech context. Several prior studies have examined the influence of insurtech companies on the traditional insurance value chain. Some scholars highlighted changes in product development, sales and distribution, actuarial, and claims (Cappiello, 2018; Njegomir et al., 2021). In a report from World Economic Forum, (2015), authors reported five primary activities: R&D/product manufacturing, distribution, underwriting, claims, and risk capital and investment management. Ching et al. (2020) identify eight key activities impacted by data: product development, sales, underwriting and claim management, they add marketing, and customer service and they slit asset management from risk management. Eling and Lehmann (2018) confirm Ching et al. (2020)'s framework of primary activities and complement with the support activities: general management, IT, human resources, controlling, legal department, and public relations. Yu and Yen (2020) track eight activities: setting databases of potential clients, adhering services to the target clients, providing products and services to the clients, underwriting risks, risk improvement before or after losses, setting risk pools by retention or treaty, allocate risks to pools by the law of large numbers, and convert insurance portfolio to the financial market. We comprehensively systematized previous value chains starting from the value chain for the general industry of Porter's (1985) value chain and considering the specificities of the insurtech companies (Appendix G). The synthesis reveals how insurtech companies are using data to tangibly gain a competitive advantage and allowed to organize the findings from the systematic literature review.

Our findings identify various activities across the value chain of insurtech companies leveraging data assets to enhance activities (Appendix F). In terms of primary activities data assets play a crucial role in shaping inbound logistics, where they contribute to product development by understanding customer needs and preferences and deploying products and services on-demand. Operations are the core of data-driven processes, ensuring estimating customer lifetime value, and optimizing resources (e.g., business processes) through an adaptable, personalized, temporary, and transferable offer. Outbound logistics, particularly in underwriting, are significantly influenced by the automatized insights or digital contracts (e.g., smart contracts) directly on apps or websites. Marketing and sales activities are empowered through data utilization, facilitating effective customer engagement by also bundling complementary products and services on demand. The provision of high-quality customer service is enabled by predictive, preventive, responsible, effective information, interactive experience, data protection, usage-based products, and services that empower customers. In terms of supporting activities, the firm's infrastructure, overseen by general management, is designed to support the strategic utilization of data for strategic planning, automated data management, and monitoring. Human resource management emphasizes the development of digital competencies to harness the full potential of data assets. Technology development encompasses infrastructure and controlling functions that optimize data asset utilization and secure data according to compliance requirements. Lastly, procurement activities are oriented toward governing data according to internal and external compliance and using new channels for procuring new sources of revenue. Insurtech company's competitive value stands on the ability to orchestrate data assets from the search and selection up to the configuration and deployment.

5. Discussion

5.1. Theoretical contributions

By leveraging on the findings in the insurtech context, the paper identifies six data pillars that decision-makers manage strategically to achieve a competitive advantage, namely data sources, data types, data characteristics, data technologies, data management practices, and data activities. In light of the resource orchestration theory of Sirmon et al. (2011), we grouped the six pillars into three strategic dimensions to be orchestrated: data assets, data infrastructures, and data activities, that allow to valorize data resources and ultimately contribute to the creation of a data valorization framework (Fig. 3).

Decision-makers shall acquire, accumulate, and destroy multiple data sources, types, and characteristics (Sirmon et al., 2011) to create useful products and services turning data into a business asset (Sen, 2004). By bundling data assets with technologies that stabilize, enrich, and pioneer (Martin, 1982; Tabesh et al., 2019) management practices, insurtech firms can strategically plan processes, methods, and business objectives using strong data infrastructures. Thus, by mobilizing and coordinating data assets, and data infrastructures, insurtech decision-makers use data for enhancing primary and supporting activities within their value chain, ultimately creating value, and developing competitive advantages. Moreover, insurtech firms' resources need to be assembled and utilized to help firms make decisions (Hitt et al., 2017; Wernerfelt, 1984), therefore orchestrating the search and selection of data assets along with data infrastructure, and configuration and deployment of data activities for creating a competitive value.

The paper contributes to the data management literature by identifying data as business assets that orchestrated with the business infrastructures enhance the corporations' activities and ultimately insurtech companies' competitive value. We identified that by searching and selecting data sources, data types, and data characteristics, corporations can turn data into a business asset. Then, evaluating existing and new technologies, corporations can manage the data infrastructure strategically. Finally, by considering the business objectives, decision-makers can configure the deploy the most appropriate data activities to achieve a competitive advantage.

5.2. Managerial contributions

In the insurtech context, data resources have transformed the business process and the value chain of insurance (Cortis et al., 2019), providing enormous opportunities to boost innovation and competition (Wuermeling, 2022). Data has a strategic value as an instrumental factor in achieving business objectives in the competitive insurance industry. Companies neglecting digital resources are subjected to a trajectory of diminishing competitiveness (Cappiello, 2018). The data valorization framework allows decision-makers to strategically manage data resources to achieve a competitive advantage (Fig. 3). Firstly, decision-makers shall evaluate how managing strategically data sources, types, and characteristics can allow them to acquire competitive information (Cavanillas et al., 2016) that drives them to achieve competitive resources to lead the market. Then, insurtech decision-makers shall evaluate their business goals, and strategically select which data technologies and data management practices allow them to use the data assets and boost their competitive positioning. Implementing specific data infrastructures, including advanced technologies, is instrumental in creating competitive edges by providing insight when managing, mitigating, and monitoring an organization's risks and reducing sourcing

