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# Value creation in data-centric B2B platforms: A model based on multiple case studies

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ABSTRACT

Data-centric B2B platforms are platforms where multiple B2B users relate and manage data for creating value. Despite the growing academic and industrial interest in these platforms, the existing research does not adequately investigate (i) who are the sides managing data within data-centric B2B platforms, (ii) what activities they perform to manage data within data-centric B2B platforms, and (iii) how their relationships aimed are governed within data-centric B2B platforms. Consequently, how data-centric B2B platforms create value (i.e., who they involve, what activities they allow to do, and how they manage sides' relationships) remains unclear. To address this gap, this paper analyzes the cases of three data-centric B2B platforms (i.e., MindSphere, Skywise, Open-es). Authors (i) categorize the sides managing data on these platforms (i.e., clients, providers, enablers), (ii) identify how these sides relate to perform data acquisition and manipulation activities, and (iii) illustrate the specific governance mechanisms supporting these relationships. Finally, a model discusses the goals, the transactional and innovation behaviors, and value creation mechanisms in data-centric B2B platforms. By adopting a value creation perspective of data-centric B2B platforms, this paper contributes to both theoretical and managerial debates surrounding B2B platforms.

## 1. Introduction

Platforms enable direct interactions and exchanges of products, services, and information between two or more independent sides (Hagiu & Wright, 2015). As they reduce friction and improve efficiency in interactions between different players, platforms have gained significant attention in academia and industry (Hein et al., 2020; Trabucchi & Buganza, 2020). Specifically, most recent interests in platforms concern data-centric "Business to Business" (B2B) platforms, where multiple B2B users relate and manage data for creating value. In these types of platforms, the collection and manipulation of data are recognized as strategic activities to configure new relationships among industrial users (Van Dyck et al., 2024), eventually resulting in the definition of new business models (Gawer, 2022). Hence, more and more companies in B2B market are adopting data-centric platforms to innovate their traditional businesses (Hein et al., 2020) and enhance competitiveness and profitability (Koenen & Falck, 2020; Tian et al., 2021).

To capture the benefits from data-centric B2B platforms, companies have to transit from old trajectories of linear value creation to new trajectories of non-linear value creation (Hein, Schreieck, et al., 2019). This transition involves embracing shared outcomes, innovation, and digital processes centered around data management (De Marco et al., 2019; Hein, Weking, et al., 2019). Thus, the need for this transition generates a fervent research setting around B2B platforms. Existing discussions on B2B platforms acknowledge that value can be generated through various types of relationships, including transactional, non-transactional, and innovation-focused relationships centered around data management (Laczko et al., 2019; Li et al., 2021). Moreover, scholars have noted that incumbents face greater challenges than new entrants in adopting B2B platforms, requiring them to implement specific strategies for a successful and profitable transition from linear to platform-based businesses (Cozzolino et al., 2021).

However, companies face several challenges in adopting data-centric B2B platforms due to three main issues. First, the involvement of multiple actors in data management (Trabucchi et al., 2017). Second, the presence of various sub-activities within data management (Lyko et al., 2016). Third, the need for specific governance mechanisms to regulate data-focused relationships (De Reuver et al., 2018). As a result, there is a lack of clarity regarding how data-centric B2B platforms facilitate sides' relationships for managing data and create value (Hein et al., 2020).

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This paper addresses this gap and aims at defining who are the sides managing data within data-centric B2B platforms, what kind of activities do the sides perform to manage data within data-centric B2B platforms, and how relationships aimed at managing data are governed within data-centric B2B platforms. To this end, we employed a multiple case study approach (Yin, 2014). This is a qualitative methodology widely utilized by scholars to develop theories in the platform literature (Hein, Weking, et al., 2019; Jovanovic et al., 2021; Tian et al., 2021). Nevertheless, case studies on platforms are required, as "by comparing cases within the same larger ecosystem, internal validity of platform studies can be enhanced" (De Reuver et al., 2018, p. 128).

We examined three cases, namely MindSphere (industrial Internet of Thing platform powered by Siemens), Skywise (cloud-based aviation platform from Airbus), and Open-es (sustainability-oriented digital platform released by Eni), to illustrate how data-centric B2B platforms allow relationships for data management, which ultimately results in value creation. Specifically, the main outcome of our study is a descriptive model of data-centric B2B platforms. This model delineates two layers of value creation deriving from sides' interactions to acquire data and manipulate data.

The paper contributes to both scientific and industrial domains. As for academia, we broaden knowledge about platforms' strategic potential in B2B market (Hein et al., 2020; Trabucchi & Buganza, 2021). Specifically, we shed new light on the adoption of data-centric B2B platforms, an area that has received limited attention in the literature (Hein et al., 2020) despite its considerable allure (Dell'Era et al., 2021). As for managerial practice, we support companies in transition from "product" to "platform" thinking (Riemensperger & Falk, 2020) by offering guidance for a successful participation in data-centric B2B platforms.

The rest of the article is organized as follows. Section 2 frames the phenomenon of data-centric B2B platforms. Section 3 explores the methodology adopted. Section 4 analyses the features of MindSphere, Skywise, and Open-es. Section 5 discusses the platform descriptive model, concluding with implications, limitations, and future research avenues.

## 2. Theoretical background: value creation in data-centric B2B platforms

Platforms facilitate interactions among at least two different groups of autonomous but interrelated users (Hagiu & Wright, 2015) exchanging physical assets, services, and knowledge (Shree et al., 2021). Consequently, platforms exhibit intra-market and inter-market network externalities (Parker & Van Alstyne, 2005; Rochet & Tirole, 2003), as the value of exchanged objects increases with the growing number of users (Trabucchi et al., 2017). These network externalities can be harnessed by the platforms themselves (Trabucchi et al., 2017), thus becoming sources of value creation. To this aim, platforms have to both onboard users and allow users to relate and use the exchanged objects (Aarikka-Stenroos & Jaakkola, 2012; Filistrucchi et al., 2014; Trabucchi et al., 2017). While users' onboarding received considerable attention in the literature (Dell'Era et al., 2021), we focus on the underexplored aspect of user relationships and exchanges within platforms for value creation (De Reuver et al., 2018). De Reuver et al. (2018) suggest that a comprehensive understanding of platform businesses requires an analysis of the actors, relationships, and governance mechanisms that constitute the platform. This viewpoint aligns with the most recent observations of Leminen et al. (2023), who emphasize that B2B platforms rely on the active participation of multiple actors openly sharing data and information through governance mechanisms. In their call for papers, Leminen et al. (2023) explicitly ask for studies exploring the creation of B2B digital platforms, uncovering the "actor roles and stakeholder management", and examining the "governance of B2B digital platforms". In line with these concerns, we aim at inquiring how "existing conceptualizations of value creation" can be "redeveloped to suit the requirements of new technology-enabled B2B platform". Our investigation specifically explores data-centric B2B platforms, namely technology-enabled B2B platforms where companies can collectively manage data to actively create value and promote platform-based businesses based on the utilization of data. We focused on such data-centric B2B platforms since "the increased connectivity and exchange of industrial data via platforms produce new interactions and trigger unexpected shifts in the organizing logic of the industry" (Van Dyck et al., 2024, p. 3).

In particular, we addressed the topic of data-centric B2B platform within the two main configurations of platforms, namely multi-sided platforms (MSPs) and innovation platforms. It is important to note that these two main configurations of platforms can merge within hybrid models (Gawer, 2022). However, for the aim of this study, we concentrated only on B2B data-centric platforms assuming the configurations of multi-sided or innovation platforms.

MSPs encompass two distinct platform behaviors, namely transaction platform behavior and non-transaction platform behavior, each supporting specific types of relationships and value creation mechanisms (Cusumano et al., 2019; Filistrucchi et al., 2014; Trabucchi et al., 2017; Trabucchi & Buganza, 2021). Transaction platforms, exemplified by Uber or eBay, facilitate the matching and connection of clients and providers for transactions. The key value creation mechanisms enabled by these platforms involve reducing asymmetric information through increased transparency and expanding the range of offerings by incorporating complementary assets. In contrast, non-transaction platforms create a "critical mass" on one side "that can be further exposed to stimuli coming from the second side" (Trabucchi & Buganza, 2021, p. 80). This is the case of the Google search engine, where one side (i.e., advertisers) can monetize the service offered to another side (i.e., end users) often for free or subsidized. The value creation mechanisms unveiled by these platforms do not rely on transactions between multiple sides but rather on interactions that generate unidirectional indirect network effects (Filistrucchi et al., 2014).

Differently, innovation platforms create value by providing the foundation for external firms to develop complementary products, technologies, or services (Cusumano et al., 2019). This is the case of IBM that provides hardware and computers leveraged by external complementors to develop software solutions.

As denoted by Trabucchi and Buganza (2021), the concept of innovation platform only partially overlaps with the concept of MSPs. For example, operating systems (e.g., Windows, iOS or Android) function as both innovation platforms and MSPs. As MSPs, they match two sides (the end users and the developers) who are sources of network externalities captured by the platform. As innovation platforms, they enable complementors to build and deliver their products upon a core foundation.

The valuable advantages and rapid evolution of platforms have motivated scholars and practitioners to approach this phenomenon (Shree et al., 2021). Notably, multi-sided and innovation platforms have recently gained traction in B2B markets, primarily driven by incumbent companies (MIT Initiative on the Digital Economy, 2021). In fact, incumbents leverage well-established relationships, assets, and networks that non-incumbents do not have to overcome the typical challenges associated with platforms' adoption, including users' onboarding (e.g., chicken-egg problem) and users' interactions (e.g., management of totally-new relationships) (Dell'Era et al., 2021).

As a result, companies in B2B markets increasingly interact on platforms and exchange data-driven information, products, and services for new value creation (Hein, Weking, et al., 2019; Jovanovic et al., 2021). However, despite this push, how data-centric B2B platforms create value remains a poorly structured theme (Hein, Weking, et al., 2019; Jovanovic et al., 2021) for four main reasons.

