Understanding Data Spaces: A Systematic Mapping Study of Foundations, Technical Building Blocks, and Sectoral Adoption

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Set of primary studies classified on facets

Table 1: Primary studies facet classification

Reference	Title	Year	Research Type	Building Blocks	Sector
Stier et al. [1]	Ontology-Based Battery Production Dataspace and Its Interweaving with Artificial Intelligence-Empowered Data Analytics	2024	Validation	Data Value Creation Enablers (Data Offering - Reuse)	Manufacturing
Ordóñez-Martínez et al. [2]	Defining the Balearic Islands' Tourism Data Space: An Approach to Functional and Data Requirements	2024	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Tourism
Ordóñez-Martínez et al. [3]	Toward Establishing a Tourism Data Space: Innovative Geo-Dashboard Development for Tourism Research and Management	2024	Solution	Data Value Creation Enablers (Value Creation Services - Reuse)	Tourism
Bellini et al. [4]	Data Sources and Models for Integrated Mobility and Transport Solutions	2024	Conceptual	Data Interoperability (Data Models - Reuse)	Mobility
Li et al. [5]	Collaborative Model-Based Systems Engineering Using Dataspaces and SysML v2	2024	Solution	Data Interoperability (Data Models - Reuse)	Manufacturing
Coppolino et al. [6]	Building Cyber-Resilient Smart Grids with Digital Twins and Data Spaces	2023	Evaluation	Data Interoperability (Data Exchange - Reuse), Data Value Creation Enablers (Value Creation Services - New)	Energy
Volz et al. [7]	On the Role of Digital Twins in Data Spaces	2023	Validation	Data Interoperability (Data Models - Reuse), Data Value Creation Enablers (Value Creation Services - New)	Green Deal
Falcão et al. [8]	A Reference Architecture for Enabling Interoperability and Data Sovereignty in the Agricultural Data Space	2023	Validation	Data Interoperability (Data Models - Reuse), Data Sovereignty (Usage Control - Reuse), Data Value Creation Enablers (Value Creation Services - NA)	Agriculture
Koppelaar et al. [9]	A Digital Product Passport for Critical Raw Materials Reuse and Recycling	2023	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Green Deal
Gil et al. [10]	Context-Aware Policy Analysis for Distributed Usage Control	2022	Validation	Data Sovereignty (Usage Control - New)	Energy
Usländer et al. [11]	Symbiotic Evolution of Digital Twin Systems and Dataspaces	2022	Solution	Data Interoperability (Data Models - Reuse), Data Value Creation Enablers (Value Creation Services - New)	Manufacturing
Niccolucci et al. [12]	Populating the Data Space for Cultural Heritage with Heritage Digital Twins	2022	Solution	Data Interoperability (Data Models - New)	Cultural Heritage
Janev et al. [13]	Responsible Knowledge Management in Energy Data Ecosystems	2022	Solution	Data Value Creation Enablers (Data Offering - Reuse, Pub. and Discovery - Reuse), Data Interoperability (Data Models - Reuse)	Energy
Pedrazzoli et al. [14]	Challenges and Founding Pillars for a Manufacturing Platform to Support Value Networks Operating in a Circular Economy Framework	2022	Conceptual	Data Interoperability (Data Exchange - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse)	Manufacturing

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Table 1: Primary studies facet classification *(continued)*

