Dec 11th, 12:00 AM

Leveraging Cloud Computing and Software-as-a-Service to Build Sustainable and Resilient Supply Chains

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Completed Research Paper

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Abstract

Building sustainable and resilient supply chains has emerged as a strategic priority for organizations to improve their environmental, social, and governance performance while deal with unexpected disruptions, such as the COVID-19 pandemic. However, clear guidance for practitioners and analysis of the practices serving both purposes are missing. Leveraging cloud computing benefits, Software-as-a-Service (SaaS) products feature commercial and technical characteristics that help organizations resolve certain sustainable and resilient supply chain challenges by strengthening key capabilities, such as transparency, collaboration, and agility. We apply an affordance lens and a theory-generation case research design to define these challenges and identify how SaaS solutions can respond to them, using empirical qualitative data. We formulate SaaS affordances promoting the concepts of community, standard, update, data, applications, communication, and governance. We determine and illustrate the potential of SaaS solutions for sustainability and resilience for supply chain practitioners and software providers to help them unleash it.

Keywords: Cloud computing, Software-as-a-Service, Resilient Supply Chain, Sustainable Supply Chain

Introduction

In its latest State of the Cloud Report 2022, Flexera observes that a majority of companies increased their cloud usage during the COVID-19 pandemic (Flexera, 2022). Why did organizations accelerate their adoption of cloud computing during this crisis? This time period brought unprecedented challenges to companies globally, especially managing their supply chains (SC) in a resilient manner (van Remko, 2020). These challenges include supply disruptions due to closed plants, spikes in demand, material shortages, and bottlenecks in the transportation of goods, all of which result in an urge to improve communication and visibility among the stakeholders of global SCs (van Remko, 2020). Supply Chain Resilience (SCR) can be defined as follows: "*The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function.*" (Ponomarov & Holcomb, 2009, p. 131). In parallel with the SC crises induced by the COVID-19 pandemic, which emphasized the need for more resilience in SCs, the Sixth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC) urgently calls for more sustainability in general (IPCC, 2022). Hassini et al. (2012) define sustainable supply chain management (SSCM) as "*the management of SC operations, resources, information, and funds in order to maximize the SC profitability while at the same time minimizing the environmental impacts and maximizing the social well-being*" (Hassini et al., 2012, p. 70). While SC management needs to become both more resilient and more sustainable, there is no clear consensus on how to drive forward both areas together simultaneously (Negri et al., 2021). In a recent literature review, Negri et al. (2021) identify practices that serve both purposes, such as SC integration, information sharing and information systems flexibility. These practices rely on SC capabilities, such as transparency, cooperation, adaptability, that usually require digital tools to be achieved. These capabilities are key enablers to target SC viability in supply

networks, a concept originating from biology that goes beyond resilience: beyond the resistance to discrete disruptions to keep performing, a viable supply network has an open, dynamic ecosystem structure and continuously evolves to survive at the society level (Ivanov & Dolgui, 2020). Hofmann and Langner (2020) consider that SC viability is the result of the combination of SCR, implemented sustainability, and digital, fully automated solutions. We position our work at the heart of these three key concepts for SC: resilience, sustainability, and digitalization.

In large organizations today, this digital support takes the form of a combination of ERP systems that are integrated with a myriad of other software performing services. These services, usually provided by software vendors with a Software-as-a-Service (SaaS) service model, have been widely adopted by organizations in the last decade, since they respond to various challenges in information technology (IT) management: freeing up cash flow, prioritizing the organization's core competencies, using state-of-the-art IT services and technology, compensating for the shortage of skilled IT resources (Benlian et al., 2009). SaaS providers need to respond to the fast-growing demand of IT services, which requires to quickly provide computing resources without a large initial investment. This is what Cloud Computing (CC) technology affords. According to the US National Institute of Standards and Technology (NIST), "*Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.*" (Mell & Grance, 2011, p. 2). CC has proven beneficial to the integration of SC partners, SC processes, and activities, and can directly impact the SC flow of information, financial flow, and physical flow (Novais et al., 2019). While research on CC adoption drivers is relatively mature, the implications of CC on organizations and on their SC still require more empirical research. CC has already proven to positively impact collaboration between business partners, including along the SC, as well as economic and environmental performance (Schniederjans & Hales, 2016). Elaborating on these statements, we can derive that CC also plays a role in SCR and SSCM, a research field that is still in its infancy and needs more empirical research, specifically on the practices that enable both SCR and SSCM (Negri et al., 2021). Our starting hypothesis is that certain technical and business characteristics of CC and SaaS solutions respond to specific SC challenges because these characteristics enable some SCR and SSCM practices. In this study, we formulate the following research question:

How can cloud computing and SaaS characteristics be leveraged to respond to certain challenges in building sustainable and resilient supply chains (SRSC)?

Our research question aims at (1) supporting companies in defining their CC and SaaS strategies, (2) determining selection criteria for SC SaaS providers, and (3) providing SaaS providers with indications on promising roadmap directions. We use the lens of Affordance-Actualization theory (A-A) to analyse the relationships between the technological artifact (in this study cloud computing), its technical characteristics, and its context of use (Markus & Silver, 2008; Strong et al., 2014). To put CC into perspective with the challenges in building SRSC, we take an empirical, inductive approach, and perform semi-structured interviews with SC decision-makers at the case company Hilti AG. We then extend these real-world findings to global SCs in general and inductively build an affordance model. Using empirical data, we define and illustrate the most relevant affordances of SaaS for SRSC. We also show that, beyond the technical functionalities and commercial characteristics of SaaS products compared to on-premises systems, it is also the organizational changes triggered by their implementation that can help organizations' SCs become more sustainable and resilient. After reviewing the theoretical background on SRSC, CC, and SaaS, the methodology based on the A-A theory is detailed. The results are presented in the form of an affordance model. Each affordance is then described, discussed, and illustrated with empirical data.

Theoretical Background

Resilient and Sustainable Supply Chain Management (SRSC)

SCR and SSCM are both high on practitioners' strategic agendas, and both research fields have been largely studied in the last two decades. However, while both objectives need to be pursued by all organizations, clarity and consensus are needed to identify how to seek both objectives at the same time. Negri et al. (2021) show that while a sustainable SC aims to be more efficient, a resilient SC tries to be effective. Since efficiency