First, the influence of data-centric B2B platforms on companies' strategies remains unclear (Hein, Schreieck, et al., 2019). Indeed, traditional linear companies encounter specific challenges to match the advent of data-centric B2B platforms, which are not fully investigated

(Cozzolino et al., 2021). These approaches and challenges include controlling various aspects of their businesses (e.g., supply chain, distribution, customer relationships) from a platform perspective (Hermes et al., 2021). Additionally, traditional companies must address organizational rigidity and structural inertia when transitioning from linear to non-linear value creation (Hermes et al., 2021).

Second, relationships in data-centric B2B platforms involve sides who are both data sources and consumers (Trabucchi et al., 2017), as well as a heterogeneous set of actors including technology partners, integration support partners, and resource integrators sustaining data management (Abendroth et al., 2021). The presence of multifold users managing data within data-centric B2B platforms is not sufficiently taken into consideration by the extant literature. Consequently, a categorization of who are the users managing data within data-centric B2B platforms is missing.

Third, relationships in data-centric B2B platforms are aimed at managing multiple data (Trabucchi et al., 2017), but the literature does not delve into what this data management consists of. Consequently, we do not know which are the specific data-based activities allowing to create value within data-centric B2B platforms (Lyko et al., 2016).

Fourth, relationships in data-centric B2B platforms have to be governed to simplify data management, complementary assets' integration, and collaborative innovations development (Hein, Weking, et al., 2019; Koenen & Falck, 2020). Despite scholars framed which are the governance mechanisms within platforms (Hein, Weking, et al., 2019; Jovanovic et al., 2021), the extant studies focused on platform attributes that serve as governance mechanisms. Instead, a relationship-based approach to governance mechanisms, intended not as mere platform attributes but as a way to regulate specific relationships among specific sides, is required (De Reuver et al., 2018).

The insufficient addressing of these four issues by the extant platforms literature complicates the understanding of how data-centric B2B platforms create value (Hein, Weking, et al., 2019; Jovanovic et al., 2021; Laczko et al., 2019; Li et al., 2021). Therefore, to address these issues we formulate the following research questions:

i) *"Who are the sides managing data within data-centric B2B platforms?"*
ii) *"What kind of activities do the sides perform to manage data within data-centric B2B platforms?"*
iii) *"How relationships aimed at managing data are governed within data-centric B2B platforms?"*

## 3. Research methodology

From a methodological viewpoint, a multiple case study was used (Yin, 2014). This qualitative investigation method is employed to explore emerging and complex phenomena (Stake, 1995), as platform innovations (Hein, Weking, et al., 2019; Jovanovic et al., 2021; Tian et al., 2021). Therefore, this research strategy is appropriate for clarifying value creation in data-centric B2B platforms. Moreover, we opted for a multiple case study as opposed to a single case study to build an enhanced generalizable theory via comparison and replication of findings across different cases (Yin, 2014). This approach aligns with the recommendations of previous scholars who have emphasized the use of multiple case studies for analyzing platform businesses (e.g., De Reuver et al., 2018).

### 3.1. Sample

For the cases' selection, the authors employed a literal replication logic (Yin, 2014) and sampled three data-centric B2B platforms, namely MindSphere, Skywise, and Open-es (Table 1). These platforms were chosen as critical and extreme cases with the expectation of producing similar findings based on four sampling criteria. First, these platforms connect multiple players in various B2B sectors. As these companies operate successfully in their respective markets and come from different sectors, the risk of industry bias in generalizing findings can be mitigated (Hermes et al., 2021). Second, these platforms establish relationships through digital technologies (e.g., Internet of Things, Big Data), hence favoring data management. Therefore, the study of these cases can unveil what is deemed as "the full potential of platform-based business models", that "can only be realized if companies collaborate and share data" (Leminen et al., 2023). Third, all three platforms exhibit relationships typical of transactional MSPs and innovation platforms, thus allowing to understand both transactional and innovation platforms' value creation mechanisms. Fourth, these platforms reflect incumbents' approaches towards data-centric B2B platforms, which are more effective than initiatives promoted by small players (Dell'Era et al., 2021).

**Table 1**
Case profile.

| | MindSphere | Skywise | Open-es |
|---|---|---|---|
| Application business and incumbent promoter | Manufacturing industry (Siemens Group) | Aviation (Airbus Group) | Heavy industry (Eni S.p.A.) |
| Platform scope | Acquire and manipulate data for accelerating industrial digital transformation | Acquire and manipulate data for improving operations efficiency | Acquire and manipulate data for supporting sustainable transition |
| Release date | 2017 | 2017 | 2021 |

### 3.2. Data collection

The data collection process employed both primary and secondary data sources to enrich the analysis with diverse perspectives, mitigate biases, and enhance the overall robustness and validity of the study (Eisenhardt & Graebner, 2007; Yin, 2014).

According to De Reuver et al. (2018), investigating digital platforms present methodological challenges in accessing empirical data. Indeed, few studies provide an in-depth understanding of digital platforms from an internal perspective. Conversely, most research relies on interviews with complementors or collects data from an external viewpoint. To address this challenge, De Reuver et al. (2018) propose analyzing diverse data sources on platform activities, as press releases, tech blogs, and developer forums. In line with these recommendations, we adopted a similar data collection strategy for our study.

Secondary data were gathered from two main data sources. On the one hand, a variety of official materials was used to provide comprehensive insights on the B2B platforms under investigation. These sources included official platforms' websites, developers' portals, guidelines, corporate blogs, brochures, YouTube and LinkedIn channels, as well as official press releases. On the other hand, independent material such as articles from the academy, the press, and specialized magazines in digital innovation, as well as webinars, reviews, and "how tos" released by third-party associations and platforms' users were examined. This two-fold approach in data collection served two main purposes. First, these data provided contextual information regarding the role of Siemens, Airbus, and Eni in B2B platforms. Second, these data outlined the specific characteristics of MindSphere, Skywise, and Open-es, hence shedding light on the main mechanisms enabling interactions and value creation. Secondary data search strategy started by seizing the official webpages connected to both the platforms and the incumbents owning the platforms. All the web links included in official webpages (e.g., links to press release, developers' portals, corporate blog, guidelines, YouTube and LinkedIn official profiles) were systematically analyzed. Each functionality within the platforms was examined and ad hoc searches were conducted on the web to locate relevant articles, industrial reports, and brochures. The collected material from each platform was meticulously organized in a text file. This file documented the web link to the

data source and included significant sentences that contributed to explain the specific characteristics for the specific case. Supplementary information regarding the secondary data collection process can be found in Appendix A.

Primary data, i.e., direct interviews with users involved in platforms, confirmed and expanded notions achieved through the analysis of secondary data. The interviewed users included the director of the association coordinating MindSphere users; a business partner - external to Siemens - involved in MindSphere; a customer representative from Skywise; the main program manager of Open-es. The conversations were based on a semi-structured protocol interview aiming to address two primary objectives. First, questions about the roles of sides, data, platform architecture, governance and value creation mechanisms were asked for sustaining replication. Second, questions to investigate specificities of individual platforms were foreseen (e.g., role of "Cross-Tenancy" functionality for MindSphere, Skywise Store in Skywise, and Development Hub evolution in Open-es). Conducted through online communication platforms, the interviews lasted approximately 45–60 min and were recorded and transcribed for accurate analysis. Memos were also written during the interviews to capture additional insights and facilitate the generation of further questions. More detailed information regarding the primary data collection process can be found in Appendix B.

### 3.3. Data analysis

The data analysis followed a two-step approach, as recommended by Eisenhardt and Graebner (2007) and Yin (2014).

The first step involved a within-case analysis, which aimed at gaining a comprehensive understanding of the individual configurations of MindSphere, Skywise, and Open-es. For each case, a narrative history portrait was developed, along with a descriptive schema, to depict the various sides interacting with the platforms. Multiple rounds of data collection were conducted to ensure clarity and prevent any potential areas of misunderstanding during the within-analysis process.

The second step of the data analysis involved a cross-case analysis to compare the characteristics of the different platforms and identify similarities, differences, and patterns. Following the literal replication logic (Eisenhardt & Graebner, 2007), the platforms' characteristics were examined, and evidence was contrasted with existing platform literature. To facilitate this analysis, the authors held discussion meetings supported by comparative tables.

Both the within-case and cross-case analyses involved data coding, which entails a manual organization of the data into first-order categories, second-order themes, and aggregate dimensions (Fig. 1). This coding process helped in structuring the data and identifying key patterns and insights.

The first-order categories were derived from the analysis of the raw data, which included both the secondary and primary data. First, we identified the relevant phrases from the secondary data that directly addressed the RQs. This ensured alignment between the first-order categories and the terminology used by platform owners and users. Once the initial set of first-order categories was formed based on the secondary data, it was further examined and refined using the primary data. A detailed line-by-line analysis of the interview transcripts validated and augmented the initial insights obtained from the secondary data. This iterative analysis process facilitated the development of reliable and comprehensive first-order categories.

Then, first-order categories were organized around second-order themes. Second-order themes reflect concepts from platforms and digital innovation literatures (e.g., "innovation in business models", "data integration and interoperability"). Thus, the organization of first-order categories in second-order themes allowed us to link empirical data with theoretical concepts. In this way, our findings were grounded in both empirical evidence and scientific theory.

