IMT
SCHOOL
FOR ADVANCED
STUDIES
LUCCA

#12
2022

IMT LUCCA CSA TECHNICAL REPORT SERIES 12
2022

Value creation mechanisms of cloud computing: a conceptual framework

Leonardo Mazzoni

Gabriele Costa

IMT LUCCA CSA TECHNICAL REPORT SERIES 12/2022

Value creation mechanisms of cloud computing: a conceptual framework

Leonardo Mazzoni
University of Padua and IMT School for Advanced Studies

Gabriele Costa
IMT School for Advanced Studies

Value creation mechanisms of cloud computing: a conceptual framework

Leonardo Mazzoni, University of Padua – Department of Economics and Management & Guest Scholar IMT School for Advanced Studies, leonardo.mazzoni@imtlucca.it **ORCID**: 0000-0002-0231-9248

Gabriele Costa, SySMA – IMT School for Advanced Studies, gabriele.costa@imtlucca.it **ORCID**: 0000-0002-9385-3998

ABSTRACT

The management literature has analysed Cloud Computing, mainly focusing on the impact of its technical properties (e.g. accessibility, elasticity, scaling) on firms' dynamics, without explicitly addressing the dynamic generation of value streams. With this paper we fill this gap, linking the unexplored potential sources of Cloud Computing with the literature on business model value creation. We define a conceptual model able to integrate existent technical knowledge on Cloud Computing with the understudied part on the value creation mechanisms, dynamically representing their interaction. Our approach is based on a mixed methodology built on three pillars:

1) systematic literature review of the properties of Cloud Computing with an impact on firms' management in order to identify possible gaps, using value generation within business models as the unit of analysis;

2) multiple case studies to inductively derive the emerging properties using Gioia methodology, analysing 20 startups in the AWS business case repository;

3) dynamic representation between technical properties extracted by literature review and emergent properties, focusing on the value streams generation.

Results confirm how the leveraging potentiality of Cloud Computing goes well beyond technical advantages, deeply inserting in the business model system and enabling different sources of value creation.

Keywords: Cloud computing; business model; value creation; startups; innovation management;

1. Introduction

In the last decade, Cloud Computing (hereinafter CC) has emerged as a new enabling technology with disruptive effects in many societal spheres. CC is a new model of computing resources that are remotely available "on-demand" and accessible simultaneously to many users with rapid times of release (Mell and Grance, 2011). Video conference services, streaming platforms, content sharing and storage systems are common examples where CC has noteworthily impacted our everyday lives (Benlian et al., 2018). Furthermore, CC also drastically affected the business world as in the case of matching platforms, data analytics platforms, IoT solutions, which allowed "*the rise of born-on-the-cloud innovators (e.g. Uber and Airbnb)"* (Amit and Han, 2017:228). In many cases, CC was the technological stepping stone to design and launch new services. Although CC cannot directly execute these processes or realise these products, it works as an "information highway" thanks to its velocity and pervasiveness, enabling a set of complementary tasks (e.g. sharing, creating, participating, researching), progressively more important in the paradigm of Servitisation (Weinman, 2012).

CC is not a new topic in management and economics. Many papers have analysed the technical and economic transformative value of CC (see Brynjolfsson et al., 2010; Kushida et al., 2011; Gawer and Cowen, 2012; Weinman, 2012; OECD, 2014; Etro, 2015), acknowledging the effects of its technical characteristics in the wider context of innovation and business model development (Tilson et al., 2010; Venters et al 2012; Nambisan, 2017).

This fact has been also observed by Kushida et al. (2015:10) who remark that:

"Cloud computing is also becoming a production platform, with not only raw storage and processing power, but platform-level tools to provide building blocks for creating systems. As we enter an era in which IT services are best considered part of production—with systems built, then delivering services through IT network—cloud services are increasingly providing the resources and tools upon which others build their service systems"

Despite this growing awareness, the prevalence of studies related to CC focus on the IT infrastructural aspects, without discussing the enabled digital innovation strategies and the mutual (often complementary) relationship between IT infrastructure and the emergence of a non-linear environment (Chen and Wang, 2022). This lack can be also motivated by the difficulty of sharply separating business processes from the IT means on which they are built (Pagani, 2013). Technical analysis of CC related to management have prevalently focused on the impact of technical properties of the cloud (e.g. accessibility, elasticity, scaling) on costs and resources (the *WHATs*), without investigating how CC shapes the dynamic generation of existing and new value streams (*HOWs* and *WHYs*). As recently argued, this lack of analyses related to new value-generation channels enabled by CC can be motivated by the absence of a holistic view of its systemic effects within the business model of organisations (Da Silva et al., 2013; Stieninger and Nedbal, 2014; Kathuria et al., 2018; Nittala et al., 2022). In this regard, Benlian et al. (2018:1) underline how the "*transformative and value-creating capacity of cloud computing"* represents the organisational and strategic backbone of existing firms and digital-born startups, calling for more analyses in this direction.

In line with the literature that investigates the value creation capacity of IT (Rai and Tung, 2014; Benlian et al., 2018; Nambisan et al., 2020; Jovanovic et al., 2021), the main goal of this paper is to fill the gap between technical analyses and the unexplored value-creation potential sources of CC, observing CC as a generative technology able to create new innovative ecosystems and emerging business models.

To this aim, we define a novel conceptual model that integrates existing technical knowledge on CC and the value creation mechanisms. Moreover, our model represents their dynamic interactions, combining business model literature with the analysis of the main technical features of CC. The conceptual model is organised around the following three pillars.

- A preliminary theoretical analysis, composed of a systematic review of the CC properties with an impact on the management literature. This part of the analysis is conducted with the aim of identifying gaps, using value generation within business models as unit of analysis
- Multiple case studies to derive with an inductive approach the unexplored properties related to value generation mechanisms.
- A dynamic representation of the interaction between technical properties and business model, focusing on the value streams generation.

Summing up, the main contributions presented in this paper are the following.

1) A novel methodology for discovering the value creation mechanisms induced by CC technologies (Section 2).
2) A systematic literature review for integrating the state-of-the-art business-related properties in our methodology (Section 3).
3) The identification, by means of 20 CC-centric startup case studies, of three main value creation mechanisms, namely *Modular layering, Interface*, and *Governance,* driven by CC (Section 4.1).
4) The definition of a *MIG* model of the three novel value creation mechanisms and their dynamic configuration (Section 4.2).

The paper is structured as follows. Section 2 shows in detail the methodological approach and the data collection process. Section 3 presents the theoretical background behind the building of the conceptual model (first pillar). Section 4 presents the empirical findings obtained from the analysis of case studies (second pillar) and a dynamic conceptual framework, discussing resources, processes and business models (third pillar). Finally, Section 5 discusses the results with respect to the literature on the topic, summarising the findings and raising some focal points for the practitioners' audience.

2. Methodology

To build our framework, we follow an approach based on *theory adaptation* (Jaakkola, 2020). Theory adaptation, problematising existing knowledge, highlights its current limitations and incompleteness, revising the phenomenon under a new lens (Alvesson and Sandberg, 2011; Jaakkola, 2020). This perspective, once gaps and limitations are identified, allows exploring well-known phenomena to generate new insights not only about the "*WHATs*", but also about the *"HOWs*" and "*WHYs*" relationships between technological innovation and business model (Kiel et al., 2017; Nittala et al., 2022). Our methodological flow is articulated, in two subsequent phases, as described in the remaining part of this section.

First, to understand the current state of the art and possible limitations, we structure our theoretical background with a review of CC from the management perspective.
Our starting point was the essential CC characteristics mentioned by the American National Institute of Standards and Technology (NIST) (Mell and Grance, 2011), chosen for its international reliability (Stieninger and Nedbal, 2014). After, we check for possible updates (NIST essential characteristics have been released more than a decade ago), operating a systematic literature review focused on the identification of CC properties. To conduct the literature review, we select the Web of Science database to gain some insights into the legitimation process of CC in the global academic debate. After some screening phases, we obtain the final sample on which we operate the analysis. Once a complete overview of the CC properties discussed in the literature has been grasped, we focus our review on the business model and the notion of value with the aim to stress how the current conceptualisation of CC properties is poorly entrenched with the value creation mechanisms. The phase described above is detailed in Section 3.
In the second phase, embracing the limitations of the current state of the art, we also use exploratory multiple case studies, to deep dive into the value creation mechanisms generated by CC within firms' business models with less dependence on contingent factors (Kiel et al., 2017). To support the theoretical building process, we adopt, for this part of the analysis, a grounded theory approach (Glaser and Strauss, 1967) based on the inductive potentiality of cases to unpack new concepts and ideas directly from the research context. This approach, well fitted with the principles of *theory adaptation* (Jaakkola, 2020) allows attributing new interpretations to well-known phenomena (Eisenhardt, 1989).
To select our case studies, we choose the CC provider Amazon Web Services (AWS). The main reason is that it has a rich database of case studies and allows for filtering by typology of organisations and used technologies. In particular, we applied two filters. First, we selected only startups, for their prevalent focus on a single business domain and for their orientation toward digital technologies. In this way we aim at avoiding analysis of CC applications embedded in complex business strategies, in which a single product/service cannot be easily isolated from other components of the global strategy. Second, we restricted to case studies related to specific AWS services which correspond to *primitive* technologies, i.e., being the atomic, building blocks of CC architectures. For instance, we considered storage service as a primitive technology. Alternatively, machine learning, which requires its own CC infrastructure, was not considered primitive.