Reference	Title	Year	Research Type	Building Blocks	Sector
Frey et al. [15]	Bauhaus.MobilityLab: A Living Lab for the Development and Evaluation of AI-Assisted Services	2022	Solution	Data Interoperability (Data Exchange - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse)	Energy
Stojanovic et al. [16]	Methodology and Tools for Digital Twin Management — The FA3ST Approach	2021	Validation	Data Interoperability (Data Models - New), Data Value Creation Enablers (Value Creation Services - Reuse)	Manufacturing
Usländer et al. [17]	Smart Factory Web — A Blueprint Architecture for Open Marketplaces for Industrial Production	2021	Evaluation	Data Value Creation Enablers (Pub. and Discovery - Reuse, Value Creation Services - New), Data Interoperability (Data Models - Reuse, Data Exchange - Reuse)	Manufacturing
Nativi et al. [18]	Digital Ecosystems for Developing Digital Twins of the Earth: The Destination Earth Case	2021	Solution	Data Value Creation Enablers (Value Creation Services - NA)	Green Deal
Munoz-Arcentales et al. [19]	Data Usage and Access Control in Industrial Data Spaces: Implementation Using FIWARE	2020	Validation	Data Sovereignty (Usage Control - New, Identity Management - Reuse), Data Interoperability (Data Exchange - Reuse)	Agriculture
Kotsev et al. [20]	From Spatial Data Infrastructures to Data Spaces — A Technological Perspective on the Evolution of European SDIs	2020	Opinion	Data Interoperability (Data Models - Reuse)	Green Deal
Cuno et al. [21]	Data Governance and Sovereignty in Urban Data Spaces Based on Standardized ICT Reference Architectures	2019	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Mobility
Alonso et al. [22]	Industrial Data Space Architecture Implementation Using FIWARE	2018	Validation	Data Interoperability (Data Exchange - Reuse), Data Value Creation Enablers (Pub. and Discovery - Reuse), Data Sovereignty (Identity Management - Reuse, Usage Control - Reuse)	Manufacturing
Meyer zum Felde et al. [23]	Extending Actor Models in Data Spaces	2023	Solution	Data Sovereignty (Identity Management - New, Trust Framework - Reuse)	Generic
Jaberansary et al. [24]	Analyzing Distributed Medical Data in FAIR Data Spaces	2023	Solution	Data Value Creation Enablers (Data Offering - Reuse, Pub. and Discovery - Reuse)	Healthcare
Fotiou et al. [25]	Data integrity protection for data spaces	2024	Validation	Data Sovereignty (Trust Framework - New, Identity Management - New)	Mobility
Marino et al. [26]	Enabling Compute and Data Sovereignty with Infrastructure-Level Data Spaces	2023	Validation	Data Interoperability (Data Exchange - New)	Healthcare
Langer et al. [27]	Towards a Data Space for Interoperability of Analytic Provenance	2023	Conceptual	Data Interoperability (Prov. and Traceability - Reuse)	Generic
Pomp et al. [28]	SPACE_DS: Towards a Circular Economy Data Space	2023	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Generic
Boukhers et al. [29]	Enhancing Data Space Semantic Interoperability through Machine Learning: a Visionary Perspective	2023	Conceptual	Data Interoperability (Data Models - Reuse), Data Value Creation Enablers (Data Offering - Reuse, Value Creation Services - Reuse)	Generic
Le Phuoc et al. [30]	Towards a Decentralized Data Hub and Query System for Federated Dynamic Data Spaces	2023	Validation	Data Interoperability (Prov. and Traceability - New), Data Value Creation Enablers (Pub. and Discovery - Reuse)	Mobility

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Table 1: Primary studies facet classification *(continued)*