Finally, second-order themes were grouped within aggregate dimensions, which were informed by the existing platform literature (Hein, Weking, et al., 2019; Trabucchi et al., 2017; Trabucchi & Buganza, 2021). This approach facilitated the identification of connections and patterns among the second-order themes. Specifically, "platform's side" was retrieved as an aggregate dimension encompassing the multifold actors and roles actively involved in data management (Abendroth et al., 2021; Trabucchi et al., 2017). Then, two other aggregate dimensions were defined, i.e., "governance mechanisms" and "value creation mechanisms". Governance mechanisms are control tools, platform rules, and boundary resources (e.g., shared techniques, technologies, and interfaces) that facilitate interactions and coordination between sides for value creation (Hein, Weking, et al., 2019; Jovanovic et al., 2021). Value creation mechanisms are the output of relationships and exchanges between sides of the platforms (Hagiu & Wright, 2015; Trabucchi et al., 2017). Both governance and value creation mechanisms exhibited specific peculiarities with reference to two key activities in data management, i.e., data acquisition and data manipulation. Specifically, data acquisition results from the sides' onboarding, use, and interaction in the platforms, as well as from the connection of sides' assets to the platforms (Trabucchi et al., 2017). Data manipulation involves instead the processing and transformation of data into insightful knowledge to support decisions, operative problem solving, and improvement in offerings and business models (Grover et al., 2018; Li et al., 2021; Trabucchi et al., 2017).

## 4. Findings

This paragraph illustrates how MindSphere, Skywise, and Open-es relate different sides to create value through data management.

Table 2 comprehensively presents the characteristics of MindSphere, Skywise, and Open-es according to the coding scheme. Then, a brief summary of each case is provided to discuss Table 2. Finally, in Appendix C, we also detail MindSphere, Skywise, and Open-es behaviors as transactional and innovation platforms.

### 4.1. MindSphere

MindSphere, developed by Siemens, is an Internet of Things (IoT) platform that operates on the cloud and enables industrial users to leverage data for various industrial applications (Marheine & Pauli, 2020; Pauli et al., 2020).[1]

Users participating in MindSphere can be grouped around a client side, a provider side, and an enabler side (Fig. 2)[1]. The client side consists of Original Equipment Manufacturers (OEMs) and industrial end-users who connect and manage their assets through the platform. OEMs utilize real data on end-users' machine adoption to enable new business models, such as personalized service contracts. Industrial end-users leverage the platform's data processing capabilities to optimize processes and implement data-driven operational strategies like predictive maintenance. An OEM representative highlighted the benefits of joining the platform, stating: *"Once the data is in the platform, data can travel and be shared. As a machine builder, I have motors and drives that I*

[1] Siemens PLM Software, 2018. "Whitepaper - MindSphere: The cloud-based, open IoT operating system for digital transformation" http://www.siemens.com.tw/release/pdf/MindSphere_Whitepaper_EN.pdf accessed on June 28th 2022.Siemens, n.d. "Become a partner" https://siemens.mindsphere.io/en/partner/become-a-partner accessed on June 28th 2022.Innovation Post, 2018. "MindSphere, il sistema operativo aperto per realizzare l'Industrial Internet of Things". https://www.innovationpost.it/2018/06/26/mindsphere-il-sistema-operativo-aperto-per-realizzare-lindustrial-internet-of-things/ accessed on June 28th 2022.Innovation Post, 2021. "MindSphere World, l'importanza di fare ecosistema per il rilancio del sistema industriale". https://www.innovationpost.it/2021/10/29/mindsphere-world-limportanza-di-fare-ecosistema-per-il-rilancio-del-sistema-industriale/ accessed on June 28th 2022.

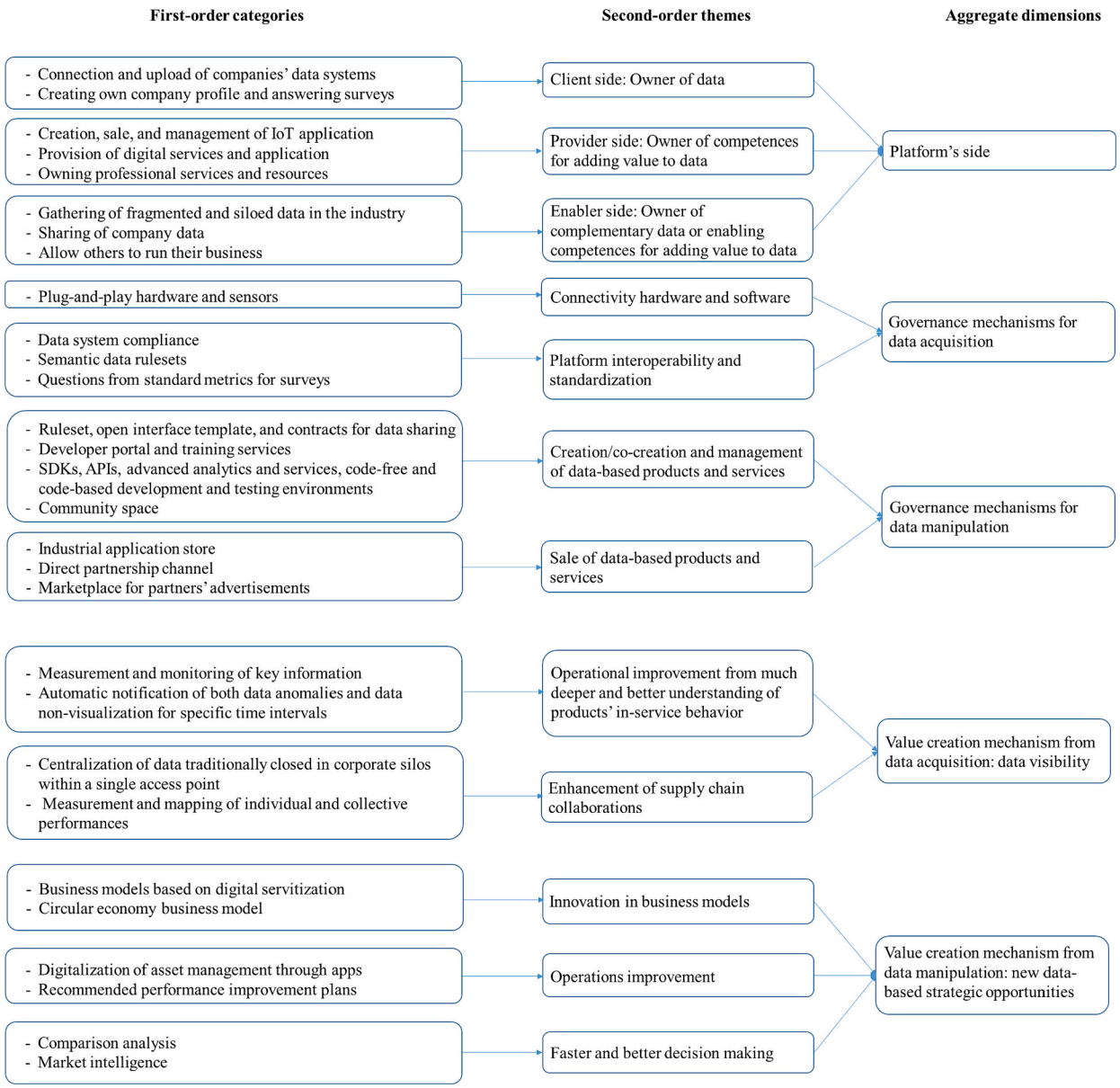


**Fig. 1.** Data analysis: coding.

*install on my lines. I receive data from these drives and motors, and for me as an OEM it is very interesting"*. Indeed, MindSphere allow data acquisition in a simple way, thanks to standardization, as reported by an OEM: *"MindSphere is an example of a platform that is becoming a standard, and this fact that MindSphere is moving towards a standard allows us to run the software as a service business model because towards my final client the app is customed for my machines but we deploy it on a standard platform so you don't have to worry that it's sitting in a non-scalable fragile infrastructure, it's sitting in a scalable standard platform and this creates some peace of mind for all users as it makes the app distribution much easier"*. Standardization as a governance mechanism has been reported also by a MindSphere manager: *"MindSphere acts as an unbounded information field and each landlord owns his own tenant. There is a MindSphere semantic, in the sense that MindSphere has its own way of modeling data so that when I bring my data into my MindSphere tenant, I bring it organized in a way that is the same way of other MindSphere users, so MindSphere has a standard in terms of how data is stored which is a requirement, a condition for us to start exchanging data"*. It is important to note that the standardization provided by MindSphere concerns the whole set of devices and applications empowered by the platform, as explained by the OEM: *"I have cases where the whole line has automation components from Rockwell Automation but the app that the customer uses is ours and runs in MindSphere. That is a winning point because MindSphere is not closed to the Siemens world"*. In summary, the client side gains advantages from MindSphere by connecting assets and capitalizing on data for business opportunities. To achieve these advantages, the client side can (1) utilize IoT applications made available by the provider side in the MindSphere application store, or (2) develop its own applications (that can eventually be distributed via the MindSphere application store) with the support of the enabler side. In both cases, digital applications allow for new business models, as reported by the OEM: *"Through IoT apps we can accompany our customer throughout the useful life of the line he bought from us, so there is a long-term relationship with the customer and it's not a relationship that ends the moment the customer starts the machine and then we only re-view for problems or needs a spare part, but being connected 100% of the time we accompany the customer"*. This opens up opportunities to charge for the machine sale with additional business models, such as service level agreements. At this regard, the OEM describes the following scenario: *"I sign a service contract with a customer. I tell you to pay me for the machine and therefore the machine is yours and I guarantee you that during its useful life (15-20*

