



**FROM FRAGMENTATION TO INTEGRATION: DEVELOPING AN
INTERDISCIPLINARY DATA SHARING FRAMEWORK FOR SURVEYING
PRACTICE IN MALAYSIA'S DIGITAL BUILT ENVIRONMENT**

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Abstract

The rapid digital transformation of the built environment has increased the need for effective interdisciplinary data sharing within surveying practice in Malaysia. However, persistent fragmentation across technical systems, organisational structures, and professional workflows continues to hinder seamless integration. This study aims to develop a structured interdisciplinary data sharing framework tailored to Malaysia's digital built environment. A qualitative research design was adopted using semi-structured interviews with 12 experts from multiple surveying disciplines under the Royal Institution of Surveyors Malaysia (RISM). The data were analysed through thematic analysis to identify recurring barriers, opportunities, and governance requirements. The findings reveal that data fragmentation is shaped by three interconnected dimensions: technical interoperability barriers, organisational and contractual constraints, and behavioural and collaborative culture challenges. In response, the study proposes an empirically informed socio technical framework that integrates interoperable digital infrastructure, governance mechanisms, and lifecycle collaborative workflows, based on insights from a purposively selected group of RISM affiliated experts. The study contributes theoretically by advancing understanding of interdisciplinary data sharing challenges in surveying practice and, practically, by offering a framework for policymakers and industry practitioners. Its novelty lies in its context specific focus on surveying data sharing and in the development of an empirically grounded framework that is intended to inform data sharing practices within the Malaysian surveying context. Future research should incorporate broader industry participation and industry based case implementation.

Keywords: Data digital; Digital built environment; Interdisciplinary data sharing; Surveying practice; Malaysia

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INTRODUCTION

The rapid digital transformation of the built environment has fundamentally reshaped the manner in which surveying professionals generate, manage, and exchange spatial and non-spatial data. Within the context of Malaysia's evolving digital construction ecosystem, the increasing adoption of technologies such as Building Information Modelling (BIM), Geographic Information Systems (GIS), remote sensing, cloud-based collaboration platforms, value creation, and digital twins has intensified the need for efficient interdisciplinary data sharing (Abdul Rahman et al., 2026; Nashruddin et al., 2024; Sunandar et al., 2025d).

Surveying practice no longer operates in isolation; rather, it is increasingly embedded within a broader network of architects, engineers, planners, quantity surveyors, contractors, and government agencies (Sayyidqosimov et al., 2025; Wei et al., 2024; Wu et al., 2025). This interconnected professional landscape demands seamless data interoperability to support informed decision-making, project coordination, and life cycle asset management across the digital built environment (Ma et al., 2025; Sun et al., 2025).

Despite these technological advancements, data sharing within surveying practice remains highly fragmented (Berlato et al., 2025; Lai et al., 2025; Parece et al., 2025). Data are often produced and stored in discipline-specific formats, managed through incompatible software environments, and governed by inconsistent organisational protocols (Ebid et al., 2025). Such fragmentation restricts the effective integration of surveying information into multidisciplinary workflows, leading to inefficiencies, duplication of work, communication breakdowns, and reduced data reliability (Ma et al., 2025; Sun et al., 2025).

In Malaysia, these issues are further compounded by variations in institutional readiness, uneven levels of digital maturity, and the absence of standardised cross-disciplinary mechanisms for surveying data governance. As the construction industry moves towards integrated digital delivery, addressing these barriers has become both an academic and a practical imperative (Construction Industry Development Board Malaysia, 2020).

The central problem underpinning this research lies in the persistent disconnect between technological capability and practical implementation. While existing digital tools offer considerable potential for data integration, the actual sharing of surveying data across disciplines remains constrained by technical incompatibility, the lack of common standards, concerns regarding data ownership, inconsistent metadata structures, and limited institutional collaboration (AlMashaan & AlMaian, 2025; Dong & Qin, 2025; Sun et al., 2025; Wang et al., 2023). These challenges hinder the realisation of a fully integrated

digital built environment and may compromise project performance, decision accuracy, and long-term data sustainability.