and effectiveness do not always call for the same practices, researchers need to better define the drivers, enablers, and barriers at this intersection between sustainability and resilience in SC management, so that organizations can select the best practices serving both purposes. Theory-building has been focusing on identifying precedence relationships between SSCM and SCR, often integrating either green SC to SCR or risk concepts to SSCM, but a holistic approach to SRSC is still missing. Within the SRSC research field, one research stream focuses on the practices that can improve both objectives, and on the enablers of these practices, where more empirical insights are required. These practices have been studied in a rather siloed approach and without always considering what enables them (Negri et al., 2021). We position this study within this research stream, demonstrating how CC, indirectly via the SaaS business model, enables certain practices that serve both resilience and sustainability in SC. Many practices have been identified to improve SC sustainability, affecting all SC activities, such as sustainable product design and circular product lifecycle management, sourcing and procurement with high environmental and social standards, waste, and carbon footprint reduction along the whole SC via logistics optimization, accurate planning and lean manufacturing processes, quality processes, obsolescence management, return, repair, and recycling processes, etc. Main barriers to the implementation of these sustainable practices include the cost of such initiatives, the lack of commitment and training of some stakeholders along the SC, the lack of cooperation and collaboration in intra- and inter-organizational relationships, the lack of technical solutions and processes, the popularity of legacy systems and processes, the potential loss of flexibility, the lack of an adequate regulatory environment, and the lack of performance measurement (Busse et al., 2016; Sajjad et al., 2015). In parallel to SSCM practices, to build resilient SCs, practices can be implemented (1) before the disruption, for instance with SC risk evaluation processes, SC design, better transparency and visibility, alert monitoring via improved SC collaboration, (2) during the disruption, for instance with agility and flexibility in the processes and system, responsiveness of SC stakeholders, contingency plans, safety stock and additional capacity, redundancy in the supply network, etc., and (3) after the disruption, for instance with knowledge management to learn from the past or the capability to quickly recover. Barriers to SCR include the lack of collaboration, visibility, and trust along the SC, financial weakness, the lack of IT integration, the lack of flexibility, long lead times and distances, the complex geopolitical and regulatory environment, and resources' scarcity (Ali & Gölgeci, 2019; Roberta Pereira et al., 2014).

Cloud Computing and SaaS in Supply Chain Management

During the last two decades, CC technology has emerged as a central keystone of our digital world, enabling a myriad of applications from the individual, private sphere to the business world. In the NIST definition of CC, five essential characteristics describe this technology: (1) on-demand self-service, (2) broad network access, (3) resource pooling, (4) rapid elasticity, and (5) measured service (Mell & Grance, 2011). By providing capital-intensive IT infrastructure and resources – such as data centres, network bandwidth, storage, and processing capacity – to their customers on demand, CC providers have introduced a servitization in the IT industry (Vendrell-Herrero et al., 2014): heavy investments in hardware resources are no longer a pre-requisite for digital service providers to start developing new services (Armbrust et al., 2009). Thanks to a multi-tenant model, computing resources owned by cloud providers are continuously reassigned automatically and dynamically between customers to meet their variable needs. CC relies on three service models: (1) SaaS, (2) Platform-as-a-Service (PaaS), (3) Infrastructure-as-a-Service (IaaS) (Mell & Grance, 2011). These service models help organizations leverage the benefits of CC in their business processes. As illustrated by Armbrust et al. (2009), CC providers sell utility computing services to their customers, which are Cloud users. Cloud users can also be SaaS providers: they purchase on-demand IT resources from CC providers to develop their software applications. SaaS providers sell these web applications to SaaS users, which can be any individual or organization, depending on the application (Armbrust et al., 2009). In this study, we focus on the SaaS service model in the context of SC management. According to Sun et al. (2007), "*Software as a Service (SaaS) is a software delivery model, which provides customers access to business functionality remotely (usually over the internet) as a service. The customer does not specially purchase a software license. The cost of the infrastructure, the right to use the software, and all hosting, maintenance and support services are all bundled into a single monthly or per-use charging*." (Sun et al., 2007).

Literature on CC and SaaS is rich and covers areas such as their technical and business characteristics, their adoption drivers, their barriers and risks, or their applications in various domains, including SC management (Y. Wu et al., 2013). CC has proven to improve certain SC capabilities, such as agility,

coordination, collaboration, knowledge and information sharing, resource servitization and virtualization, and to impact SC-relevant factors, such as cost reduction, IT value and performance increase, IT security, and inter-organizational trust (Cao et al., 2017; Jede & Teuteberg, 2015). These areas are all also key enablers for SRSC, but the available literature detailing how CC can improve both sustainability and resilience is rather limited. For instance, Ivanov et al. (2022) show that cloud-enabled technologies have a role to play in improving supply networks' adaptability, end-to-end visibility, and collaboration capabilities, which contribute to building resilient, viable, and sustainable supply networks. Most researchers would rather focus on either sustainability or resilience. Main benefits of CC for SSCM include: (1) low infrastructure running cost (Gunasekaran et al., 2015), (2) reduction of carbon footprint, energy consumption and physical material usage thanks to higher information availability and data processing tools (Gunasekaran et al., 2015), (3) communication, collaboration and coordination to efficiently design sustainable products and share sustainable data (Chetthamrongchai & Jermsittiparsert, 2019; Feng et al., 2022), (4) user-friendly and up-to-date applications and tools to perform sustainable SC activities (Gunasekaran et al., 2015), (5) supplier integration and supplier sustainability benchmarking thanks to cloud-based platforms and tools (Chetthamrongchai & Jermsittiparsert, 2019; Feng et al., 2022). CC is also seen as a helpful technology to improve SCR, especially in highly dynamic supply networks (Herrera & Janczewski, 2016). Storing business data and process documentation in a secure cloud environment can help organizations ensure business continuity in case of disruption (Manuel Maqueira et al., 2019). CC can also significantly support collaboration and integration within the SC, which are key drivers of SCR, to be able to monitor risks and alerts along the SC (Herrera & Janczewski, 2016; Manuel Maqueira et al., 2019).

Methodology

Research design

To identify the affordances of CC and SaaS products to build SRSC, we use the adapted affordance theory, which is a variant of the theory of affordance-actualization (Du et al., 2019; Strong et al., 2014). The "affordance" concept is increasingly used in information systems research to evaluate the value and potential of new technologies and IT artifacts in a specific context of use, basing the analysis on the features and material properties of the IT artifact. In our study, the IT artifact is mainly the CC technology, which affords SaaS products to offer certain commercial and technical properties to their end-customers. These end-customers are organizations that integrate these SaaS products into their SC management system and process landscape. The identification of affordances requires two steps: (1) define the properties of CC and their consequences on the properties and capabilities of SaaS products, (2) define the context of use and its challenges, namely SC management in a resilient and sustainable way.

To perform these two steps, the existing literature provides theoretical insights on the properties and capabilities of CC and SaaS products; yet existing theoretical background on their potential for actions in the context of SC management, in particular for SRSC, is limited. To get a deep understanding of the challenges faced by SC decision-makers to improve resilience and sustainability in their processes and organizations, we use empirical and qualitative data collected in a single case company, Hilti, a multinational company headquartered in Liechtenstein that develops, manufactures, and markets products and services for the architecture, engineering, and construction industries. Since the scope of this study encompasses all SC areas of the Supply-Chain Operations Reference Model (SCOR) (Stewart, 1997), Hilti is of high interest. With its direct customer sales model and internal product engineering and manufacturing, Hilti's SC integrates the characteristics of both manufacturer and distributor business models. By using existing general theories on CC and SaaS products and a large amount of situationally grounded empirical data on the context of use, we adopt a theory generation case research design (Ketokivi & Choi, 2014).