Reference	Title	Year	Research Type	Building Blocks	Sector
Brost et al. [31]	An Ecosystem and IoT Device Architecture for Building Trust in the Industrial Data Space	2018	Validation	Data Sovereignty (Usage Control - New, Identity Management - Reuse), Data Interoperability (Data Exchange - Reuse)	Generic
Ahmadian et al. [32]	Extending model-based privacy analysis for the industrial data space by exploiting privacy level agreement	2018	Conceptual	Data Sovereignty (Trust Framework - New)	Generic
Klug and Prinz [33]	Fair prices for sustainability in agriculture and food. Requirements and design options for a data-based transparency system	2023	Solution	Data Interoperability (Prov. and Traceability - NA), Data Sovereignty (Identity Management - Reuse, Usage Control - Reuse)	Agriculture
Deshmukh et al. [34]	Requirements and Building Blocks for Manufacturing Dataspaces	2023	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Manufacturing
Sang et al. [35]	Predictive Maintenance in Industry 4.0	2021	Solution	Data Interoperability (Data Exchange - Reuse, Prov. and Traceability - Reuse)	Manufacturing
Breidenbach et al. [36]	Development of a flexible and interoperable architecture to customize clinical solutions targeting the care of multimorbid patients	2023	Solution	Data Value Creation Enablers (Value Creation Services - NA)	Healthcare
Paulus et al. [37]	The PLASMA Framework: Laying the Path to Domain-Specific Semantics in Dataspaces	2023	Solution	Data Interoperability (Data Models - New), Data Value Creation Enablers (Value Creation Services - New)	Mobility
Anthony Jnr. [38]	Applying Enterprise Architecture for Digital Transformation of Electro Mobility towards Sustainable Transportation	2020	Solution	Data Value Creation Enablers (Value Creation Services - NA), Data Interoperability (Data Exchange - Reuse)	Mobility
Pinto et al. [39]	Data Spaces Based Approach for B2B Data Exchange: A Footwear Industry Case	2023	Solution	Data Value Creation Enablers (Value Creation Services - NA)	Manufacturing
Neubauer et al. [40]	Architecture for Manufacturing-X: Bringing Asset Administration Shell, Eclipse Dataspace Connector and OPC UA together	2023	Solution	Data Value Creation Enablers (Value Creation Services - Reuse), Data Interoperability (Data Models - Reuse)	Manufacturing
Alexopoulos et al. [41]	An industrial data-spaces framework for resilient manufacturing value chains	2023	Solution	Data Value Creation Enablers (Data Offering - Reuse, Value Creation Services - Reuse), Data Interoperability (Data Models - Reuse)	Manufacturing
Auñón et al. [42]	Evaluation and utilisation of privacy enhancing technologies — A data spaces perspective	2024	Validation	Data Sovereignty (Trust Framework - New)	Healthcare
Pinheiro et al. [43]	Industrial Information Sharing 4.0	2022	Solution	Data Interoperability (Data Exchange - Reuse)	Manufacturing
Farahani and Monsefi [44]	Smart and collaborative industrial IoT: A federated learning and data space approach	2023	Solution	Data Sovereignty (Trust Framework - Reuse)	Manufacturing
Corte-Real et al. [45]	Blockchain technology and universal health coverage: Health data space in global migration	2022	Conceptual	Data Interoperability (Prov. and Traceability - Reuse)	Healthcare
Lahti et al. [46]	The Concept of Urban Mobility Innovation Environment for Data-Driven Service Development	2023	Solution	Data Interoperability (Data Exchange - Reuse)	Mobility
Landolfi et al. [47]	A MaaS platform architecture supporting data sovereignty in sustainability assessment of manufacturing systems	2019	Conceptual	Data Interoperability (Prov. and Traceability - Reuse), Data Sovereignty (Usage Control - New), Data Value Creation Enablers (Value Creation Services - New)	Manufacturing
Wolfert et al. [48]	Digital innovation ecosystems in agri-food: design principles and organizational framework	2023	Experience	Data Value Creation Enablers (Value Creation Services - NA)	Agriculture
Michikata et al. [49]	Applying Homomorphic Encryption to Data Spaces	2023	Validation	Data Sovereignty (Trust Framework - New)	Mobility

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Table 1: Primary studies facet classification *(continued)*