In line with Kiel et al. (2017), to ensure the internal validity of the research, we select organisations having heterogeneous core businesses, industrial sectors and CC usage. Instead, the choice of AWS is due to ensure the external validity for its market leadership as a CC provider. Considering the grounded approach of the second phase, we select an adequate data analysis method, i.e., the Gioia Methodology (Gioia et al., 2012). The Gioia Methodology allows researchers to organise large unstructured amounts of data with a rigorous codification of ideas and concepts into more aggregate dimensions, establishing an inductive dialogue with emerging theories. The Gioia Methodology is articulated in three subsequent phases: a) identification of first-order categories (usually composed of several ideas and concepts without a predetermined order); b) comparison and purposeful integration of first-order categories in second-order categories with the help of emerging theories, and; c) conceptualisation of second-order categories into few relevant aggregated conceptual clusters[1].

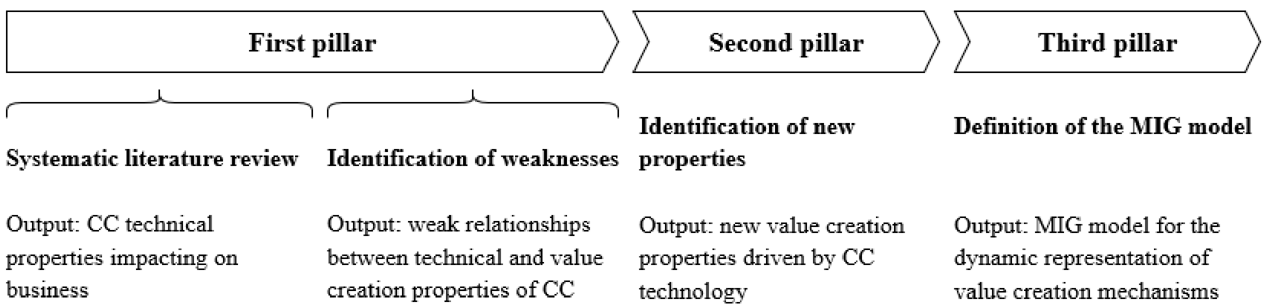
In our case, we analyse the information reported by AWS about each startup and the startup website to triangulate the data, as done in Spanò et al. (2022), extracting relevant concepts related to value creation mechanisms into CC enabled business models (our first-order categories).

Despite the usual application of this method to "*knowledgeable agents*" (Gioia et al., 2012), namely privileged informants within organisations that can reveal tacit knowledge mechanisms, we decide to adopt web sources (AWS and startup websites) to collect evidence for the theory development. Websites for their extensive use by companies to communicate their strategic activities have become interesting information repositories (Gök et al., 2015), with the advantage to provide open-access fresh information with an unobtrusive gathering procedure, guaranteeing at the same time transparency about the employed data sources.

Finally, we represent the impact of CC properties on value creation mechanisms of well-known business models, aggregating the traditional ones with those we extract from the multiple case study analysis.

Figure 1 summarises the whole methodological process.

Figure 1. Process for the definition of the conceptual model.



Source: authors' elaboration

3. Theoretical background

This section is devoted to describing the first pillar of Figure 1. In particular, Section 3.1 presents our systematic review of the literature, while Section 3.2 identifies the weaknesses of the existing properties by critically revising CC technologies, business models and the concept of value.

3.1. Literature Review on Cloud Computing

[1] For a similar approach applied to entrepreneurship, see Mazzoni et al. (2021).

The idea of remotely providing computing services, simultaneously accessible and shareable by at least two people, originates in 1955 thanks to the intuition of McCarthy, an American computer scientist (Garfinkel, 2011). This idea was then developed by Licklider, a psychologist active also in computer science who pioneered the project ARPANET (Advanced Research Projects Agency Network), a multi-platform network accessible from everywhere (Lukasik, 2010), in 1969.

However, the current representation of CC as a commercial service dedicated to enterprises occurred many years later, starting in the late nineties thanks to Salesforce and continued in the first decades of the twenty-first century with the launch of several service platforms such as Amazon Web Services (AWS).

According to the widely accepted definition from the NIST, CC can be defined as:

"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" (Mell and Grance, 2011:2).

Weinman (2012) uses the acronym "C.L.O.U.D." to describe the fundamental characteristics of CC: *Common* infrastructure, *Location* independence between providers and users (it is not important from where in both cases), *Online* accessibility meant as broad network diffusion, *Utility* pricing in the sense of cloud as a utility service of the twenty-first century and *Demand* resources that are configurable according to the needs of users in a pay-per-use logic.

The basic idea behind CC is to allow the large virtual sharing of a set of physical and digital resources to multiple users and so with a multitenant architectural model, where every client can simultaneously access a common pool of resources working with separated instances (Vaquero et al., 2009; Williams, 2012; OECD, 2014).

The resources of the CC paradigm are articulated across three service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) (Bayrak et al., 2011; Mell and Grance, 2011; OECD, 2014). IaaS is the model in which the provider manages only the "hardware parts" and the clients' access to a set of computational resources (eg. CPU), with the possibility to fully control operating systems, software development and networking components (popular examples are AWS EC2, Microsoft Azure and Google Compute Engine). PaaS allows users to deploy applications and services, without controlling networks or the operating systems, but using specific application programming interfaces (APIs) (popular examples are Heroku and AWS Lambda). SaaS is the simpler CC model and it allows consumers to easily access applications via thin interfaces from various devices (well-known examples are email services and Customer Relationship Manager tools, such as SalesForce, Gmail and Dropbox).

Beyond these three service models above mentioned, NIST describes four deployment models, which represent the possible management frameworks (Mell and Grance, 2011). P*rivate cloud*, operating for a single organisation, managed autonomously or by a third party and working on or off-premise. *Community Cloud,* operating for a pool of organisations that share a set of common policies, managed autonomously or by a third party and working on or off-premise. *Public Cloud,* managed by an organisation active in the selling of cloud services and available for open use by businesses, government, academic institutions or other types of organisations. *Hybrid Cloud,* a composition of two or more of the previous three possibilities, which despite their separation, allowing the communication between them (for example this solution is thought to manage peaks in service usage with the support of public solutions, keeping at the same time the sensitive information within the private cloud).

To integrate this shared knowledge on CC, we conduct a systematic review, starting from the essential characteristics mentioned by the NIST, chosen as a reference for its international credibility (Stieninger and Nedbal, 2014). The properties identified by the NIST are the following (Mell and Grance, 2011, p.2).

- *"On-demand self-service. A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider".*
- *"Broad network access. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations)".*
- *"Resource pooling. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, and network bandwidth".*
- *"Rapid elasticity. Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time".*
- *"Measured service. Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service".*

After, we check for possible updates (NIST essential characteristics have been released more than a decade ago), operating a systematic literature review focused on the identification of managerial and economic properties of CC. Within the database Web of Science, we search the keywords "cloud computing" in the research categories belonging to management and economics, considering only the English language, obtaining 1348 papers. We refine the search, excluding proceedings and searching for the keywords "literature review*" or "review*" in the title and abstract, reducing the sample to 22 papers. Then we manually scrape these 22 papers, searching for papers that explicitly focus on a review of the characteristics and properties of CC (excluding specific applications) from the management and economics point of view, obtaining a final sample of 8 papers[2] (see the list reported in Table 1.A in the appendix).

[2] We exclude Jede, A. and Teuteberg, F. (2016), "Towards cloud-based supply chain processes: Designing a reference model and elements of a research agenda", The International Journal of Logistics Management, Vol. 27 No. 2, pp. 438-462 for the similarity of theoretical themes faced by the same two authors in Jede and Teuteberg (2015).

We review each of them, finding different terminologies and definitions. Some of them are coherent with the five essential characteristics of CC described by the NIST guidelines (Mell and Grace, 2011). Thanks to the wide usage and discussion about CC that occurred in the last decade, other new characteristics emerged (see Table 1 for a complete summary). These four new categories are:

- *Maintenance*: The IT maintenance of firms can be devoted only to update on the software, while the management and maintenance of hardware are on behalf of providers, reinforcing the flexibility given by the *On-demand self-service* (Hussein and Sulaiman, 2013; Raut et al., 2019).
- *Resilience*: the capacity of the system to react to a shock and to recover a previous, safe state (Hussein and Sulaiman, 2013; Kumar et al., 2017; Raut, 2019). The digital resilience of firms has increased thanks to the possibility to save and restore their information system, ensuring a better business continuity (Hussein and Sulaiman, 2013).
- *Security*: the wide adoption of security standards by cloud providers (Christauskas, and Miseviciene, 2012; Maresova et al., 2017; Jede and Teuteberg, 2015) and the data protection policy relieve firms from several security risks and the derived costs.
- *Reliability*: The increasing availability of cloud-based services and the easy level of usability for adopters has notably increased the reputation among firms (Kumar et al., 2017; Raut, 2019).

Table 1 summarises the findings.

