FAIRness in Event Accreditation Systems

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Accreditation systems play a critical role in managing access, personnel, and logistics during large-scale events. Although many organisers have shifted from spreadsheets to web-based solutions, challenges such as fragmented data flows, manual entry, and unclear governance remain. These issues raise operational and legal concerns, particularly under regulations such as the General Data Protection Regulation. The FAIR principles were designed to provide a framework for improving data quality and reuse. However, current accreditation practices show limited alignment. This study investigates how centralised and decentralised data architectures could support FAIR-compliant accreditation systems in the event industry. Three existing comparison frameworks are discussed to assess their suitability for this purpose. The results indicate that while these frameworks highlight necessary design trade-offs, none fully address the operational, legal, and stakeholder-specific needs of event accreditation systems. Based on the results, five design considerations are proposed. The study concludes that hybrid and context-specific architectural solutions, combined with sector-wide alignment on data standards and governance, offer the most viable path forward. These findings provide a structured theoretical foundation for improving accreditation systems using FAIR-aligned design principles and informed architectural choices.

Additional Key Words and Phrases: FAIR principles, Accreditation Systems, Event Industry, Inter-Organisational, Data Sharing, GDPR, Centralised Architecture, Decentralised Architecture

1 INTRODUCTION

The event industry brings together an ecosystem of stakeholders. Coordinating this ecosystem is challenging for large-scale events, where logistical complexity, regulations, and safety must be addressed simultaneously [7]. Accreditation systems are essential tools for managing access to event sites, tracking personnel, and allocating resources. They allow suppliers to register staff in advance, enabling organisers to grant access rights, monitor attendance, and ensure legal compliance [12, 24].

Accreditation processes have evolved from spreadsheets and emails to web-based platforms [2]. This shift is a result of technological advancement and legal obligations. For example, under EU counter-terrorism and General Data Protection Regulation (GDPR) policies, organisers must know who is on site, for what purpose, and with what permissions [10, 20]. Accreditation systems collect personnel data, assign access levels, and generate credentials, enabling secure, inter-organisational data sharing.

To illustrate how these systems work in practice, we consider the following example of a catering supplier at a multi-day festival. The supplier's planner registers all personnel using the organiser's accreditation platform. Staff details, including identification information, role, access area, and working hours, are submitted. Upon arrival, credentials are verified to receive access badges. Without these badges, access to the location is denied.

Multiple parties are involved in the use of accreditation systems, including organisers, suppliers, system vendors, and regulatory actors, each with distinct responsibilities that are explored in detail in Section 6.1.2.

Despite digitisation, challenges remain. Data fragmentation, manual entry, and unclear governance create inefficiencies and legal risks [4, 14]. FAIR data principles suggest data should be reusable across events and systems [29], yet most accreditation systems fall short.

Research has been conducted in other sectors to determine whether centralised or decentralised architectures better support FAIR-compliant systems [6, 27, 28]. This research applies those insights to the event industry.

The remainder of this report is structured as follows: Section 2 outlines the research problem and presents the research questions. Section 3 reviews relevant literature. Section 4 describes the research methodology. Section 5 justifies the methodological approach. Section 6 presents the findings organised by research question, followed by a discussion in Section 7 following the same structure. Additionally, in Section 7, the limitations are discussed with directions for future work. Section 8 concludes the report.

2 PROBLEM STATEMENT

Accreditation systems facilitate controlled access and logistical coordination across stakeholders involved in large-scale events. Even though these systems have evolved over the years, significant challenges persist, particularly in how data is shared and managed across organisations.

Current accreditation practices often involve fragmented data flows, redundant manual input, and unclear responsibilities for data governance [2]. These issues not only reduce operational efficiency but also raise legal and ethical concerns under frameworks like the General Data Protection Regulation (GDPR) [4, 20]. Additionally, the lack of interoperability between systems limits the ability to reuse or align data across events and stakeholders, violating data management principles as defined by the FAIR framework [29].

Several vendors and event suppliers operate within loosely connected or separated digital ecosystems [2]. While there is growing awareness of the need for improvement [2], it remains unclear which design approaches, centralised or decentralised, are best suited for addressing these challenges in a FAIR-compliant way.

2.1 Research Goal & Questions

The goal of this research is to explore existing comparison frameworks for centralised and decentralised data systems and apply these to the context of accreditation systems in the event industry to formulate recommendations for designing FAIR-compliant data management solutions.

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To achieve this goal, the following research questions have been formulated:

- **RQ1:** What are the current data management practices within accreditation systems in the event industry, and to what extent do they align with the FAIR principles?
- **RQ2:** What are the key differences between centralised and decentralised data architectures in terms of enabling FAIR-compliant data sharing in inter-organisational contexts?
- **RQ3:** How can existing comparison frameworks for centralised and decentralised data systems be applied to the event industry to support the design of FAIR-compliant accreditation systems?

Providing an answer to the research questions helps achieve the project goal.

3 RELATED WORK

This section reviews relevant literature on FAIR principles, challenges to accreditation systems, and architectural frameworks for inter-organisational data sharing.

3.1 Accreditation Systems and FAIR Principles

The FAIR principles (*Findability*, *Accessibility*, *Interoperability*, and *Reusability*) were introduced to improve scientific data management by promoting standardisation, metadata quality, and reusability [29]. The complete list of FAIR subprinciples is provided in Table 2 in the Appendix.