Reference	Title	Year	Research Type	Building Blocks	Sector
Nast et al. [50]	Work-in-Progress: Towards an International Data Spaces Connector for the Internet of Things	2020	Solution	Data Interoperability (Data Exchange - New)	Generic
Somma et al. [51]	Digital Twin Space: The Integration of Digital Twins and Data Spaces	2023	Validation	Data Interoperability (Data Models - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse)	Mobility
Iñigo et al. [52]	Towards Standardized Manufacturing as a Service through Asset Administration Shell and International Data Spaces Connectors	2022	Solution	Data Interoperability (Data Models - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse)	Manufacturing
Sayad and Lemoine [53]	Towards Cross-domain Resilience in SDN-enabled Smart Power Grids: Enabling Information Sharing through Dataspaces	2023	Solution	Data Value Creation Enablers (Value Creation Services - NA), Data Interoperability (Prov. and Traceability - Reuse)	Energy
Sarabia-Jácome et al. [54]	Seaport Data Space for Improving Logistic Maritime Operations	2020	Validation	Data Value Creation Enablers (Value Creation Services - NA), Data Interoperability (Data Exchange - Reuse), Data Sovereignty (Identity Management - Reuse, Usage Control - Reuse)	Mobility
Qarawlus et al. [55]	Sovereign Data Exchange in Cloud-Connected IoT using International Data Spaces	2021	Validation	Data Interoperability (Data Exchange - Reuse)	Mobility
Vassilev et al. [56]	Towards First Urban Data Space in Bulgaria	2022	Experience	Data Value Creation Enablers (Value Creation Services - NA), Data Interoperability (Data Exchange - Reuse), Data Sovereignty (Identity Management - Reuse)	Mobility
Volz et al. [57]	An Industrial Marketplace - the Smart Factory Web Approach and Integration of the International Data Space	2019	Solution	Data Interoperability (Data Exchange - Reuse, Data Models - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse, Pub. and Discovery - Reuse), Data Sovereignty (Usage Control - Reuse)	Manufacturing
Klîmek et al. [58]	Atlas: A Toolset for Efficient Model-Driven Data Exchange in Data Spaces	2023	Solution	Data Interoperability (Data Models - New)	Generic
Matsunaga et al. [59]	ITDT: International Testbed for Dataspace Technology	2023	Solution	Data Value Creation Enablers (Value Creation Services - NA)	Generic
Kalogeropoulos et al. [60]	EdgeDS: Data Spaces enabled Multi-Access Edge Computing	2023	Validation	Data Value Creation Enablers (Value Creation Services - New)	Mobility
Krasteva et al. [61]	How Federated Machine Learning Helps Increase the Mutual Benefit of Data-Sharing Ecosystems	2023	Solution	Data Value Creation Enablers (Value Creation Services - Reuse)	Mobility
Balint and Truong [62]	On Supporting Contract-Aware IoT Dataspace Services	2017	Validation	Data Sovereignty (Usage Control - New)	Generic
Karagiannis et al. [63]	Data Sovereignty at the Edge of the Network	2023	Validation	Data Value Creation Enablers (Value Creation Services - NA)	Energy
Pullmann et al. [64]	Ontology-based information modelling in the industrial data space	2017	Solution	Data Value Creation Enablers (Data Offering - Reuse)	Manufacturing
Elia et al. [65]	A Data Space for Climate Science in the European Open Science Cloud	2023	Solution	Data Value Creation Enablers (Value Creation Services - NA)	Green Deal
Berenguer et al. [66]	From Research on Data-Intensive Software to Innovation in Data Spaces: A Search Service for Tabular Data	2024	Experience	Data Value Creation Enablers (Pub. and Discovery - New)	Generic
Karacic [67]	Europe, we have a problem! Challenges to health data-sharing in the EU	2022	Opinion	Data Sovereignty (Trust Framework - Reuse)	Healthcare

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Table 1: Primary studies facet classification *(continued)*