In Table 1, we summarize the research activities performed in this study, which are in line with the theory generation case research design and the affordance theory presented above. A first phase relies on existing literature to identify the properties and capabilities of CC and SaaS products and to establish the links between these two IT artifacts. A second phase uses situationally grounded empirical qualitative data to identify the challenges to building SRSC. The last phase defines affordances by mapping the properties of CC and SaaS products with the SRSC challenges they can help resolve.

Main objective	*Activity*	*Output*
Identify what CC can afford via the intermediary of SaaS providers (literature-based)	Review the literature on CC affordances for organizations and for SC.	Identify the characteristics and capabilities of CC.
	Review the literature on SaaS affordances for organizations and for SC.	Identify the characteristics and capabilities of SaaS.
	Map the affordances of CC with SaaS capabilities.	Matrix linking CC properties with SaaS capabilities.
Identify the challenges and required capabilities to build SRSC (empirics-based)	Perform semi-structured interviews with SC decision-makers from each part of the SC.	Qualitative empirical data on SCR and SSC enablers, drivers, and barriers.
	Coding and analysing interviews in several iterations: deductive coding, inductive coding, and codes' filtering and grouping.	List of enablers, drivers, barriers, and capabilities for each part of the SC for resilience and sustainability, challenges to building SRSC.
Identify affordances	Map required SRSC capabilities with CC and SaaS affordances using A-A theory and empirical data.	Affordance model

Table 1: Overview of the research activities

Identification of the Properties of Cloud Computing and SaaS Products

To use the affordance theory to evaluate the value of an IT artifact, the first step is to determine which are the material properties of this IT artifact. For CC, the technical properties have been clearly defined by the NIST (Mell & Grance, 2011). However, if we restrict the scope of this study to the affordances of CC for SRSC directly, we ignore all the "indirect" benefits of CC for SC management provided to organizations by SaaS providers. SaaS is a specific service model of CC, providing easily accessible applications to customers without the need for this customer or even for the SaaS provider to manage the computing infrastructure. CC provides utility computing to SaaS providers, which provide applications to the end-customers, namely, in this study, organizations using various SaaS products to manage certain processes within their SC. Therefore, to have a full picture of the potential benefits of CC for SC management, it is necessary to identify the properties and capabilities of SaaS products, that CC properties afford for some of them.

To determine the properties of SaaS products, we performed a limited literature review. We started the literature search by identifying a seminal article on CC and SaaS (Armbrust et al., 2009) and performed iterations of backward and forward citation searches, while coding deductively all SaaS characteristics mentioned in these articles. We stopped the literature search process when it reached saturation: articles found in the next search iteration were not mentioning new characteristics. In total, 13 articles have been selected and coded deductively to identify either commercial characteristics of the SaaS service model, or technical characteristics of the SaaS products. This resulted in a list of SaaS properties and a list of CC properties. Using the existing literature, we mapped the CC properties with the SaaS properties they enable to create a matrix clarifying the links between CC and SaaS.

Identification of Challenges to Build Resilient and Sustainable Supply Chains

The second step of this research design specifies the context of use and potential areas of application, based on empirical data. To collect situationally grounded qualitative data, we conducted 22 semi-structured interviews, which allows the researcher to ask follow-up questions, with a theory-in-use approach (TIU) (Zeithaml et al., 2020): participants were invited to elaborate on the links between the ideas they were providing, on their own theories. To select the interviewees, we chose four to five SC decision-makers per area of the SCOR model, to cover a maximum of process areas and SC activities, and used snowball sampling to identify the right contact persons within Hilti (Myers & Newman, 2007). As displayed in Table 2, we ensured diversity in terms of processes, responsibility level, years of experience, involvement in the corporate sustainability community, and gender. We followed interview principles as described by Yin et al. (2014). We structured the interview guideline around five main parts, following the research directions listed by Negri et al. (2021), while ensuring to get a deep understanding of the processes, challenges, and potential biases of the interviewees:

(1) Please explain your process area, professional background, and touchpoints to sustainability.
(2) What are the enablers, barriers, drivers, and examples of SC resilience in your process area?
(3) What are the enablers, barriers, drivers, and examples of SC sustainability in your process area?
(4) What is the impact of SC resilience on SC sustainability in your area, and vice versa?
(5) What are the largest challenges today in your process area?

Nr	*SCOR Area*	*Processes / Decisions areas*	*Experience in years*	*In corporate sustainability community?*	*Gender*	*Interview Duration*	*Interview Date*
1	Plan	Material Management	10-20	No	M	67 min	04.05.2022
2	Deliver	Logistics, Transportation, Replenishment	> 20	Yes	M	67 min	06.04.2022
3	Make	Digital Manufacturing	10-20	No	M	58 min	06.04.2022
4	Source	Sustainable sourcing, Product design	10-20	Yes	M	59 min	07.04.2022
5	Plan	Global forecasting	> 20	No	M	67 min	07.04.2022
6	Source	Supplier management	3-10	Yes	M	60 min	12.04.2022
7	Enable	CO2 assessment	10-20	Yes	M	63 min	20.04.2022
8	Make	Supplier management, Packaging	10-20	Yes	M	58 min	20.04.2022
9	Plan	Detailed Scheduling	10-20	No	F	58 min	21.04.2022
10	Make	Lean manufacturing, Facilities Sustainability	> 20	Yes	M	60 min	26.04.2022
11	Deliver	Transport & Logistics, Region Logistics	> 20	No	M	58 min	27.04.2022
12	Plan	S&OP	> 20	No	M	43 min	28.04.2022
13	Source	Supplier management	> 20	No	M	59 min	29.04.2022
14	Enable	Digital SC	> 20	No	M	58 min	02.05.2022
15	Return	Circularity	10-20	Yes	F	27 min	03.05.2022
16	Deliver	Prefabrication Business	10-20	No	M	56 min	03.05.2022
17	Enable	Supplier risk, Product Compliance	3-10	No	F	57 min	05.05.2022
18	Source	Direct Procurement, SC Contracts	10-20	Yes	M	57 min	12.05.2022
19	Make	Digital Manufacturing	3-10	No	M	55 min	19.05.2022
20	Enable	Corporate Sustainability	> 20	Yes	M	49 min	22.06.2022
21	Return	Spare parts management	> 20	No	F	52 min	15.07.2022
22	Make	Supplier management, Packaging	> 20	No	M	58 min	20.04.2022