**Table 2**
Findings.

| | MindSphere | Skywise | Open-es |
|---|---|---|---|
| Platforms' sides: | | | |
| Client side | OEMs and industrial end-users possess data on plants and processes | Airlines and aviation suppliers possess data on flights' behavior and health status | Industrial and energy companies possess and generate data on their sustainability performances |
| Provider side | Third-party developers offer digital applications in a store and as a managed services | Third-party developers offer digital applications and services in a store | Third-party service providers offer sustainability-oriented enterprise solutions in a marketplace |
| Enabler side | Systems integrators and connectivity developers equip the platform with infrastructures and modules for exchanging data and running digital applications | | Public, ESG, trade, rating, and financial institutions equip the platform with additional data and/or require data from the platform |
| Governance mechanisms for data acquisition: | | | |
| Connectivity hardware and software | MindConnect suite of hardware and software for connection of plants and machines to the clients' cloud infrastructure | Flight Operations and Maintenance Exchanger (FOMAX) hardware for on-board data-capture/ transmission | No need for connectivity hardware or software |
| Platform interoperability and standardization | MindConnect API and MindConnect LIB for support of standard communication protocols; MindSphere Semantic for integration of data from different sides regardless of source, size, and format | Interoperability-oriented platform design via compatible communication protocols; Skywise Ontology for harmonizing terminology with standards and definitions that work for all the sides | Interoperability-oriented platform design via AI algorithms assuring same treatment for different types of reports; Dynamic questionnaire for acquisition of same information by different sides |
| Governance mechanisms for data manipulation: | | | |
| Creation/co-creation and management of data-based products and service | Operator and Developer Cockpits, Mendix, SDKs, APIs, How Tos, developer community for application development; MindSphere Ecosystem Manager simplifying contract template for data sharing | SDKs, APIs, Skywise Academy, code free environments and machine learning studios for application development | Community space for discussion |
| Sale of data-based products and services | MindSphere Store as a marketplace for application sale; MindSphere Ecosystem Manager as a marketplace for advertisement of projects needing for partners; MindSphere Launchpad as a direct partnership channel making available digital applications for private exchange between clients and providers | Skywise Store as a marketplace for application sale; Skywise Core X as a direct channel offering infrastructure for collaborative projects | Development Hub as a marketplace for advertisement of partners |
| Value creation mechanisms form data acquisition: | | | |
| Data visibility at individual and value chain level for operational improvement and enhancement of supply chain collaborations | Visualization of operative data previously not measured/ monitored | Visualization of operative data previously not measured/ monitored; Better information sharing among all players within aviation supply chain | Better information sharing among all players within a value chain |
| Value creation mechanisms from data manipulation: | | | |
| Identification of strategic opportunities in business models, operations, and decisions | Servitization business models; Operative optimization (e.g., energy consumption) | Operative optimization (e.g., predictive maintenance); Data-driven decision on design processes, fleets, schedule, and workflow | Circular economy business models; Implementation of recommended plans aimed at advancing measured sustainability performances; Data-driven decision on offering configuration |

*years) it will have an OEE of 92% and you don't have to worry about nothing, all spare parts, interventions on the site are included and we are both connected to the machine. You have to pay me an annual fee of X in which I guarantee you that the machine will always be at 92% OEE; if it exceeds 92% you pay me a premium on the service level agreement amount, if it falls below 92% there is a penalty for me and you pay me less"*.

The provider side of MindSphere comprises two types of third-party application developers. Firstly, there are developers who create, sell, deploy, and support standard or customized IoT applications based on or integrated with MindSphere. This is confirmed by the official MindSphere whitepaper, which states: *"MindSphere provides a solid foundation for applications and data-based services from Siemens and third-party providers"*[1]. The foundation includes development environments, software development kits (SDKs), application programming interfaces (APIs), and tools to assist developers in building and managing applications. These applications can be sold through an application store, which features both Siemens and third-party offerings. Secondly, there are developers who *"offer applications as managed services"*[1], catering to the specific business and project needs of clients. These developers specialize in cloud or on-premise solutions. They access a direct partnership channel and an advertising marketplace (i.e., Ecosystem

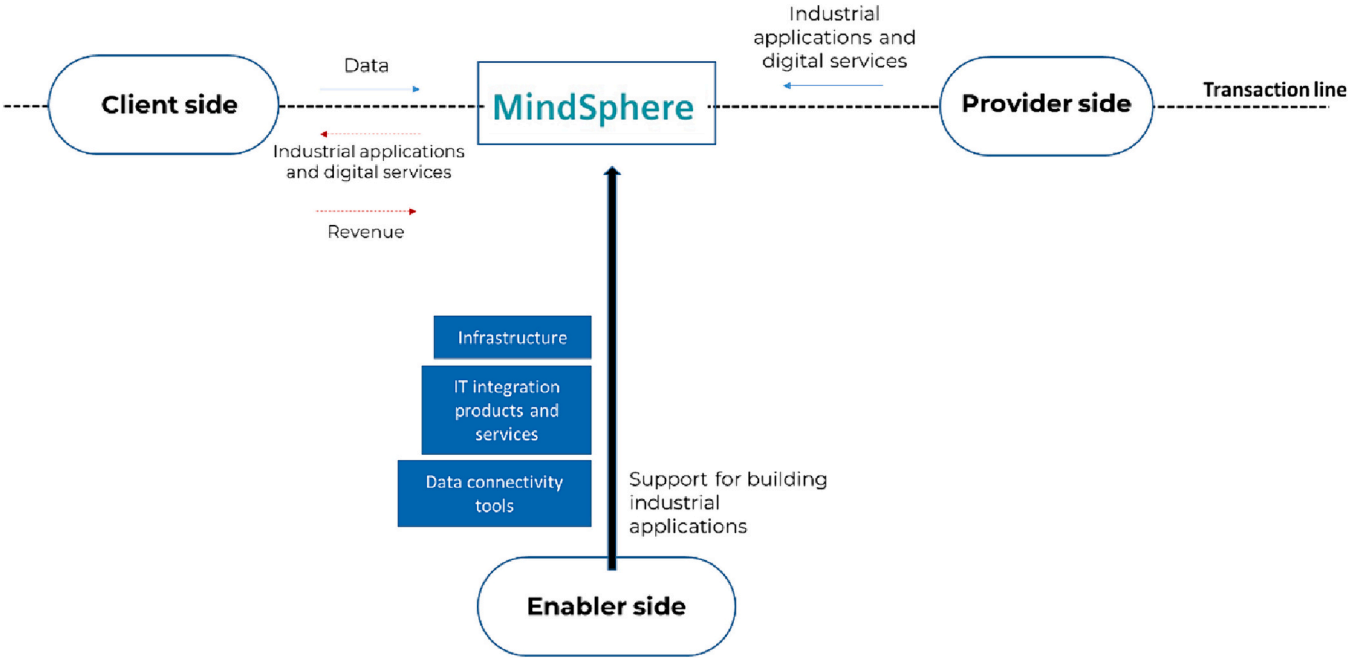


**Fig. 2.** MindSphere platform.

Manager) to connect with potential customers. In summary, the provider side benefits from MindSphere by gaining access to data, tools, and a market that enables the creation, deployment, and management of industrial applications. This notion aligns with previous literature, as Pauli et al. (2020) stated: *"MindSphere […] offers third parties to create, test and sell applications, and to access data. […] The side of solution providers […] create[s] value by developing apps, implementing use cases or making their domain-specific knowledge available"*. To connect the client and provider sides for manipulating data through app development, rulesets and contract templates for data sharing are provided by the platform, as reported by a MindSphere manager: *"To exchange data we establish tenant sharing agreements in MindSphere. Then contracts are established very quickly with the MindSphere 'cross-tenacy' function in which the sharing of my tenant's data with another tenant is requested. This establishes a collaboration agreement and when both parties accept the terms then MindSphere automatically allows data sharing, without the need for connectors or bridges because the data was already there, separated by a barrier and the agreement broke down the barrier. In this way, I can make data available to my customers, suppliers, a company that does data analytics, and I can collaborate on the data […]. If the company that owns the data in its MindSphere tenant wants to use a digital service (whether it bought it on the store, or made it for itself, or bought it from a company that sells it door to door), it downloads a MindSphere app into its MindSphere tenant, and then the app can insist on the tenant's data, which remains there and you agree that the app can have access to the data and with that data it generates a service. So I, the owner of the machines and assets, have the data and their ownership and someone gives me the algorithm (which is the app) which insists on the data and this is the key to the MindSphere ecosystem"*.

The enabler side of MindSphere consists of various players who enable the parties involved to effectively utilize the platform. This includes system integrators and connectivity developers who ensure the technical integration of clients' diverse data sources into MindSphere. Additionally, technology providers offer clients specialized tools or analytic modules for MindSphere, while infrastructure as a service (IaaS) providers offer deployment architectures tailored to clients' requirements. As noted by Pauli et al. (2020), the MindSphere ecosystem encompasses a significant level of complexity due to the multitude of enablers and their diverse functions and interests. The enabler side benefits from MindSphere by gaining access to a wide range of industrial clients, and it provides support to both clients and providers in developing industrial applications. For instance, a MindSphere manager explained: *"MindSphere can be available as a solution within a cloud infrastructure managed by the customer. In this case, thanks to the MindSphere network, the customer engages an IaaS provider who supplies the necessary capabilities, hardware, and software. The expertise provided by system integrators is crucial for implementing these solutions"*. Examples of enablers for MindSphere include Microsoft Azure, Amazon Web Services (AWS), Atos, SAP, and Alibaba Cloud. Such enablers are needed for data acquisition, as explained by an OEM: *"To connect our lines to MindpShere we have an edge computing device and in almost 100% of case it is a Siemens device but it might as well not be. Then, the IoT app takes data from the ERP, MES, and from the machine. So in every project we do the end customers ask to integrate the data that comes from these different levels with our app. Therefore we have to talk to system integrators, i.e. with SAP if it is SAP that provided them [the customers, ndr.] with the ERP, or with the hundreds of system integrators who have MES solutions. So our app takes data from all these layers"*. The result of data acquisition activity is explained by a MindSphere manager, who stated that connecting assets allows users to gain visibility into internal processes, exchange data with OEMs and industrial end users, and access more mature information technology for better monitoring. This enhanced visibility enables users to identify anomalies, exceedance of thresholds, and unexplored areas for improvement. The manager explains: *"Before, it was not possible to measure energy consumption, but now that it is possible, it has been noticed that energy consumption can vary greatly from one day to the next. This enables easier intervention to resolve the situation and optimize the system. In this way, not only you can better manage existing operations with greater speed, precision, and shorter reaction times, but you can also explore new opportunities and manage previously unaddressed aspects"*.