Reference	Title	Year	Research Type	Building Blocks	Sector
Regazzoni et al. [68]	SECURED for Health: Scaling Up Privacy to Enable the Integration of the European Health Data Space	2024	Solution	Data Sovereignty (Trust Framework - Reuse)	Healthcare
Meneguzzo et al. [69]	Shaping the Future of Energy Markets: Federated Systems and Blockchain Synergy	2024	Solution	Data Interoperability (Prov. and Traceability - New), Data Sovereignty (Identity Management - Reuse)	Energy
Yang et al. [70]	Truthfully Negotiating Usage Policy for Data Sovereignty	2022	Validation	Data Sovereignty (Usage Control - New)	Generic
Koshizuka and Mano [71]	DATA-EX: Infrastructure for Cross-Domain Data Exchange Based on Federated Architecture	2022	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Generic
Karagiannis et al. [72]	The Blue Dataverse: A System for Marine Data Sovereignty	2023	Validation	Data Value Creation Enablers (Value Creation Services - Reuse)	Green Deal
Kapsalis et al. [73]	An Energy Efficiency Marketplace for Buildings: The ENERGATE System Architecture	2023	Solution	Data Value Creation Enablers (Value Creation Services - Reuse)	Energy
Lia and Colella [74]	CkanFAIR: a digital tool for assessing the FAIR principles	2023	Validation	Data Value Creation Enablers (Pub. and Discovery - New)	Public Administration
Ono and Tangteerasunun [75]	Design Thinking Framework for Values Capturing and Technical Features Validation for Digital Healthcare Platform	2022	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Healthcare
Qarawlus et al. [76]	Demonstration of Data-Sovereign Telemetry Broker for Open and Disaggregated Optical Networks	2023	Validation	Data Value Creation Enablers (Value Creation Services - NA)	Generic
Yu et al. [77]	Food Supply Blockchain: A Bright Future for the Food Supply Chain	2023	Validation	Data Value Creation Enablers (Value Creation Services - Reuse), Data Interoperability (Prov. and Traceability - Reuse)	Agriculture
Piest et al. [78]	Demonstrating the Architecture for Situation-aware Logistics using Smart Returnable Assets	2023	Validation	Data Value Creation Enablers (Value Creation Services - NA)	Manufacturing
Chandran et al. [79]	Transforming Personal Data Transactions with Auditable, Privacy-Preserving Data Exchange Agreements: Fostering Transparency and Trust in Digital Wallet Ecosystems	2023	Solution	Data Sovereignty (Usage Control - Reuse, Trust Framework - New, Identity Management - Reuse)	Healthcare
Bellini et al. [80]	Rapid Prototyping & Development Life Cycle for Smart Applications of Internet of Entities	2023	Evaluation	Data Value Creation Enablers (Value Creation Services - Reuse), Data Interoperability (Data Exchange - Reuse, Data Models - Reuse)	Mobility
Harjula et al. [81]	Smart Manufacturing Multi-Site Testbed with 5G and Beyond Connectivity	2021	Solution	Data Value Creation Enablers (Value Creation Services - Reuse), Data Interoperability (Data Exchange - Reuse)	Manufacturing
Dickopf et al. [82]	Application of the Asset Administration Shell in the context of Engineering Data Management Systems	2023	Solution	Data Interoperability (Data Models - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse)	Manufacturing
Ajdinović et al. [83]	Interoperable Digital Product Passports: An Event-Based Approach to Aggregate Production Data to Improve Sustainability and Transparency in the Manufacturing Industry	2024	Solution	Data Interoperability (Data Exchange - Reuse, Data Models - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse)	Manufacturing
Appenzeller et al. [84]	Towards Distributed Healthcare Systems – Virtual Data Pooling Between Cancer Registries as Backbone of Care and Research	2021	Solution	Data Sovereignty (Usage Control - Reuse)	Healthcare
Jurmu et al. [85]	Exploring the Role of Federated Data Spaces in Implementing Twin Transition within Manufacturing Ecosystems	2023	Experience	Data Value Creation Enablers (Value Creation Services - NA)	Manufacturing
Hellmeier et al. [86]	Implementing Data Sovereignty: Requirements & Challenges from Practice	2023	Experience	Data Value Creation Enablers (Value Creation Services - NA)	Generic

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Table 1: Primary studies facet classification *(continued)*