Table 2: Profiles of the interviewees

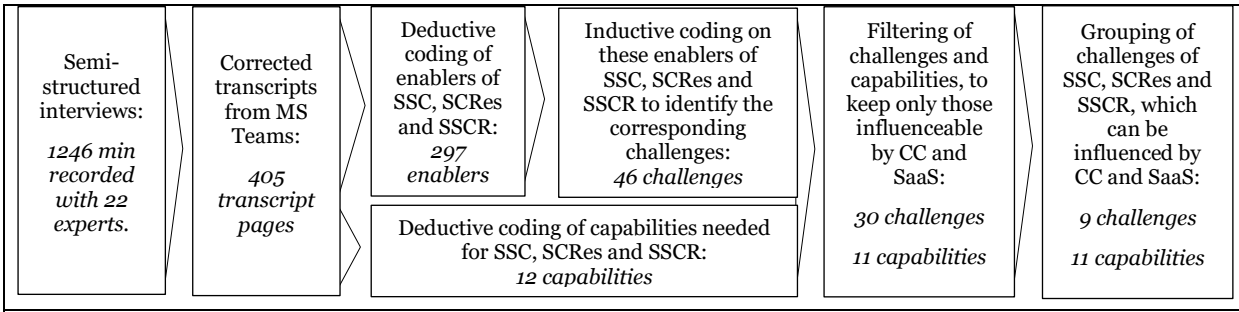

Figure 1: Coding and analysis procedure

Interviews were conducted in English, recorded, and transcribed using Microsoft Teams to ensure integrity. Transcripts have been corrected using intelligent verbatim transcription to improve understandability. The qualitative data has then been first coded deductively to identify all enablers and capabilities mentioned during the interviews, for either SC resilience or SC sustainability, or both. In a second iteration, these enablers have been coded inductively to determine the SRSC challenge they correspond to. After filtering the coded challenges and capabilities that SaaS products can influence based on participants' own constructs, in line with the TIU approach, the challenges have been grouped based on similarity to generalize them across the SC areas. Figure 1 depicts these coding and analysis steps, all performed by a

researcher with theoretical and practical experience on SaaS products for SC management, to ensure consistency across the coding.

Identify Affordances of Cloud Computing and SaaS Products for Sustainable and Resilient Supply Chains

Finally, based on the interviews and practical examples provided in those interviews along with the relevant literature, a matrix analysis has been performed to map the CC and SaaS product properties to the SRSC challenges. By associating the potential for action of the SaaS products with the challenges identified in the context of use, we defined the relevant affordances of CC and SaaS products for SRSC. Based on this matrix analysis, an affordance model has been built.

Results

Properties of Cloud Computing and SaaS Products

	Properties	*Description of the properties*	*Example of authors*
SaaS business model	Pay-per-use	Affordable price, pay-per-use license subscription model	Armbrust et al. (2009), Jede and Teuteberg (2015)
	No IT infrastructure	Rapid, simple software installation, low hardware and software resource requirements	Armbrust et al. (2009) , Sultan (2011)
	Trialability	Possibility of trying the service before purchasing it	Alshamaila et al. (2013)
	Support	Customer support and software tool training	Ercolani (2013)
	Upgrades	Regular, cost-efficient functional, technical, and security upgrades	Ercolani (2013)
	Innovation	Possibility to start small without high commitment on resources, and to incorporate the latest technologies	Armbrust et al. (2009)
	Community	Cross-industry customers' community to share best practices and influence the SaaS roadmap	Jede and Teuteberg (2015)
SaaS technical product	Availability	Internet-based worldwide, device-independent	Armbrust et al. (2009), Palos-Sanchez et al. (2017)
	Ease of use	Easy to use, to configure, and to maintain	Benlian et al. (2009), Palos-Sanchez et al. (2017)
	Scalability	Scalable architecture, data volume, and processing capacity	Benlian et al. (2009), Palos-Sanchez et al. (2017)
	Reusability	Software elements are reusable in other software services.	Buyya et al. (2009)
	Limited customizability	Limited customer-specific customization possibilities, incentive to transform business processes to fit with industry standards	Palos-Sanchez et al. (2017), Büyüközkan and Göçer (2018), Loukis et al. (2019)
	Compatibility	Easy integration of the SaaS product with other systems	Safari et al. (2015), W.-W. Wu (2011)
	Sharing and Collaboration	Embedded features to facilitate cross-team and cross-organization collaboration, transparency, and data exchanges	Safari et al. (2015), Lin and Chen (2012), Jede and Teuteberg (2015)
	Data Management	Data management ensuring data privacy, security, and performance according to Service Level Agreements	Safari et al. (2015), Jede and Teuteberg (2015), Büyüközkan and Göçer (2018)
	Powerful processing	Run memory- and storage-intensive programs (ML, AI, Analytics, batch processing)	Armbrust et al. (2009), Jede and Teuteberg (2015)

Table 3: Properties of SaaS products based on literature.

The NIST defines the properties of CC as follows: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service (Mell & Grance, 2011). As a result of the limited literature review performed to identify the properties of SaaS products, we identified characteristics related to the SaaS service model, and technical product characteristics, which are listed and described in Table 3.