### 4.2. Skywise

Skywise is an open cloud-based data platform developed by Airbus (Chang et al., 2019) for stimulating aviation supply chain cooperation. This is possible by centralizing industry information usually locked in corporate silos and by leveraging digital services and data-based applications.

Skywise platform participants belong to a client side (i.e., aviation

customers and suppliers) and to a provider side (i.e., business partners and developers),[2] as illustrated in Fig. 3.

Aviation customers (i.e., airlines) and suppliers (e.g., manufacturers of various aviation components), represent the Skywise's client side. These participants utilize the platform to exchange specific data related to both Airbus and non-Airbus flights in real-time. For instance, airlines share their operational and maintenance data, while manufacturers provide details about their equipment and components. By sharing these data, they gain access to digital services and applications available on the platform's application store, which can help them address operational challenges. Specifically, airlines benefit from Skywise by accessing anonymized datasets and benchmark metrics enabling them to compare their performance with industry standards. This allows them to identify opportunities for improvement across various aspects of their operations, including processes, fleets, and components. On the other hand, suppliers can make more informed decisions and enhance the reliability, quality, and performance of their manufacturing processes through data sharing and analysis. Here it is reported the testimony of an aviation customer: *"Instead of having multiple tools to manipulate data, we do possess now a single, secured, cloud-based, BI platform"*.[3] Hence, clients engage in data acquisition by sharing their aviation data for a *"much deeper and better understanding of [products'] in-service behavior, which generates shared value for Airbus, aircraft, suppliers"*. This concretizes in recognition of *"trends that require early actions"*, as well as in faster simultaneous work and communication *"on the same data that is a single point of truth"*. Data acquisition by clients is governed through platform interoperability with users' existing IT infrastructures (Izzo, 2019), as no *"strong specific skills to work on Skywise"* are required. Moreover, connectivity hardware for less advanced aircrafts (Chang et al., 2019) increase data deriving from *"onboard sensors"* provided by the platform owner. Finally, an ontology harmonizes the terminology and *"integrate [s] in one single place different types of data regardless of source, size, and format, allowing to link the data together, […] maintain the data in a more robust way, and […] re-use the analysis and applications developed"*.

The provider side consists of business partners, such as IT consulting firms and developers who offer value-added digital services and applications tailored to the aviation industry. These services include access to datasets, automated reporting, interactive performance dashboards, and benchmarking capabilities. Digital services and applications generate insights for faster and better decision making as well as for productivity gains in operation and design activities, influencing *"design office, operations, support services"* through *"data-driven decisions"*. Indeed, clients leverage applications *"to solve operational business and issues"*, thus improving several operational areas, such as health monitoring and asset utilization. As reported by Harvard Business School (2020), Skywise *"provides tools for users to prepare, aggregate, analyze data and templates to create applications inside the platform"*[2]. Providers are supported in their application development efforts by having access to aviation data and *"a powerful range of cutting-edge tools to manage the lifecycle of their apps, from their inception all the way through their deployment to a customer"*.[4] These tools include development environments and an application marketplace. In particular, a great opportunity for developers to deliver valuable applications is *"opening the Skywise platform"* by giving *"developers and integrators access to extensive digital aviation data"*. This potential for application development has been acknowledged by previous researchers studying Skywise. For example, Zutshi and Grilo (2019) reported: *"These data enable third party developers to develop a variety of different applications such as predictive & preventative maintenance, operational efficiency, aircraft performance, and reporting for regulatory bodies"*. Once developed, *"the first application store ever in the industry"* hosts applications created by providers and by Airbus, and allows for the sharing of applications specifically co-developed by clients and providers with the wider community.

### 4.3. Open-es

Open-es is the community-oriented platform powered by Eni for measuring, sharing, and improving sustainability data across companies engaged in sustainable development.[5]

The sides that Open-es aims to connect are a client side, an enabler side, and a provider side (Fig. 4).

As for the client side, each company can act on the platform both as a supplier and as a customer, depending on the role played in the value chain. Clients benefit from Open-es through the systematic handling of their sustainability data. This occurs on the platform by creating own ESG profile, by sharing data with enablers, and by assessing sustainability performance through simple questions aimed at quantifying sustainability readiness level. Clients engage in this process by responding to simple questions that are designed to quantify the sustainability readiness level. These assessments are conducted at both the individual company level and the value chain level, allowing for a comprehensive understanding of sustainability performance, as commented by an Open-es manager: "*You have a series of questions, but it's not like you say I have 100 questions and I have to answer these 100 questions. So an SME can answer 10 and is unable to answer the others, or perhaps, from the answers it gives to the first 10, the system realizes that it does not make sense to ask for the next ones. It is a dynamic path, it's not just filling out the static questionnaire*". Additionally, Open-es governs relationships for data acquisition by addressing two main problems that arise when

[2] Harvard Business School, 2020. "Skywise: Airbus bet on big data" https://digital.hbs.edu/platform-digit/submission/skywise-airbus-bet-on-big-data/ accessed on March 19th 2022.Airbus, 2019. "Expanding reach of the Airbus Services portfolio" https://aircraft.airbus.com/en/newsroom/news/2019-06-expanding-reach-of-the-airbus-services-portfolio accessed on March 19th 2022. Aviator, 2018. "Airbus extends Skywise to suppliers" https://newsroom.aviator.aero/airbus-extends-skywise-to-suppliers/ accessed on March 19th 2022.Airbus, 2018. "Airbus extends Skywise to suppliers" https://www.airbus.com/en/newsroom/press-releases/2018-07-airbus-extends-skywise-to-suppliers accessed on March 19th 2022.Airbus, 2021. https://www.jmfrri.gr.jp/content/files/Open/2021/20211004_RRI%20Sympo/D3-2_Mr.%20Hubert%20Tardieu.pdf accessed on May 28th 2023.

[3] LinkedIn, n.d. https://www.linkedin.com/posts/airbus-skywise_skywise-airbus-activity-6896360234366177280-k911?utm_source=share&utm_medium=member_desktop

[4] LinkedIn, n.d. https://www.linkedin.com/posts/airbus-skywise_airbus-skywise-activity-6864140083402952705-jnIM?utm_source=share&utm_medium=member_desktop

[5] Rinnovabili, 2021. "Open-es, per la collaborazione e lo sviluppo sostenibile delle filiere" https://www.rinnovabili.it/green-economy/green-market/open-es-piattaforma-digitale-transizione-energetica/ accessed on June 28th 2022. Digital 360, 2021. "Open-es: Eni promuove collaborazione e sostenibilità nelle filiere energetiche" https://www.digital4.biz/supply-chain/visibility-e-collaboration/collaborazione-e-sostenibilita-ecosistema-filiere-energetiche-open-es-eni/ accessed on June 28th 2022.Il Sole 24 Ore, 2021. "Open-es, la piattaforma aperta a tutte le imprese per un ecosistema sostenibile" https://www.ilsole24ore.com/art/open-es-piattaforma-aperta-tutte-imprese-un-ecosistema-sostenibile-AEEJuI0 accessed on June 28th 2022.Techedge, 2021. "Techedge e Open-es: reporting ESG automatico, una leva trasformativa per le imprese" https://www.techedgegroup.com/it/blog/techedge-e-open-es-reporting-esg-automatico-una-leva-trasformativa-per-le-imprese accessed on June 28th 2022. Corriere Romagna, 2023. "Open-es, la piattaforma che guida le imprese verso la sostenibilità" https://www.corriereromagna.it/open-es-la-piattaforma-che-guida-le-imprese-verso-la-sostenibilita/ accessed on May 28th 2023.InnovationPost, 2022. "Open-es, la piattaforma che unisce imprese, procurement e banche per la sostenibilità dell'intero ecosistema" https://www.innovationpost.it/sponsored-content/open-es-la-piattaforma-che-unisce-imprese-procurement-e-banche-per-la-sostenibilita-dellintero-ecosistema/ accessed on May 28th 2023.

