

A Framework for Data Mesh Architecture: Decentralized Governance and Data-as-a-Product Paradigms

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Abstract

The data mesh has emerged as one of the most influential responses to the limitations of centralised data platforms in large organisations. Rather than concentrating data management in a single team, it distributes ownership to the business domains that produce and understand the data, while maintaining shared standards and interoperability through federated governance. Although the concept has attracted considerable interest, organisations frequently struggle to implement it because practical, structured guidance is scarce—particularly for its two most distinctive and demanding principles: decentralised governance and the treatment of data as a product. This paper develops a structured framework for implementing data mesh architecture, with a specific focus on these two principles. The framework is built through a qualitative, design-oriented methodology grounded in a review of the academic literature and documented practice, and it organises data mesh implementation into four interconnected pillars—domain ownership, data as a product, a self-serve platform, and federated governance—supported by a foundation of enabling conditions comprising culture, skills, and incentives. The paper gives particular attention to how governance can remain effective when authority is distributed, proposing a model in which global policies are defined centrally by a federated group but applied and owned locally by each domain, and wherever possible embedded in the shared platform as automated rules, an approach often termed "governance as code." It also makes the data-as-a-product concept concrete by defining the characteristics a dataset must have to qualify as a product: discoverability, understandability, trustworthiness, accessibility, and accountability. The framework is intended as practical guidance for organisations considering a data mesh, and it emphasises throughout that the approach succeeds only when organisational readiness matches technical capability. The paper concludes that the data mesh is best understood as a socio-technical model in which governance and product thinking are as important as infrastructure, and that adopting it is an organisational transformation rather than a purely technical project.

Keywords: data mesh; decentralised governance; data as a product; federated governance; domain ownership; self-serve platform; data architecture

1. Introduction

1.1 Background context

As organisations have expanded their use of data, many have discovered that centralised data platforms, however well engineered, eventually become bottlenecks. A single team responsible for ingesting, cleaning, integrating, and serving data for an entire enterprise cannot realistically keep pace with the diverse, changing, and often urgent needs of many business domains. The result is long delays, growing backlogs, and a widening gap between the teams that understand the data and the team responsible for managing it. This tension has motivated the development of the data mesh, a model that decentralises data ownership to the domains themselves while preserving shared standards and interoperability across the organisation.

The data mesh rests on four principles. Domain-oriented ownership assigns responsibility for data to the business domains that produce and use it. Data as a product requires that the datasets a domain shares be designed, documented, and maintained with the same care as a product offered to customers. A self-serve data platform provides the shared infrastructure that allows domains to build and manage their data products without specialist engineering for every task. Federated computational governance maintains consistency and compliance across autonomous domains by defining shared policies and embedding them in the platform. Of these four principles, two are both the most distinctive and the most difficult to implement in practice, and they are the focus of this paper.

1.2 Problem statement

Decentralised governance challenges the long-standing assumption that control must be centralised to be effective. It raises a difficult question: how can an organisation maintain consistency, quality, security, and regulatory compliance when authority over data is distributed across many autonomous domains? Without a clear answer, decentralisation risks fragmenting standards and eroding trust in data. The idea of data as a product challenges an equally entrenched habit—that of treating data as an incidental by-product of operational systems. It requires instead that datasets be deliberately designed and maintained as reliable,

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reusable assets, which demands new skills, roles, and ways of working. Many organisations adopt the language of the data mesh without resolving these two challenges, and their implementations consequently fail. There is a clear need for structured, practical guidance on how to implement decentralised governance and data-as-a-product thinking concretely.

1.3 Research gap

Although the foundational literature on the data mesh describes its principles at a high level, and a growing number of practitioner accounts report adoption experiences, there remains a shortage of structured frameworks that translate these principles into practical implementation guidance—especially for the governance and product dimensions. Much of the existing material is either conceptual, describing what the mesh is, or anecdotal, describing one organisation's experience, with relatively little that organises implementation into a coherent, reusable structure. This paper addresses that gap by developing such a framework.