While initially designed for research data, the FAIR principles are now increasingly applied in sectors such as logistics, agriculture, and healthcare, where secure and efficient data exchange is essential [13, 18, 25, 31]. Projects like WorldFAIR [31] and FAIR-IMPACT [13] illustrate how these principles can improve data sharing across organisations. In the context of this research, FAIR serves as a theoretical foundation for evaluating the strengths and weaknesses of current accreditation systems in the event industry.

3.2 Challenges in Current Practices

Although there is limited academic literature explicitly focused on accreditation systems in the event industry, relevant insights can be drawn from studies on inter-organisational data exchange in other sectors. These studies highlight common challenges such as fragmentation, inconsistent standards, and unclear data responsibilities [21].

Manual data re-entry remains widespread in contexts lacking interoperability [14], resulting in inefficiencies and an increased risk of errors. Additionally, regulatory constraints such as the GDPR complicate data sharing, especially when it is unclear who the data controller is and who the processor is [4, 20]. These findings provide a transferable foundation for evaluating accreditation practices in the event industry. To assess system design options, relevant architectural frameworks are reviewed next.

3.3 Architectural Models and Evaluation Frameworks

Choosing between centralised and decentralised data architectures is a key design decision in inter-organisational systems. Centralised models consolidate data in a shared system, ensuring standardisation and control, but can create single points of failure or power asymmetries [3, 17]. Decentralised models support local autonomy and data sovereignty, but require high coordination [28]. Several frameworks help assess these trade-offs. Velu et al. [27] propose a model based on environmental uncertainty and organisational similarity to evaluate when centralisation is optimal. Verstraete et al. [28] apply affordance theory to assess decentralised designs in terms of data control and interoperability. Affordance theory is explained further in Section 6.3. Domingue et al. [6] extend this with the FAIR-TRADE framework, designed to evaluate whether decentralised systems can meet FAIR compliance. These frameworks form the theoretical foundation for comparing system designs in this study.

4 METHODOLOGY

This research adopts a mixed-methods approach to provide evidence-based answers to the research questions. The methodology consists of four components: a literature search, an evaluation of current practices, a design analysis, and the adaptation of existing comparison frameworks.

4.1 Literature Search

A literature review was conducted to establish a theoretical foundation for the study and inform the answers to Research Questions 1, 2, and 3. Academic databases such as WorldCat [30] and Scopus [9] were queried using a set of keywords and synonyms related to interoperability, GDPR, accreditation systems, and architectural models. An overview of all search terms is provided in Table 3 in the Appendix. Preference was given to peer-reviewed literature and academic journals, with cautious use of non-academic sources where necessary. The review aimed to identify transferable insights from related sectors on data management and explore existing frameworks used to evaluate or compare centralised and decentralised data systems.

4.2 Evaluation of Current Practices

To assess the relevance of the identified challenges, current practices within the event industry were validated through a semi-structured expert interview [2]. The aim was to gather insights into current data-sharing workflows, challenges related to fragmentation or inefficiency, and how GDPR compliance is handled. These insights helped validate the transferability of challenges from other domains, as identified in the literature.

4.3 Design Analysis

Two contrasting design paradigms were analysed to understand their respective strengths and weaknesses in the accreditation context:

(1) **Centralised architecture:** implications of consolidating accreditation data within a single industry-wide platform.
(2) **Decentralised architecture:** implications of developing an industry standard for data structures used in accreditation systems.

The comparative strengths and weaknesses identified in this analysis informed the evaluation criteria used in the final evaluation.

4.4 Comparison Framework

From the frameworks introduced in the Related Work section (Section 3), elements were adapted to qualitatively evaluate centralised and decentralised architectures in the context of accreditation systems. The evaluation focused on aspects such as stakeholder control over data, interoperability between systems, alignment with FAIR principles, and the complexity of implementation. These considerations guided the structured analysis presented in the Results section (Section 6).

5 RESEARCH DESIGN

The conceptual and exploratory research methodology is suitable for evaluating system designs and architectural frameworks, without requiring system implementation. Although the FAIR principles and existing architectural frameworks were developed in other domains, their focus on data management and interoperability makes them applicable to event accreditation systems.

6 RESULTS

This section presents the findings for each of the three research questions. The results are based on a review of literature, platform documentation, and a semi-structured expert interview. The first part explores current accreditation practices and their alignment with the FAIR principles (RQ1). The second part compares centralised and decentralised architectures in terms of data governance and FAIR compliance (RQ2). The third part evaluates how existing comparison frameworks support the design of accreditation systems in the event industry (RQ3).

6.1 RQ1: Current Practices and FAIR Alignment

This section presents findings related to current data management practices in accreditation systems, who is involved, and how these practices align with the FAIR principles, as required for RQ1.

6.1.1 Data Management in Accreditation Systems. Data management refers to the systematic handling of information to maintain its accuracy, integrity, and availability throughout its lifecycle [23]. It includes structuring, validating, and maintaining data to ensure it can be reliably accessed and reused by authorised parties [16]. In the event industry, data is often managed informally through spreadsheets, email, or manual entry, especially by subcontractors [2]. These approaches persist due to their low cost and ease of use, but increase the risk of error and complicate GDPR compliance. Formal accreditation platforms support structured functionalities such as personnel tracking, access management, and resource allocation [1, 12, 24]. However, these systems are not consistently adopted across stakeholders [2], leading to fragmented data handling and manual transfers.