Affordances of Cloud Computing and SaaS Products for SRSC

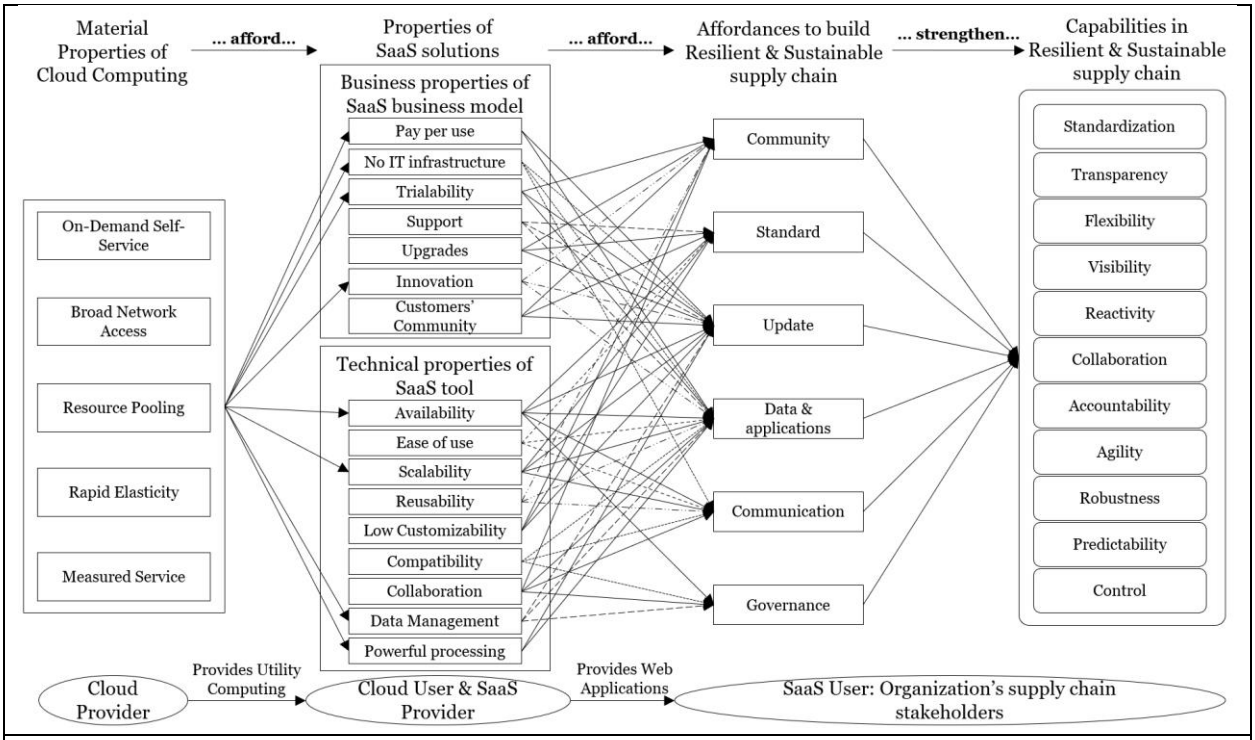

Figure 2: Affordance model

In this section, we define each affordance, describe the challenges it can solve, and describe what CC and SaaS properties afford to do to respond to these challenges to build SRSC, based on examples collected from empirical data from the case company in various SC areas. These affordances all refer to one or several capabilities to strengthen the pursuit of SC resilience and sustainability. Based on the deductive coding of the interviews, these organizational capabilities include accountability, agility, collaboration, control, flexibility, predictability, reactivity, robustness, standardization, transparency, and visibility. These general capabilities applicable to all SC activities and found in the empirical qualitative data are in line with the capabilities usually associated with SRSC in the state-of-the art literature. Figure 2 provides an overview of the relationships between the material properties of CC, the business and technical properties of SaaS solutions based on the literature review (Table 3). These properties are then linked to the affordances that they enable for SRSC, based on interviews' data. The SRSC capabilities strengthened by these affordances are added on the right to link the affordances to the overall discussion on capabilities required for SRSC. The following paragraphs detail each affordance, the SaaS properties that enable them, and the SRSC capabilities they reinforce. In this study, for the sake of generalisation, these affordances are not ranked, because ranking them by relevance would vary depending on the application, on the supply chain activity, or on the industry.

Community: Share best practices and learn from the industry and community.

The affordance "Share best practices and learn from the industry and community" can help organizations benefit from the experience of many other industry players to improve their own SC systems and processes, in particular sustainability and resilience, where the maturity levels of the organizations can differ significantly. Different SaaS mechanisms enable this affordance: firstly, SaaS vendors regularly organize customer exchange forums, webinars, and experience exchanges, where customers are invited to network with each other and share best practices using the SaaS solutions. This type of event nurtures the development of business relationships between SC stakeholders from various industries, which is an asset for resilience in a world of intertwined supply networks. Secondly, SaaS vendors' product management relies on customers to share their best practices, requests, and feedback on future functionalities during regular experience exchanges and via specific online portals. By collecting requirements from many

customers, selecting the most relevant, impactful requests, developing them, and releasing them for the whole community of customers, SaaS vendors help them benefit from the best practices across industries and latest technological innovations. By releasing new features to all customers, it also enables customers to try certain processes and functionalities offered by the system. Finally, when it comes to digitalizing processes across an entire supply network, SaaS solutions can play the role of common platforms between big and small industry players, and help the smaller players benefit from the market power and effort of the bigger player.

For instance, to collect sustainability and risk data from suppliers, Hilti used a standard SaaS solution where suppliers could submit their certificates, sustainability information, or contingency plans. Since automotive suppliers already went through this process with their customers, they could recycle their answers and avoid duplicating effort: *«Suppliers that are very close to automotive are much more aware that such topics are relevant. We benefit from what the OEMs in automotive already asked them, because they are a bit more advanced than us probably on that way. »* (Interview 16, min 14). With the continuously developing and upgraded software systems, SaaS vendors are also seen as the industry players that can impose clear standard to define and calculate sustainability standards which are still largely missing, for instance to calculate products' CO2 footprints: *«In essence, what we would need in the future is a data transfer from the supplier to us with their real carbon footprint. And please: standardized, electronic, and automated, because otherwise we have too many products and too many suppliers, nobody can look at PDFs, etc. I need to have a standardized boundary; otherwise, I can never compare the kilogram of steel with the kilogram of steel of somebody else. That's a struggling point. It's in development. But I think we miss a standard voice. There are industry players that have the market power to do that. It should be the same for everyone. There are a lot of startups trying to provide such a service. There is a lot of CO2 consulting companies that try to put up their own platforms where you can exchange data. In the end, there will be one winner who takes it all. The one who grows fastest, biggest, whatever, is going to be the standard»* (Interview 7, min 23).

Standard: Enforce clearly defined, streamlined, and standardized processes and key indicators.

The affordance "Enforce clearly defined, streamlined, and standardized processes and key indicators" addresses several SRSC challenges. The digitalization or automation of certain SC activities, which nowadays mostly happens using cloud-based SaaS products, can support SRSC. A SaaS vendor offers its customers a standard software system with limited customizability, where the processes proposed in the tool as best practices are built to fit a maximum of potential customers across industries. When a customer implements such a tool, change management is often required to streamline the existing processes and adapt them to the best practices built into the tool. This is an opportunity for the organization to simplify and standardize its own custom processes, which often have grown in complexity over time due to legacy technical limitations and individual workarounds. By enforcing processes in a standard SaaS tool, a SC can gain control, transparency, and visibility. SaaS tools' ease of use usually relies on lean, intuitive user interfaces that help the users, here SC stakeholders, execute their processes without initiating complex process variations. This helps to stabilize the SC, improve its predictability, and integrate best practices from the industry.

The implementation of a SaaS solution for supply chain collaboration (SCC) illustrates this affordance for SRSC. On one side, SCC improves the stability, robustness, simplification, standardization, and control of the operational procurement process, which contributes to resilience by reducing delays and lost orders, which can result in business disruptions. *«SCC is for me about resilience. On the one hand, we are taking processing time out of the chain, and on the other, we are taking process noise out of the system. Process noise is a signal that could just be statistical noise that is tempting people to take decisions, even though it is not a decision signal. »* (Interview 18, min 34). *«In order to implement SCC, we need decent master data, and SCC has been instrumental in cleaning up quite a few very strange processes, because SCC says "This is the standard here, we stick to that". Standards are an important factor in fostering resilience. Because recent master data has reduced complexity significantly, I can trust the system, and then I don't need to come up with those strange workarounds.»* (Interview 18, min 46).

On the other side, by improving the communication of purchase orders and collaboration with suppliers regarding delivery schedules, this SaaS SCC solution contributes to significantly reducing expedited

shipments by airfreight, at a high environmental and financial cost. *«Before SCC, there was no PO [purchase order] confirmation. The materials managers were waiting, and they were expecting an ASN [shipment notification], but none was coming, so they would call the supplier and say, "We expected your ASN last week " and the supplier would answer, "I have not received any order". So what happens then? Delay is not acceptable. Delivery basically happens, with an expedited cost. We send it by plane.»* (Interview 18, min 43).

Update: Integrate the latest compliance rules, regulations, technology, and standards.