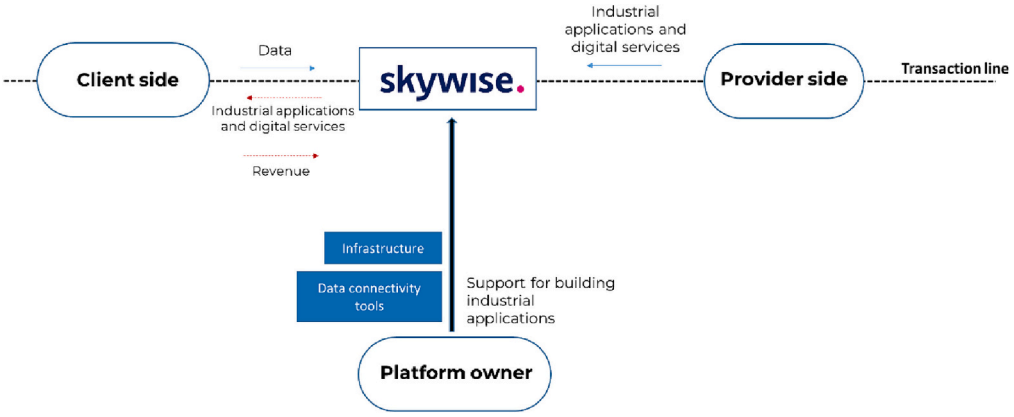


**Fig. 3.** Skywise platform.

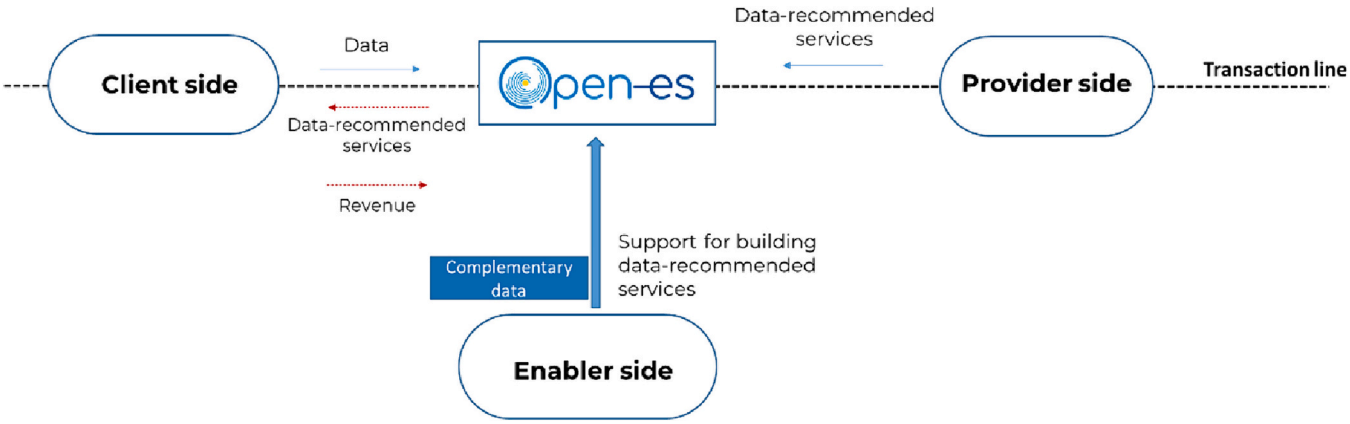


**Fig. 4.** Open-es platform.

completing traditional questionnaires: *"One, the request for info is experienced as a bureaucratic practice and to avoid a rejection behavior Open-es has been designed with a view to gamification, progressive improvement. The second problem is the proliferation of different measurement methods (we can do 10 questionnaires, all possibly valid to measure the sustainability performance of companies). So we rely on a standard model […], on the stakeholder capitalisms metrics of the WEF and on the anticipations of the EFRAG model"*. Hence, relationships for data acquisition are governed through gamification and standardization. To further support data acquisition, clients engage with the enabler side to *"exchange information in mutual way and authorize data access without duplications"*. By systematizing their data on the platform, clients can optimize internal reporting and stakeholders' accreditation. This is the comment provided by an Open-es manager at this regard: *"For example, Rina is a supplier of We Build, Iveco, Autostrade, therefore it is a supplier of several players on the platform. So the sharing of Rina's sustainability profile with its customers is facilitated on the platform. On the other hand, Rina wants to collect data from its suppliers and it can use the platform to this aim. Then, when Rina carries out assessments or certifications, it needs to collect the info on its customers who are companies that are suppliers of others. Having the data uploaded once and analyzing them with modern tools enabled by Open-es, is the advantage - it removes bureaucracy and simplifies the process of those who have to share their data and gives the possibility to have everything within the same platform up to an evaluation of the supply chain. So for example We Build has Rina as its supplier, and according to the European directive for corporate sustainability and due diligence, it is required that We Build takes care of its entire supply chain. And to do this, if you don't have a platform like Open-es that contains all of these data, it is difficult to manage this information"*. In addition to the systematic organization and sharing of sustainability data, the Open-es platform offers clients access to statistics and benchmarks. This feature assists clients in identifying strengths, weaknesses, and areas for improvement related to sustainable development, both within their own company and throughout their value chain. By facilitating data quantification and providing aggregated insights, the platform encourages clients to connect with one another and with providers. This connection allows for the operationalization of the insights provided by data analysis. Furthermore, the platform integrates a marketplace that enables connections between clients and providers. Through this marketplace, clients can collaborate with each other and with providers to implement sustainability development plans and share experiences within a community network. As a clients in Open-es reports: *"the Open-es platform is a real community in which to share experiences and paths undertaken, with the aim of leaving no one behind in the creation of a common sustainable value"*[5]. These are the community's characteristics as illustrated by an Open-es manager: *"Here companies discuss doubts, clarifications, needs. It is a sort of advanced forum, where they can get in touch with the team of Open-es and experts who support companies in finding solutions. Moreover, we host an open experience sharing session where you can share with peers a project done for employees or for the environment or for the local community. This creates inspiration also for others who may be in other sectors but can draw cue. Accordingly, we resume the best experiences (the ones with the most votes, because there is also the possibility of leaving likes on the experiences) and advertise them also outside of Open-es, such as on LinkedIn or with events, to give even more pride"*. It is worth noting that the community is governed through an open policy: *"The platform shifts the focus from a simple questionnaire or measurement path to evaluating how I am positioned, what is my benchmark, where the areas of strength and points for improvement are, who can I ask for*

*support, who can I compare myself to if I haven't understood certain things, and therefore the community effect that is created within the platform stimulates the improvement of ESG performance. The data and the ESG profile remain the property of the company that uploaded it and then with a click as if it were on a social network decides who to share it with".*

The enabler side consists of public institutions, organizations involved in ESG reporting, trade associations, rating providers, and financial institutions. These stakeholders are interested in measuring ESG performance throughout their stakeholders' value chains. Enablers, who already possess or require clients' sustainability data, provide access to sustainability data related to their stakeholders. In turn, they gain comprehensive visibility of ESG information across all levels of their stakeholders' value chains, eliminating the need for data duplication. By exporting and integrating Open-es information into their corporate management systems (e.g., procurement, vendor management, and credit risk), enablers can effectively manage their existing businesses. Indeed, the platform provides a direct way for enablers to engage with clients. In this way, the process of data sharing, which would typically involve non-standardized reports or formats, is simplified. As explained by the Open-es manager: *"Companies can obtain an automatic acquisition of data from other platforms. Examples are the carbon disclosure program or even specific cases (e.g., customer says 'I answered the questionnaire from my customer's vendor management system'), or category initiatives. Opening is also intended as an integration with other platforms, so if the company has already uploaded the data to another initiative and this initiative is associated with Open-es, then there may be a mutual exchange between Open-es and this initiative (either the data is on Open-es and you want to put it on the other initiative or it is on the other initiative and you want to put it on Open-es). Therefore, there is a theme of IT integration of platforms which is a distinctive and focal point".*

The provider side contains innovative realities in the ESG field offering their solutions for sustainable development (e.g., training, consulting, and certification companies, circular economy and energy efficiency experts). Providers leverage Open-es to showcase their services on a marketplace and on a community. Hence, through Open-es, providers have a more streamlined approach to connect with clients, supporting them in performing sustainable development plans. An example of client-provider relation is reported by an Open-es manager: *"Once it has reached a good level of information coverage with a click I can automatically create, for example, a draft of a sustainability report, which is a service provided by Esego, a player joining the platform with a technology for creating sustainability reports. And there everything is automatic, the data that the company has entered on Open-es speaks to the Esgeo platform which elaborates a draft of a sustainability report".* Esego is an example of provider joining the platform through the Development Hub, i.e., a marketplace with *"players who are experts in the ESG field"* supporting the matching between providers and clients. Additionally, Open-es gives providers valuable market intelligence. Indeed, through access to statistics and aggregated data on sustainability performance, providers can gather insights that facilitate optimizing their offerings and identifying new business opportunities. This data-driven approach allows providers to enhance their understanding of market needs, adapt their services accordingly, and stay at the forefront of sustainable development practices.

## 5. Discussion

This paper investigates how data-centric B2B platforms create value by allowing sides' relationships to actively and collaboratively manage data (Gawer, 2021; Hein et al., 2020).

The result of our study is resumed in the data-centric B2B platform model described in Fig. 5, which defines how to create value within data-centric B2B platforms. In particular, the model highlights within two distinct layers of value creation both the transactional behavior and the innovation behavior covered by data-centric B2B platforms.

Within the first layer of value creation, the platform's goals of measuring and aggregating data are the foundation upon which the sides can perform transactions and innovations. In particular, within this layer, clients owning the data relate with enablers owning the resources to transfer the data on the platform. As a result, the data acquisition activity is performed. The clients-enablers relationship is governed by the platform via specific mechanisms and creates value through enhanced data visibility on products, processes, and performance (Grover et al., 2018; Li et al., 2021).