Table 1. Topics and themes related to the impact of CC in management and economics

Topics	Theme	NIST 2011
- Possibility to tests the cloud capabilities with demos without interacting with a human seller (Christauskas, and Miseviciene, 2012; Giannakis et al., 2019)	On demand self service	YES
- Global accessibility (Christauskas, and Miseviciene, 2012) even with multiple standards (Giannakis et al., 2019) - On time delivery (Raut et al., 2019) - Coordination and knowledge sharing of resources internal and external to the firm (Jede and Teuteberg, 2015; Raut et al., 2019)	Broad network access	YES
- No exact knowledge on the location of data (only country and city are knowable parameters) and some implications can arise with data privacy (Maresova et al., 2017)	Resource pooling	YES
- Dynamic resources scalability adapted to evolving business needs (Christauskas, and Miseviciene, 2012; Raut, 2019) - Easiness to add new resources/configuration through horizontal scaling (additional machines) and vertical scaling (e.g. faster CPU or more memory). (Christauskas, and Miseviciene, 2012) - Flexibility to supply chain variations (Jede and Teuteberg, 2015; Giannakis et al., 2019)	Elasticity	YES
- Possibility to reduce costs (Christauskas, and Miseviciene, 2012; Hussein and Sulaiman, 2013) in terms of servers, back-ups and licenses (Jede and Teuteberg, 2015) - New (additional) costs for training staff (Jede and Teuteberg, 2015) and set up operations (Kumar et al., 2017)	Measured service	YES

- Automatic optimisaiton of resources (Giannakis et al., 2019)		
- Management and maintenance of hardware parts are on behalf of providers (Hussein and Sulaiman, 2013; Raut et al.,, 2019)	Maintenance	NO
- Disaster recovery (Hussein and Sulaiman, 2013; Kumar et al., 2017; Raut, 2019) - Business continuity (Hussein and Sulaiman, 2013)	Resilience	NO
- High security standards (Christauskas, and Miseviciene, 2012; Maresova et al., 2017; Jede and Teuteberg, 2015) - Data protection and privacy (Raut et al., 2019)	Security	NO
- The increasing availability of cloud-based service and global providers has increased its trustworthiness/reputation among firms (Kumar et al., 2017; Raut, 2019) - Easiness of use (Raut et al., 2019)	Reliability	NO

Source: authors' elaboration on Wos database

3.2 Cloud Computing, business models and the concept of value

As we can notice from the properties described in Section 3.1, CC has radically changed many aspects related to business, enlarging the possibility of taking dynamic decisions on how to manage digital infrastructure. Some scholars have underlined the economies of scale argument brought by CC, which in turn is a mechanism to reduce fixed costs and lower investment requirements, transforming capital expenditures into operative costs (Williams, 2012; Etro, 2015)[3].

The description of CC and its characteristics reported since now outline a driver of productivity that generates positive externalities on a wide set of individuals and industries, enabling collective creativity and needs, showing peculiar characteristics of a General-Purpose Technology (GPT), such as pervasiveness, continuous improvement and innovation generator (Bresnahan and Trajtenberg, 1995; Etro, 2015). CC as a "GPT" has been compared to public utilities such as electricity for its capacity to catalyse complementary artifacts and services (Brynjolfsson et al., 2010). Notwithstanding the intuitive similarities (such as ubiquity and pay-per-use model) electricity and CC are at completely different maturity stages. The former represents a stable public good able to provide the same resource to all businesses and families (essential to conduct many human activities but at the same time part of the cost structure), while the latter has been defined as a utility that can be dynamically configured for its capacity to enable innovative business models or new competitive advantages thanks to various attributes, functionalities and technological frameworks (Brynjolfsson et al., 2010; Kushida et al., 2011; Weinman, 2012).

As already highlighted in the introduction, the literature that has linked CC with management and economics has mainly focused on its technical advantages, while the value creation mechanisms occurring within business

[3] Weinman (2012) purposefully clarifies that the scaling process in CC cannot be considered in the unit of production, given the complexity of parameters set by users in the choice of service and the twofold possibility of scaling out (more quantity) and scaling up (more quality). The argument of economies of scale is thus to be framed within a broader framework brought by cloud adoption (e.g. computing equipment as servers, cooling systems, power costs such as electricity, cyber-attack resilience, saving on IT competencies and skills are criteria that influence the total cost estimation) (Weinman, 2012; Williams, 2012; Gupta et al., 2013).

models have been underestimated. Concurrently, the notion of business model has gained popularity as a concept able to represent and describe the mechanisms that are behind the revenues of a firm and to identify the relevant actors and relationships that contribute to the product/service architecture (Timmers, 1998).
Amit & Zott (2001:511) define the business model as a meta-structure able to depict "*the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities*". Chesbrough and Rosenbloom (2002: 529) define the business model as "*the heuristic logic that connects technical potential with the realization of economic value".* In a similar vein, Teece (2010) explains the business model concept as a construct able to explain the logical connection among revenues, value proposition and costs sustained by a firm to sell products/services.
Despite its relevance, this notion has been criticised over time for its vagueness and for the lack of empirical analysis able to measure the phenomenon (Hedman and Kalling, 2003). In this regard, Zott et al. (2011) have stressed how the fuzziness around the business model notion and the absence of agreement on a certain definition has hindered the process of knowledge accumulation, favouring the emergence of separated streams.
On the other side, this awareness about the limit of business model concept has pushed scholars to rethink key elements to catalyse the analysis of the phenomenon (Zott et al., 2011), especially considering the digital transformation process fostered by the techno-economic scenario of XXI century (Mazzoni et al., 2021).
Zott et al. (2011) underline how the business model is a unit of analysis distinct from the product, industry or network with conceptual boundaries that trespass and include these other factors. This in turn implies a systemic-level approach to analyse not only the components of a business but also the value generation mechanisms, bridging the gap among clients' needs and product/service characteristics and functionalities (Zott and Amit, 2010; Zott et al., 2011).
In order to adopt a systemic perspective and to explain the multiple sources of competitive advantages, Amit and Zott (2001) support the necessity to integrate views and theories from different approaches such as transaction costs, Schumpeterian Innovation, Resource-Based View of the firm and network theory, especially dealing with disruptive technologies that reshape market actors, relationships and outcomes. This system view perspective has been purposefully adopted by Amit and Han (2017) to explain how digital resources reconfigure the value creation path and mechanisms generated by focal firms. These value creation mechanisms involve a plethora of co-creators and are expressed in various forms. Amit and Han (2017) identify three main leitmotivs that came from digital resources reconfiguration: a) uncovering unmet needs or discovering new unknown unknowns needs (e.g crowdsourcing), b) connecting upstream resources with downstream customers, enabling or facilitating transactions (predictive matching by the means of algorithm or sorting matching by efficient categorisation), c) bridging needs with resources, creating value with complementary links (e.g. new combinations of resources and needs).
These conceptualisations of value, strictly linked with a holistic perspective on firm activities, have been largely underestimated by previous research on CC (Benlian et al., 2018, Kathuria et al., 2018). The transformative value capacity of CC goes beyond its technical features, allowing the "*realized or unrealized potential that widespread diffusion of this technology leads to fundamental and large-scale innovations that benefit individuals, organizations, markets, and societies*" (Benlian et al:1)

CC has actively entered in almost every dimension of business, such as planning, information management, delivery, support (installation/maintenance), affecting the entire innovation journey from ideation to execution, contributing to attach new meaning to products and services, reconceptualising completely cooperative and collaborative behaviours (Weinman, 2012; Kushida et al., 2015; Nambisan, 2018). CC has the potentiality to create, by means of sophisticated technical means, new use of data, new systems of delivery and exchange and digital twin of products, among the more evident effect, with a sensible effect on digital strategies and ways of consumption of goods and services (Iansiti and Lakhani, 2014; Porter and Heppelmann, 2015; Mitra et al., 2018; Kathuria et al., 2018). In these models the real novelty is not the pay-per-use approach, already implemented in other industries such as hotels, rental cars and utilities (Weinman, 2012), but the holding of two fundamental properties: (i) being part of a system and (ii) being easily connected along a network (Cusumano, 2012).

This has important implications for the business model concept and value creation mechanisms that become extremely adaptable according to the evolutionary character of resources, models and strategies. As a consequence, static conceptualisations of competitive advantage become no more useful and with the urgency for the definition of value streams (generated and captured) able to incorporate resources, motivation into dynamic heuristics. Accordingly, in relation to CC, Ahokangas et al., (2014) underline the necessity to use the business model unit of analysis not only to identify "*WHAT*" resources are used, but "*HOW*" and "*WHY*" these resources are used to create value. Benlian et al (2018) operate a first conceptualisation of transformative mechanisms of CC, identifying three possible ways: *decoupling, platformisation and recombination*. Decoupling describes a process in which one element of a system becomes independent by underlying components. Platformisation creates an arena of interactions between customers and firms and complementary stakeholders. Recombination combines cloud services with other technologies (e.g. blockchain, IoT). Interestingly enough, some of these categories share a few common features with our proposal. Nevertheless, their conceptualisation does not include some aspects that we consider crucial, such as Governance (see Section 4.2). A further, remarkable distinction is that the theoretical building process of Benlian et al. (2018) does not explicitly consider the value streams in relation to business model literature and no dynamic analysis is present.

The limitations discussed above open up new perspectives for enriching the CC properties presented in the literature. We discuss them in the next section.