6.1.2 Stakeholders and Operational Drivers. While Van Niekerk [26] provides a general classification of event stakeholders, only a subset engages directly with accreditation systems. This report focuses on organisers, suppliers, system vendors, and authorities—those responsible for access control, data entry, or legal compliance. Organisers prioritise operational control [1], suppliers aim to simplify registration processes [24], and authorities oversee regulatory compliance and safety [11]. These roles influence how accreditation data is created, shared, and governed, which directly affects FAIR alignment. A visual overview of the different roles is provided in Figure 1 in the Appendix.

6.1.3 Application of the FAIR Principles. While the FAIR principles originated in the scientific domain, they have since been applied in sectors such as healthcare and agriculture [18, 25]. Initiatives like FAIR-IMPACT and WorldFAIR show their relevance for fragmented multi-stakeholder data ecosystems [13, 31], supporting their applicability to event accreditation systems.

6.1.4 Assessment of FAIR Alignment. Table 1 presents an evaluation of how six accreditation systems align with the FAIR principles, based on documented functionalities and publicly available technical information. Each system was assessed against the FAIR subprinciples as described in Table 2 in the Appendix.

The evaluation is based on publicly available documentation provided by each platform. In some cases, certain FAIR principles could not be verified directly and required interpretation based on platform features or technical descriptions. The colour coding in Figure 1 reflects the level of support found for each sub principle: green indicates that the requirement was confirmed through documentation, yellow that it was partially supported or inferred, red that the principle was not met, and blue that no relevant information could be found.

Table 1. FAIR alignment matrix

System	F1	F2	F3	F4	A1	A1.1	A1.2	A2	I1	I2	I3	R1	R1.1	R1.2	R1.3
Accredit Solutions	✓	✓	✓	✓	✓	✓	✓	✕	✕	✕	~	✓	✕	✓	~
WeezeEvent	✓	✓	✓	✓	✓	✓	✓	✕	✕	✕	~	✓	✕	✕	✕
RFIdentikit	✓	✓	✓	✓	✓	✓	✓	✕	✕	✕	✓	✓	✕	✓	~
EventsAIR	✓	✓	✓	✓	✓	✓	✓	✕	~	✕	✓	✓	✕	✓	~
UNA	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Eva	✓	✓	~	✓	✓	✓	✓	✕	~	✕	~	✓	✕	~	

Across the evaluated systems, support for the Findable and Accessible subprinciples is relatively consistent, with most platforms offering unique identifiers, searchable records, and secured access mechanisms. In contrast, fewer systems support persistent metadata access, formal interoperability, or data reusability features such as licensing, provenance, and adherence to community standards.

6.1.5 Summary of Current Practices and FAIR alignment. In summary, while formal accreditation systems offer structured functionalities, they are applied inconsistently across stakeholders and lack key mechanisms to support full FAIR compliance. Informal methods remain widespread due to their low cost and ease of use, but increase the risk of data errors and regulatory non-compliance. The assessment indicates that Findability and Accessibility are generally supported, while Interoperability and Reusability are significantly weaker. Particularly concerning metadata standards, data provenance, and licensing. These limitations highlight the need for architectural strategies that enable consistent data handling, standardisation, and cross-organisational reuse, as further explored in RQ2 (6.2) and RQ3 (6.3).

6.2 RQ2: Architectural Models for FAIR Data Sharing

This section presents findings for RQ2 by comparing centralised and decentralised data architectures in terms of their alignment with the FAIR principles. It begins with a general description of architectural characteristics, followed by a principle-by-principle evaluation of FAIR alignment. The section concludes with an analysis of applicability in the event industry and a summary of the architectural trade-offs.

6.2.1 System Architectures. Architectural choices shape both technical structure and the distribution of responsibilities among stakeholders [19], which directly influences interoperability, control, and legal accountability in inter-organisational systems. The analysis focuses on two contrasting paradigms: centralised and decentralised. Their relevance has been established in prior frameworks [27, 28] and FAIR-specific evaluation models such as FAIR TRADE [6]. Alternative architectures exist but fall outside the scope of this study.

Centralised inter-organisational systems are structured around a lead organisation that manages the core technical infrastructure and enforces common standards across participants [19]. This design consolidates data and governance within a single platform, simplifying integration through shared data models, access rules, and centralised oversight [19]. A prominent example of a centralised architecture is Energie Data Services Nederland (EDSN), a national data hub for the Dutch energy sector [8]. EDSN aggregates and distributes energy usage data across suppliers and grid operators via a single access layer, enabling standardisation, coordination, and regulatory compliance. This example illustrates how centralised platforms can support inter-organisational data processes. In this study, a centralised architecture refers to a system adopted by the entire event industry. A system used only by a subset of organisations is not considered fully centralised.

Decentralised data systems distribute the responsibilities of storing, accessing, and governing data across multiple independent organisations [28], which allows each organisation to retain autonomy [19]. In decentralised architectures, coordination is often achieved through federated models. One example is the MedMij initiative in the Netherlands, which facilitates the secure exchange of medical data while preserving data sovereignty through agreed technical standards and legal roles [22]. Such systems demonstrate how decentralised governance can enable interoperability and trust in multi-stakeholder environments.