The affordance "Integrate the latest compliance rules, regulations, technology, and standards" is highly value-adding for SC stakeholders in such a volatile, dynamic world. Organizations constantly need to modernize and upgrade their systems and processes to improve efficiency, safety, health and safety, cybersecurity, identity management, data protection, etc. In the area of cybersecurity, attacks use the latest technological innovations: they become increasingly more sophisticated, which requires embedded IT security systems to be regularly upgraded to prevent attacks. SaaS vendors offer regular product releases to implement the latest security patches and keep pace with the upgrades of the cloud providers themselves, so that the SaaS solutions' versions still fit with the cloud database versions. Since cyberattacks are a major source of unexpected, costly business disruptions, SaaS solutions and their regular upgrades enable SCR. To make sure their customers follow the release schedule of the SaaS solutions they use, SaaS vendors can include a contractual condition for the solution support, so that only the latest SaaS software version releases are supported: *«It's not only that we bring new functionality, but all the safety patches are included in these upgrade procedures. This is how to keep our systems on the supported version and not lose the support of a major software supplier. »* (Interview 14, min 24).

Another crucial pillar and prerequisite to both resilience and sustainability in SC is compliance with sustainability, accounting, financial, tax, foreign trade regulations, and certain quality certificate requirements. These regulations evolve rapidly and affect numerous SC processes embedded in information systems. Non-compliance can result in business disruptions, lost customers, lost certificates, lost market authorizations, and additional efforts to regularize the situation with state institutions. To avoid non-compliance, SaaS SC solutions regularly adapt their product roadmaps and release changes in some technical features to help customers upgrade their own processes to the latest regulatory standards. For instance, most SaaS solutions in the SRM area recently released improved functionalities to monitor direct suppliers according to the criteria requested by Germany's new Supply Chain Due Diligence Act (LkSG). It prevents customers from making their own code adjustments to keep complying with the law, so that the SaaS product remains standard with as few customizations as possible. These regular product releases are also used to deploy new, innovative features, based, for instance, on machine learning (ML) or artificial intelligence (AI). This empowers the customers to discover certain technologies in a simple, easy manner without requiring high implementation effort on their side. Since SaaS solutions are based on CC, new functionalities requiring powerful data processing or a scalable database, such as ML or AI, can also be explored by customers, using the pay-per-use pricing model. Functionalities requiring optimization or simulation with a large amount of data, for instance to optimize or simulate the supply network, the transportation routes, the shipments and truck loads, or the detailed planning schedule of the machines, can significantly benefit from the CC flexibility, availability, and scalability made available via the SaaS solutions.

Data and Applications: Support human decisions by making use of reliable data with user-friendly, easily configurable applications.

The affordance "Support human decisions by making use of reliable data with user-friendly, easily configurable applications" enables SC stakeholders to best leverage their own data and external data to make informed decisions, thanks to user-friendly, easy-to-deploy SaaS services. This affordance is two-sided: it needs reliable, available data from internal sources such as ERP systems and other SaaS services in use in the organization, as well as externally sourced data, from data marketplaces, social media, etc. Reliability, governance, and visibility are key factors: to be usable and interpreted correctly for decision-making, data needs to be cleansed and synchronized across compatible systems, using regular review processes and automatic synchronization via system interfaces to transfer data changes to all affected systems. Data reliability and governance help to simplify processes and decisions by removing uncertainty

due to inconsistent data: it helps to take better and quicker decisions during disruptions. *«I can rely on the system. I don't need workarounds. That, by itself, reduces process complexity significantly. We are not dependent on the one person that knows exactly that, though the value is 15, you shall read it as 10. Because there is just one single truth, you look at it, and everyone understands. That is what master data governance should be about.»* (Interview 18, min 49). Large amounts of data referring to complex situations need to be considered and ingested to make better, more sustainable SC decisions. Therefore, data visibility is of paramount importance: all decision-relevant data should be easily accessible at the same place with user-friendly dashboards. SaaS solutions often use integration layers in their architecture to collect and integrate relevant data from various sources, using APIs to connect to other systems. For instance, to make more resilient and sustainable supplier selection decisions, supply managers can use sources such as external social media or financial monitoring to assess supplier risk, certification organizations to evaluate suppliers' quality and sustainability commitments and internal ERP to consult their purchasing histories (Interview 6, min 38).

Reliable, visible data is not sufficient if processes are not leveraging this data for better decision making. User-friendly applications developed by SaaS vendors are responding to this challenge by helping users make sense of the data and analyze it using CC powerful processing capabilities. *«If we have good processes and good data, I think we can avoid a lot of effort. We can avoid a lot of planned shipments that might not take the best route. If you can go with a low steam vessel, it's not only less expensive, but it's much better for our environment. Here, I think that if we can provide very good forecasting systems, Sales and Operations Planning (S&OP), replenishment systems, and solutions for S&OP alignment, it's not only in the systems, but the processes that we implement, which are helping sustainability but also resilience.»* (Interview 14, min 35). For example, to take decisions on capacity level and demand during the S&OP process, SaaS solutions can support the users in simulating the results of a variety of possible scenarios and in comparing their consequences in terms of inventory level, cost, product availability, CO_2 footprint, etc. By taking decisions based on the best scenarios, planning results become more accurate and predictable, which helps to proactively reorder components, avoid expedites and air freight, reduce shortages and overproduction, and better control the required warehouse space and capital. SaaS solutions, which can regularly enrich their products with state-of-the-art data analytics functionalities and release them to their customers, provide users with the capability to make the most of their data even in complex supply network setups, using scenario simulation, optimization, ML, AI, etc. These technologies can be easily tried temporarily or used at scale by SC stakeholders, since no additional IT infrastructure installation is required, and CC usage can be rapidly available and scalable on demand. Real-time tracking of the containers in transit is an example of how a SaaS solution can leverage various data sources to provide visibility to the users over a complex setup, to anticipate delays and disruptions in product availability, often at the source of unsustainable decisions: *«I click, and I have all the information: where it is going, the number of the containers, and even what product it is. I know precisely where the containers are. Before, we didn't know what was on the ocean. It also has a planned arrival date, and in our system, if it deviates from this plan because it's late or in advance, it will automatically give a notification and update the arrival time in the ERP. Thanks to that, we knew exactly which containers were on their way to the Suez Canal. We could take the decision to reroute them, depending on where they were, on the product category…. This tool gives us so much more possibility to react and transparency»* (Interview 11, min 40).

Communication: Provide a collaboration and communication platform supporting process execution.