4. Empirical findings and conceptualisation

4.1. inductive analysis of case studies –emergent value creation properties of CC

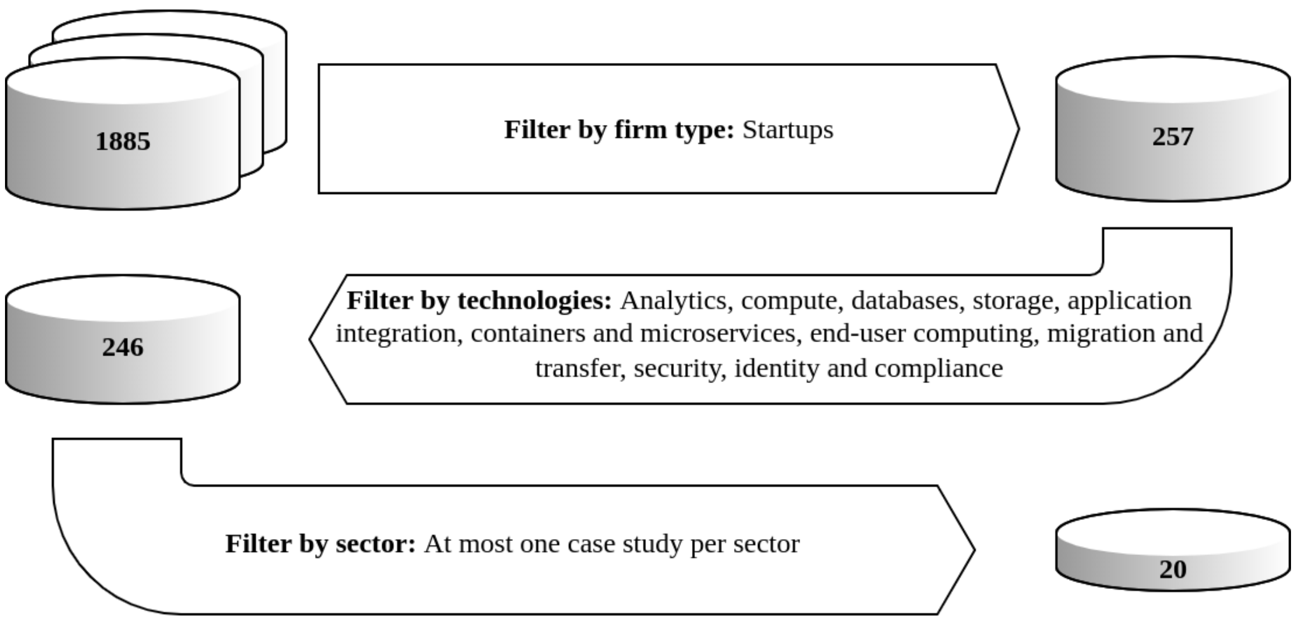
This section shows our contribution to the value creation mechanisms of CC, which have been scarcely analysed in the literature, despite its interesting potentiality (DaSilva et al., 2013; Ahokangas et al., 2014; Stieninger and Nedbal, 2014; Benlian et al., 2018).

To conduct our inductive theory building process, we use a multiple case study composed of 20 startups, selected after a filtering process occurred in three steps. First, we select the startup category among the possible organisations included in the AWS filtering options, reducing the sample from 1885 to 257. Then we filter by primitive technologies, restricting the sample to 246. Lastly, we filter by sector considering at least one startup for industry categories reported in AWS.

The startups selected covered 20 out of 25 industries reported by AWS, including agriculture, manufacturing, and services for people and goods. The countries considered in the analysis are geographically distributed in 4 continents: Europe (France, Germany, Israel, Norway, UK), Oceania (Australia, New Zealand), Asia (India, Indonesia, Korea, Philippines, Vietnam) and North America (US). This broad spectrum has guaranteed the analysis of CC enabling value in different markets, and typologies of business. Figure 2 synthesises the entire filtering procedure.

The information retrieved from AWS business case studies has been integrated with information collected by manually scraping their websites in search of information related to the startups' core activities (for the complete list of startups check table 2.A in the appendix). In what follows we present the result of the Gioia methodology (Gioia et al., 2012), clustering the results in three aggregate dimensions we identify, namely Modular Layering, Interface and Governance.

Figure 2. Startup selection procedure



Source: Author's elaboration

Modular layering

The contemporary business landscape contains many examples of services/products that succeed exploiting, as distinctive factors, the infrastructural properties of CC. For instance, Busby is an App that automatically detects accidents by relying on the phone's sensors. The possibility to build a service on existing layering (the personal safety detection based on bikers' phones) allows a prompter rescue management in case of accidents, improving the safety of riders.

Consider also the example of Yanolja which uses IoT sensors in a room and for check-in management or the Heat-to-electricity converter to produce electricity with heat from any fuel source (including natural gas, biogas and even green hydrogen). Yanolja was developed by Modern Electron which relies on a physical endpoint to configure products and services with the use of elasticity and global accessibility.

In other cases edge computing platforms or AI-based solutions are used to leverage the potentiality of data. In this regard, Crop-X has developed a platform able to integrate data from soil sensors with multiple layers (weather, aerial imagery, topography maps, soil mapping, hydraulic models, crop models, user inputs) for predictive purposes. Similarly, BetterMe is an App with workouts, dietary and mental health programs that elaborates AI-based analysis of subscribers on input directly provided by users.

We cluster these cases under the concept of *modular layering.* Layering in IT terms means setting up a software, building blocks (such as libraries) and operating systems using hierarchical layers with a given degree of dependence. Also, modularity refers to decomposing architecture in subsystems, responding to functional schemes made by modules or business units (Yoo et al., 2010; Liu et al., 2011). In a nutshell, **modular layering amounts to implementing a new product or service by mainly composing existing modules in a novel architecture**. Such an implementation typically follows a modular architectural pattern, in which self-contained modules can be easily connected, creating a new value stream (Pagani, 2013) as, e.g., in microservice architectures and IoT-based, smart infrastructures. With CC the layered modular architecture has been radically magnified for the intrinsic properties of cloud (such as ubiquity, reliability, scalability, etc.) the presence of physical endpoints (at the edge level) able to communicate between them and with the cloud in a "*cloud-to-thing continuum*" architecture (Svorobej et al., 2020).

Interface

The CC has stimulated the distribution and accessibility of apps on a global scale, making essential for firms thinking of "sharing borders". In this context, Eightfold, a startup that developed a Talent Intelligence Platform, based on big data (combining private and public sources) and equipped with AI to provide companies with data-driven insights to talent acquisition and retention, has allowed the integrability with enterprise software.

Another example comes from Urbanbase that uses spatial data platforms to help corporate partners to find potential value for their customers through VR/AR technology and data. The collaboration with interior design, construction and furniture companies is ensured also by means of API and it can create completely new networks and business ecosystems.

Tier, an electric scooter ride-sharing and provider of micro-mobility solutions allows the integrability with other apps (detection of weather, speed restrictions, traffic, or other events that would change trip time) to create new values that these single data could not guarantee if singularly taken.

We cluster these cases under the concept of *interface.* Interface within computing theory represents the shared boundaries through which hardware, software and even humans interact and exchange information (Kushida et al., 2011). Through the integrability and openness of analogical and digital modules, a high degree of complementary with external elements is allowed (Jovanovic et al., 2021). In the case of CC, this communication capability, also defined as interoperability, is commonly present in the forms of authentication and authorisations and voluntary sharing of data with a predictable outcome. In addition, there is the concept of cloud portability as the capacity of moving data or applications from a service and/or provider to another, maintaining their usability. In a nutshell, **interface means to implement transducers, i.e., software components or services that link together two objects, not originally meant to communicate.**

A well-known case within the CC paradigm, is represented by the APIs. APIs provide the endpoints that allow these human-machine and machine-machine interactions, enabling the creation of the so-called "add-on" products and services[4] (Um, 2016). Gawer (2020) points out how the gateway function of APIs is bidirectional and therefore with different degrees of exchange between the two parts involved. This point is particularly important to understand the network of functional connections that result in the concept of market interoperability[5] (Yoo et al., 2010; Weinman, 2012).
Other examples of products that belong to this category are the well-known crypto bridges, i.e., cloud platforms that provide integration between two or more cryptocurrencies/blockchains.

Governance

CC allows to efficiently manage data and processes, with the guarantee that privacy and security standards are on behalf of third-party providers, ensuring a higher level of reliability than on-premise solutions. What is the value generated by this mechanism?
TestWe is a Platform for administering in-class and remote computer-based assessments, which introduce a new dematerialised process for the digital management of educational assessment (from creation to administration and control of results). Another example comes from Tibber, an Energy provider which adopts

[4] Regard the relationship between API and CC, consider the case of Microservice architecture. Nowadays it is more convenient for developers the realisation of small building blocks able to recall the desired function through an API, saving time in the production (a portion of codes already available) and the maintainability.

[5] It is interesting the attempt made by Apple with iPhone 5 to promote its native map app in order to substitute Google Maps. This attempt probably due to technical reasons showed to Apple a kind of consumer resistance (a sort of cognitive lock-in) to abandon Google Maps (Kushida et al., 2011).

a fixed "flat" fee, offering energy at the purchasing power that introduced an “anticipatory framework” to manage domestic energy.

Sayurbox is a startup with the aim to improve the freshness and affordability of the Indonesian food chain, monitoring the supply chain, matching between consumer preferences and producer crops and saving costs. It introduces a completely new food provision framework (on-line and within 24 hours).