Reference	Title	Year	Research Type	Building Blocks	Sector
Raab et al. [87]	Federated electronic health records for the European Health Data Space	2023	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Healthcare
Hussein et al. [88]	Towards the European Health Data Space (EHDS) ecosystem: A survey research on future health data scenarios	2023	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Healthcare
Martella et al. [89]	Identifying key factors in designing data spaces for Urban Digital Twin Platforms: a data driven approach	2023	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Mobility
Pampus et al. [90]	Evolving Data Space Technologies: Lessons Learned from an IDS Connector Reference Implementation	2022	Experience	Data Interoperability (Data Exchange - Reuse), Data Sovereignty (Identity Management - Reuse), Data Value Creation Enablers (Data Offering - Reuse)	Generic
Werkmeister [91]	Development of User-Centred Interaction Design Patterns for the International Data Space	2021	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Generic
Dobreva et al. [92]	Data Spaces for Cultural Heritage: Insights from GLAM Innovation Labs	2022	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Cultural Heritage
Rucco et al. [93]	Supporting Energy Digital Twins with Cloud Data Spaces: An Architectural Proposal	2022	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Energy
Belsa et al. [94]	A Novel Approach for Calculating Real-Time Composite Indicators Relying on Internet of Things and Industrial Data Spaces	2022	Solution	Data Interoperability (Data Models - Reuse, Data Exchange - Reuse), Data Sovereignty (Identity Management - Reuse, Usage Control - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse)	Manufacturing
Firdausy et al. [95]	A Data Connector Store for International Data Spaces	2022	Validation	Data Value Creation Enablers (Pub. and Discovery - Reuse, Data Offering - Reuse)	Generic
Bruckner et al. [96]	A Policy-Agnostic Programming Language for the International Data Spaces	2021	Solution	Data Sovereignty (Usage Control - New)	Generic
Bader et al. [97]	The International Data Spaces Information Model – An Ontology for Sovereign Exchange of Digital Content	2020	Solution	Data Value Creation Enablers (Data Offering - New)	Generic
Petersen et al. [98]	Value-Added Services, Virtual Enterprises and Data Spaces Inspired Enterprise Architecture for Smart Cities	2019	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Mobility
Möller et al. [99]	Towards an Architecture to Support Data Access in Research Data Spaces	2021	Solution	Data Value Creation Enablers (Pub. and Discovery - Reuse)	Research and Innovation
Kannisto and Hästbacka [100]	Data Autonomy in Message Brokers in Edge and Cloud for Mobile Machinery: Requirements and Technology Survey	2022	Experience	Data Interoperability (Data Exchange - NA)	Manufacturing
Usmani et al. [101]	Towards Multimodal Knowledge Graphs for Data Spaces	2023	Solution	Data Value Creation Enablers (Data Offering - New)	Mobility
Cimmino et al. [102]	Open Digital Rights Enforcement framework (ODRE): From descriptive to enforceable policies	2025	Validation	Data Sovereignty (Usage Control - New)	Generic
Kulkarni et al. [103]	Using SysML as a Modelling Language for Dataspaces	2024	Validation	Data Interoperability (Data Models - Reuse)	Mobility
Kovach et al. [104]	Sovereign IIoT Data Exchange Using DAG-Based DLT and International Data Spaces Architecture	2024	Solution	Data Interoperability (Prov. and Traceability - Reuse), Data Sovereignty (Identity Management - Reuse, Usage Control - New)	Generic
Blumenröhr et al. [105]	FAIR Digital Objects for the Realization of Globally Aligned Data Spaces	2024	Solution	Data Value Creation Enablers (Pub. and Discovery - Reuse)	Generic

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Table 1: Primary studies facet classification *(continued)*

Reference	Title	Year	Research Type	Building Blocks	Sector
Huang et al. [106]	Design of a Secure Industrial Data Interaction System Based on International Data Space and Optimized KP-ABE Algorithm	2024	Validation	Data Sovereignty (Trust Framework - Reuse)	Generic
Der Sylvestre Sidibe and Dhouib [107]	An Approach for Sovereign Data Exchange of AAS Digital Twins Through the International Data Space Network	2024	Solution	Data Interoperability (Data Models - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse)	Manufacturing
Distefano and Yifru [108]	Exploring the interplay between DataSpaces and Large Language Models	2024	Validation	Data Value Creation Enablers (Value Creation Services - New, Data Offering - Reuse, Pub. and Discovery - Reuse), Data Interoperability (Data Models - Reuse)	Healthcare
Al-Qatf et al. [109]	RAG4DS: Retrieval-Augmented Generation for Data Spaces—A Unified Lifecycle, Challenges, and Opportunities	2025	Conceptual	Data Value Creation Enablers (Value Creation Services - New, Data Offering - Reuse, Pub. and Discovery - Reuse), Data Interoperability (Data Models - Reuse)	Generic
Morabito et al. [110]	Intent-Based Pseudonymization for Healthcare Workflows on Intra-Hospital Data Space Domain	2024	Validation	Data Sovereignty (Trust Framework - Reuse)	Healthcare
García et al. [111]	Privacy Preserving Enablers for Data Space Ecosystems	2025	Conceptual	Data Sovereignty (Trust Framework - Reuse, Identity Management - Reuse, Usage Control - Reuse)	Generic
Ahmadian et al. [112]	Privacy-Friendly Sharing of Health Data Using a Reference Architecture for Health Data Spaces	2024	Solution	Data Sovereignty (Trust Framework - New, Usage Control - New)	Healthcare
Doulkeridis et al. [113]	The MobiSpaces Manifesto on Mobility Data Spaces	2024	Solution	Data Value Creation Enablers (Data Offering - Reuse, Value Creation Services - Reuse), Data Interoperability (Data Exchange - Reuse, Prov. and Traceability - Reuse), Data Sovereignty (Usage Control - Reuse)	Mobility
Nizamis et al. [114]	Introducing an Enhanced Metadata Broker for Manufacturing Data Spaces	2024	Solution	Data Value Creation Enablers (Data Offering - New, Pub. and Discovery - Reuse)	Manufacturing
Steinert and Altendeitering [115]	Data Trustees: A Whitelisting Approach for Trusted Data Sharing	2024	Solution	Data Sovereignty (Trust Framework - New)	Generic
Taniguchi et al. [116]	DSPOL: A High-Level Language for Defining Data Policies in Data Spaces	2024	Solution	Data Sovereignty (Usage Control - New)	Generic
Gavric et al. [117]	Enhancing Security in International Data Spaces: A STRIDE Framework Approach	2025	Validation	Data Sovereignty (Trust Framework - Reuse)	Generic
Mitrovska et al. [118]	Federated Learning Governance using Eclipse Dataspace Components Connectors	2024	Validation	Data Value Creation Enablers (Value Creation Services - Reuse)	Healthcare
Danish and Schnicke [119]	Integrating Systems of Record (SOR) into the Asset Administration Shell (AAS) Dataspace	2024	Validation	Data Value Creation Enablers (Value Creation Services - Reuse), Data Interoperability (Data Models - Reuse, Data Exchange - Reuse)	Manufacturing
Ranathunga et al. [120]	Enabling secure and self-sovereign machine learning model exchange in manufacturing data spaces	2024	Validation	Data Value Creation Enablers (Value Creation Services - Reuse, Data Offering - New), Data Sovereignty (Usage Control - Reuse), Data Interoperability (Data Models - Reuse)	Manufacturing