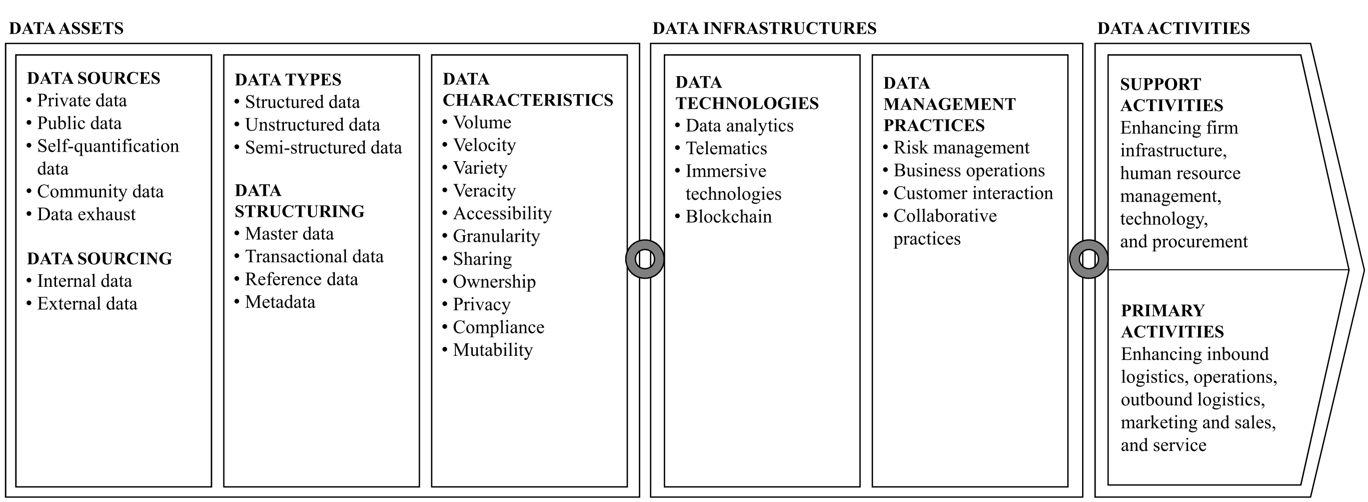

Fig. 3. Data valorization framework.

challenges in the long-term (PwC, 2022). Finally, by leveraging data assets and data infrastructures, the decision makers shall evaluate their primary and support activities as-is and to-be to sustain their competition in the markets.

By strategically orchestrating data-driven resources, insurtech firms achieve several competitive advantages. These competitive advantages can be summarized into enhanced risk assessment, optimized operations, customer engagement, and openness. By acquiring, and accumulating multiple data sources, types, and characteristics, insurtech companies enhance risk assessments (e.g., risk pooling, risk spreading - Cevolini and Esposito, 2020) for product development, underwriting, loss prevention, product pricing, and product distribution (Cortis et al., 2019; Gupta and Tham, 2018; Njegomir et al., 2021). However, data and digitalization lead to being more exposed to cyber-attack risks (Njegomir et al., 2021). Further, by pooling data insights on risks and individuals, insurtech companies reduce the adverse selection and moral hazard through better pricing the policyholders (e.g., personalization) and preventing changes of attitude following the coverage. The enhancement or risk assessment lead also to include unserved individuals or exclude higher-risk individuals (Corea, 2019; Cortis et al., 2019; Paul and Sadath, 2021), although might lead to higher performance and healthier customer behaviors, open the discussion to privacy and regulatory issues. For example, some schemes, such as one developed in the United Kingdom for flood protection, can create a reinsurance pool whereby every household policyholder pays a small extra premium to allow higher-risk individuals to be offered insurance at normal rates (Millie, 2021) may be considered.

Insurtech companies optimize operations by leveraging on data infrastructures to effectively reduce costs of business transactions (Kaigorodova et al., 2021) in servicing clients (e.g., time, accuracy), claims management, eliminating bottlenecks, fraud detection, improving capacity in structuring information, effective planning (e.g., data-driven KPIs), and automated processes (e.g., reporting, contracts, white labeling, compliance, privacy and cybercrime monitoring).

Furthermore, insurtech companies teach the centrality of the customer (Saidat et al., 2023), enriching customer engagement by evaluating the customer's lifetime value and customers patterns in order to provide an adaptable, personalized, temporary (on-demand), or transferable offer which includes policies and complementary financial and non-financial products and services. This engagement allows the presence of usage-based and more informed products and services, despite it requires a higher amount of personal data where rewards or premium discounts may occur (Talonen et al., 2022).

Finally, insurtech companies' interaction is increasing based on an open approach to co-creating products and services, building a true ecosystem between traditional players, newer players, and innovation labs. Openness offers the usage of data in a more transparent and trusted channel for the data stakeholders by the adoption of a centralized data lake (PwC, 2022), often leveraged by decentralized infrastructures even if policies often require some sort of human interaction because of their complexity (Standaert and Muylle, 2022). However, questions on the sensitivity of data and fragmented regulations block insurance players from really leveraging the amount of data and information they own. As pointed also from previous studies (Baker, 2017; Eling and Lehmann, 2018; Standaert and Muylle, 2022), scholars and policymakers are invited to reflect on which data and to what extent may be used for enhancing innovation and the competition. Our paper can provide a framework for policymakers to address more uniform, competitive, and innovative data usage initiatives (e.g., open insurance) in the insurance industry.

Therefore, the paper underscores the importance of data management for insurtech firms, emphasizing the need for decision-makers to strategically assess and utilize the data pillars to achieve competitive advantages. By orchestrating data-driven resources, insurtech companies can enhance risk assessment, optimize operations, engage customers, and promote openness in their interactions with stakeholders, ultimately positioning themselves for success in the insurance market.

6. Conclusion

The paper underscores the value of data as a business asset, highlighting the need for insurtech companies to orchestrate data assets, data infrastructures, and data activities to gain a competitive advantage. The findings identify the data pillars that strategically managed allow to turn data into a valuable resource for gaining a competitive positioning in the insurtech context. We identified six pillars and leveraged the resource orchestration theory to build a theoretical data valorization framework. The framework enlightens data as business assets that are orchestrated with the business infrastructures for specific activities enhance the corporations' competitive value. Further, we summarized insurtech companies' data-driven competitive advantages to concretely contribute to managerial needs.

The study's insights can be applied practically by insurtech companies to gain competitive advantages. They can strategically use data resources to enhance risk assessment, optimize operations, engage customers, and promote openness. This includes optimizing risk assessment for various aspects of their business, reducing adverse selection, and improving operational efficiency. Additionally, by focusing on customer-centric approaches, insurtech companies can offer personalized and data-informed products and services, though they must address privacy and regulatory concerns. Embracing an open approach to collaboration and co-creation in the industry encourages the transparent use of data resources among various stakeholders. While the paper primarily centers on insurtech companies, we believe that the findings have the potential to be generalized to other data-driven industries. For example, our findings can be incorporated by traditional insurance companies to boost innovation. To validate our theoretical framework in broader contexts, further investigation through multiple case studies and surveys may be warranted. Further studies can also explore more in-depth each of the identified data-driven competitive advantages.