6.2.2 Findability. Centralised architectures often support consistent identifier assignment (F1) and unified metadata exposure (F2–F4), both of which strengthen *Findability* [3]. A single platform allows coordinated metadata indexing, but proprietary systems may still limit public discoverability (F4). In decentralised systems, metadata management is distributed. While this aligns with organisational autonomy, it increases the need for coordination on schemas and indexing protocols (F2, F3). Without strong alignment, discoverability across systems may be inconsistent (F4) [28]. Overall, centralisation more readily supports *Findability*, while decentralised models require governance agreements to reach similar outcomes.

6.2.3 Accessibility. Centralised architectures offer strong *Accessibility* through consistent authentication, authorisation, and audit mechanisms (A1.1, A1.2). A single platform allows a lead organisation to define access roles and enforce standardised policies, which supports regulatory compliance [3, 19]. These features are especially valuable when governance responsibilities are unclear or coordination is limited. In decentralised systems, *Accessibility* depends on federated protocols and shared governance frameworks. While this supports autonomy, it increases the risk of inconsistent implementation across participants (A1.2) [19]. Without aligned policies, retrieval may be unreliable due to unclear roles or incompatible procedures. Centralised architectures are better equipped to provide consistent *Accessibility* in such settings.

6.2.4 Interoperability. Centralised architectures promote *Interoperability* by enforcing uniform data models, schemas, and interfaces under a lead organisation (I1, I2) [19]. This top-down structure enables consistent integration and supports regulatory compliance, especially in settings with high uncertainty or weak governance [3, 27]. However, it may limit flexibility when local adaptations are needed [19]. In contrast, decentralised systems rely on federated protocols and shared standards, enabling participants to maintain autonomy while aligning on interoperability frameworks (I1–I2) [19, 28]. This model increases design flexibility but requires active coordination to prevent fragmentation or conflicting implementations (I3) [28]. Overall, centralisation simplifies *Interoperability* through enforced consistency, while decentralisation supports autonomy at the cost of higher coordination effort.

6.2.5 Reusability. Centralised systems support *Reusability* by embedding shared licensing agreements (R1.1), metadata quality controls (R1.2), and adherence to domain standards (R1.3) within a single governance model [19]. This uniformity simplifies reuse across organisations but can limit adaptability to local needs. Central control may introduce power asymmetries or vendor lock-in. When a single actor operates as a data processor or platform owner, it may also raise legal concerns under the GDPR regarding role clarity and liability [3]. In decentralised systems, *Reusability* depends on whether each participant implements FAIR-aligned practices independently. When supported by shared standards and governance agreements, this model preserves autonomy and supports reuse [28]. However, in the absence of coordination, metadata quality and licensing clarity may diverge across nodes, which reduces reusability and increases compliance complexity (R1–R1.3).

6.2.6 Event Industry Applicability. The current lack of shared metadata standards, consistent access protocols, and formal governance structures limits the event industry's readiness for decentralised coordination [3, 21]. These challenges mirror those described in broader inter-organisational data environments, where fragmented responsibilities and ad hoc agreements hinder FAIR-aligned data sharing [19]. Centralised architectures are more applicable under these conditions. Accreditation workflows are already controlled by dominant actors—such as organisers, municipalities, or safety authorities—who define access requirements and manage system integration [3]. This situation makes it feasible to implement centralised access control, metadata harmonisation, and regulatory oversight in support of FAIR principles (A1.1, A1.2, I1, R1.2) [19]. In contrast, decentralised models require strong coordination and shared governance, including agreements on access, licensing, and metadata standards [28]. While they reflect the distributed responsibilities common in the event ecosystem, their applicability remains limited without sector-wide alignment on roles, protocols, and interoperability frameworks [19, 28].

6.2.7 Summary of Architectural Trade-offs. In summary, centralised and decentralised architectures each offer distinct trade-offs in supporting *FAIR*-aligned data sharing. Centralised systems promote alignment with persistent identifier assignment and searchable metadata exposure (F1) through unified standards, enforce consistent access controls (A1.1), and enable integrated data exchange via shared schemas and interfaces (I1) [19]. They also support provenance tracking and quality control (R1.2), but may reduce flexibility and reuse potential due to vendor lock-in and centralised governance (R1.1, R1.3) [3]. Decentralised systems support autonomy and data sovereignty (R1.1, A1.2), but rely on strong coordination, shared vocabularies, and formal governance agreements to maintain consistency across participants (I1–I3, R1.2) [28]. Neither model guarantees complete FAIR compliance in isolation. Their suitability depends on trust relationships, governance maturity, and interoperability capacity—factors examined further in RQ3 (6.3).

6.3 RQ3: Applying Comparison Frameworks to Accreditation Design

This section addresses RQ3 by evaluating how existing frameworks can support the selection of centralised or decentralised architectures that align with the FAIR principles in the context of event accreditation systems. Three frameworks are considered: the centralised architecture model by Velu et al., the decentralised architecture model by Verstraete et al., and the FAIR-TRADE framework by Domingue et al.. Each is assessed individually, followed by a comparison of their ability to evaluate FAIR alignment and suitability for the event industry.

6.3.1 Existing Comparison Frameworks. **Velu et al.** propose a decision framework to assess when data management should be centralised or decentralised [27]. While both architectural options are considered, the framework focuses on identifying conditions under which centralisation is optimal. It provides a structured approach to evaluating trade-offs in system design, based on two key variables: environmental uncertainty and business-unit similarity.

- **Environmental uncertainty**: the degree of predictability of external conditions.
- **Business-unit similarity**: the extent to which operational units share structures, goals, and data needs.