We cluster these cases under the concept of *governance*. Governance, within infrastructure, platform and software, refers **to the ability to introduce or significantly change the management of a process, e.g., for making it more efficient, thus modifying the rules of the game and/or the incentive structure** (Constantinides et al., 2018). The issue of governance is severely impacting cloud providers at any level, being necessary an appropriate level of control, that results in a constant tension between evolvability and stability (Wareham et al., 2014). As underlined by Wareham et al. (2014), their concurrent presence is an essential “paradox” to allow a certain flexibility in terms of generativity (creator/enabler of new outputs, structure and behaviour), maintaining trust in the existent control mechanisms. The Orchestration of Cloud is a relevant case where the governance sphere has a key role, connecting different Cloud resources (private and public) into a cohesive automated workflow able to encompass the various policies related to management and security.

Governance is polycentric and multi-layered in the sense that can refer to a different typology of actors’ links, articulated on different scales and power relations, which are centralised (as dedicated service SAP), decentralised (as blockchain platform such as Ethereum) or even consortial (as open-source CC platform such as Cloud Foundry) (Constantinides et al., 2018; Hein et al., 2019). For instance, Justeat is a well-known case of an enabled CC platform that significantly changed the management of food delivery and consumption, creating a new consumers-producers network. Table 3.A in the appendix summarises the findings of the Gioia methodology.

4.2 Value creation mechanisms of Cloud Computing: a dynamic representation

The role of CC has radically changed the modality of product and service design, as the CC properties allow the involvement of a wider plethora of actors that actively participate in the realisation of the final outcome, empowering a set of possible digital actions (e.g. *editability, addressability, senseability, communicability, memorizeability, treaceability and associability* - see Yoo et al., 2010) that contribute to define multiple value paths and channels (Henfridsson et al., 2018; Nambisan et al., 2020; Verhoef, 2021).

As a consequence of this paradigmatic change, well-known multinationals such as GE and IBM transformed themselves from leading product companies into service groups (Orlikowski and Scott, 2015). A lot of other examples come from specific business models, including new ways of producing industrial goods (smart manufacturing models); platforms for entertainment, tourism and business (e.g., Spotify, Netflix, Uber, Zoom, etc.); add-on software (e.g., mobile applications), add-on hardware (product consultancy, maintenance, dismantling) and data-driven models (re-engineering of information systems, big data analysis), new typology of services as smart contracts (Decentralised Autonomous Organisation). These business models enabled by

CC are emerging outcomes observable in physical, digital or hybrid final forms: platforms (Facebook) where digital objects remain digital, orchestration of physical resources (Uber and Airbnb), new ways of controlling production processes and design new products (IOT platforms by Siemens and Huawei) (Harmon and Castro-Leon, 2018; Verhoef et al., 2021; Tian et al., 2021).

The key question that has remained substantially unanswered is how happened the conversion of CC resources into cloud-based products and services, in other words how do the value creation mechanisms enabled by CC allow to create new products and services?

Consider the case of Airbnb. Airbnb, born in 2008, is a community platform that connects private hosts and travellers, enabling renting activities such as homestays and house-sharing, without owning any physical space. It is based on a principle of collaborative consumption, where both hosts and visitors access the market, paying a rental fee. Airbnb is a PaaS that highly relies on broad network access and resilience to work. Its business model works by the means of the introduction of a new way of organising physical resources that otherwise would remain unexploited because of the intermediary absence that guarantees a set of conditions. It is therefore the incentive structure and a more efficient management of accommodation (both for tourists and hosts) that has favoured its emergence as a reference model. Of course, its success over time has been severely impacted by the use of big data and AI; as an example, Airbnb has implemented a recommendation system to predict the best price for each day of the year considering specific location, past trends and simultaneous current events that help hosts to fill vacant places.

A second example is MindSphere[6], an IoT open operating system created by Siemens. MindSphere works as a PaaS to enable the digitalisation of the entire product lifecycle, integrating processes and services and thus creating cyber-physical systems. These digital twins permit to create, experiment and collaborate with customers and suppliers, relying on layering modular architectures, APIs and libraries that allow the development of related applications. In this case technical properties of CC, such as elasticity (scaling considering the addition of new machines and flexibility to supply chain variations), measured service (to monitor costs and performances) and resilience leverage the use of physical machines that are connected to plants and systems by providing advanced analytics and AI solutions. These tools allow to gather and monitor data in real time (from the physical edges to the cloud), creating new phygital infrastructure by allowing a continuous data flow (real time or near real time), enhancing the diagnostics, predictive and prescriptive power and/or by offering new forms of servitisations to external customers.

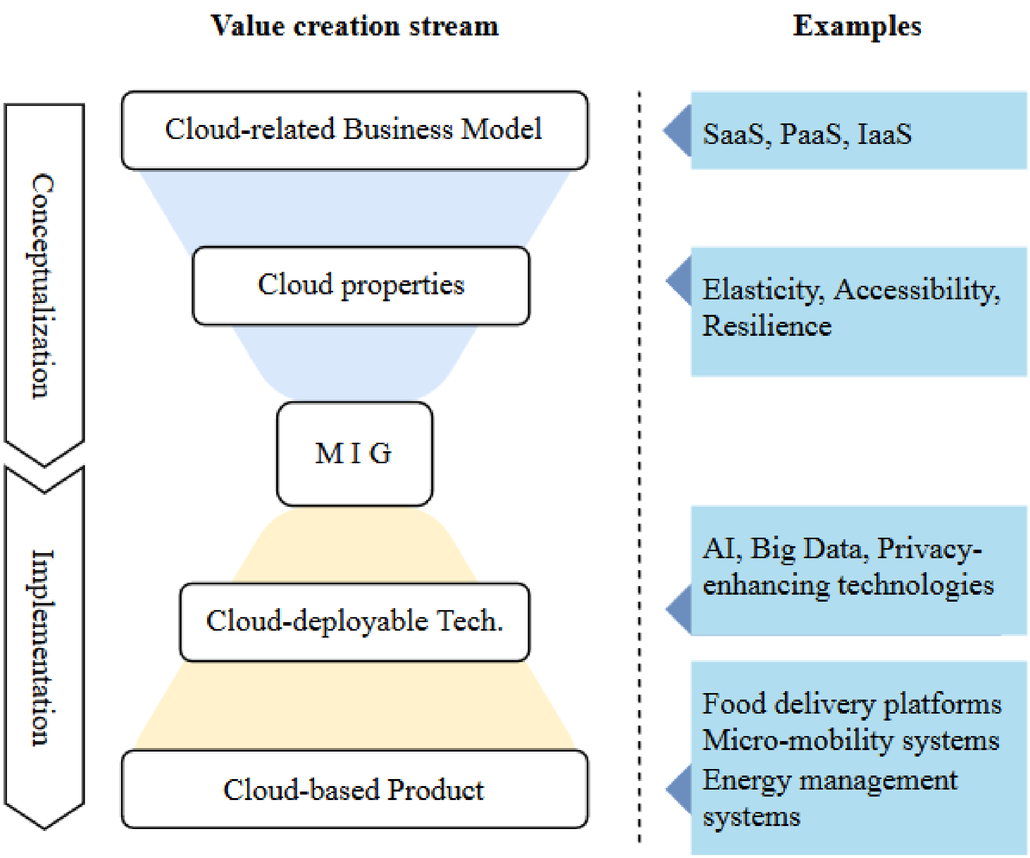
As a last example we propose DiffBot, a platform that commercialises access to their SaaS to allow for the analysis of big data, with the mission to build a comprehensive map of human knowledge. Diffbot is a service that provides a powerful interface that crawls and extracts facts (e.g. related to news and companies), by processing unstructured web contents with several advanced technique, e.g., natural language processing. The systems they have built are based on knowledge graph principles, but the possibility to access the whole internet database makes Diffbot an interesting starting point to develop machine learning and market intelligence tools for market analysis and news monitoring. In terms of our CC technical properties, Diffbot is a SaaS that highly relies on *broad network access*, *elasticity* and *measured service*. Nevertheless, in this case

[6] https://iiot-world.com/wp-content/uploads/2017/03/Siemens_MindSphere_Whitepaper.pdf

value creation is mainly provided by the interface of DiffBot, which is accessible through APIs or add-ons for the major office suites, e.g., Microsoft Excel[7].

As reported in these three examples, the "MIG" value creation, occurred by three mechanisms (Modular Layering, Interface and Governance), connects the properties typically associated with CC (the initial conceptualisation) to the implementation of products and services that occur by the means of cloud-deployable technologies. This entire value stream is synthetically represented from the blue top to the bottom yellow part of the "hourglass" in Figure 3.

Figure 3 Value creation stream of Cloud Computing



Source: Author's elaboration.

[7] https://www.diffbot.com/products/knowledge-graph/excel/

5. Concluding remarks

This section concludes the paper with theoretical and managerial implications, interpreting the results presented in section 4 in the wider logic of value creation notion, evidencing also possible impact in the critical junctures of firms' business model. Lastly, some limitations and future research avenues are discussed.

5.1. Theoretical implications

The value creation mechanisms presented in Section 4 have the advantage to overcome a business perspective on CC strictly focused on the "traditional" cloud properties (such as elasticity, accessibility, resilience), recognising their role in the whole value generation stream. The mediating action carried out by "MIG" between the design and implementation of cloud-based products and services allows to integrate existing analyses on CC with the notion of business model and value creation in a coherent and logical manner. With this conceptual paper, we pursue the analysis of the literature that connects IT enabling technologies and business model (Da Silva et al., 2013; Stieninger and Nedbal, 2014; Rai and Tung, 2014; Nittala et al., 2022; Benlian et al., 2018; Nambisan et al., 2020; Jovanovic et al., 2021), evidencing how technical features of CC has amply impacted non-technical capabilities to innovate and build new competitive advantage.