Following this paper, future research may use the data valorization framework as the base for a single case study of a successful insurtech, or multiple case studies to address the state of the art of non-life and life insurance providers given the limited distinction that emerged in our review. It can be the base also for a survey instrument to validate the determinants of competitive value. The framework can be also addressed to compare data competitive initiatives among insurtech players, incumbent insurance players, and potentially new players such as bigtechs. In addition to benefits to insurtech practitioners, policymakers can leverage our theoretical framework to build guidelines that allow to competitive use of data assets, while promoting innovation. Although the paper detected the opportunity to use data assets to include underserved individuals in previously excluded insurance services, further studies are needed to evaluate the potential issue of oversharing personal data and the risk of excluding previous individuals from which regulatory policies may derive.

In summary, this paper identifies the pivotal role of data as a strategic business asset and emphasizes the need for data orchestration in insurtech companies to attain a competitive edge. The identification of six key data pillars has led to the creation of a data valorization framework that highlights the strategic managerial steps to enhance competitiveness. While our study primarily focuses on the insurtech context, these insights have the potential for broader applications in various data-driven industries. Policymakers can draw on our framework to create guidelines promoting innovation through data valorization. Therefore, by valorizing data with strategic data decisions, insurtech companies and other data-driven industries are given the potential to create value and place themselves competitively in a market in continuous transformation. Further research is needed to validate and expand our theoretical framework and to delve deeper into each data-driven competitive advantage, but we believe this work provides the prime fundamentals for unlocking the value of data.

Data availability

No data were used for the research described in the article.

Appendix

A. Data sources

Data sources
Public data
(Paul and Sadath, 2021; Rawat et al., 2021; Gupta and Tham, 2018; Standaert and Muylle, 2022; Baker, 2017; Njegomir et al., 2021; Savchuk et al., 2021; Saliba et al., 2022; Tereszkiewicz and Południak-Gierz, 2021)
Private data
(Cevolini and Esposito, 2020; Paul and Sadath, 2021; Rawat et al., 2021; Talonen et al., 2021; Stoeckli et al., 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Njegomir et al., 2021; Volosovych et al., 2021; Zeier Röschmann et al., 2022; Al-witwit & Ibrahim, 2020; Zarifis and Cheng, 2022; Ma and Ren, 2023; Millie, 2021; Braun et al., 2023)
Data exhaust
(Cevolini and Esposito, 2020; Ching et al., 2020; Rawat et al., 2021; Saidat et al., 2023; Talonen et al., 2021; Cortis et al., 2019; Njegomir et al., 2021; Gramegna and Giudici, 2020; Saliba et al., 2022; Eling and Lehmann, 2018)
Community data
(Ching et al., 2020; Rawat et al., 2021; Saidat et al., 2023; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Zeier Röschmann et al., 2022; Eling and Lehmann, 2018; Ratnakaram et al., 2021)
Self-quantification data
(Cevolini and Esposito, 2020; Gupta and Tham, 2018)
Internal
(Ching et al., 2020; Rawat et al., 2021; Saidat et al., 2023; Talonen et al., 2021; Xu and Zweifel, 2020; Cortis et al., 2019; PwC, 2022; BCG, 2013; Ventiv Technology, 2023)
External
(Cevolini and Esposito, 2020; Ching et al., 2020; Rawat et al., 2021; Saidat et al., 2023; Stoeckli et al., 2018; Cortis et al., 2019; Standaert and Muylle, 2022; PwC, 2022; Ventiv Technology, 2023)

B. Data types

Data types
Structured
(Rawat et al., 2021; Cao et al., 2021; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; PwC, 2022)
Semi-structured
(Rawat et al., 2021; Cortis et al., 2019; Corea, 2019; Eling and Lehmann, 2018; PwC, 2022)
Unstructured
(Ching et al., 2020; Rawat et al., 2021; Talonen et al., 2021; Gupta and Tham, 2018; Cortis et al., 2019; Gramegna and Giudici, 2020; Corea 2019; Marafie et al., 2018; Cappiello, 2018; Eling and Lehmann, 2018; Bharal and Shapiro, 2016; PwC, 2022)
Master data
(Cortis et al., 2019; PwC, 2022)
Transactional data
(BCG, 2013; Zeier Röschmann et al., 2022)
Reference data
(Marafie et al., 2018; Ventiv Technology, 2023)
Metadata
(European Commission, 2018; Wilkinson et al., 2016; PwC, 2022)

C. Data characteristics

Data characteristics
Volume
(Cevolini and Esposito, 2020; Lanfranchi and Grassi, 2022; Paul and Sadath, 2021; Rawat et al., 2021; Saidat et al., 2023; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Corea, 2019; Cao et al., 2021; Tereszkiewicz and Południak-Gierz, 2021; Faure and Li, 2020; Volosovych et al., 2021; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Bharal and Shapiro, 2016; Al-witwit & Ibrahim, 2020; King et al., 2021; Millie, 2022)
Velocity
(Cevolini and Esposito, 2020; Ching et al., 2020; Paul and Sadath, 2021; Saidat et al., 2023; Talonen et al., 2021; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Volosovych et al., 2021; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Yu and Yen, 2020; Pressman, 2003; Ma and Ren, 2023; King et al., 2021; Braun et al., 2023; EIOPA, 2021; BCG, 2013)
Variety

(continued on next page)

(*continued*)