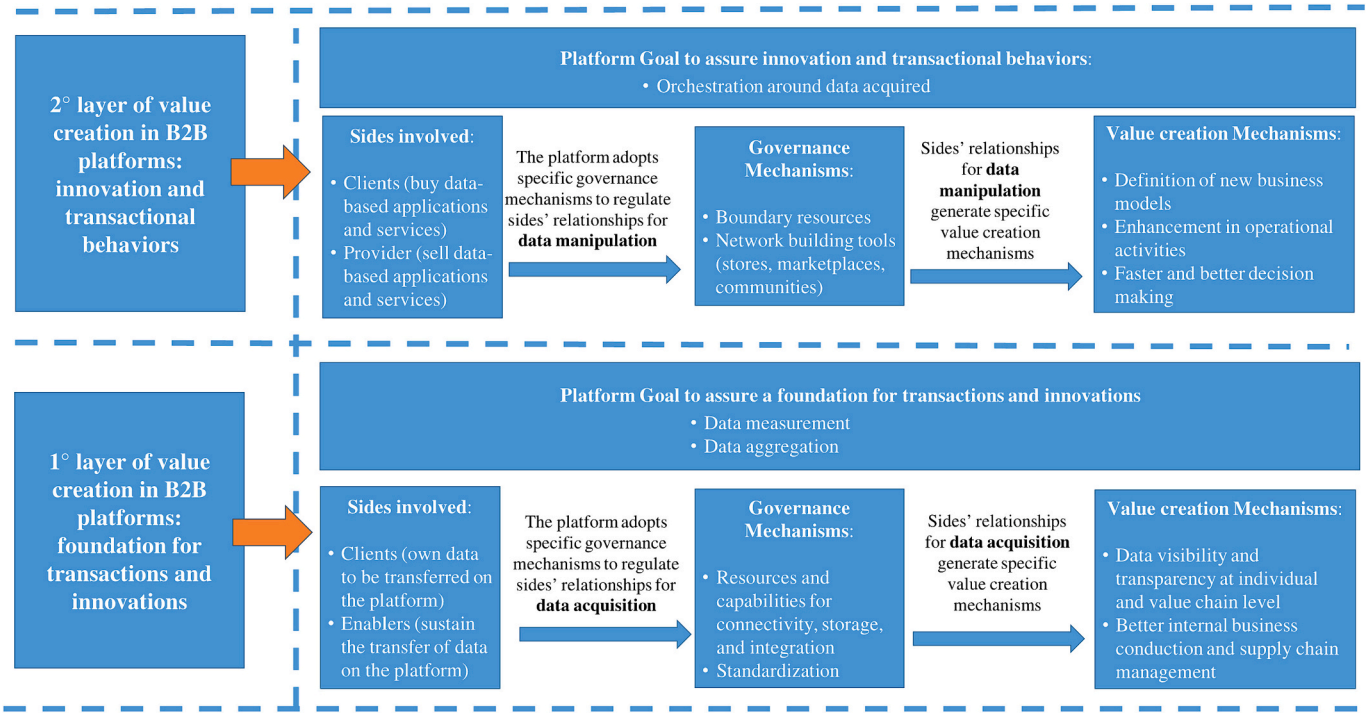


**Fig. 5.** Data-centric B2B platform model.

Within the second layer of value creation, both the transactional and innovation behaviors are evident. Indeed, the platform allows for the co-created knowledge deriving from data to be transformed into business models innovation, operations optimizations, and better decision making (Acharya et al., 2018; Grover et al., 2018; Li et al., 2021). This is possible through the providers-clients relationship to manipulate data. In particular, providers develop data-based products (i.e., digital applications) and services (i.e., data-recommended business services) to be sold to clients based on data manipulation. Hence, B2B platforms firstly stimulate innovation by facilitating the development of data-based products and services, and secondly induce transactions of the data-based products and services.

### 5.1. 1st layer of value creation

The platform-based approach of the first layer of value creation allows clients and enablers to seamlessly amalgamate diverse data sources within a platform, allowing for a comprehensive and holistic view across individual assets and entire value chains. In this way, platforms transcend the limitations of a traditional linear approaches by facilitating data acquisition with greater efficiency as compared to conventional linear methodologies. This is possible thanks to the platforms' unique ability to centralize and unify disparate data sources within a single access point. Indeed, data centralization within platforms establishes a unified truth, laying the foundation for streamlined communication and information sharing across stakeholders. As a consequence, the platform-based approach drives operational efficiencies and uncovers strategic opportunities that are otherwise unattainable through traditional linear methods.

These two propositions define the first level of value creation:

*Proposition 1: "The relationship among clients and enablers allow data acquisition and is governed through resources and capabilities for connectivity, storage and integration as well as standardization".*

*Proposition 2: "The data-centric B2B platform performs the data measurement and data aggregation goals to allow value creation in the form of data visibility and transparency at individual and value chain level, as well as better internal business conduction and supply chain management".*

*Platform Goal*

In the first layer of value creation, data acquisition is performed. The platform sustains this activity with the aim of measuring and aggregating data. Data measurement goal assists the transformation of unstructured information into useful data (Grover et al., 2018; Waller, 2020). We argue that this is possible via sensors and interfaces connected to users' assets as well as via questions to be filled by users, as in our cases. Data aggregation goal facilitates the upload and storage of data scattered in different data sources within a unique data pool from which extracting business value (World Economic Forum, 2017). We argue that this is possible by means of cross-organizational data sharing and exchange, as in MindSphere and Skywise. To achieve its goals, the platform leverages governance mechanisms.

*Governance mechanisms*

Governance mechanisms implemented by the platform during data acquisition favor relationships for capturing data from the assets and from the users. On the one hand, connectivity hardware and software, open interfaces, professional training and services allow sides' relationships to acquire data directly from the assets, as in MindSphere and Skywise. With this consideration, we deepen Sjödin et al. (2021) who recognized resources and capabilities for connectivity, storage, and integration as important governance mechanisms. In particular, we assess that connectivity resources and capabilities are a specific type of governance mechanism sustaining relationships for acquiring data directly from the assets. On the other hand, standardization helps in complying information, as the cases demonstrated with the provision of data rulesets (in MindSphere and Skywise) and questions (in Open-es). These mechanisms assured acquisition and integration of data directly from the users. Therefore, we extend Hein, Weking, et al., 2019, Hein, Schreieck, et al. (2019) considerations about the use of standardization by platforms. While they view at standardization as a mean to support the integration and aggregation of already structured data, we found that standardization can be used to measure data from unstructured information. Specifically, we assess that standardization is a specific type of governance mechanism supporting relationships for acquiring data directly from the users.

*Value creation*

Data acquisition creates value through greater data visibility and transparency at individual and value chain levels. Indeed, data acquisition allows clients for a complete visibility of their assets by measuring and monitoring key information. This turns, for MindSphere and Skywise, in the evaluation of previously unmeasured data (e.g., assets' energy consumption) as well as in the better management of data already measured but not monitored (e.g., assets' health status). Therefore, the value created through data acquisition arises from a deeper and improved understanding of assets' in-service behavior. Consequently, operations are enhanced by identifying new, faster, and more precise measures for operational improvements. In this way, issues can be addressed and systems can be optimized based on previously unmeasured and/or unmonitored data. In accordance with our findings, also previous works emphasize internal transparency as a benefit of data-centric B2B platforms due to faster and easier information access (Elia et al., 2020). Relatively to data visibility at value chain level, Skywise and Open-es are ideal examples illustrating how data visibility improves also value chain collaborations. In fact, the centralization of data owned by different stakeholders within a single access point creates a unified source of information, establishing a single point of truth for communication and data sharing. Therefore, data acquisition generate value through full visibility, access, and visualization of information along all levels of the value chains and among different stakeholders. Hence, the combination of internal and external data sources generates expanded and networked knowledge (Elia et al., 2020; Li et al., 2021). As a result of making products, processes, and performance data visible and transparent to multiple sides, better internal business conduction and supply chain management arise (Grover et al., 2018; Li et al., 2021; Urbinati et al., 2019). This concretizes into operative cost reduction and strategic opportunities (Acharya et al., 2018; Elia et al., 2020; Grover et al., 2018), performed by all the three cases.

### 5.2. 2nd layer of value creation

The platform-based approach of the second layer of value creation allows clients and providers to relate for developing and transacting products, services, and knowledge based on the acquired data. Platforms orchestrate interactions among the sides allowing them to combine resources and skills actively, fostering a two-sided market with cross-side network effects. This enables the development and exchange of applications and resources needed for data-based improvement actions. Achieving similar results in a traditional linear way would be considerably challenging as linear value chains usually comprises limited interaction points, siloed operations, and reduced potential for collaborative innovation, resulting in expensive efforts for the sides to relate for creating value.

These two propositions define the second level of value creation:

*Proposition 3: "The relationship among clients and providers allow data manipulation and is governed through boundary resources as well as network building tools".*

*Proposition 4: "The data-centric B2B platform performs the goal of orchestrating resources around the data acquired to allow value creation in the form of definition of new business models, enhancement in operational activities, and faster and better decision making".*

*Platform Goal*

In the second layer of value creation, data manipulation occurs to generate and exchange products, services, and knowledge based on data (Laczko et al., 2019; Urbinati et al., 2019). This is what happened with

industrial apps released in MindSphere and Skywise and with improvement development plans released in Open-es. In this layer of value creation, the platform goal is to orchestrate ongoing interactions around the acquired data (Abendroth et al., 2021). This is possible by allowing the sides to easily combine their resources and skills to take an active part in the innovation and transactional processes (Laczko et al., 2019). To this aim the platform creates a two-sided market leveraging cross-side network effects (Hein et al., 2020; Koenen & Falck, 2020). In such market users can build and exchange applications, as in the cases of MindSphere and Skywise, and/or find the resources and competences needed to implement data-based improvement actions, as in the case of Open-es.

*Governance mechanisms*

The platform governs data manipulation relationships through resources designed for handling communication and optimizing the distribution of data-based knowledge and complementary innovations (Cenamor et al., 2019; Gawer, 2021; Hein, Weking, et al., 2019). Specifically, on the one hand there are boundary resources, such as SDKs, APIs, connectivity devices, interfaces, rulesets, data sharing agreements. They have been leveraged by MindSphere and Skywise to sustain the release of data-based digital services and applications. On the other hand, there are functional resources, as the platform-integrated stores and marketplaces within all the cases. We argue that these functional resources orchestrate communities to develop network building (De Marco et al., 2019). While this finding is in line with the existing literature, our study also proposes an important advancement. We spot that network building can be further improved by the platform through the utilization of data. This is evident in Open-es case, where development plans jointly created by clients and providers are recommended by the platform based on data analysis. This is in line with the considerations of Trabucchi et al. (2017), who argue that data can increase efficiency in platform internal processes, core product, or services for a deeper and ongoing users' engagement. Specifically, we advance Trabucchi et al. (2017) considerations by asserting that the manipulation of vast amount of data gathered by the platform can enhance its' transactional behavior. This results in data-driven matching and data network effects that augment the value of relationships and transactions among sides (Bhargava et al., 2020; Grover et al., 2018; Li et al., 2021).

*Value creation*

The second layer of value creation generates value by identifying business opportunities based on data-derived knowledge. This is possible though the building and sharing of data-based complementary applications (Gawer, 2021; Hein, Weking, et al., 2019), as in the cases of MindSphere and Skywise. In addition to confirming that value creation can result from a direct manipulation of data, i.e., from the use of data to realize data-based application, we provide also a novel contribution. We assess that data can create value via an indirect manipulation, i.e., by triggering the identification of actions needed to improve the values assumed by the data, as in the case of Open-es.