The logic is conditional: centralisation is advised when uncertainty is low and units are similar, or when high uncertainty can be mitigated through coordinated decision-making. In contrast, decentralisation is favoured when local adaptability provides more value than cross-unit standardisation. These combinations are visualised in the simplified matrix shown in Figure 2 in the Appendix.

Verstraete et al. propose an evaluation framework grounded in affordance theory to assess the potential of decentralised data-sharing architectures [28]. Affordances, initially defined by Gibson, are the possibilities for action that arise from user-system interaction [15]. In information systems, they are considered context-specific uses of a system's technical features [5]. Verstraete et al. apply this concept to evaluate how decentralised data solutions can create value in multi-stakeholder environments. The framework is explicitly applied to systems with decoupled data storage and application logic. These systems allow users and organisations to store data in personal data stores, over which they retain ownership and control. This design supports access management and data interoperability through standardised permissions and semantic linking.

Eight affordances are identified as evaluation criteria: **Transparency**, **Personalization**, **Automation**, **Collaboration**, **Interoperability**, **Decentralization**, **Validity**, and **Legal Compliance**. These dimensions are derived from stakeholder interviews and reflect both technical capabilities (e.g., interoperability, automation) and organisational concerns (e.g., legal compliance, collaboration). Together, they allow system design to be evaluated from multiple stakeholder perspectives, particularly in distributed data environments. For example, Verstraete et al. highlight access management as a key affordance, enabling agents to grant and revoke permissions, which supports legal compliance in decentralised settings [28].

The framework assumes a decentralised-by-design architecture, in which multiple actors operate independently while coordinating through shared technical standards. This design is particularly relevant for fragmented environments, such as the event industry, where no single entity governs the entire system and data sovereignty is a key concern.

Domingue et al. proposed the FAIR-TRADE framework to evaluate whether decentralised data infrastructures can effectively support the FAIR principles [6]. Developed in the context of scientific data governance, the framework supports the evaluation of decentralised data management approaches. The authors argue that while the original FAIR model from Wilkinson et al. [29] provides basic guidelines, it does not fully address the architectural challenges of decentralised coordination, prompting the introduction of the TRADE extension—an acronym for TRusted, Autonomous, Distributed, and dEcentralised [6].

The TRADE extension adds four core design principles to complement the original FAIR model [6]:

- **TRusted**: metadata and provenance must be verifiable and auditable by independent systems.
- **Autonomous**: data owners must be able to control access and usage policies for their data.
- **Distributed**: data should be physically stored across multiple nodes to reduce reliance on a single point.
- **dEcentralised**: no central authority should control which data resides on which nodes.

The framework is goal-driven, evaluating which architectural features and governance mechanisms enable decentralised systems to meet FAIR outcomes. Unlike the evaluation proposed by Verstraete, FAIR-TRADE explicitly maps system capabilities to normative FAIR data goals, making it particularly suitable for assessing decentralised compliance. Its emphasis on verifiability, decentralised control, and shared governance is especially relevant in the event industry, where regulatory oversight and multi-party collaboration are both required.

6.3.2 Evaluating Frameworks Against FAIR Principles. This section evaluates how the selected frameworks support the design of FAIR-compliant data systems. Velu and Verstraete were not explicitly developed with FAIR principles in mind and are therefore assessed for their indirect alignment with these principles. Domingue's FAIR-TRADE framework, by contrast, was designed specifically for this purpose and is not re-evaluated here.

Although not FAIR-specific, Velu's framework offers a basis to evaluate centralisation in context [27]. Its emphasis on coordination and standardisation indirectly supports *Findability* and *Accessibility* but lacks criteria for *Interoperability* or *Reusability.* Verstraete et al.'s framework is also not explicitly based on the FAIR principles but aligns with key dimensions through its emphasis on decentralisation, semantic interoperability, and legal compliance [28]. Affordances such as semantic compatibility and policy enforcement support Interoperability and Reusability, but Findability and Accessibility are not addressed. While well-suited to decentralised coordination, the framework requires additional criteria to fully assess FAIR compliance.

The three frameworks support each other in their coverage of the FAIR principles. Velu et al. address Findability and Accessibility through standardisation in centralised contexts, while Verstraete et al. support Interoperability and Reusability via semantic technologies and decentralised affordances. The FAIR-TRADE framework, although not re-evaluated here, explicitly addresses all four FAIR dimensions for decentralised systems. As a result, a comprehensive FAIR evaluation may require combining or extending existing frameworks to ensure complete coverage across architectural scenarios. For an overview of each framework's coverage of the four FAIR principles, see Appendix Table 4.

6.3.3 Evaluating Frameworks Against Accreditation Systems. This section evaluates how the selected frameworks support the specific needs of accreditation systems in the event industry. As shown in RQ1 (6.1) and RQ2 (6.2), these systems involve temporary access, GDPR-sensitive data, fragmented tooling, and multi-stakeholder collaboration. The analysis below identifies how each framework addresses these characteristics, noting both alignment and gaps relative to FAIR-aligned design.