Data characteristics
(Saidat et al., 2023; Talonen et al., 2021; Cortis et al., 2019; Cappiello, 2018)
Veracity
(Rawat et al., 2021; Saidat et al., 2023; Stoeckli et al., 2018; Cortis et al., 2019; Njegomir et al., 2021; Saliba et al., 2022; Tereszkiewicz and Południak-Gierz, 2021; Mai, 2018; Cappiello, 2018; Yu and Yen, 2020; Ratnakaram et al., 2021; PwC, 2022; Ventiv Technology, 2023)
Accessibility
(Ching et al., 2020; Cevolini and Esposito, 2020; Lanfranchi and Grassi, 2022; Paul and Sadath, 2021; Rawat et al., 2021; Stoeckli et al., 2018; Standaert and Muylle, 2022; Njegomir et al., 2021; Sosa and Montes, 2022; Savchuk et al., 2021; Zeier Röschmann et al., 2022; Eling and Lehmann, 2018; Yu and Yen, 2020; Pressman, 2003; Kaswan et al., 2022;King et al., 2021; PwC, 2022; BCG, 2013; Ventiv Technology, 2023)
Granularity
(Stoeckli et al., 2018; Gupta and Tham, 2018; Standaert and Muylle, 2022; Corea, 2019; Zeier Röschmann et al., 2022; Cappiello, 2018; PwC, 2022)
Sharing
(Ching et al., 2020; Rawat et al., 2021; Talonen et al., 2021; Standaert and Muylle, 2022; Njegomir et al., 2021; Saliba et al., 2022; Volosovych et al., 2021; Zeier Röschmann et al., 2022; Eling and Lehmann, 2018; Yu and Yen, 2020; Pressman, 2003; Bharal and Shapiro, 2016; Puschmann, 2017; Ma and Ren, 2023; Li et al., 2023; Saeed and Arched, 2022)
Ownership
(Kaigorodova et al., 2021; Talonen et al., 2021; Cortis et al., 2019; Standaert and Muylle, 2022; Volosovych et al., 2021)
Privacy
(Kaigorodova et al., 2021; Lanfranchi and Grassi, 2022; Xu and Zweifel, 2020; Talonen et al., 2021; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Baker, 2017; Njegomir et al., 2021; Saliba et al., 2022; Volosovych et al., 2021; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Bharal and Shapiro, 2016; Millie, 2021; Braun et al., 2023; Deloitte, 2023; BCG, 2013)
Compliance
(Lanfranchi and Grassi, 2022; Paul and Sadath, 2021; Rawat et al., 2021; Saidat et al., 2023; Xu and Zweifel, 2020; Cortis et al., 2019; Njegomir et al., 2021; Sosa and Montes, 2022; Volosovych et al., 2021; Zeier Röschmann et al., 2022; Eling and Lehmann, 2018; Bharal and Shapiro, 2016; PwC, 2022; Ventiv Technology, 2023)
Mutability
(Ching et al., 2020; Xu and Zweifel, 2020; Gupta and Tham, 2018; Cortis et al., 2019; Eling and Lehmann, 2018)

D. Data technologies

Data analytics	Telematics	Immersive technologies	Blockchain
Application programming interface (Choon Yan et al., 2017; Paul and Sadath, 2021; Stoeckli et al., 2018; Standaert and Muylle, 2022; Agarwal et al., 2022; EIOPA, 2021; Ventiv Technology, 2023)	Devices (e.g., sensors, black boxes, drones; wearables) (Choon Yan et al., 2017; Cevolini and Esposito, 2020; Ching et al., 2020; Lanfranchi and Grassi, 2022; Saidat et al., 2023; Talonen et al., 2021; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Baker, 2017; World Economic Forum, 2015; Njegomir et al., 2021; Saliba et al., 2022; Agarwal et al., 2022; Faure and Li, 2020; Volosovych et al., 2021; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Chester et al., 2018; Puschmann, 2017; King et al., 2021)	Multimedia (e.g., photos, videos) (Ching et al., 2020; Lanfranchi and Grassi, 2022; Cortis et al., 2019; Volosovych et al., 2021; Zeier Röschmann et al., 2022; Eling and Lehmann, 2018)	Centralized ledger (Choon Yan et al., 2017; Standaert and Muylle, 2022; Faure and Li, 2020; Yu and Yen, 2020)
Artificial intelligence (Ching et al., 2020; Lanfranchi and Grassi, 2022; Kaigorodova et al., 2021; Paul and Sadath, 2021; Rawat et al., 2021; Saidat et al., 2023; Xu and Zweifel, 2020; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Njegomir et al., 2021; Gramegna and Giudici, 2020; Lanfranchi and Grassi, 2021; Corea 2019; Savchuk et al., 2021; Cao et al., 2021; Agarwal et al., 2022; Volosovych et al., 2021; Cappiello, 2018; Ratnakaram et al., 2021; Bharal and Shapiro, 2016; Schulte and Lee, 2019; Al-witwit & Ibrahim, 2020; Zarifis and Cheng, 2022;Kimberly, 2022; Ma and Ren, 2023; Li et al., 2023; Millie, 2021; Saeed and Arched, 2022; Millie, 2022; EIOPA, 2021)	Internet of things (Choon Yan et al., 2017; Cevolini and Esposito, 2020; Ching et al., 2020; Choon Yan et al., 2017; Kaigorodova et al., 2021; Saidat et al., 2023; Paul and Sadath, 2021; Xu and Zweifel, 2020; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Baker, 2017; Njegomir et al., 2021; Agarwal et al., 2022; Mai, 2018; Faure and Li, 2020; Volosovych et al., 2021; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Yu and Yen, 2020; Al-witwit & Ibrahim, 2020; Zarifis and Cheng, 2022; Saeed and Arshed, 2022; Chen et al., 2023; King et al., 2021; Saeed and Arched, 2022; EIOPA, 2021)	Image recognitioning (Kaigorodova et al., 2021; Xu and Zweifel, 2020; Agarwal et al., 2022; Zeier Röschmann et al., 2022; Ratnakaram et al., 2021)	Decentralized ledger (Choon Yan et al., 2017; Ching et al., 2020; Kaigorodova et al., 2021; Xu and Zweifel, 2020; Paul and Sadath, 2021; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Njegomir et al., 2021; Lanfranchi and Grassi, 2022; Savchuk et al., 2021; Cao et al., 2021; Faure and Li, 2020; Volosovych et al., 2021; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Yu and Yen, 2020; Chester et al., 2018; Schulte and Lee, 2019; Al-witwit & Ibrahim, 2020; Hoffmann, 2021; Kaswan et al., 2022; Ma and Ren, 2023; Li et al., 2023; Saeed and Arched, 2022)