The affordance "Provide a collaboration and communication platform supporting process execution" supports organizations in creating transparency in the intra- and inter-organization collaboration required between all SC stakeholders. Supplier Relationship Management (SRM) SaaS solutions give their customers the opportunity to interact and share data with their suppliers or with other internal teams in a secure and easy way. This data exchange can include quality certificates, requests for quotations, sustainability data, contingency plans, product specifications, demand previews, purchase orders, contracts in place, etc. Role concepts, identity management, secure authentication methods, and data encryption on the cloud improve

cybersecurity, data protection and confidentiality. Since SaaS solutions do not require their customers to have any specific IT infrastructure and are easily scalable and globally available thanks to CC, it is easy and rapid to onboard many suppliers on the network proposed by the SaaS vendor, which offers a common platform for them to communicate with all their customers using this solution. Most SaaS tools for SC are also compatible with other SaaS tools via standard application programming interfaces (APIs) or with ERPs, which help all SC stakeholders integrate and reuse their data across their systems and ensure data consistency and transparency. By documenting the collaboration processes, using clearly defined roles and responsibilities, and safely storing all types of supplier relationship-related data in one place in the cloud environment, the SaaS solution ensures that all authorized users have access to the information they need in a continuous, sustainable manner. Even if the responsible user changes positions or is absent, communication channels, data, and decision documentation are not lost in a locked email inbox. This prevents duplicate work and improves efficiency, collaboration, reactivity, and control over the SC data and processes.

For instance, compliance with European Union (EU) regulation is a crucial topic to build SRSC. Non-compliance can result in disruptions, such as the permanent removal of the products from the market, and in low sustainability performance, which is repellent to an organization's business partners, customers, internal stakeholders, etc. To be compliant with the REACH regulation (Registration, Evaluation, Authorization, and Restriction of Chemicals) and to fill in the SCIP database, Hilti needed to collect declarations on the chemicals and substances of concern that more than 1000 suppliers are using in the products they sell to Hilti. To perform such a task, a SRM SaaS solution significantly helped: *«In two months' time, we got an 85% response rate, and for us, it was basically two days of work sending out all the questionnaires, because modular questionnaires are automatic. The same activity was done manually in parallel two years ago by the department of approval: there were three people who were doing this full time, reaching out to 600 suppliers, and half of them were not replying. When you send the Excel sheet, they send back whatever they want. The quality of the data was really bad. With [the SaaS solution], it was easy because the suppliers replied exactly to what you asked. It's very easy to enable efficient data collection and storage.»* (Interview 17, min 27)

Governance: Manage knowledge, track and document decisions, performance, roles and responsibilities.

The affordance "Manage knowledge, track and document decisions, performance, roles and responsibilities" provides the necessary governance over the system, the data, the decision process, and the key indicators for performance and sustainability. For SC stakeholders to rapidly take the right decision during an unexpected disruption, sustainable knowledge management is a key pillar and must be ensured by leveraging the expertise and experience of team members, and by facilitating the onboarding of new team members and stakeholders onto any SC process. When discussing the factors that helped Hilti be resilient during the COVID-19 crisis and its consequences on global lead times, one interviewee noted the following success factors: *«First of all, the correct people in the right positions, and for sure, their experience and knowledge. And second, our system environment, which allows this kind of change quite quickly.» (*Interview 1, min 26). It is crucial for all SC stakeholders to know their roles and responsibilities, to have access to past decisions and their rationale, to easily find any required process documentation, and to act accordingly. If process or system knowledge or knowledge acquired during the last disruptions is not documented, the risk is high that it gets lost with time, or whenever the team members who built up this knowledge change positions. Therefore, effective governance over all decisions related to processes, systems, and SC in general should be implemented to improve transparency, control, accountability, agility, and ultimately SC resilience. This governance should also have tracking systems in place to monitor key indicators related to the documented processes and decisions. SaaS solutions support the implementation of this governance by providing in-system communication capabilities, seamless data integration from other compatible systems, user logs, reporting, and dashboarding functionalities. These functionalities empower the SaaS tool users to have full transparency and visibility on the key indicators for environmental, social, and economic performance. For instance, the CO_2 footprint generated by the selection of a given supplier or by the decision to increase inventory or lead times can be easily calculated using various data sources and displayed at the decision point in a process workflow.

At Hilti, this affordance starts to be actualized when evaluating requests for quotations (RFQ) sent to suppliers via the SRM SaaS solution. By considering both the suppliers' answers collected via a SaaS

network and the suppliers' sustainability score from other SaaS solutions such as IntegrityNext or Ecovadis, each supplier is given bonus or minus points, which are given a monetized value and added to the supplier quotes. This way, the decision to select a supplier who is potentially more expensive but shows a higher sustainability performance can be transparently documented in the system (Interview 6, min 27). In the SC planning area, which is not yet only relying on SaaS solutions, this affordance is seen as a requirement to improve product lifecycle management and avoid overproduction of phasing-out products: *«I would like to embed communication within the planning system; for instance, somebody who is producing a forecast or adjusting a forecast would be required to put the underlying business assumption, and then we could come back after a few months and check whether this assumption was valid. Or when we want somebody to shut down that product because it does not deserve forecast, I would love to put a note in the system, that would pop out on the screen of the planners so that they would then feel more responsible for acting on it, because if they don't act on it, then we can just check if they are compliant with the phasing-out process. »* (Interview 5, min 54).

Discussion and Implications

Discussion and limitations

SRSC objectives are turning some SC challenges into capabilities to develop urgently, such as transparency, agility, etc. The empirical, qualitative data collected for this study at Hilti confirms and illustrates these challenges, that exist across all SC areas, from supplier management to planning and distribution. To reach supply network viability, organizations are now pressured to respond to SRSC challenges, which include a high level of complexity in supply networks, processes, and legal requirements; the urgency to improve their environmental and social performance; the volatility of global demand and product availability; and increased global risks in terms of climate crises, legal changes, geopolitical tensions, economic instability, and cybersecurity. To face all these challenges, organizations can rely on some of their key assets: data and people. Data requires organizations to develop specific capabilities so that people can fully leverage it. This is what SaaS products can offer through their architecture and service model based on CC. Data conversion into available information and knowledge are key to handling the complexity of supply networks and their associated risks, as stated by van Remko (2020): *«Key levers for de-risking the supply chain include the need to balance global sourcing with nearshore and local sourcing, the adoption of multiple sources and a greater utilization of information technology to drive more complete and immediate information availability»* (van Remko, 2020). Yet available information is not sufficient: for SC stakeholders to take the best decisions in terms of sustainability and resilience, processes must be adapted accordingly, to integrate data usage and embrace the dynamism of the changes happening and of the disruptions affecting supply networks. SaaS solutions can support organizations in this change management process by acting on several aspects. Thanks to CC providers, SaaS solutions can provide on-demand extensible data processing capabilities that exceed what on-premises servers and self-developed applications can provide with high development and maintenance costs to stay up-to-date and secure. Thanks to multi-tenancy and customers' communities of SaaS solutions, SaaS providers can leverage their pooled knowledge on legal requirements, technological innovations, and industries' best practices to improve sustainability and resilience, in order to develop relevant features and embed standard processes into the software solutions they offer. We can also note the behavioural aspect of SaaS solutions, usually available online in a browser, following the codes of social media in terms of user experience, messaging functionalities, notifications, etc., to make solutions more user-friendly and nudge users.