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Table 1: Primary studies facet classification *(continued)*

Reference	Title	Year	Research Type	Building Blocks	Sector
Gerlach et al. [121]	Gaia-X-Med: Experiences with Building Dataspaces for Medical Applications	2024	Experience	Data Sovereignty (Usage Control - New, Trust Framework - New, Identity Management - Reuse)	Healthcare
Karl et al. [122]	Building a Data Space for the Public Security Domain Using Smart Contracts	2024	Solution	Data Sovereignty (Trust Framework - Reuse)	Public Administration
Latvakoski et al. [123]	A Simulation-Based Study on Securing Data Sharing for Situational Awareness in a Port Accident Case	2024	Evaluation	Data Value Creation Enablers (Value Creation Services - NA), Data Interoperability (Data Exchange - Reuse), Data Sovereignty (Trust Framework - Reuse, Identity Management - Reuse)	Mobility
Georgiou et al. [124]	SKILLAB: Creating a Skills Supply and Demand Data Space	2024	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Skills
Gaeta et al. [125]	GATEKEEPER Platform: Secure Processing Environment for European Health Data Space	2025	Evaluation	Data Value Creation Enablers (Value Creation Services - Reuse), Data Sovereignty (Trust Framework - Reuse), Data Interoperability (Data Exchange - Reuse)	Healthcare
Wang et al. [126]	Industrial Data Space Framework Design and Feasibility Analysis - A Case Study of China's New Energy Industry	2024	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Energy
Mitrovska et al. [127]	Data Governance Framework for Telemetry Sharing	2024	Solution	Data Value Creation Enablers (Value Creation Services - NA), Data Interoperability (Data Exchange - NA)	Generic
Petroulakis et al. [128]	Towards the development of a network provisioning platform for data exchange in the health data space	2024	Experience	Data Value Creation Enablers (Value Creation Services - NA)	Healthcare
Coppolino et al. [129]	Connecting the Mobility and the Refuelling/Recharging Infrastructures: The Role of Data Spaces	2024	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Mobility
Bacco et al. [130]	Agricultural Data Space: the METRIQA Platform and a Case Study in the CODECS project	2024	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Agriculture
Perera et al. [131]	Confidentiality Preserving Data Sharing for Life Cycle Assessment in Process Industries	2024	Conceptual	Data Sovereignty (Trust Framework - Reuse, Identity Management - Reuse)	Manufacturing
Nardone et al. [132]	Secure and Transparent Data Sharing Among Connected Devices: Integrating Data Spaces and Provenance	2024	Conceptual	Data Interoperability (Prov. and Traceability - Reuse)	Healthcare
Kalatzis et al. [133]	Smart Farming data and IoT in Support of Agricultural Policy Monitoring	2024	Conceptual	Data Value Creation Enablers (Value Creation Services - NA)	Agriculture
Alsamhi et al. [134]	Skyward secure: Advancing drone data-sharing in 6G with decentralized dataspace and supported technologies	2025	Solution	Data Value Creation Enablers (Value Creation Services - Reuse), Data Interoperability (Prov. and Traceability - Reuse)	Mobility
Liao et al. [135]	An industrial dataspace for automotive supply chain: Secure data sharing based on data association relationship	2025	Evaluation	Data Value Creation Enablers (Value Creation Services - NA)	Manufacturing
Akaichi et al. [136]	Interoperable and Continuous Usage Control Enforcement in Dataspaces	2024	Solution	Data Sovereignty (Usage Control - New)	Generic
Hosseinzadeh et al. [137]	A Systematic Approach toward Extracting Technically Enforceable Policies from Data Usage Control Requirements	2020	Solution	Data Sovereignty (Usage Control - New)	Generic