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Data analytics	Telematics	Immersive technologies	Blockchain
Machine learning (Ching et al., 2020; Cevolini and Esposito, 2020; Kaigorodova et al., 2021; Paul and Sadath, 2021; Rawat et al., 2021; Gupta and Tham, 2018; Cortis et al., 2019; Choon Yan et al., 2017; Corea, 2019; Cao et al., 2021; Volosovych et al., 2021; Marafie et al., 2018; Eling and Lehmann, 2018; Yu and Yen, 2020; Ratnakaram et al., 2021; Bharal and Shapiro, 2016; Zarifis and Cheng, 2022; Ma and Ren, 2023;King et al., 2021)		Augmented reality (Ching et al., 2020; Gupta and Tham, 2018; Ratnakaram et al., 2021)	
Deep learning (Rawat et al., 2021; Xu and Zweifel, 2020; Cortis et al., 2019; Choon Yan et al., 2017; Agarwal et al., 2022; Al-witwit & Ibrahim, 2020)		Virtual reality (Xu and Zweifel, 2020; Gupta and Tham, 2018; Chester et al., 2018; Ratnakaram et al., 2021)	
Data mining (Cevolini and Esposito, 2020; Rawat et al., 2021; Cao et al., 2021)			
Network analysis (Saidat et al., 2023; Agarwal et al., 2022)			
Biometric analysis (Gupta and Tham, 2018; Cortis et al., 2019; Baker, 2017 ; Volosovych et al., 2021)			
Server/cloud computing (Ching et al., 2020; Kaigorodova et al., 2021; Lanfranchi and Grassi, 2022; Xu and Zweifel, 2020; Gupta and Tham, 2018; Standaert and Muylle, 2022; Njegomir et al., 2021; Sosa and Montes, 2022; Savchuk et al., 2021; Marafie et al., 2018; Cappiello, 2018; Eling and Lehmann, 2018; Ratnakaram et al., 2021; Schulte and Lee, 2019; King et al., 2021)			
Robotic automated processing (Ching et al., 2020; Kaigorodova et al., 2021; Paul and Sadath, 2021; Saidat et al., 2023; Xu and Zweifel, 2020; Stoeckli et al., 2018; Gupta and Tham, 2018; Standaert and Muylle, 2022; Corea, 2019; Tereszkiewicz and Południak-Gierz, 2021; Marafie et al., 2018; Cappiello, 2018; Eling and Lehmann, 2018; Ratnakaram et al., 2021; Bharal and Shapiro, 2016; Kaswan et al., 2022; Millie, 2022)			
Quantum computing (Gupta and Tham, 2018; Schulte and Lee, 2019)			

E. Data management practices

Data management practices			
Adjustment based on behaviors/needs (Paul and Sadath, 2021; Talonen et al., 2021; Gupta and Tham, 2018; Standaert and Muylle, 2022; Cappiello, 2018; Al-witwit & Ibrahim, 2020)	Digital interaction (Lanfranchi and Grassi, 2022; Saidat et al., 2023; Stoeckli et al., 2018; Cortis et al., 2019; Cappiello, 2018; Eling and Lehmann, 2018)	Loss mitigation (Cevolini and Esposito, 2020; Kaigorodova et al., 2021; Lanfranchi and Grassi, 2022; Xu and Zweifel, 2020; Stoeckli et al., 2018; Cortis et al., 2019; Njegomir et al., 2021; Corea, 2019; Volosovych et al., 2021; Zeier Röschmann et al., 2022; Cappiello, 2018)	Pricing (usage/behavior/rewards-based) (Choon Yan et al., 2017; Cevolini and Esposito, 2020, Lanfranchi and Grassi, 2022; Rawat et al., 2021; Talonen et al., 2021; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Sosa and Montes, 2022; Volosovych et al., 2021; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Ratnakaram et al., 2021; Al-witwit & Ibrahim, 2020;Puschmann, 2017; Braun et al., 2023)
Aggregation (Cevolini and Esposito, 2020; Standaert	Digital signing and identification (Kaigorodova et al., 2021; Paul and	Automated fraud detection (Ching et al., 2020; Kaigorodova et al., 2021;	Personalized offer (Choon Yan et al., 2017; Cevolini and

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Data management practices			
and Muylle, 2022; Eling and Lehmann, 2018; PwC, 2022)	Sadath, 2021; Xu and Zweifel, 2020; Stoeckli et al., 2018; Cortis et al., 2019; Eling and Lehmann, 2018)	Rawat et al., 2021; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Agarwal et al., 2022; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Ratnakaram et al., 2021; Kaswan et al., 2022; Ma and Ren, 2023; Deloitte, 2023; BCG, 2013)	Esposito, 2020; Lanfranchi and Grassi, 2022; Rawat et al., 2021; Saidat et al., 2023; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Njegomir et al., 2021; Corea, 2019; Tereszkiewicz and Południak-Gierz, 2021; Mai, 2018; Volosovych et al., 2021; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Bharal and Shapiro, 2016; Al-witwit & Ibrahim, 2020; Puschmann, 2017; Ma and Ren, 2023; Millie, 2021)
Openness (Standaert and Muylle, 2022; Hoffmann, 2021; Li et al., 2023; EIOPA, 2021)	Digital notification or feedback (Choon Yan et al., 2017; Stoeckli et al., 2018; Marafie et al., 2018; Cappiello, 2018; Eling and Lehmann, 2018; Pressman, 2003; Millie, 2021)	Data augmentation/enrichment (Rawat et al., 2021; Cappiello, 2018; Eling and Lehmann, 2018; PwC, 2022)	Context/flexible offer (Saidat et al., 2023; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Al-witwit & Ibrahim, 2020; Ma and Ren, 2023; Braun et al., 2023)
Automated processing (Ching et al., 2020; Kaigorodova et al., 2021; Saidat et al., 2023; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Njegomir et al., 2021; Agarwal et al., 2022; Marafie et al., 2018; Eling and Lehmann, 2018; Ratnakaram et al., 2021; Pressman, 2003; Puschmann, 2017; Deloitte, 2023)	Digital transaction and processing (Stoeckli et al., 2018; Marafie et al., 2018; Zeier Röschmann et al., 2022)	Predictive assessment (Cevolini and Esposito, 2020; Lanfranchi and Grassi, 2022; Saidat et al., 2023; Stoeckli et al., 2018 Cortis et al., 2019; Standaert and Muylle, 2022; Njegomir et al., 2021; Gramegna and Giudici, 2020; Faure and Li, 2020; Volosovych et al., 2021; Zeier Röschmann et al., 2022; Cappiello, 2018; Ratnakaram et al., 2021; Al-witwit & Ibrahim, 2020; Ma and Ren, 2023)	Digital administration (Stoeckli et al., 2018; Njegomir et al., 2021; Cappiello, 2018)
Automated verification (Stoeckli et al., 2018; Cortis et al., 2019)	Digital submission (Stoeckli et al., 2018)	Data custody (Standaert and Muylle, 2022)	Digital adjustment (Stoeckli et al., 2018)
Behavioral policy evaluation (Cevolini and Esposito, 2020; Lanfranchi and Grassi, 2022; Saidat et al., 2023; Rawat et al., 2021; Standaert and Muylle, 2022; Marafie et al., 2018; Cappiello, 2018; Al-witwit & Ibrahim, 2020; Millie, 2021)	Peer-to-peer network (Cortis et al., 2019; Choon Yan et al., 2017; Ma and Ren, 2023; Li et al., 2023)	Proactive warnings (Stoeckli et al., 2018; Cortis et al., 2019; Marafie et al., 2018; Zeier Röschmann et al., 2022)	Effective planning (Cevolini and Esposito, 2020)
Compliance monitoring (Rawat et al., 2021; Standaert and Muylle, 2022; Baker, 2017)	Digital offer (Saidat et al., 2023; Standaert and Muylle, 2022; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018)	Customer profiling (Rawat et al., 2021; Saidat et al., 2023; Corea, 2019; Agarwal et al., 2022; Tereszkiewicz and Południak-Gierz, 2021; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Ratnakaram et al., 2021; Li et al., 2023; Saeed and Arched, 2022)	Service provisioning on demand (Choon Yan et al., 2017; Stoeckli et al., 2018; Gupta and Tham, 2018; Standaert and Muylle, 2022; Zeier Röschmann et al., 2022)
Digital advisory (Ching et al., 2020; Stoeckli et al., 2018; Marafie et al., 2018; Cappiello, 2018; Bharal and Shapiro, 2016; Millie, 2021)	Know your customer (Saidat et al., 2023; Rawat et al., 2021; Cortis et al., 2019; Choon Yan et al., 2017)	Automated recommendation (Gupta and Tham, 2018; Cortis et al., 2019)	Recovery service (Rawat et al., 2021; Stoeckli et al., 2018; Njegomir et al., 2021)