A critical review of the literature reveals a significant research gap in the development of interdisciplinary frameworks specifically designed for surveying practice in Malaysia. Although previous studies have examined broader data sharing ecosystems within the built environment, they generally focus on cross sector digital integration, platform architectures, or generic information management. In contrast, this study specifically examines interdisciplinary data sharing within surveying practice, emphasising the unique professional workflows, governance arrangements, and interoperability requirements among surveying disciplines in the Malaysian context.

The novelty of this study lies in its interdisciplinary and context specific approach to framework development. Unlike broader studies that conceptualise data sharing ecosystems at the general built environment level, this research develops a surveying specific framework grounded in empirical evidence from Malaysian surveying professionals. By integrating technical interoperability, governance mechanisms, and collaborative workflows within the context of surveying practice, the proposed framework provides a more profession focused perspective on digital data sharing.

This study contributes to the body of knowledge in three principal ways. First, it advances the theoretical understanding of interdisciplinary data sharing challenges within the surveying profession. Second, it provides an empirically informed framework that may serve as a reference for policymakers, professional bodies, and industry practitioners in Malaysia. Third, it offers practical guidance for improving digital collaboration strategies within the broader built environment ecosystem.

More specifically, the study seeks to develop a structured and contextually relevant framework that addresses the technical, organisational, and procedural challenges associated with data exchange among multiple stakeholders. In doing so, the research aims to support greater interoperability, improve collaborative efficiency, and strengthen the role of surveying data as a strategic asset in digital construction processes. Accordingly, the research is guided by two main objectives (RO). RO1 is to identify the key thematic factors influencing interdisciplinary data sharing in surveying practice within Malaysia's digital built environment. RO2 is to develop an interdisciplinary data sharing framework across surveying and related built environment disciplines.

RESEARCH METHODOLOGY

Data Collection

This study adopted a qualitative research design to explore the complexities of interdisciplinary data sharing within surveying practice in Malaysia's digital built

environment. Given the exploratory nature of the research objectives, semi-structured interviews were employed as the primary method of data collection (Sunandar, Abd Karim, et al., 2026b). Semi-structured interviews offer the flexibility required to investigate complex professional issues while maintaining sufficient consistency across participants (Shakur et al., 2021; Sunandar, Andriyanti, et al., 2026a). The respondents were selected using a purposive sampling strategy. In this study, the selection criteria focused on professionals who were actively involved in surveying practice and held recognised roles within the Royal Institution of Surveyors Malaysia (RISM). The inclusion of RISM members ensured that the participants possessed professional credibility, practical exposure, and disciplinary expertise within Malaysia's surveying ecosystem.

A total of 12 experts were interviewed, at which point data saturation was achieved, as no new themes or insights emerged from the subsequent interviews (Saunders et al., 2018). The participants represented diverse surveying disciplines, including Building Surveying (BS), Geomatics and Land Surveying (GLS), Property Surveying (PS), and Quantity Surveying (QS). They comprised individuals from various professional backgrounds, including academia, government agencies, consultancy, business practice, and directorial roles. In addition, several participants held senior professional positions within RISM, such as fellows, committee members, and ordinary members. This diversity was intentionally sought to capture a broad range of interdisciplinary perspectives and institutional experiences related to data sharing practices. The profile of the participants is presented in Table 1. The interview protocol was organised into three principal parts to ensure alignment with the study objectives. The first part focused on barriers to effective data sharing, exploring the technical, organisational, and procedural constraints experienced by experts when exchanging data across disciplines. The second part addressed opportunities and expectations for data sharing integration. The third part centred on governance and future direction, investigating policy frameworks, institutional responsibilities, professional standards, and strategic recommendations for enhancing long-term interdisciplinary collaboration. All interviews were conducted in a manner that ensured consistency, ethical integrity, and confidentiality (Knott et al., 2022; Sunandar et al., 2025b). The interview responses, obtained through both verbal and written formats, were subsequently transcribed verbatim to facilitate systematic qualitative analysis.