We define three business opportunities deriving from direct and indirect use of data, namely new business models definition, operational activities enhancement, and faster and better decision making.

New business models result from sides' interaction to manipulate data (Abendroth et al., 2021), as in MindSphere (e.g., personalized service contracts according to asset use, supply of semi-finished products and spare parts according to real-time necessity, consulting services on asset employment) and Open-es (e.g., circular economy business models involving the whole value chain). This is in line with Koenen and Falck (2020) who consider platforms as accelerators of new business models. Moreover, we advance the current literature by unpacking two main pathways for business model innovation. On the one hand, there is the enrichment of traditional business models with data insights, as in Open-es case, where development plans made companies' business models more sustainable. On the other hand, there is the creation of new offerings based on data availability, as in MindSphere case. Here, the access to assets' data allowed users to offer new digital services.

Alongside to business strategy, also operations are impacted by data manipulation, thus creating value. Indeed, users in MindSphere and Skywise developed new services based on digital applications to improve their internal operational processes. Indeed, in MindSphere and Skywise, clients can digitalize asset management processes through the use of various applications (Stolwijk et al., 2019). These applications are designed to optimize operations and improve overall asset performance. For example, in MindSphere, clients can leverage apps that focus on energy data management to achieve cost reductions. Similarly, in Skywise, clients can utilize applications that enable predictive maintenance. Accordingly, value creation results in digital servitization, as data are manipulated to provide advanced services for an internal use (Jovanovic et al., 2021). Moreover, also Open-es's clients optimize operations by implementing development plans to enhance the values assumed by data. With this result, we advance literature streams asserting that platforms' intermediation increase process efficiency through digitalization (Koenen & Falck, 2020). In particular, we spot that platforms stimulate sides to interact for manipulating data and thus obtaining operational benefits (Elia et al., 2020; Tian et al., 2021).

Finally, the third value creation mechanism from data manipulation is a better and faster decision making (Cenamor et al., 2019; Elia et al., 2020), as happened in Skywise and Open-es. Specifically, in Skywise case users from various sides of the platform can compare their own performance with industry ones (Izzo, 2019). In this way, it was possible to simplify decision making as regard opportunities' identification across design processes, fleets, schedule, and workflows. Instead, in Open-es, providers are empowered to make faster and more data-driven decisions through market intelligence. By leveraging statistics and aggregated data from clients, providers gain valuable insights on emerging trends and community needs, useful to optimize the offerings and respond to market demands more effectively. With these results, we extend the findings of Srinivasan (2021) from B2C to B2B platforms. He asserted that B2C platforms facilitate decision-making by bridging the information asymmetry between users through close-looping of information flows. We note that this happens also in B2B platforms and we argue that the faster and better decision making results not only from the provision of data by the platform, but also from the manipulation of data within the platform.

## 6. Conclusion

The paper investigates how data-centric B2B platforms create value by addressing three distinct RQs, namely who are the sides managing data within data-centric B2B platforms, what kind of activities do the sides perform to manage data within data-centric B2B platforms, and how relationships aimed at managing data are governed within data-centric B2B platforms. The analysis of three cases of data-centric B2B platforms allowed to answer these three RQs. Specifically, the data-centric B2B platform model provided in Fig. 5 highlights that clients, providers, and enablers relate for realizing two types of data-based activities, i.e., data acquisition and manipulation, which are recognized as input factors for value creation (Tian et al., 2021). Specifically, the model shows that data-centric B2B platforms pursuit different goals and use specific governance mechanisms to stimulate sides' relationships for creating value through data acquisition and manipulation.

### 6.1. Theoretical implications

The paper features three main contributions within the platform literature.

The primary contribution of this article lies in providing a comprehensive characterization of the sides managing data within data-centric B2B platforms. This aspect has received limited attention in the existing literature (Abendroth et al., 2021; Trabucchi et al., 2017), which focused on so-called “static” elements pertaining with platform sides, as pricing and network effects (Gawer, 2021). Instead, Gawer (2021)

emphasizes the significance of analyzing the number and the composition of the connected sides. Accordingly, our first contribution explains how platform sides configure in reference to data-centric B2B platforms where sides are all actively involved in the transformation of data into value. Specifically, we defined the client, provider, and enabler sides, illustrating their roles and exchanges within data-centric B2B platforms. The client side is defined as the side that possesses and/or generates data and can enhance the value of data through platform-mediated interactions. The provider side is instead defined as the side that natively possesses the resources and expertise to increase the value of data and utilizes the platform to monetize this capability by engaging with the client side. It is worth noting that the client side can also enhance data value through client-client relationships, leveraging platform tools for value creation. Finally, the enabler side is defined as the side allowing data transfer on the platform and/or possessing data complementary to that of clients. The definition of the enabler side represents one of the major contributions of our article within the platform literature (Cusumano et al., 2019). Specifically, we argue that enablers facilitate the work of providers by reducing the transaction costs for the providers, as they offer resources (i.e., infrastructure and data) that the provider could not develop independently. Furthermore, since the resources provided by enablers are not specific to a particular business relationship and are easily transferable, enablers reduce the typical contractual dependency existing between providers and clients. In this way, enablers decrease the need for providers to make relationship-specific investments (Williamson, 1985), i.e., investments made by providers in the economic relationship with the clients that would lose their value if the relationship were to end. Consequently, the flexibility and adaptability within sides' relationships is increased thanks to enablers (Yang et al., 2019), and the pressure for the platform owner to establish high data governance mechanisms and technological infrastructure is reduced (Sun & Zhong, 2020). Hence, while the main literature on platforms focuses on the need for providers to perform relationship-specific investments to create value (Chen et al., 2017), we assert that the presence of enablers reduces the need for providers to perform relationship-specific investments for creating value within data-centric B2B platforms.

The second major contribution of the article consists in deepening the concept of data management in data-centric B2B platforms, which have remained relatively unexplored (Leminen et al., 2023; Lyko et al., 2016). We examined the two key types of data-based activities within data-centric B2B platforms, i.e., data acquisition and data manipulation, indicating how they trigger value creation (Tian et al., 2021). Data acquisition results from sides' onboarding, use, and interaction within platforms as well from connection of sides' assets to the platform (Trabucchi et al., 2017). Following data acquisition, data manipulation supports decisions and improves the offering with insightful knowledge (Trabucchi et al., 2017).

The third contribution lies in the examination of the governance of data-based relationships in data-centric B2B platforms. We found that governance mechanisms for data acquisition involve clients and enablers to ensure the proper collection and integration of data, while governance mechanisms for data manipulation involve clients and providers to facilitate the development and exchange of data-based products and services. Hence, while the existing research mainly focused on how to manage simultaneous collaboration and competition with complementors in traditional platforms (Chen et al., 2022; Jovanovic et al., 2021), we identified governance mechanisms typical of data-centric B2B platforms that ensure the effective performance of data-based activities among all sides.

### 6.2. Managerial implications

The paper provides managerial suggestions to the increasing share of companies willing to participate in existing data-centric B2B platforms and/or develop own data-centric B2B platforms (Hermes et al., 2021; World Economic Forum, 2017).

First, we described how to join in existing data-centric B2B platforms. Specifically, we identified the categories of actors involved in data-centric B2B platforms, namely the client, provider, and enabler sides. We also elucidated the nature of their relationships, focusing on the distinct activities of data acquisition and manipulation. Additionally, we outlined the specific value creation mechanisms arising from each type of relationship. These insights support B2B companies in understating opportunities and profiting from existing platforms. Specifically, understanding the categorization of sides and their activities enables informed decisions regarding platform participation, strategic resource investment, and strategic collaborations.

Second, our analysis advises companies who are interested in building data-centric B2B platforms. At this regard, we investigated how specific governance mechanisms facilitate interactions and value creation. With this result, we provided a comprehensive list of core elements to be considered when designing B2B platforms (i.e., resources and capabilities for connectivity, storage, and integration, standardization techniques, network building tools, boundary resources). Furthermore, we defined three key practices that companies can perform on data-centric B2B platforms to behave as platform owners. First, the platform owner can compete with the sides for the supply of the products and services needed to data management. This is the case of Siemens, which released its own data collection services (as enablers) as well as its own digital applications (as providers) within MindSphere. Second, the platform owner can cooperate with the sides for the supply of the products and services needed to data management. This is the case of Eni, which performed data analyses to assure the convergence of the interests among all the sides involved in Open-es, without providing any complementary product or service. Third, the platform owner can coopete with the sides for the supply of the products services needed to data management. This is the case of Airbus, which, on the one hand, cooperated with Skywise clients by providing complementary data, and on the other hand, competed with Skywise providers by offering data-based applications.

### 6.3. Limitations and future research avenues

The paper features some limitations inspiring further research avenues. First, the research considers only three cases operating in industrial productive environments. The analysis of platforms in other sectors can augment findings generalizability, together with quantitative studies. Second, the research analyzed three incumbents. Future research may consider SME's or start-ups' approaches towards data-centric B2B platforms. Moreover, the evolution in platforms' configuration is worthy of deepening through longitudinal studies. Third, this study focuses on value creation in platforms. Further research can investigate also value capture, which should be examined in detail (Hein et al., 2020). Fourth, we considered only data-centric platforms where the sides actively engage in the acquisition and manipulation of data to create value on the platform. Further studies can verify the applicability of our findings to other types of platforms where data are only transacted (e.g., data marketplaces).

## CRediT authorship contribution statement

**Ilaria Mancuso:** Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Antonio Messeni Petruzzelli:** Supervision, Validation. **Umberto Panniello:** Validation, Visualization.

## Data availability

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

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.indmarman.2024.04.001.

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