1.4 Research questions and significance

The study is guided by three questions: first, how can governance function effectively when data ownership is distributed across autonomous domains; second, what characteristics define a well-designed data product; and third, what organisational conditions are necessary for a data mesh to succeed. Answering these questions matters because the data mesh, when implemented well, can substantially improve an organisation's agility and ability to scale its use of data, but when implemented poorly it can fragment standards, duplicate effort, and reduce trust. Providing structured guidance can help organisations assess whether the mesh suits them and, if so, approach it in a disciplined way. The remainder of the paper sets out the objectives and scope, reviews the literature, describes the framework-building methodology, presents the proposed framework with embedded figure descriptions, discusses its implications and the conditions for success, and concludes.

2. Objectives

The primary objective of this study is to develop a structured framework for implementing data mesh architecture, centred on decentralised governance and the data-as-a-product paradigm. The supporting objectives are: to explain how federated governance can maintain consistency and compliance while preserving domain autonomy; to define concretely the characteristics of a well-designed data product; to identify the organisational conditions—culture, skills, and

incentives—required for success; and to provide practical guidance that organisations can adapt to their own context.

3. Scope of Study

This study focuses on the implementation of the data mesh as an architectural and organisational model, with particular emphasis on its governance and data-as-a-product dimensions. It covers the four principles of the mesh and the enabling conditions required to support them. It does not provide detailed technical instructions for building specific platform components, evaluate particular vendor products, or address the internal design of storage and processing engines, which lie outside its scope. The study is conceptual and design-oriented rather than empirical: it synthesises existing scholarship and documented practice to construct a framework, but it does not validate that framework through implementation in a specific organisation. The guidance offered is general and intended to be adapted to particular organisational contexts, and the paper notes throughout that the data mesh is appropriate mainly for large, complex organisations with sufficient data maturity.

4. Literature Review

4.1 The origins and principles of the data mesh

The data mesh concept was introduced by Dehghani (2022), who argued that the recurring failure of large, centralised data platforms is rooted in their organisational structure rather than in their technology. She observed that as organisations grow, a single central data team becomes unable to serve the needs of many domains, regardless of how capable its technology is. Drawing on principles from domain-driven design, which organises software around business domains, and from product management, which emphasises designing for users, she proposed distributing data ownership to domains and treating datasets as products. This reframing shifted the conversation about data architecture from infrastructure toward organisation, and it generated substantial interest as well as debate about how the principles work in practice.

4.2 Decentralised and federated governance

Research on governance in decentralised systems predates the data mesh and provides useful foundations. Federated governance models, developed in the context of large and distributed organisations, seek to balance local autonomy with global consistency by defining shared policies centrally while delegating their application to local units (Weber et al., 2009). The data mesh applies this idea in a computational form: rather than relying on manual review to enforce standards, it embeds governance rules into the shared self-serve platform so that compliance is enforced automatically as domains build and publish data products (Machado et al., 2022). This approach, sometimes called "governance as code," is widely regarded as essential to making decentralisation workable at scale, because manual governance cannot keep pace with many autonomous teams. However, it requires significant investment in the platform and in defining policies clearly enough to be automated.

4.3 Data as a product

The notion of data as a product builds on established thinking about data quality, usability, and management. A data product is expected to be discoverable, so that potential users can find it; understandable, through clear documentation and metadata; trustworthy, through quality guarantees and defined service levels; accessible, through standard interfaces; and accountable, through a named owner responsible for it (Dehghani, 2022; Goedegebuure et al., 2023). This set of characteristics transforms a raw dataset into a reliable asset that other teams can use with confidence, and it is the practical core of the data-as-a-product paradigm. Realising it requires new roles, such as data-product owners within domains, and new practices, such as treating data documentation and quality as first-class responsibilities rather than afterthoughts.