Table 1: Details of Experts

Code	Professional Status	Role in RISM	Discipline
R1	Business Practice, Academic, Consultant	Member	BS
R2	Academic, Consultant	Fellow	BS
R3	Government Officer	Fellow	BS

Code	Professional Status	Role in RISM	Discipline
R4	Consultant, Director	Graduate	GLS
R5	Academic, Government Officer	Fellow, Committee	PS
R6	Business Practice	Member	PS
R7	Business Practice, Consultant	Fellow, Committee	PS
R8	Consultant, Director	Fellow	PS
R9	Academic	Member	QS
R10	Business Practice	Fellow, Committee	QS
R11	Business Practice, Director	Member	QS
R12	Business Practice	Member	QS

Source: Author's Own Creation (2026)

Data Analysis

The collected interview data were analysed using thematic analysis, a widely accepted qualitative analytical technique for identifying, organising, and interpreting patterns of meaning within textual data (Sunandar, Abd Karim, et al., 2026a; Sunandar et al., 2025c). The analytical process began with data familiarisation, during which all interview transcripts were read repeatedly to develop a comprehensive understanding of the content and contextual nuances of the participants' responses (Braun & Clarke, 2021; Saldana, 2021). The second stage involved open coding, whereby meaningful segments. Similar codes were then compared and merged through constant comparison into higher order categories based on conceptual similarity. Finally, these categories were synthesised into three overarching themes. This iterative process established a transparent analytical pathway from initial codes to categories and themes. To enhance the credibility and consistency of the analysis, the coding process was conducted iteratively and independently reviewed by the research team (Sunandar, Andriyanti, et al., 2026b; Sunandar et al., 2025a). Coding decisions, category definitions, and theme boundaries were discussed until consensus was achieved, thereby reducing individual researcher bias and strengthening analytical reliability. The resulting themes formed the empirical basis for addressing RO1 and subsequently informed the development of the interdisciplinary data sharing framework under RO2.

ANALYSIS AND DISCUSSION

Thematic 1: Barriers to Effective Interdisciplinary Data Sharing

The first major theme emerging from the interview data concerns the barriers that continue to constrain effective interdisciplinary data sharing within surveying practice in Malaysia's digital built environment. Thematic analysis of responses reveals that these barriers extend beyond purely technical issues and are deeply embedded in organisational structures, contractual arrangements, and professional culture. Across participants, three interrelated categories were consistently identified: technical and system interoperability barriers,

organisational and contractual constraints, and behavioural and collaborative culture challenges. Collectively, these categories demonstrate that fragmentation in data sharing is not solely a matter of software incompatibility, but a multidimensional issue involving governance, trust, and professional behaviour. The findings further indicate that the persistence of fragmented data ecosystems is reinforced by both structural and human factors, thereby necessitating an integrated framework that addresses these dimensions simultaneously. The key thematic coding derived from the interviews is summarised in Table 2.

Table 2: Thematic Summary for Barriers to Effective Data Sharing

Category	Coding	Source
Technical and system interoperability barriers	Incompatible software platforms; interoperability gaps; data loss during transfer; legacy systems; inconsistent file formats; manual data re-entry; lack of common standards; version incompatibility; limited automation; security access restrictions	R1, R2, R3, R4, R6, R9, R12
Organisational and contractual constraints	Unclear data ownership; liability concerns; intellectual property protection; confidentiality restrictions; contractual scope limitations; organisational silos; lack of SOPs; accountability ambiguity; absence of data governance	R1, R2, R3, R4, R5, R6, R9, R12
Behavioural and collaborative culture challenges	Silo mentality; low trust; defensive attitudes; knowledge protectionism; reluctance to digitise; weak collaboration culture; compliance driven sharing; fear of blame; selective information disclosure	R1, R2, R3, R4, R6, R7, R9, R10, R12

Source: Author's Own Creation (2026)

The first category, technical and system interoperability barriers, highlights the operational challenges faced by practitioners when exchanging data across multiple digital platforms. Respondents consistently emphasised incompatibility between BIM, CAD, GIS, spreadsheets, and legacy systems as a major obstacle. As R2 explained, “importing a structural engineer's model into our architectural software often results in data loss or geometry errors,” illustrating persistent interoperability limitations across digital platforms. Similarly, R3 observed that “different systems are not fully integrated, making data sharing slow and fragmented,” while R12 noted that compatibility issues frequently require manual coordination across disciplines. The continued reliance on manual re-entry and platform specific formats increases the risk of duplication, inaccuracy, and delay, ultimately weakening data reliability across project life cycles (R3, R9, R12).