First, accreditation systems require access management, including role-based and time-limited permissions 6.1. Velu et al. do not address access control or credentialing, focusing on architectural coordination [27]. Verstraete includes access control [28], but lacks support for role-specific or temporary access. Domingue includes autonomy and decentralised control [6], but does not cover short-lived or stakeholder-specific credentialing. Second, accreditation systems process personal data and must comply with GDPR 6.1. Velu et al. do not address legal roles or data protection [27]. Verstraete includes legal compliance as an affordance [28] but does not distinguish controllers from processors. Domingue refers to data controllers [6], but not within a GDPR-compliant role structure. Third, accreditation systems lack interoperability and reusability 6.1. Velu proposes centralisation to reduce integration costs but does not address interoperability between independently developed systems [27]. Verstraete supports interoperability via semantic standards and linked data [28], but this depends on consistent implementation. Domingue promotes shared ontologies and metadata for FAIR-compliant architectures [6], but these rely on sector-wide standardisation. Finally, accreditation data is often exchanged manually between organisers, suppliers, and subcontractors, increasing the need for effective coordination 6.1. Velu addresses this through centralised architectures with uniform governance [27]. Verstraete includes collaboration as an affordance, assuming shared standards and governance [28]. Domingue supports distributed control [6] but overlooks power imbalances and weak adoption incentives.

In conclusion, while each framework addresses aspects of the accreditation context, none fully supports all identified requirements.

6.3.4 Summary of Framework Alignment. In summary, existing frameworks address key aspects of FAIR-compliant accreditation system design, but none offer complete coverage. Systems must support consistent metadata structures and shared semantics (F1, I1), temporary and role-based access control (A1.2), legal role clarity for GDPR compliance (R1.1), and decentralised coordination without assuming universal cooperation (R1.2, I3) (6.1)(6.2). Frameworks differ in their approach to these needs, and their assumptions do not always align with the fragmented nature of the event industry. Selecting an appropriate architecture depends on environmental structure, governance maturity, and stakeholder alignment [19, 27], and may require hybrid configurations to balance standardisation with local autonomy. These conditions are explored further in the Discussion (7).

7 DISCUSSION

The goal of this research was to explore existing comparison frameworks for centralised and decentralised data systems and apply these to the context of accreditation systems in the event industry, to formulate recommendations for designing FAIR-compliant data management solutions. To achieve this goal, three research questions were developed. The following sections interpret the findings and provide a direct answer to each research question, before offering an analysis across all three.

7.1 Research Question 1

What are the current data management practices within accreditation systems in the event industry, and to what extent do they align with the FAIR principles?

As shown in Section 6.1, data management practices in the event industry are split between informal methods, favoured for their simplicity, and formal platforms with more structured functionalities. However, the limited standardisation across these platforms means that even formal systems often fall short of enabling efficient or interoperable data exchange. Even though most platforms support *Findability* and *Accessibility* to some extent, *Interoperability* and

Reusability remain weak due to the lack of shared metadata standards and reuse policies. Diverging stakeholder priorities have led to minimal progress in aligning systems. Organisers focus on control, suppliers on simplicity, and authorities on compliance, which complicates efforts to develop unified data infrastructures.

Answer to RQ1: *Current accreditation systems in the event industry show a mix of informal and formal data practices, with limited alignment to the FAIR principles. Findability and Accessibility are moderately supported, while Interoperability and Reusability are largely unmet, revealing structural and governance gaps in data management.*

7.2 Research Question 2

What are the key differences between centralised and decentralised data architectures in terms of enabling FAIR-compliant data sharing in inter-organisational contexts?

As discussed in Section 6.2, centralised architectures enable consistent metadata control and legal oversight, which supports FAIR-aligned data sharing, especially for *Findability* and *Accessibility*. However, in inter-organisational contexts, this model risks concentrating power and limiting flexibility, which may hinder *Reusability* and cross-organisational trust. Decentralised architectures promote autonomy and can improve *Reusability* through local control of licensing and stewardship. However, they rely on sector-wide coordination to ensure *Interoperability*. In fragmented environments, this often proves difficult, limiting the ability to implement FAIR-compliant systems without strong governance agreements.

Answer to RQ2: *Centralised architectures support FAIR compliance through standardisation and unified governance, but risk centralised control and reduced flexibility. Decentralised architectures better align with Reusability and data sovereignty but require strong coordination to ensure Interoperability and avoid fragmentation.*

7.3 Research Question 3

How can existing comparison frameworks for centralised and decentralised data systems be applied to the event industry to support the design of FAIR-compliant accreditation systems?

Section 6.3 evaluated three existing frameworks and found that while each addresses key design concerns, none fully meet the operational and FAIR-specific needs of accreditation systems in the event industry. While Velu et al. provide strategic guidance on centralisation choices, their model lacks coverage of operational factors such as data access or legal roles [27]. Verstraete et al. address interoperability and legal compliance from a decentralised perspective, but assume high cooperation and offer limited support for role-based or temporary access [28]. Domingue et al.'s FAIR-TRADE framework maps directly to the FAIR principles but omits sector-specific challenges, such as GDPR roles or conflicting stakeholder incentives [6]. These gaps informed five design considerations: (1) consistent metadata structures, (2) time-limited and role-based access control, (3) decentralised coordination mechanisms, (4) legal role clarity for GDPR compliance, and (5) mechanisms to support interoperability without assuming full stakeholder cooperation. While organisers typically decide which system to adopt, broader adoption depends on how well the system supports the operational needs of all stakeholders. Improving usability and interoperability may increase supplier participation and gradually steer preferences toward more FAIR-compliant solutions. These architectural preferences will also depend on environmental uncertainty and the degree of similarity between stakeholders' operational needs, reflecting the core variables in Velu et al.'s decision model [27].