4.4 Reported challenges and the research gap

Studies of early adopters report tangible benefits in agility and scalability but also consistent obstacles. These include the need for new skills within domains, cultural resistance to taking on data ownership, unclear or misaligned incentives, and the risk of inconsistent standards across autonomous teams (Bode et al., 2023). The literature agrees that the data mesh is an organisational transformation as much as a technical one, and that its success depends heavily on organisational readiness. What remains scarce, and what this paper provides, is a structured framework that organises implementation—particularly of governance and data-as-a-product—into a coherent and practical form.

5. Research Methodology

5.1 Research approach

This study uses a qualitative, framework-building methodology, which is appropriate for research that aims to produce practical design guidance rather than to test a hypothesis statistically. The objective is to synthesise existing knowledge from scholarship and documented practice into a coherent and usable framework. This design-oriented approach is well established in information-systems research, where frameworks are developed from established principles and assessed for internal consistency and completeness.

5.2 Data sources and selection

The framework is grounded in two bodies of evidence. The first is the foundational and recent literature on the data mesh, federated governance, and data-product management, drawn from peer-reviewed articles, foundational texts, and documented case experience published between 2009 and 2023. The second is documented industry practice, including published accounts of data-mesh implementations and their reported successes and difficulties. Sources were selected for direct relevance to the governance and data-as-a-product dimensions that are the focus of the study.

5.3 Framework-building procedure

The development of the framework proceeded in three stages. First, the literature and documented practice were reviewed to establish an accurate understanding of the mesh's principles and of the challenges reported by adopters. Second, recurring themes, requirements, and difficulties were identified and grouped, with particular attention to governance and the data-as-a-product concept. Third, these themes were organised into a structured framework consisting of pillars and enabling conditions, designed so that each element of the framework addresses a specific requirement or challenge identified in the review. The framework was then checked for internal consistency and completeness against the known principles of the mesh and the obstacles reported by adopters.

5.4 Limitations of the methodology

Because the study is conceptual rather than empirical, the proposed framework is justified by reasoning and established practice rather than validated through implementation in a specific organisation. This is an appropriate approach for developing design guidance, but it means that the framework's effectiveness has not been measured directly. Empirical validation—applying the framework in organisations and measuring outcomes such as governance consistency, data-

product reuse, and time-to-value—would be a valuable direction for future work and is noted as such in the discussion.

6. The Proposed Framework

6.1 Overview of the framework

The framework organises data mesh implementation into four pillars supported by a foundation of enabling conditions. The four pillars correspond to the four principles of the mesh—domain ownership, data as a product, a self-serve platform, and federated governance—while the foundation captures the organisational conditions without which the pillars cannot stand. The framework is designed to make clear that these elements are interdependent: the pillars reinforce one another, and all of them rest on organisational readiness.