F. Data activities

Primary activities		
Inbound logistics	Product development	Acquisition from multiple sources (e.g., public providers, third party) and technologies (e.g., telematics, blockchain) for understanding customers' needs and test products/services (Kaigorodova et al., 2021; Njegomir et al., 2021; Ching et al., 2020; Cappiello, 2018; Eling and Lehmann, 2018; Bharal and Shapiro, 2016; Saidat et al., 2023; Stoeckli et al., 2018; World Economic Forum, 2015; Gupta and Tham, 2018; Standaert and Muylle, 2022; Gramegna and Giudici, 2020; Corea 2019; Volosovych et al., 2021) Complementing insurance with prevention and recovery service e.g., check early warnings (Bank for International Settlements, 2018; Stoeckli et al., 2018; Zeier Röschmann et al., 2022) and customer preferences trends (Kaigorodova et al., 2021; Gupta and Tham, 2018) Integration with innovation labs to merge products/services (Cappiello, 2018; Njegomir et al., 2021; Zeier Röschmann et al., 2022) or related services (e.g., financial services, employee benefits, health services) (Stoeckli et al., 2018) Development on-demand (Sosa and Montes, 2022; Zeier Röschmann et al., 2022; Lisowski & Chojan, 2021; Stoeckli et al., 2018; Eling and Lehmann, 2018; Braun et al., 2023) Dynamic/instant pricing of customers comparing the clusters with customers' profile e.g., risk-adjusted pricing (Zeier Röschmann et al., 2022; Savchuk et al., 2021; Schulte and Lee, 2019; Eling and Lehmann, 2018; Baker, 2017; World Economic Forum, 2015, Saidat et al., 2023, Talonen et al., 2021; Rawat et al., 2021; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Ma and Ren, 2023; BCG, 2013) Adopting to changes of insured risks, i.e., the capability to adjust insurance products/services to the changing nature of the insured risks e.g., usage-based products/services, gamification (Gupta and Tham, 2018; Stoeckli et al., 2018; Cortis et al., 2019; Zeier Röschmann et al., 2022; Ratnakaram et al., 2021)