The second category, organisational and contractual constraints, reflects the institutional barriers that restrict effective data exchange. Several respondents emphasised that unclear contractual provisions regarding ownership, liability, and access rights discourage professionals from sharing raw data openly.

As R2 explained, “we lock data in PDFs” because sharing editable files increases professional liability. Likewise, R4 observed that “the absence of clear Standard Operating Procedures for data handling” creates uncertainty regarding third party data sharing responsibilities. At the organisational level, silo based structures and the lack of formal standard operating procedures further reinforce fragmentation (R3, R4). Confidentiality concerns, particularly in relation to government sensitive and client related information, also emerged as significant constraints (R5, R11, R12). These findings indicate that technical solutions alone are insufficient without clear governance mechanisms and contractual alignment.

The third category, behavioural and collaborative culture challenges, reveals that human and professional attitudes significantly shape data sharing practices. Trust emerged as a central issue influencing data sharing practices. R2 described a persistent “check it yourself” culture in which professionals continue to verify information independently despite receiving digital datasets from other disciplines. Similarly, R6 referred to a historical culture of “data protectionism,” whereas R7 succinctly characterised current practice as “all secretive.” Conversely, respondents acknowledged that stronger knowledge sharing cultures and clearly mandated collaborative requirements could improve transparency and interdisciplinary coordination (R3, R11). This finding demonstrates that cultural transformation is as critical as technological innovation in achieving effective data integration.

Thematic 2: Opportunities and Framework Design Principles

The second major theme focuses on the opportunities for improving interdisciplinary data integration and the essential design principles required for an effective framework. Responses reveal a strong consensus that the current fragmented environment can be substantially improved through standardisation, shared digital platforms, and lifecycle oriented data governance. Two major categories emerged from the analysis: integration opportunities and framework design principles. The thematic coding is summarised in Table 3.

Table 3: Thematic Summary for Barriers to Effective Data Sharing

Category	Coding	Source
Opportunities for interdisciplinary integration	Standardised data formats; centralised digital platform; API integration; metadata tagging; predictive maintenance; digital twins; lifecycle continuity; real time data access; cross disciplinary visibility	R1, R2, R3, R4, R6, R9, R11, R12
Framework design principles	Interoperability; standard definitions; role clarity; version control; data provenance; tiered access; accountability; vendor neutrality; lifecycle usability	R1, R2, R3, R4, R6, R9, R10, R12

Source: Author's Own Creation (2026)

The first category, opportunities for interdisciplinary integration, highlights the significant potential for improving collaboration across surveying disciplines. Respondents identified centralised digital platforms, open standards, and metadata integration as key opportunities for improving collaboration. R2 highlighted the importance of maintaining a “Golden Thread” of information throughout the building lifecycle, while R6 advocated “API driven market data” and standardised metadata to facilitate real time information exchange. The findings suggest that future integration should move beyond isolated project delivery and instead support continuous information flow throughout planning, construction, operation, and maintenance phases (R2, R3, R9, R12).

The second category, framework design principles, defines the critical features required for a practical and effective interdisciplinary data sharing framework. Participants consistently emphasised interoperability, accountability, and standardisation. As R6 stated, “data must be platform agnostic,” while R3 argued that surveyors require “clear roles, ownership and professional accountability” to support reliable interdisciplinary collaboration. Equally important were governance oriented principles such as role clarity, accountability, and version control (R3, R12). These findings indicate that the proposed framework must balance technological functionality with institutional trust and professional accountability, ensuring both usability and legal defensibility.

Thematic 3: Governance and Future Digital Direction

The third theme addresses the strategic governance mechanisms and future digital directions necessary to sustain secure and effective interdisciplinary data sharing. The findings indicate that long-term integration requires strong institutional leadership, nationally aligned standards, and compatibility with emerging digital initiatives. Two categories were identified: governance and institutional support, and alignment with emerging digital initiatives. Table 4 summarises the thematic coding.