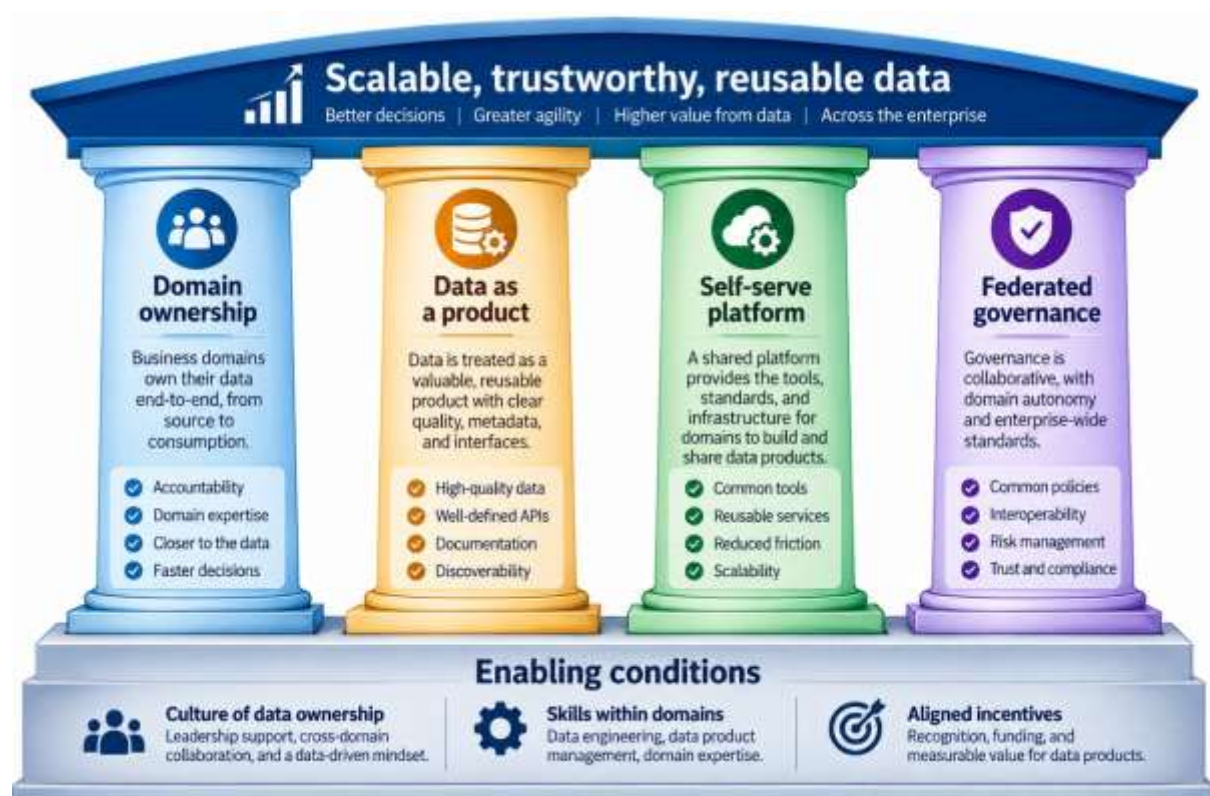


Figure 1. The four pillars of the data mesh framework.

6.2 Pillar one: domain ownership

The first pillar assigns responsibility for data to the business domains that produce and use it.

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Each domain owns its data end to end, from ingestion through transformation to serving, which aligns responsibility with the knowledge held by those closest to the data. This alignment is the fundamental move of the data mesh: it removes the dependency on a central team and allows domains to work in parallel at their own pace. Domain ownership requires that each domain has the capacity to manage its data, which in turn depends on the self-serve platform and on the enabling conditions of skills and culture. Without these supports, assigning ownership to domains simply shifts the burden without providing the means to carry it.

6.3 Pillar two: data as a product

The second pillar requires that each dataset a domain shares with the rest of the organisation be treated as a product with defined qualities, rather than as a raw output that others must interpret for themselves. This is the pillar that most directly determines whether decentralisation improves or degrades the organisation's data.