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Primary activities		
		Predictive risk assessment e.g., credit scoring, frauds (Cevolini and Esposito, 2020; Sosa and Montes, 2022;Lisowski & Chojan, 2021; Volosovych et al., 2021; Rawat et al., 2021; Bank for International Settlements, 2018; Eling and Lehmann, 2018; Schulte and Lee, 2019; World Economic Forum, 2015; Saidat et al., 2023; Cappiello, 2018; Njegomir et al., 2021; Paul and Sadath, 2021; Stoeckli et al., 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Agarwal et al., 2022; Faure and Li, 2020; Al-witwit & Ibrahim, 2020)
		Co-created product or service cooperation ecosystem (Stoeckli et al., 2018; Standaert and Muylle, 2022; World Economic Forum, 2015; Volosovych et al., 2021; Zeier Röschmann et al., 2022; Al-witwit & Ibrahim, 2020; Puschmann, 2017; EIOPA, 2021)
Operations	Operations	Resource optimization e.g., reduce costs on servicing, matching, business transaction, and new revenues streams by adapting to client needs (Cevolini and Esposito, 2020; Ching et al., 2020; Kaigorodova et al., 2021; Paul and Sadath, 2021; Rawat et al., 2021; Xu and Zweifel, 2020; Cortis et al., 2019; Njegomir et al., 2021; Corea, 2019; Agarwal et al., 2022; Volosovych et al., 2021; Mai, 2018; Cappiello, 2018; Yu and Yen, 2020;Chen et al., 2023; Ma and Ren, 2023; Saeed and Arched, 2022; BCG, 2013; Ventiv Technology, 2023)
		Increased influx of clients (Kaigorodova et al., 2021), reduction of churn rates (Cortis et al., 2019; Gramegna and Giudici, 2020; BCG, 2013), and estimation of customer lifetime value (Standaert and Muylle, 2022)
		Enhanced risk assessment (e.g., real time; personalized risk ratings, risk classification) (Cevolini and Esposito, 2020; Ching et al., 2020; Kaigorodova et al., 2021; Paul and Sadath, 2021; Saidat et al., 2023; Xu and Zweifel, 2020; Rawat et al., 2021; Stoeckli et al., 2018; Choon Yan et al., 2017; Sosa and Montes, 2022; Agarwal et al., 2022; Mai, 2018; Marafie et al., 2018; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Ratnakaram et al., 2021; Millie, 2021; Braun et al., 2023; BCG, 2013)
		Understand customers behavior, needs and expectations for improving relationships (Cevolini and Esposito, 2020; Ching et al., 2020; Agarwal et al., 2022; Njegomir et al., 2021; Saidat et al., 2023; Xu and Zweifel, 2020; Rawat et al., 2021; Gupta and Tham, 2018; Cappiello, 2018)
		Adaptable, personalized, temporary, or transferable offer (Cevolini and Esposito, 2020; Ching et al., 2020; Lanfranchi and Grassi, 2022; Standaert and Muylle, 2022; Lisowski & Chojan, 2021; Njegomir et al., 2021; Cappiello, 2018; Saidat et al., 2023; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Zeier Röschmann et al., 2022; Bohnert et al., 2019;Puschmann, 2017)
Outbound logistics	Underwriting	Tracking usage and behavior of the customer/objects/environment on apps, websites, and satellites e.g., tailored products (Kaigorodova et al., 2021; Njegomir et al., 2021; Schulte and Lee, 2019; Cappiello, 2018; Eling and Lehmann, 2018; Baker, 2017; Rawat et al., 2021; Xu and Zweifel, 2020; Gupta and Tham, 2018; Cortis et al., 2019; Zeier Röschmann et al., 2022; Bharal and Shapiro, 2016)
		Automatization of business processes (e.g., processing of contracts, reporting) and decisions (e.g., automated underwriting, settlement, product offerings) also with smart contracts (e.g., programs that automatically execute the claim payment under pre-defined conditions stored in the blockchain) (Choon Yan et al., 2017; Agarwal et al., 2022; Sosa and Montes, 2022; Lisowski & Chojan, 2021; Ching et al., 2020; Kaigorodova et al., 2021; Njegomir et al., 2021; Volosovych et al., 2021; Faure and Li, 2020; Cappiello, 2018; Eling and Lehmann, 2018; Bharal and Shapiro, 2016, Saidat et al., 2023; Ching et al., 2020; Paul and Sadath, 2021; Rawat et al., 2021; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Corea, 2019; Volosovych et al., 2021; Zeier Röschmann et al., 2022; Pressman, 2003; Puschmann, 2017; Saeed and Arched, 2022)
Marketing and sales	Marketing	Acquisition from multiple sources of data for researching ideas, analyzing, and clustering of target groups (Cevolini and Esposito, 2020; Ching et al., 2020; Yu and Yen, 2020; Eling and Lehmann, 2018; World Economic Forum, 2015; Saidat et al., 2023; Stoeckli et al., 2018; Corea 2019; Cappiello, 2018; Ratnakaram et al., 2021)
		Track customers' behaviors to create a comprehensive picture of their identities and lifestyles e.g., customer profiling (Cevolini and Esposito, 2020; Kaigorodova et al., 2021; World Economic Forum, 2015; Rawat et al., 2021; Stoeckli et al., 2018; Choon Yan et al., 2017)
		(Real-time) targeted advertisement, loyalty programs, discounts, and calculation of customer lifetime (Rawat et al., 2021; Schulte and Lee, 2019;Chuen and Deng, 2018; Eling and Lehmann, 2018; World Economic Forum, 2015; Saidat et al., 2023; Stoeckli et al., 2018; Gramegna and Giudici, 2020)
		Standardized platforms and improved sensors enable to create app-based telematics offerings that customers can easily sign up for (World Economic Forum, 2015; Paul and Sadath, 2021; Xu and Zweifel, 2020)
	Sales	Data enrichment allows for automated sales via aggregator or chatbot relevant for the customer (Ching et al., 2020; Kaigorodova et al., 2021; Lanfranchi and Grassi, 2022; Njegomir et al., 2021; Cappiello, 2018; Eling and Lehmann, 2018; Corea 2019)
		Offering bundles of complementary products/services or cross-selling and up-selling (Lanfranchi and Grassi, 2022; Standaert and Muylle, 2022; Bharal and Shapiro, 2016; Zeier Röschmann et al., 2022; Cappiello, 2018; Ma and Ren, 2023; BCG, 2013) also for free e.g., wearables (Cortis et al., 2019)
		Compare and purchase products and prices via aggregator platforms also in peer to peer contributing to creating a data lake. (Ching et al., 2020; Eling and Lehmann, 2018; World Economic Forum, 2015; Xu and Zweifel, 2020; Kaigorodova et al., 2021; Stoeckli et al., 2018; Gupta and Tham, 2018; Standaert and Muylle, 2022; Choon Yan et al., 2017; Cappiello, 2018; Ma and Ren, 2023; PwC, 2022)
		On demand (Paul and Sadath, 2021; Xu and Zweifel, 2020; Standaert and Muylle, 2022; Corea, 2019; Cao et al., 2021; Ma and Ren, 2023; Braun et al., 2023)
Service	Customer service	Predicted/preventive information with warnings and advice to support safer behaviors toward accidents (Sosa and Montes, 2022; Njegomir et al., 2021; Volosovych et al., 2021; Bharal and Shapiro, 2016; World Economic Forum, 2015; Saidat et al., 2023; Talonen et al., 2021; Stoeckli et al., 2018; Cortis et al., 2019; Al-witwit & Ibrahim, 2020; Puschmann, 2017; Ma and Ren, 2023; BCG, 2013)
		More responsible/effective information to customers based on needs e.g., client interfaces, scoring (Agarwal et al., 2022; Kaigorodova et al., 2021; Ching et al., 2020; Eling and Lehmann, 2018; Marafie et al., 2018)
		Intelligent/rapid digital response e.g., chatbot, mobile (Kaigorodova et al., 2021; Volosovych et al., 2021; Ching et al., 2020; Bharal and Shapiro, 2016; Lanfranchi and Grassi, 2022; Paul and Sadath, 2021; Saidat et al., 2023; World Economic Forum, 2015; Xu and Zweifel, 2020; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Njegomir et al., 2021; Eling and Lehmann, 2018) and interactive experience e.g., automated recommendation, reconstruction of events, user friendly system, peer-to-peer insurance and network mutual aid (Ching et al., 2020; Kaigorodova et al., 2021; Talonen et al., 2021; Gupta and Tham, 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Tereszkiewicz and Południak-Gierz, 2021; Marafie et al., 2018; Mai, 2018; Ratnakaram et al., 2021; Bohnert et al., 2019; Li et al., 2023)
		Data protection for business continuity, avoid risks, regulatory sanctions, and retain policyholders trust (Choon Yan et al., 2017; Njegomir et al., 2021; Paul and Sadath, 2021; Zarifis and Cheng, 2022)
		Service provisioning at the point-of-demand (Stoeckli et al., 2018; Zeier Röschmann et al., 2022; Braun et al., 2023)
		Usage based products/services (Cevolini and Esposito, 2020; Xu and Zweifel, 2020; Braun et al., 2023)