CC resources represent the digital frontier not only for their global diffusion and elasticity, but mainly for their capacity to embed a digital architecture into the physical reality (combining input and output) and vice versa, shaping a radically new socio-economic landscape (Kushida et al., 2015). This architectural design has enabled an endless functional space, but agnostic respect to the contents or purpose of the service or products realisable, where products and services may assume different configurations in a different space-time conception that affect organisational structures of government, firms and users (Baldwin and Woodard, 2009; Hein et al., 2019). This outstandingly echoes the ontological transformation of information systems, from an objective representation of internal and external firms' processes (information about reality, for reality, as reality) to information that shapes and defines reality (Baskerville et al., 2020). This is evident for new smart manufacturing strategies and operations in advanced industries as aerospace and car makers but also in more traditional sectors based on human capabilities and tacit knowledge such as textile embroideries (Huikkola et al., 2022).

The results of this conceptual paper give prominence to two fundamental issues that are discussed in this section.

First, value generation mechanisms are not the same as ten years ago, as enabling (and enabled) technologies and emerging needs are offering new paths to explore. Has the notion of value changed thanks to the intimate embeddedness of CC in the business process?

With the advent of CC, the number of stakeholders involved in the value generation has notably increased, expanding the importance of singles as part of a connected ecosystem. Advanced Analytics and Artificial Intelligence have done the rest, leveraging the unceasing information flows and contributing to the new model of data monetisation. The old vertical integration of product conception and realisation has started to move towards ecosystem logic, where product/service "A" can be decoupled in modules and maximised by the complementarity with product/service "B", "C" and "D" (Hein et al., 2019). Iansiti and Levien (2004:69) grasped the high complexity of XXI century business models, underlining their embeddedness in business ecosystems made by hundreds/thousands of components: "*suppliers, distributors, outsourcing firms, makers of related products or services, technology providers, and a host of other organizations*". With the advent of this model, the boundaries of firms and external environment have progressively become blurred, creating new enveloper roles (complementors and substitutes) responsible in same case of the creation of techno dependency relationships (Eisenmann et al., 2011; Floerecke et al., 2020 Jovanovic et al., 2021). This has provoked two typologies of consequences: an increasing capacity to answer to the unmet needs of customers, but also a more vanishing notion of competitive advantage for the high substitutability by services and products continuously improved by a fierce global competition (Zhu and Iansiti, 2019; Gawer, 2020). In this sense the notion of value has a new timing (CC has allowed an increasing responsiveness thanks to the widespread adoption of other enabling technologies such as AI) a new morphology (it is embedded in open ecosystems) and a new sources of recursive feedback (it is nurtured by multilevel networks made by humans and machine that interact together).

Second, the implications on the evolution of value creation in business models, has important consequences on the modalities through which companies innovate and build competitive advantages. As reported by McGrath (2010:248):

"*Business model analysis also gives us a sense of firms in action. But this dynamic perspective is not central to two ideas about the genesis of competitive advantage that are well-accepted in strategy: the industry positioning view or the so-called resource-based or dynamic capability view.*

….As new technologies and other shifts relax constraints or impose different ones, the opportunities for new models (and the threats to existing ones) increase"

The business model has therefore become a future projection activity and CCs markedly impact critical firms' juncture (functions and organisation), imposing to managers to stay on the technological frontier. We briefly describe three processes that exemplify this: (i) experimentation, (ii) co-creation and (iii) orchestration.

(i) The creative use of CC resources is incredibly accelerating the pace of innovations thanks to the possibility to create and destroy virtual environment very rapidly (as the digital twin for manufacturing) at a relatively low cost, saving time and money and shortening time to market of products and services (Venters et al., 2012). Experimenting in this condition allows to test many ideas, leading to a more "democratic" and accessible creation process. That is possible because of the interoperability of platforms and the tendency to deploy microservices (a sort of package ready to use in combination between them), avoiding duplication of efforts. Resources can be re-used and some processes can be automatised (e.g. a business intelligence service based on big data) or optimised (as in industrial supply chains), making really important not only the knowledge about the single resource but the vision of how to purposefully integrate them (Venters et al., 2012; Kushida et al., 2015).

(ii) The concept of co-creation lies in the middle between creation and collaboration, even if the collaborative aspect is more relevant. Physical goods are progressively becoming an extensible part of a wider service and CC allows it to be massively present in digital spaces (Orlikowski and Scott, 2015). This in turn enables a heterogeneous and non-hierarchical interactive network (from the design in partnerships with universities and research centres, to a customised delivery based on customers' preferences), which becomes a sort of collective intelligence process applied to innovation and entrepreneurship (Elia et al., 2020; Verhoef et al., 2021).

(iii) The impact of CC on firms' organisational structure has been mainly discussed as a managerial tool (e.g. Enterprise Resource Planning) or in the easiness of orchestration of internal and external resources (Ali et al., 2017; Harmon and Castro-Leon, 2018). Its introduction is changing business routines, decision-making procedures and distribution or responsibility, posing several challenges (e.g. technical, legal, security) and opportunities (rapid reconfigurations of operations and functions) that define a "*composable enterprise model*" (Kushida et al., 2015). Accordingly, the possibility to remove a fixed component from the productive structure (thanks to the digital twinness), modelling on the company's experience and the evolving performance of business units, has a fundamental cascade effect on the general business organising logic (Yoo et al., 2010; Henfridsson et al., 2018).

5.2 Managerial implications

CC is the foundational technology of a myriad of services and products and the backbone of other enabling technologies, such as IoT and AI. However, CC does not represent a competitive advantage per se, being neither rare nor inimitable. A systemic view on value creation mechanisms built upon the CC technical resources can help organisations to build competitive advantages. It is important to deep dive into the desired system we want to build upon, as new innovative services are highly dependent on non-technological affordances.

Acknowledging the impact of intermediate mechanisms such as Modular Layering, Interface and Governance in the value generation streams has important implications and connection with the strategy and operations of the firms and the development of their business model. Modular Layering allows the evaluation of the infrastructure embeddedness of services and products from their design to their exploitation. Interface allows conceptualising a connection between two parts that were previously not linked, opening many possible "what-if" scenarios. Governance allows to properly understand the management of new processes and the connection with the decision-making of users, suppliers and competitors.

Having in mind what mechanisms connect the design and implementation of cloud-based products and where they innest in the process allow managers and strategists to navigate the complexity of the business environment with a clearer roadmap. From a managerial point of view, we underline the necessity to acquire the necessary competencies and skills to set technological development into business strategy and not viceversa. These skills encompass the technical understanding of the phenomenon but develop in the "value chain" and ecosystem that arise on it. This means the assessment of value propositions, which can change for specific services, as well as the relationship with external partners and users with a discovery-driven approach aimed to monitor change and appropriation of business value.

Profiles responsible for the level of innovation culture in a firm and dedicated to bridge different departments (e.g. Innovation Manager and/or Chief Digital Officers) need to embrace these value generation mechanisms, adapting the general principles on the specific business model of their organisation, dedicating efforts in identifying new value paths enabled by CC. This of course is relevant also for public managers that are responsible for public services such as energy (e.g. power grid management).

As a final point, we suggest a "CC ambidexterity" to nimbly navigate the tension between short-term objectives (enabled by exploitation of existing strengths and conducted through small-medium projects) and long-term goals (enabled by exploration of alternative possibilities and reached through medium-big programs).

5.3 Limitations and future avenues

This paper introduces a qualitative process to represent the unexplored, potential sources of value creation enabled by CC within the literature on business model. The main threat to the validity of our model derives from the limited number of cases that we considered in this paper. In this respect, future research with a focus on the relationship between CC and business model notion could start from this conceptualisation and search for alternative ways of validating our three MIG categories, possibly on a wider scale. For instance, web scraping techniques might be employed for inspecting websites of startups and building a larger corpus of information about CC usages. However, the qualitative information detection carried out in this paper is not easily automatable. As a matter of fact, processing and connecting the technical properties of CC with value creation mechanisms is based on a systematic interpretation and correlation of multiple aspects, including the semantic analysis of natural language description. These tasks are notoriously hard for computer programs.

Alternatively, surveys or semi-structured interviews administered to managers could be used to collect information on the adoption timing and different uses of CC by firms. This approach could be used for testing the mechanisms conceptualised in this paper.

6. References

Ahokangas, P., Juntunen,M., Myllykoski, J. (2014) Cloud computing and transformation of international e-business models R. Sanchez, A. Heene (Eds.), *Focused Issue on Building New Competences in Dynamic Environments*, 7, Emerald Group Publishing Limited, pp. 3-28.

Ali, A., Warren, D., & Mathiassen, L. (2017). Cloud-based business services innovation: A risk management model. *International Journal of Information Management*, *37*(6), 639-649.

Alvesson, M., & Sandberg, J. (2011). Generating research questions through problematization. *Academy of management review*, *36*(2), 247-271.

Amit, R. , & Zott, C. (2001) Value creation in e-business. *Strategic Management Journal*, 22: 493-520.

Amit, R., & Han, X. (2017). Value creation through novel resource configurations in a digitally enabled world. *Strategic Entrepreneurship Journal*, *11*(3), 228-242.

Baldwin, C. Y., & Woodard, C. J. (2009). The architecture of platforms: A unified view. *Platforms, markets and innovation*, *32*, 19-44.