Although the proposed design rules offer theoretically grounded improvements, their success in practice depends on alignment with stakeholder incentives and sensitivity to implementation costs. For organisers, incentives include regulatory compliance, operational oversight, and risk mitigation. They benefit from centralised control and standardisation, especially when accountability and error reduction are prioritised. Centralised systems, however, may require upfront investments in platform integration, access control, and legal clarification. Suppliers, by contrast, are motivated by ease of use, minimal manual data entry, and maintaining control over sensitive personnel data. While decentralised architectures may support these needs, they also introduce coordination burdens that can deter participation. If these factors are ignored, well-designed systems will still risk limited adoption or limited stakeholder buy-in.

Answer to RQ3: *Existing comparison frameworks each offer partial support for designing FAIR-compliant accreditation systems. However, none fully address the operational, legal, and governance needs of the event industry. Effective application requires adapting or combining frameworks to meet domain-specific requirements such as metadata consistency, role-based access, and decentralised coordination. In addition to technical adaptation, successful adoption will depend on whether the proposed solutions align with stakeholder incentives and cost considerations.*

7.4 Research Goal Evaluation

Together, the three research questions demonstrate that while accreditation systems in the event industry are evolving, they still lack support for full FAIR compliance, particularly in Interoperability and Reusability. Centralised and decentralised architectures each address parts of the problem, but neither fully resolves the structural and governance challenges identified. The analysed frameworks offer valuable insights but fall short in addressing operational needs, such as temporary access control, GDPR roles, and stakeholder diversity. As such, hybrid and context-specific system designs—supported by shared metadata standards and flexible governance—offer the most viable path toward FAIR-compliant accreditation systems.

7.5 Limitations and Future Research

This study has several limitations that affect the generalisability and practical validity of its findings.

First, the analysis is conceptual and literature-based, relying on document analysis and theoretical frameworks rather than empirical testing. While this approach was suitable for identifying design gaps, it limits the ability to assess feasibility or usability in real-world settings. Future work could include prototyping or field studies to evaluate implementation in practice.

Second, the FAIR-alignment matrix (Table 1) was constructed from publicly available documentation, which was often incomplete. In some cases, metadata structure or licensing had to be inferred, introducing potential interpretive bias that may affect the accuracy of the assessment. Future research could involve direct collaboration with platform providers to access technical specifications and conduct FAIR compliance analysis based on full system access.

Third, the study draws on a single expert interview [2] to validate the relevance of challenges in current practice. While informative, this limited sample constrains the generalisability of stakeholder perspectives. Future research could expand on this by conducting structured interviews or surveys with a broader range of stakeholders across the event supply chain.

Fourth, the study focuses exclusively on the European regulatory context, particularly the General Data Protection Regulation (GDPR). While GDPR is widely considered one of the most comprehensive data protection frameworks, regulatory models differ in other regions. Comparative research could reveal how regional legal differences affect design choices, governance structures, and stakeholder incentives across implementation regions.

Beyond addressing the limitations noted above, further research could explore additional directions to enhance the practical implementation and adoption of these approaches. This includes conducting stakeholder interviews or surveys to clarify industry preferences, as well as prototyping FAIR-aligned systems to test feasibility. Comparative studies involving organisers, suppliers, and system vendors would help identify acceptable and effective architectural models across different contexts. Additionally, future research should explore and compare the concrete cost structures associated with centralised and decentralised accreditation architectures, to support design decisions grounded not only in conceptual evaluation but also in financial viability.

8 CONCLUSION

This research aimed to investigate how existing comparison frameworks for centralised and decentralised data systems can inform the design of FAIR-compliant accreditation systems in the event industry. By analysing current practices (RQ1), architectural alternatives (RQ2), and the applicability of comparison frameworks (RQ3), the study provides a foundation for future design and governance decisions in this context.

The findings show that while formal accreditation platforms offer structure, their implementation is fragmented and lacks alignment with FAIR principles, particularly **Interoperability** and **Reusability**. Architectural comparisons demonstrated that centralised and decentralised approaches each have distinct advantages, but also limitations when applied to the event industry. Existing comparison frameworks partially address these challenges, but lack support for operational, legal, and stakeholder-specific needs of event accreditation systems.

As a result, the study identified five design considerations and related selection criteria to guide the development of more FAIR-aligned systems. These findings suggest that hybrid and context-specific architectures, supported by sector-wide alignment on data and governance mechanisms, offer the most promising path. While no single solution guarantees FAIR compliance to the best of our knowledge, this research contributes a conceptual basis for guiding future design efforts in event accreditation systems.

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A APPENDIX

A.1 AI Disclosure

During the development of this project, I utilised ChatGPT and Grammarly to improve the quality and consistency of the writing, and Google (including Gemini) to search for information. Other search engines or applications used in the process may also have employed AI technologies without my explicit knowledge. After using these tools and services, I thoroughly reviewed and edited the content as needed, taking full responsibility for the outcome.