If SaaS solutions can be seen as SRSC enablers, some limiting aspects need to be mentioned. The standards proposed by SaaS vendors may be too rigid to fit certain organizations' specific business models or established processes. This can be detrimental to the overall SRSC objectives. At the other extreme, if standard practices proposed by the SaaS solutions can be very broadly customized, it could induce customers to replicate non-optimized processes in the system. This can cancel the benefits of sticking with standards, prevent easily rolled-out automatic upgrades, and require more internal skills to maintain and govern a complex system. Another major aspect to consider is the dependency of organizations on SaaS providers. For cybersecurity and data protection, responsibility partly lies in the hands of the SaaS vendor and its subcontractors. Whenever an issue happens, despite service level agreements (SLAs), organizations depend on the support process of SaaS vendors to solve it, which usually takes more time than internal bug-fixing on self-developed programs. This affects SC reactivity. Dependency on SaaS and CC providers also

affects data hosting: certain countries only legally accept domestic data hosting, which is technically difficult to respect with on-premises systems. With SaaS solutions, organizations hand over this complexity to their cloud providers, but they are still responsible for ensuring their compliance with data hosting regulations, to avoid risking any SC disruption due to a breach of the law.

Limits of this study include potential biases in the collection and analysis of the empirical data, despite the rigor and structure used to perform these activities. Interview participants are naturally biased toward their area of expertise, which can lead to distorted results once they are generalized. Generalization of the findings can be a limit in this study, which relies on the data of a single case company to identify SRSC challenges, but its large scope, covering both resilience and sustainability across all SC areas, and the different coding steps, helped zoom out to extract key concepts and ideas.

Practical and theoretical implications

This study aims at demonstrating to SC practitioners that the implementation of SaaS products based on CC is a key technological and organizational enabler to develop capabilities that are critical to reaching SRSC objectives. To fully leverage the SaaS benefits, though, a simple implementation of some SaaS products as add-ins for specific, limited use cases is not sufficient. Beyond the technical advantages and functionalities offered by the specific SaaS products, implementing SaaS solutions should be the opportunity for organizations to question and review their SC processes and system landscape, to engage with other companies, to review the governance of their processes and data, to improve their flexibility, agility, and integration of innovations, while focusing on their strategy and value-adding activities. These changes impact end-users at all decision levels across SC areas, which requires a robust change management approach. A SaaS IT strategy can trigger organizational changes, especially for the internal IT department, which moves from a focus on development and IT infrastructure management competencies to a higher focus on SaaS vendor management with a deeper knowledge of business applications, system landscape, cybersecurity, data protection and data governance (Loukis et al., 2019). The journey towards more SaaS solutions also includes accounting and infrastructure changes: organizations' IT capabilities shift from a model based on own development, physical servers, data centres, and other computing infrastructure owned as depreciable assets, to a servitization model with yearly license' subscriptions (operational expenses), which has an impact on finance and accounting at the organization level. We highlight the role of SaaS vendors in supporting their customers to network across different industries and this way to spread best practices while building the foundation for cross-industry SC collaboration, which is a challenge to build viable SC networks, for instance to reconfigure SCs during crises and survive disruptions. This study also addresses SaaS product managers in SC and provides them with indicators on the key SaaS characteristics to improve sustainability and resilience. This can help them shape their product roadmaps to better support their existing and potential customers in their SRSC journey. With regards to CC technical characteristics, this study can support CC providers in prioritizing their technical product roadmaps according to what SaaS providers need for their customers to build SRSC.

From a theoretical perspective, this study explores and explains a phenomenon – the role played by SaaS solutions in SRSC – with an empirical approach and an application of the affordance theory. It contributes to the research on SaaS and CC applications in organizations and to the more recent academic discourse on SRSC, in particular on how to enable practices advancing SRSC. Beyond the technical considerations, to build SRSC, all identified affordances require a high level of strategic, tactical, and operational collaboration between CC providers, SaaS solution vendors, their customers, and their customers' suppliers. Theoretically, it implies that cross-organization collaboration should hold a central position when conceptually integrating SSCM and SCR, as a driver and enabler of other key SRSC capabilities. Inside the organization, we demonstrated that process and data management are a cornerstone of all identified affordances to leverage SaaS solutions. Therefore, we justify the usage of business process management (BPM) theories such as business process reengineering (BPR) or capability maturity model integration (CMMI) to adapt and improve SC and data management processes while implementing SaaS solutions.

Conclusion

It is difficult for practitioners to take sustainable and resilient decisions, due to the complexity and dynamism of today's supply networks. Taking the right SRSC decisions requires processing huge amounts of data and collaborating with many internal and external SC stakeholders. The geopolitical situation, the

legal landscape, the business context, and the available technology evolve rapidly, with constant new requirements and disruptions, and an increasing urge to take action to tackle the climate crisis. With on-premises software solutions, systems and processes cannot be updated fast enough to fit these constantly changing requirements. Additionally, utility computing activities now require such a high level of investment to match the required level of security and performance that it has become strategic to outsource them: it enables to concentrate internal resources and expenses on the sources of competitive advantage, such as renovating SC processes and systems to make them more sustainable and resilient. We established that SaaS products, thanks to their cloud-based service model and system architecture, enable SCs to respond to some of their most critical challenges and build up resilience and sustainability. The limited customizability and multi-tenancy of SaaS products help organizations enforce clearly defined, streamlined, and standardized SC processes. The compatibility and user-friendliness of SaaS products provide collaboration and communication platforms for SC stakeholders to execute processes more efficiently. The decisions' documentation and user concept applied in most SaaS solutions support organizations to enforce governance over their processes and knowledge management, thereby improving accountability and transparency. The SaaS providers' customer community helps SC stakeholders across industries network, share best SRSC practices, and influence SaaS product roadmaps to best fit rapidly evolving SC requirements. Regular SaaS product feature releases afford organizations a seamless integration of innovations and regulatory changes into dynamic SC processes. User-friendly SaaS solutions, backed by powerful, scalable, flexible CC, support SC stakeholders in taking better, more resilient, more sustainable decisions, by providing them with all the data they need in a visible way, alongside with analytical capabilities and decision-support functionalities. SaaS is changing the way organizations and SC stakeholders are working by going towards more data-driven decisions and a servitization of IT tools, by removing IT infrastructure to stay cybersecure and up-to-date, and by enhancing the user experience so that users focus on value-adding tasks for SC. SaaS solutions help SC stakeholders react quickly in case of disruption, and provide them with the knowledge, tools, and relevant data to take better, more sustainable decisions. To fully leverage the SaaS benefits, SCs need to embrace the organizational changes and the opportunity to improve governance and processes during SaaS solutions' implementation. Future research includes the actualization of these affordances, following the A-A theory. To do so, collecting data from SaaS providers would provide a complementary perspective to this study. Analysing the specific risks of SaaS and CC for SRSC would complete the picture on the barriers to SaaS in SRSC. To help organizations develop their overall IT strategy, evaluating the validity and generalizing these SaaS affordances for resilience and sustainability at the organization level could also be of interest, in areas such as finance or marketing.

Acknowledgements

We would like to thank the interview participants for their valuable contribution.

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