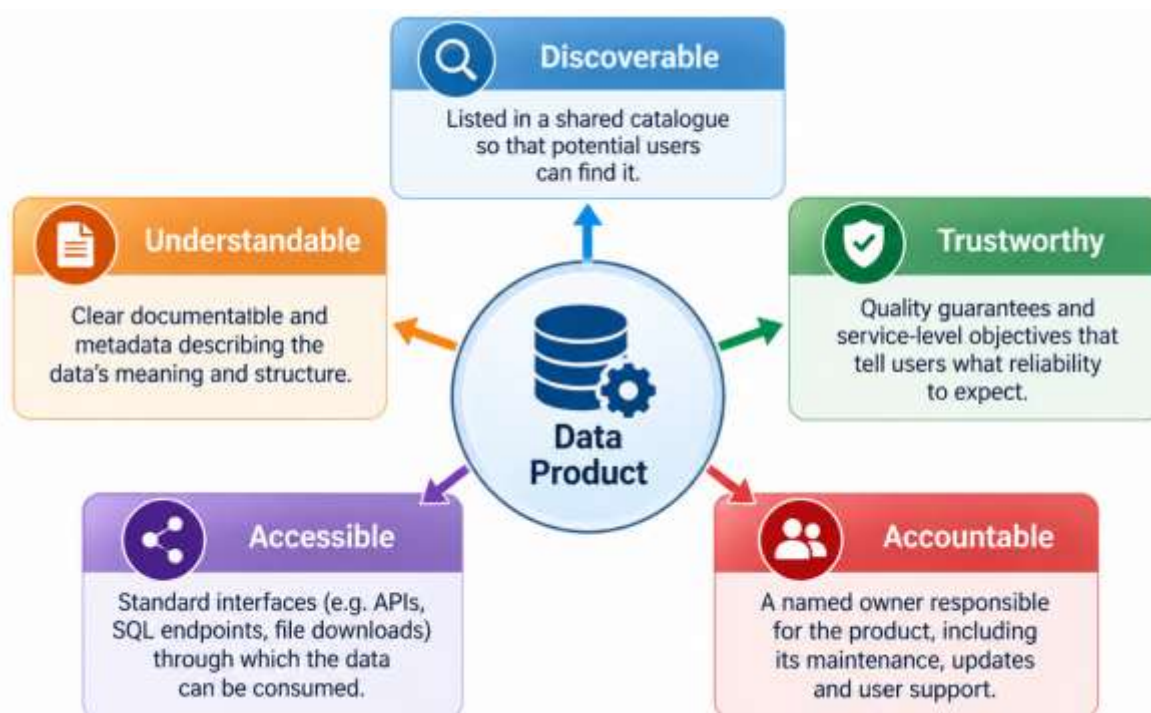


Figure 2. Anatomy of a data product.

In the framework, a dataset qualifies as a data product only when it exhibits all five of these characteristics. Discoverability ensures that data products can be found and reused rather than rebuilt, reducing duplication. Understandability ensures that users can interpret the data correctly without recourse to the producing team. Trustworthiness, expressed through explicit quality guarantees and service-level objectives, allows users to rely on the data for important

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decisions. Accessibility through standard interfaces ensures interoperability across domains. Accountability, through a named owner, ensures that someone is responsible for maintaining the product and responding to problems. Together, these characteristics turn decentralisation from a risk into a strength.

6.4 Pillar three: the self-serve platform

The third pillar provides the shared infrastructure that makes domain ownership feasible. Without it, requiring each domain to build and operate its own data infrastructure would be overwhelming and would reintroduce duplication and inconsistency. The self-serve platform standardises common capabilities—storage, pipelines, cataloguing, access control, and monitoring—so that domains can build and manage data products without specialist platform engineering for every task. The platform is also the vehicle through which governance is enforced automatically, as described in the fourth pillar. A well-designed platform reduces the effort required of domains to a level that makes ownership realistic, and it is therefore a precondition for the success of the other pillars.

6.5 Pillar four: federated governance

The fourth pillar, federated governance, is the framework's central concern and the mechanism that resolves the apparent contradiction at the heart of the data mesh: how to distribute ownership while maintaining consistency. The framework proposes a model in which global policies—covering security, privacy, data quality, and interoperability—are defined by a cross-domain governance group that includes representatives from the domains, but are applied and owned locally by each domain. Wherever possible, these policies are embedded in the self-serve platform as automated rules, so that compliance is enforced by the infrastructure as domains build and publish data products, rather than through manual review after the fact. This "governance as code" approach allows global consistency to coexist with local autonomy.



Figure 3. Federated governance model ("governance as code").