Baskerville, R. L., Myers, M. D., & Yoo, Y. (2020). Digital First: The Ontological Reversal and New Challenges for Information Systems Research. *Management Information Systems Quarterly*, *44*(2), 509-523.

Bayrak, E., Conley, J. P., & Wilkie, S. (2011). The economics of cloud computing. *The Korean Economic Review*, *27*(2), 203-230.

Benlian, A., Kettinger, W. J., Sunyaev, A., Winkler, T. J.(2018). The transformative value of cloud computing: a decoupling, platformization, and recombination theoretical framework. *Journal of management information systems*, *35*(3), 719-739.

Berman, S.J., Kesterson-Townes, L., Marshall, A. and Srivathsa, R. (2012), "How cloud computing enables process and business model innovation*", Strategy & Leadership*, 40(4):27-35.

Bresnahan, T., Trajtenberg, M. (1995) General purpose technologies "Engines of growth?", *Journal of Econometrics,* 65(1), 83–108.

Brynjolfsson, E., Hofmann, P., & Jordan, J. (2010). Cloud computing and electricity: beyond the utility model. *Communications of the ACM*, *53*(5), 32-34.

Cheng, C., & Wang, L. (2022). How companies configure digital innovation attributes for business model innovation? A configurational view. *Technovation*, *112*, 102398.

Chesbrough, H. W., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spinoff companies. Industrial and Corporate Change, 11: 533-534.

Christauskas, C., & Miseviciene, R. (2012). Cloud–computing based accounting for small to medium sized business. *Engineering Economics*, 23(1), 14-21.

Constantinides, P., Henfridsson, O., & Parker, G. G. (2018). Introduction—platforms and infrastructures in the digital age. *Information Systems Research*, *29*(2), 381-400.

Cusumano, M.A. (2012) Platforms Versus Products: Observations from the Literature and History S.J. Kahl, B.S. Silverman, M.A. Cusumano (Eds.), *History and Strategy, Advances in Strategic Management*, vol. 29 (2012), pp. 35-67.

DaSilva, C. M., Trkman, P., Desouza, K., & Lindič, J. (2013). Disruptive technologies: a business model perspective on cloud computing. *Technology Analysis & Strategic Management*, *25*(10), 1161-1173.

Eisenmann, T., Parker, G., & Van Alstyne, M. (2011). Platform envelopment. *Strategic management journal*, *32*(12), 1270-1285.

Eisenhardt, K. 1989. "Building Theories from Case Study Research." *Academy of Management Review* 14 (4): 532–550.

Elia, G., Margherita, A., & Passiante, G. (2020). Digital entrepreneurship ecosystem: How digital technologies and collective intelligence are reshaping the entrepreneurial process. *Technological Forecasting and Social Change*, *150*, 119791.

Etro, F. (2015). The economics of cloud computing. In *Cloud Technology: Concepts, Methodologies, Tools, and Applications* (pp. 2135-2148). IGI Global

Floerecke, S., Lehner, F., & Schweikl, S. (2020). Cloud computing ecosystem model: evaluation and role clusters. *Electronic Markets*, 1-21.

Garfinkel, S., (2011), The Cloud Imperative, *MIT Review.*

Gawer, A. (2020). Digital platforms' boundaries: The interplay of firm scope, platform sides, and digital interfaces. *Long Range Planning*, 102045.

Gawer, A., & Cowen, T. (2012). Competition in the Cloud: Unleashing investment and innovation within and across platforms. *Communications & Strategies*, (85), 45-62.

Giannakis, M., Spanaki, K., & Dubey, R. (2019). A cloud-based supply chain management system: effects on supply chain responsiveness. *Journal of Enterprise Information Management*. 32(4):585-607.

Gioia, D., K. Corley, and A. Hamilton. (2012) "Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology." *Organizational Research Methods* 16 (1): 15–31. doi:10.1177/ 1094428112452151.

Glaser, B., and A. Strauss. (1967 *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Chicago: Aldine.

Gök, A., Waterworth, A., & Shapira, P. (2015). Use of web mining in studying innovation. *Scientometrics*, 102(1), 653-671.

Gupta, P., Seetharaman, A., & Raj, J. R. (2013). The usage and adoption of cloud computing by small and medium businesses. *International Journal of Information Management*, *33*(5), 861-874.

Harmon, R. R., & Castro-Leon, E. G. (2018). Service innovation in the cloud: implications for strategy development. In *2018 Portland International Conference on Management of Engineering and Technology (PICMET)* (pp. 1-15). IEEE.

Hedman, J., & Kalling, T. (2003). The business model concept: theoretical underpinnings and empirical illustrations. *European journal of information systems*, *12*(1), 49-59.

Hein, A., Schreieck, M., Riasanow, T., Setzke, D. S., Wiesche, M., Böhm, M., & Krcmar, H. (2019). Digital platform ecosystems. *Electronic Markets*, 1-12.

Henfridsson, O., Nandhakumar, J., Scarbrough, H., & Panourgias, N. (2018). Recombination in the open-ended value landscape of digital innovation. *Information and Organization*, *28*(2), 89-100.

Herskovits, R., Grijalbo, M., & Tafur, J. (2013). Understanding the main drivers of value creation in an open innovation program. *International Entrepreneurship and Management Journal*, *9*(4), 631-640.

Huikkola, T., Kohtamäki, M., & Ylimäki, J. (2022). Becoming a smart solution provider: Reconfiguring a product manufacturer's strategic capabilities and processes to facilitate business model innovation. *Technovation*, 102498.

Hussein, W. N., & Sulaiman, R. (2013). E-Business and Cloud Computing: A New Practice or a Trend. In Chuan, P., Khachidze, V., Lai, I. K. W., Liu, Y., Siddiqui, S., & Wang, T. (Eds.). (2013). *Contributions to economics. Innovation in the high-tech economy*. *Innovation in the High-Tech Economy* (pp. 67-77). Springer, Berlin, Heidelberg.

Iansiti, M., & Levien, R. (2004). Strategy as ecology. *Harvard business review*, *82*(3), 68-78.

Jaakkola, E. (2020). Designing conceptual articles: four approaches. *AMS Review*, *10*(1), 18-26.

Jede, A., & Teuteberg, F. (2015). Integrating cloud computing in supply chain processes: a comprehensive literature review. *Journal of Enterprise Information Management*, 8 (6): 72-94.

Jovanovic, M., Sjödin, D., & Parida, V. (2021). Co-evolution of platform architecture, platform services, and platform governance: Expanding the platform value of industrial digital platforms. *Technovation*, 102218.

Kathuria, A., Mann, A., Khuntia, J., Saldanha, T. J., & Kauffman, R. J. (2018). A strategic value appropriation path for cloud computing. *Journal of management information systems*, *35*(3), 740-775.

Kiel, D., Arnold, C., & Voigt, K. I. (2017). The influence of the Industrial Internet of Things on business models of established manufacturing companies–A business level perspective. *Technovation*, *68*, 4-19.

Kumar, D., Samalia, H. V., & Verma, P. (2017). Exploring suitability of cloud computing for small and medium-sized enterprises in India. *Journal of Small Business and Enterprise Development*.24 (4): 814-832.

Kushida, K. E., Murray, J., & Zysman, J. (2011). Diffusing the cloud: Cloud computing and implications for public policy. *Journal of Industry, Competition and Trade*, *11*(3), 209-237.

Kushida, K. E., Murray, J., & Zysman, J. (2015). Cloud computing: From scarcity to abundance. *Journal of Industry, Competition and Trade*, *15*(1), 5-19.

Liu, F., Tong, J., Mao, J., Bohn, R., Messina, J., Badger, L., and Leaf, D., (2011) *NIST Cloud Computing Reference Architecture,* NIST Special Publication 500-292.

Lukasik, S. (2010). Why the ARPANET was built. *IEEE Annals of the History of Computing*, *33*(3), 4-21.

Maresova, P., Sobeslav, V., & Krejcar, O. (2017). Cost–benefit analysis–evaluation model of cloud computing deployment for use in companies. *Applied Economics*, *49*(6), 521-533.

Mazzoni, L., Lazzeretti, L., & Innocenti, N. (2021). Entrepreneurship, complexity and the emergent order in the techno-economic scenario of the twenty-first century. Evidence from a field study in Tuscany. *Industry and Innovation*, *28*(5), 570-593.

McGrath, R. G. (2010). Business models: A discovery driven approach. *Long range planning*, *43*(2-3), 247-261.

Mell, P., and Grance, T. (2011). *The NIST definition of cloud computing*, NIST Special Publication 800-145.

Mitra, A., O'Regan, N., & Sarpong, D. (2018). Cloud resource adaptation: A resource based perspective on value creation for corporate growth. *Technological Forecasting and Social Change*, *130*, 28-38

Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Entrepreneurship Theory and Practice*, 41(6), 1029-1055.

Nambisan, S. (2018). Architecture vs. ecosystem perspectives: Reflections on digital innovation. *Inf. Organ.*, *28*(2), 104-106.

Nambisan, S., Lyytinen, K., & Yoo, Y. (2020). Digital innovation: towards a transdisciplinary perspective. In *Handbook of Digital Innovation*. Edward Elgar Publishing.

Nittala, S. S. S., Bharadwaj, S. S., Tripathi, S. S., & Seif, H. (2022). Service innovation enabled by Internet of Things and cloud computing–a service-dominant logic perspective. *Technology Analysis & Strategic Management*, *34*(4), 433-446.