Table 4: Thematic Summary for Governance and Future Direction

Category	Coding	Source
Governance and institutional support	National standards; SOPs; cybersecurity; professional mandates; ethical governance; training; regulatory oversight; secure access control; policy alignment	R1, R2, R3, R4, R6, R9, R10, R11, R12
Alignment with emerging digital initiatives	BIM integration; GIS interoperability; digital twins; asset lifecycle support; integrated digital delivery; technology neutrality; national transformation alignment; platform flexibility	R1, R2, R3, R4, R6, R9, R11, R12

Source: Author's Own Creation (2026)

The first category, governance and institutional support, demonstrates that effective data sharing requires formal regulatory and professional oversight. Respondents consistently pointed to the need for nationally recognised standards and stronger institutional leadership. R2 recommended “professional body mandates” together with “standardised data protocols,” whereas R6 advocated a “National Property Data Standard” supported by regulatory oversight. These findings suggest that governance must operate across policy, organisational, and project levels to ensure consistency and accountability.

The second category, alignment with emerging digital initiatives, reflects the necessity of designing a framework that supports BIM, GIS, digital twins, and national digital transformation agendas. Respondents emphasised that future frameworks should support interoperable digital ecosystems rather than isolated technologies. R3 argued that the framework should be “asset centric, not project centric,” while R6 emphasised that BIM should evolve into “6D BIM” by integrating valuation and lifecycle costing information. Alignment with national initiatives such as integrated digital delivery and broader digital transformation policies was viewed as essential for long-term relevance and scalability (R4, R6, R12). This finding strongly supports the development of a forward looking framework that can remain adaptable to future technological advancements within Malaysia’s digital built environment.

Development of the Interdisciplinary Data Sharing Framework

The proposed interdisciplinary data sharing framework was developed directly from the thematic analysis of the interview data rather than being predetermined from existing theoretical models. The three overarching themes identified through the coding process served as the primary analytical foundation for the framework. Figure 1 presents the resulting framework, which consists of five interrelated components: technical interoperability, organisational governance, access control, lifecycle collaborative workflow, and professional responsibility. Each component corresponds directly to one or more themes generated through the thematic analysis. Rather than representing an abstract conceptual model, the framework constitutes an empirical synthesis of the recurring issues, opportunities, and governance requirements consistently identified across the expert interviews. The framework subsequently underwent an expert review through presentations to the respective RISM surveying divisions and at the RISM Conference 2026, where constructive professional feedback was incorporated to refine the framework presentation and clarify stakeholder responsibilities.

The first component of the framework focuses on technical interoperability and digital infrastructure integration. This layer addresses the operational barriers associated with incompatible software platforms,

inconsistent data formats, and manual data transfer processes identified under Thematic 1. At the core of this component is the establishment of a centralised interoperable digital platform capable of integrating BIM, GIS, remote sensing outputs, cost databases, and asset management systems. The framework advocates the use of standardised data schemas, metadata protocols, and vendor neutral exchange formats. API based connectivity and cloud enabled database architecture are incorporated to support real time data access, version synchronisation, and automated updating of shared datasets. By embedding interoperability as a foundational principle, the framework reduces duplication, minimises data loss during transfer, and enhances the usability of surveying data across planning, design, construction, and operational stages. Nevertheless, successful implementation requires considerable organisational investment in digital infrastructure, system integration, and workforce capability development. Smaller surveying firms may experience financial constraints when upgrading legacy systems and adopting interoperable digital platforms, suggesting that implementation should be undertaken progressively according to organisational readiness.