6.6 The foundation: enabling conditions

Underpinning all four pillars are the enabling conditions, which the framework treats as a foundation rather than an afterthought. The first is a culture of data ownership, in which domains accept responsibility for their data and view it as a product to be maintained rather than a by-product to be discarded. The second is the presence of the necessary skills within domains, including data engineering and data-product management, since domains cannot own data they lack the capacity to manage. The third is a system of incentives that rewards teams for producing high-quality, reusable data products, because without such incentives domains will deprioritise data work in favour of their immediate operational goals. These conditions are the most common point of failure in data-mesh implementations, and the framework places them at the foundation to emphasise that technical pillars cannot stand without them.

7. Discussion

7.1 Resolving the central tension

The framework highlights that the success of a data mesh depends on resolving an apparent contradiction: how to distribute ownership while maintaining consistency. The proposed model of federated governance addresses this by separating the definition of policy from its

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application. Global standards are defined centrally by a federated group and codified in the shared platform, where they are enforced automatically; their application and ownership, however, are distributed to the domains. This separation allows the organisation to achieve consistency without a central team acting as a bottleneck, and autonomy without a loss of control. It is, in effect, the mechanism that makes the data mesh coherent rather than merely decentralised.

7.2 Making data-as-a-product concrete

A further contribution of the framework is to make the data-as-a-product paradigm concrete by specifying the five characteristics a dataset must exhibit to qualify as a product. This specificity matters because the greatest risk of decentralisation is that domains produce inconsistent, poorly documented, and untrustworthy data. By defining discoverability, understandability, trustworthiness, accessibility, and accountability as requirements rather than aspirations, the framework turns the abstract principle into a checklist that domains and governance groups can apply. This helps ensure that decentralisation improves the organisation's data rather than fragmenting it.

7.3 The primacy of organisational readiness

The analysis reinforces the view in the literature that the data mesh is a socio-technical model in which organisational factors are as important as technical ones. The framework's placement of enabling conditions at its foundation reflects the finding that most data-mesh failures stem not from technical shortcomings but from inadequate culture, skills, or incentives. Organisations that adopt the language and technology of the mesh without addressing these conditions are likely to find that decentralisation fragments their standards and reduces trust in their data. This has an important practical implication: before adopting a data mesh, an organisation should honestly assess its readiness, and the mesh is appropriate mainly for large, complex organisations with sufficient maturity. Smaller organisations, or those lacking the enabling conditions, may be better served by a well-governed central platform.

7.4 Limitations and future research

The principal limitation of this study is that the framework is conceptual and has not been validated through implementation in a specific organisation. While it is grounded in established scholarship and documented practice, its effectiveness has not been measured directly. Future research should apply the framework in organisations and measure outcomes such as governance consistency across domains, the reuse of data products, time-to-value for new data

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initiatives, and the frequency of data-quality and compliance incidents. Comparative case studies would also help refine the framework and clarify how it should be adapted to different sectors and regulatory environments, and longitudinal studies could examine how organisations build the enabling conditions over time.

8. Conclusion

The data mesh offers a compelling response to the limitations of centralised data platforms, but its distinctive principles—decentralised governance and the treatment of data as a product—are also the most difficult to implement, and the lack of structured guidance has caused many implementations to fail. This paper has developed a structured framework that organises data mesh implementation into four interdependent pillars—domain ownership, data as a product, a self-serve platform, and federated governance—resting on a foundation of enabling conditions comprising culture, skills, and incentives. It has given particular attention to the two most challenging principles, proposing a federated governance model that separates the central definition of policy from its local application and automated enforcement, and specifying the five characteristics that make a dataset a genuine data product. Above all, the framework emphasises that the data mesh is a socio-technical transformation in which governance and product thinking matter as much as infrastructure, and that it succeeds only when organisational readiness matches technical capability. Organisations that build the enabling conditions and apply disciplined, federated governance can use the mesh to scale their use of data with both agility and trust; those that adopt its language without its foundations risk fragmenting the very data they seek to make more useful. The framework presented here is intended as practical guidance to help organisations make that distinction and approach the data mesh in a disciplined and realistic way.

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