OECD (2014), "Cloud Computing: The Concept, Impacts and the Role of Government Policy", *OECD Digital Economy Papers*, No. 240, OECD Publishing, Paris.

Orlikowski, W. J., & Scott, S. V. (2015). The Algorithm and the Crowd. *MIS quarterly*, *39*(1), 201-216.

Pagani, M. (2013). Digital business strategy and value creation: Framing the dynamic cycle of control points. *MIS Quarterly*, 37(2):617-632.

Porter, M. E., & Heppelmann, J. E. (2015). How smart, connected products are transforming companies. *Harvard business review*, *93*(10), 96-114.

Rai, A., & Tang, X. (2014). Research commentary—information technology-enabled business models: A conceptual framework and a coevolution perspective for future research. *Information Systems Research*, *25*(1), 1-14.

Raut, R. D., Gardas, B. B., Narkhede, B. E., & Narwane, V. S. (2019). To investigate the determinants of cloud computing adoption in the manufacturing micro, small and medium enterprises: A DEMATEL-based approach. *Benchmarking: An International Journal*. 26(3): 990-1019.

Spanò, R., Massaro, M., & Iacuzzi, S. (2021). Blockchain for value creation in the healthcare sector. *Technovation*, 102440.

Stieninger, M., & Nedbal, D. (2014). Characteristics of cloud computing in the business context: A systematic literature review. *Global Journal of Flexible Systems Management*, *15*(1), 59-68.

Svorobej, S., Bendechache, M., Griesinger, F., & Domaschka, J. (2020). Orchestration from the Cloud to the Edge. *The Cloud-to-Thing Continuum*, Cham: Springer International Publishing, pp: 61-77.

Teece, D. J. (2010), Business models, business strategy and innovation. Long Range Planning, 43: 172-194.

Tian, J., Coreynen, W., Matthyssens, P., & Shen, L. (2021). Platform-based servitization and business model adaptation by established manufacturers. *Technovation*, 102222.

Tilson, D., Lyytinen, K., & Sørensen, C. (2010). Research commentary—Digital infrastructures: The missing IS research agenda. *Information systems research*, *21*(4), 748-759.

Timmers, P. (1998). Business models for electronic markets. *Electronic markets*, *8*(2), 3-8.

Um, S. (2016). *The co-evolution of digital ecosystems.*, PhD dissertation, Templet University, Philadelphia.

Vaquero, L. M., Rodero-Merino, L., Caceres, J., & Lindner, M. (2009). A break in the clouds: Towards a cloud definition. *Computer Communication Review*, 39(1), 50–55.

Venters, W., & Whitley, E. A. (2012). A critical review of cloud computing: researching desires and realities. *Journal of Information Technology*, *27*(3), 179-197.

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, *122*, 889-901.

Wareham, J., Fox, P. B., & Cano Giner, J. L. (2014). Technology ecosystem governance. *Organization science*, *25*(4), 1195-1215.

Weinman, J. (2012). *Cloudonomics: The business value of cloud computing*. John Wiley & Sons.

Williams, B. (2012). *The economics of cloud computing*. Cisco Press.

Yoo, Y., Henfridsson, O., Lyytinen, K., (2010). The new organizing logic of digital innovation: an agenda for information systems research. *Inf. Syst. Res*. 21 (4), 724–735.

Zhu, F., & Iansiti, M. (2019). Why Some Platforms Thrive and Others Don't. *Harvard Business Review* (1), 118-125.

Zott, C., & Amit, R. (2010). Business model design: An activity system perspective. *Long range planning*, *43*(2-3), 216-226.

Zott, C., Amit, R., & Massa, L. (2011). The business model: recent developments and future research. *Journal of management*, *37*(4), 1019-1042.

7. APPENDIX

Table 1.A. Papers identified by the search on the WOS database

Authors	Article Title	Journal	Publication Year
Christauskas, C; Miseviciene, R	Cloud - Computing Based Accounting for Small to Medium Sized Business	INZINERINE EKONOMIKA-ENGINEERING ECONOMICS	2012
Hussein, WN; Sulaiman, R	E-Business and Cloud Computing: A New Practice or a Trend	INNOVATION IN THE HIGH-TECH ECONOMY	2013
Jede, A; Teuteberg, F	Integrating cloud computing in supply chain processes A comprehensive literature review	JOURNAL OF ENTERPRISE INFORMATION MANAGEMENT	2015
Maresova, P; Sobeslav, V; Krejcar, O	Cost-benefit analysis - evaluation model of cloud computing deployment for use in companies	APPLIED ECONOMICS	2017
Kumar, D; Samalia, HV; Verma, P	Exploring suitability of cloud computing for small and medium-sized enterprises in India	JOURNAL OF SMALL BUSINESS AND ENTERPRISE DEVELOPMENT	2017

Raut, RD; Gardas, BB; Narkhede, BE; Narwane, VS	To investigate the determinants of cloud computing adoption in the manufacturing micro, small and medium enterprises: A DEMATEL-based approach	BENCHMARKING-AN INTERNATIONAL JOURNAL	2019
Giannakis, M; Spanaki, K; Dubey, R	A cloud-based supply chain management system: effects on supply chain responsiveness	JOURNAL OF ENTERPRISE INFORMATION MANAGEMENT	2019
Jayeola, O; Sidek, S; Abd Rahman, A; Mahomed, ASB; Hu, JM	CLOUD COMPUTING ADOPTION IN SMALL AND MEDIUM ENTERPRISES (SMEs): A SYSTEMATIC LITERATURE REVIEW AND DIRECTIONS FOR FUTURE RESEARCH	INTERNATIONAL JOURNAL OF BUSINESS AND SOCIETY	2022

Source: authors' elaboration on Wos database

Table 2.A The selected startups

ID	Startup	Year of adoption AWS	State (location)	Sector	Core business
1	Rad Ai	2021	US	Healthcare	App to support Radiologists in their daily tasks
2	KEYOU	2021	Germany	Automotive	Clean hydrogen engines for Sustainable vehicles
3	Busby	2021	UK	Software and Internet	App to automatically detects accidents using phone's sensors
4	AppsFlyer	2021	US	Digital Marketing	SaaS to measure engagement and analytics
5	Modern Electron	2021	US	Professional Services	Heat-to-electricity converter to produce electricity with heat from any fuel source, including from natural gas, biogas and even green hydrogen.
6	FaunaBio	2020	US	LifeScience	Proprietary genetic, epigenetic and proteomic data (the largest biobank of hibernating animals in the world) to identify novel drug targets (mainly relate to

					cardiovascular protection)
7	CropX	2020	US; Israel; New Zeland; Australia	Agriculture	Advanced analytics platform able to integrate data from soil sensors with multiple layers (weather, aerial imagery, Topography maps, soil mapping, Hydraulic models, crop models, user inputs) for predictive purposes
8	Tier	2020	Germany	Transport and Logistics	Electric scooter ride-sharing and provider of Micro mobility solutions
9	Yanolja	2020	Korea	Travel and Hospitality	Travel agency for accommodation and leisure activities (collection of real-time data for personalised guest experiences).
10	ProteanTecs	2019	Israel	Computer and Electronics	Software platform for the prediction performance (e.g. health and failure) of the entire lifecycle of microchips (from design to production) in manufacturing and telecom sectors.
11	Urbanbase	2019	Korea	Consumer Goods	Spatial data platform that helps corporate partners to find potential value for their customers through VR/AR technology and data.
12	TestWe	2020	France	Education	Platform for administering in-class and remote computer-based assessments
13	Tibber	2021	Norway	Energy	Energy provider which adopts a fixed "flat" fee, offering energy at the purchasing power
14	Tnex	2021	Vietnam	Financial Services	Digital bank for retail customers and SMEs
15	Games24x7	2020	India	Gaming	Gaming online company based on scientific principles (e.g. behavioural science and data science)
16	Eightfold	2020	US	Government-General Public Service	Talent Intelligence Platform, based on big data (combining private and public sources) and

					equipped with AI to provide companies with data-driven insights to talent acquisition and retention
17	Sayurbox	2021	Indonesia	Retail	Platform to improve the freshness and affordability of Indonesian food chain
18	Devicescape	2014	US	Telecommunication	Huge scale wi-fi beacon network that enable consumer detection connecting access points
19	BetterMe	2020	Europe, Middle East, Africa	Media and Entertainment	App with workouts, dietary and mental health programs
20	Ayala Land	2014	Philippines	Real Estate	Property developer

Source: Author's elaboration on AWS database and website of each startup

Table 3.A Emergent properties that stimulate value creation capacity in Cloud Computing enabled business models

First order	***Second order***	***Aggregate dimensions***
- Personal safety accident detection - IoT-based Hotel automation - Smart Thermionic converters	Edge Computing	Modular Layering
- Soil data analysis for smart agriculture - Smart energy consumption analytics - AI-based analysis of videogame players - AI-based smart reporting on health data	Data aggregation	
- Integration with localisation app (GPS) - Integrability with enterprise software	Closed integration	Interface
- Integrability with other apps (detection of weather, speed restrictions, traffic, or other events that would change trip time) - API services	Open integration	
Digital management of scholar assessment Anticipatory framework to manage domestic energy Introduction of new smart steps in HR management process New food provision framework (on-line and within 24 hours)	Process management	Governance

Security policy management Disruptive multichannel service	Infrastructure management	

Source: Author's elaboration

IMT SCHOOL FOR ADVANCED STUDIES LUCCA