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Table 1: Primary studies facet classification *(continued)*

Reference	Title	Year	Research Type	Building Blocks	Sector
Arnold et al. [138]	Towards Enabling FAIR Dataspaces Using Large Language Models	2024	Solution	Data Sovereignty (Usage Control - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse, Data Offering - Reuse)	Generic
Vogt et al. [139]	Towards Digital Twin-Based Dataspaces for Industrial Computer Vision Services	2024	Validation	Data Interoperability (Data Models - Reuse), Data Value Creation Enablers (Value Creation Services - Reuse)	Manufacturing
Kyriakou et al. [140]	A Secure and Trustworthy Biometric Data Ecosystem for Cross-border Suspect Identification	2024	Solution	Data Sovereignty (Trust Framework - Reuse), Data Value Creation Enablers (Value Creation Services - NA)	Public Administration
Manoury et al. [141]	Supporting Changes in Digital Ownership and Data Sovereignty Across the Automotive Value Chain with Catena-X	2025	Conceptual	Data Value Creation Enablers (Value Creation Services - Reuse)	Manufacturing
Gonçalves et al. [142]	Evaluating Legal Compliance of Federated Learning Tools for the European Health Data Space (EHDS)	2024	Evaluation	Data Sovereignty (Trust Framework - Reuse)	Healthcare
Hoseini et al. [143]	Challenges and Opportunities of LLM-Augmented Semantic Model Creation for Dataspaces	2025	Conceptual	Data Value Creation Enablers (Data Offering - Reuse)	Generic
Gil et al. [144]	Sovereignty by design and human values in agriculture data spaces	2025	Experience	Data Value Creation Enablers (Value Creation Services - NA)	Agriculture
Lancker et al. [145]	Semantic and Technically Interoperable Data Exchange in the Flanders Smart Data Space	2024	Validation	Data Value Creation Enablers (Value Creation Services - NA, Pub. and Discovery - Reuse), Data Interoperability (Data Exchange - Reuse)	Mobility
Soltysinski et al. [146]	Digital Calibration Certificate in a trusted quality infrastructure federated data space: A proof of concept	2024	Solution	Data Value Creation Enablers (Value Creation Services - NA), Data Sovereignty (Identity Management - Reuse)	Public Administration
Zhang et al. [147]	Trans-Border Trusted Data Spaces: A General Framework Supporting Trustworthy International Data Circulation	2025	Evaluation	Data Value Creation Enablers (Value Creation Services - NA), Data Sovereignty (Usage Control - Reuse), Data Interoperability (Prov. and Traceability - Reuse)	Generic
Nagel et al. [148]	IntraDataspace: An architecture of a company-internal Dataspace	2024	Experience	Data Value Creation Enablers (Value Creation Services - NA), Data Interoperability (Data Exchange - Reuse)	Manufacturing
Papadakis et al. [149]	CCDUIT: A Software Overlay for Cross-Federation Collaboration Between Data Spaces	2024	Validation	Data Interoperability (Data Models - Reuse, Data Exchange - Reuse)	Mobility

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