A.2 FAIR subprinciples

Table 2. FAIR Subprinciples as defined by Wilkinson et al. [29]

Code	Description
F1	(Meta)data are assigned a globally unique and persistent identifier.
F2	Data are described with rich metadata.
F3	Metadata clearly and explicitly include the identifier of the data it describes.
F4	(Meta)data are registered or indexed in a searchable resource.
A1	(Meta)data are retrievable by their identifier using a standardised communications protocol.
A1.1	The protocol is open, free, and universally implementable.
A1.2	The protocol allows for authentication and authorisation where necessary.
A2	Metadata remain accessible even if the data is no longer available.
I1	(Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
I2	(Meta)data use vocabularies that follow FAIR principles.
I3	(Meta)data include qualified references to other (meta)data.
R1	(Meta)data are richly described with a plurality of accurate and relevant attributes.
R1.1	(Meta)data are released with a clear and accessible data usage license.
R1.2	(Meta)data are associated with detailed provenance.
R1.3	(Meta)data meet domain-relevant community standards.

A.3 Keyword Overview Literature Search

Table 3. Keywords and synonyms used in the literature search

Theme	Keywords / Synonyms
Events	Public events, Festivals, Corporate events
FAIR Principles	FAIR, FAIR compliance, FAIR data, Findability, Accessibility, Interoperability, Reusability
Inter-Organisational Collaboration	Inter-organisational, Cross-organisational, Multi-stakeholder, Federated systems, IOS
Data Sharing	API, Data Interoperability, Data sharing, Information exchange, Data integration, Data flows
GDPR and Compliance	GDPR, Data protection, Legal compliance, Data governance, Privacy regulations
Accreditation Systems	Accreditation, Event access control, Personnel registration, Entry management systems
System Architectures	Centralised architecture, Decentralised architecture, Federated architecture, Distributed systems
Comparison	Evaluation framework, Architecture comparison, System design analysis, Trade-off analysis

A.4 Event Accreditation System Stakeholders

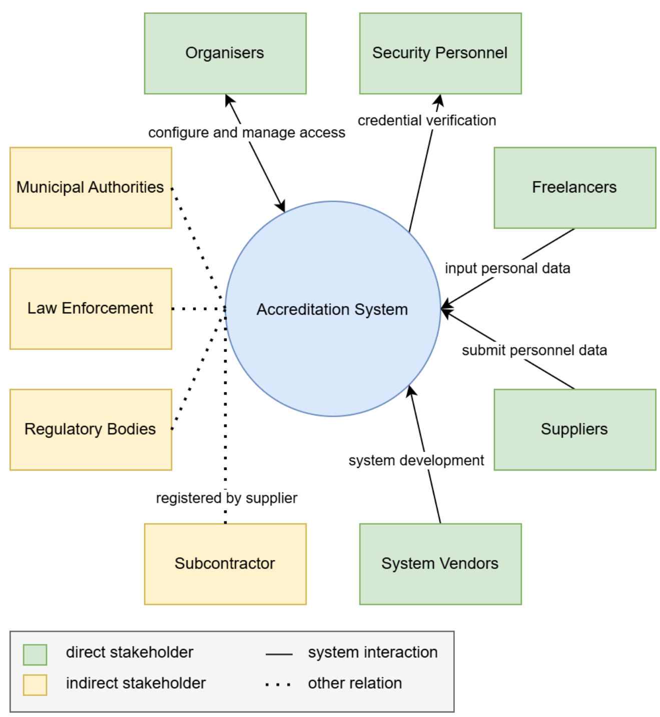

Fig. 1. Stakeholder diagram of event accreditation systems

A.5 Architecture Decision Matrix

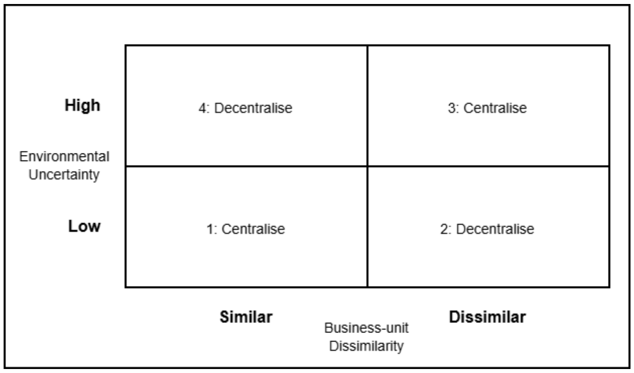

Fig. 2. Architecture decision matrix adapted from Velu et al. [27]

A.6 Comparison of framework FAIR alignment

Table 4. Alignment of the three frameworks with the FAIR principles

System	Findability	Accessibility	Interoperability	Reusability
Velu et al.	✓	✓	✕	✕
Verstraete et al.	~	~	✓	✓
Domingue et al.	✓	✓	✓	✓

A.7 Comparison of Architectures and FAIR Principles

Table 5. Comparison of Centralised and Decentralised Architectures in Supporting FAIR Principles

FAIR Principle	Centralized Architecture	Decentralized Architecture
Findable	Unified metadata and persistent identifiers are easier to implement through centralised control. High discoverability through a single point of access.	Requires federated indexing and shared metadata schemas. Offers resilience, but coordination complexity can hinder consistent discoverability.
Accessible	Centralised access controls and authentication mechanisms simplify user access. Easier to manage oversight and audit trails.	Access is governed locally using shared protocols. Promotes autonomy, but access consistency depends on cross-organisational alignment.
Interoperable	Standard vocabularies and data models can be enforced top-down, ensuring consistency and uniformity. Integration is technically easier.	Requires agreement on standards and interfaces. Allows flexibility, but risks fragmentation without active governance.
Reusable	Provenance, licensing, and metadata practices can be centrally defined and enforced. Reuse is consistent within the system.	Supports reuse through local control and transparency. Requires strong coordination to maintain quality and trust across nodes.