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Primary activities		
		Digital self-service infrasturctures (e.g., web portal, mobile app, interfaces, white label, peer-to-peer networks, platform), adding new points of contacts (Choon Yan et al., 2017; Stoeckli et al., 2018; Cortis et al., 2019; Standaert and Muylle, 2022; Corea, 2019; Pressman, 2003) Social inclusion e.g., underserved customer segments (Paul and Sadath, 2021; Standaert and Muylle, 2022; Millie, 2021) or healthier behviors (Cortis et al., 2019; Njegomir et al., 2021; Corea, 2019; Saliba et al., 2022; Marafie et al., 2018; Eling and Lehmann, 2018)
Support activities		
Firm infrastructure	General management	Understanding company's acceptance patterns (Rawat et al., 2021; Millie, 2021) Modern information technologies enable decisions based on cost/benefit analysis and taking into account a lot of factors that influence the risks in order to improve financial performances (Njegomir et al., 2021; Cappiello, 2018) Strategic planning supported by data-KPIs e.g., claims cycle time, customer satisfaction, fraud detection, claims recovery and claim handling costs (Cevolini and Esposito, 2020; Eling and Lehmann, 2018; Kaigorodova et al., 2021; Rawat et al., 2021; Stoeckli et al., 2018; Njegomir et al., 2021; Corea 2019; Agarwal et al., 2022; Volosovych et al., 2021; Cappiello, 2018) Automated data management (e.g., risk assessment), reduction of transaction costs, reporting, and prevention of fraud, adverse selection, moral hazard (Volosovych et al., 2021; Cappiello, 2018; Ching et al., 2020; Eling and Lehmann, 2018; Njegomir et al., 2021; Kaigorodova et al., 2021; Stoeckli et al., 2018; Gupta and Tham, 2018; Cortis et al., 2019; Choon Yan et al., 2017; Zeier Röschmann et al., 2022; Mai, 2018; Cappiello, 2018; Ratnakaram et al., 2021; Zavolokina et al., 2016; Li et al., 2023) Monitor profit/loss ratio, and track activities (Cortis et al., 2019; Kaigorodova et al., 2021; Rawat et al., 2021; Bharal and Shapiro, 2016; Mai, 2018)
Human resource management	Digital competencies	Companies need a workforce and tools to analyze large, often unstructured datasets (e.g., customer feedback, pictures, videos), considering legal, social, and ethical questions. Use of cloud computing for handling activities. (Eling and Lehmann, 2018; Kaigorodova et al., 2021; Baker, 2017; Saidat et al., 2023; Sosa and Montes, 2022)
Technology development	IT	Implementing hardware and software solutions, and real-time troubleshooting, timely data-driven results (Sosa and Montes, 2022; Eling and Lehmann, 2018; Marafie et al., 2018; Pressman, 2003; EIOPA, 2021) Storage in cloud allows data to be available in real time or near-real time (Ching et al., 2020; Eling and Lehmann, 2018; Gupta and Tham, 2018) Increased IT security (Kaigorodova et al., 2021; Paul and Sadath, 2021; Xu and Zweifel, 2020), and secured storing of data in blockchain (Ching et al., 2020; Faure and Li, 2020; Gupta and Tham, 2018)
	Controlling	Control data capture, reporting, business KPI measurement: digitalized automated report, auto generation, real time planning, self-assessment, payment (Kaigorodova et al., 2021; Schulte and Lee, 2019; Eling and Lehmann, 2018; Gupta and Tham, 2018; Mai, 2018; PwC, 2022; BCG, 2013) (Automated) compliance to the regulations (Choon Yan et al., 2017; Baker, 2017; European Commission, 2020; Tereszkiewicz and Południak-Gierz, 2021; Wilkinson et al., 2016; Cappiello, 2018; Eling and Lehmann, 2018; Saeed and Arched, 2022; BCG, 2013)
Procurement	Legal department	Preventive due diligence, anonymization, ensure human control of hardware and software, meet regulatory requirements (Kaigorodova et al., 2021; Eling and Lehmann, 2018; European Commission, 2020; Tereszkiewicz and Południak-Gierz, 2021; Wilkinson et al., 2016; Standaert and Muylle, 2022; Corea, 2019; Cappiello, 2018) Ensures consistency, synchronization, invariability, transparency of the stored information and cybersecuirty (Kaigorodova et al., 2021; Njegomir et al., 2021; Zeier Röschmann et al., 2022; Cappiello, 2018; Eling and Lehmann, 2018; Pressman, 2003; Ma and Ren, 2023; PwC, 2022)
	Public relations	Monitor user flows, new communication channels e.g., video calling (Eling and Lehmann, 2018; Standaert and Muylle, 2022; Agarwal et al., 2022; Volosovych et al., 2021; Cappiello, 2018; Bohnert et al., 2019)

G. Systematic comparison of value chains emerged from insurtech documents

Value chain activities	Porter (1985)	Cappiello (2018); Njegomir et al. (2021)	World Economic Forum, 2015	Ching et al. (2020)	Yu and Yen (2020)	Eling & Lehmann (2018)
Primary activities	Inbound logistics	Product development	R&D/product manufacturing	Product development	Provide products and services to the clients	Product development
	Operations	N/A	N/A	N/A	N/A	N/A
	Outbound logistics	Underwriting	Underwriting	Underwriting	Underwrite risks	Underwriting
	Marketing and sales	Sales and distribution	Distribution	Marketing Sales	Setup data bases of potential clients Adhere services to the target clients Provide products and services to the clients	Marketing Sales
	Services	Claims	Claims Risk capital and investment management	Customer service Claim management Asset Management Risk Management	Convert insurance portfolio to financial market Risk improvement before or after losses Setting risk pools by retention or treaty Allocate risks to pools by law of large numbers	Contract admin & customer service Claim management Asset and risk management
Support activities	Firm infrastructure	N/A	N/A	N/A	N/A	General management
	Human resource management	N/A	N/A	N/A	N/A	Human resources
	Technology development	N/A	N/A	N/A	N/A	IT Controlling
	Procurement	N/A	N/A	N/A	N/A	Legal department Public relations

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