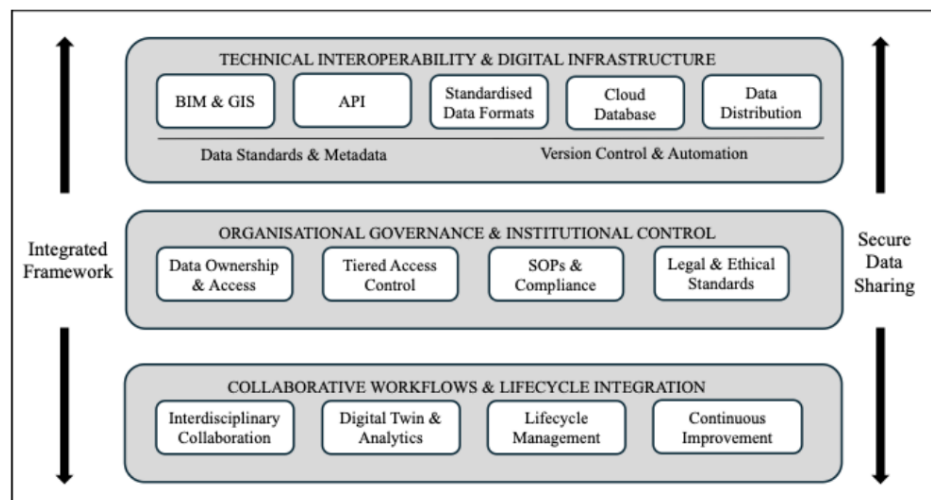


Figure 1: Interdisciplinary Data Sharing Framework
Source: Author's Own Creation (2026)

The second component addresses organisational governance and institutional control mechanisms. The empirical findings clearly demonstrate that technical solutions alone are insufficient in the absence of robust governance structures. Accordingly, this component introduces a formal governance layer that defines data ownership, access rights, accountability structures, and standard operating procedures for interdisciplinary data exchange. Tiered access control is

proposed to ensure that data confidentiality, intellectual property protection, and cybersecurity requirements are maintained without undermining collaborative efficiency. Access permissions are assigned according to stakeholder roles and project responsibilities, ensuring that authorised users can create, modify, validate, or retrieve data while maintaining transparency, accountability, and data security throughout the project lifecycle. Ethical governance, legal liability provisions, and data sharing protocols are embedded to strengthen institutional trust and reduce ambiguity regarding information use and ownership. This governance component is essential in creating a defensible and professionally credible structure capable of supporting both public and private sector implementation.

The third component emphasises collaborative workflow integration and lifecycle continuity, which directly responds to the behavioural and cultural barriers identified in the thematic findings. The framework recognises that sustainable data sharing cannot be achieved without strengthening the collaborative culture among professionals. This includes defined procedures for data validation, collaborative review, and cross disciplinary feedback loops to minimise silo based decision making. Professional responsibility is embedded by assigning clear responsibilities for data creation, verification, updating, and approval to each participating discipline, thereby improving data quality, reducing duplication, and strengthening accountability throughout the information lifecycle.

To facilitate practical implementation, the framework operationalises professional responsibility by assigning complementary roles to the principal stakeholders within Malaysia's digital built environment. RISM may serve as the professional coordinator by promoting common data standards, competency development, and interdisciplinary practice guidelines. Government agencies may provide regulatory oversight through standard operating procedures, cybersecurity requirements, and alignment with national digital transformation initiatives. Private surveying firms may operationalise the framework by adopting interoperable BIM and GIS workflows, standardised metadata, and internal data governance procedures. Project teams, including surveyors, architects, engineers, contractors, and asset managers, are responsible for coordinated lifecycle information management, role based data access, interdisciplinary data validation, and timely updating of shared datasets to ensure consistent, reliable, and accountable information exchange across all project phases.

CONCLUSION

This study concludes that interdisciplinary data sharing within surveying practice in Malaysia's digital built environment remains constrained by interconnected technical, organisational, and behavioural barriers. The findings demonstrate that

fragmentation is not merely a technological issue, but is also deeply influenced by ambiguities in governance, contractual limitations, and a weak culture of collaboration across professional disciplines. In response, this research developed a structured interdisciplinary data sharing framework that integrates technical interoperability, governance mechanisms, and lifecycle collaborative workflows to support more effective and sustainable data exchange. The novelty of this study lies in its context specific and socio technical approach to framework development. Unlike previous studies that have primarily focused on isolated technological solutions, this research advances a holistic framework grounded in empirical insights obtained from multidisciplinary surveying experts within the Malaysian context. This offers a more realistic and practice oriented model for addressing local institutional and professional challenges.

The study contributes theoretically by extending the current understanding of data interoperability challenges in surveying practice and contributes practically by offering a reference framework for policymakers, professional bodies, and industry practitioners. To facilitate practical implementation, a staged adoption pathway is recommended. The initial stage should prioritise the establishment of common data standards, governance policies, and stakeholder capacity building. The second stage should focus on implementing interoperable digital platforms, standardised metadata, and role based access control across surveying disciplines. The final stage should promote lifecycle data integration through BIM, GIS, digital twins, and continuous institutional monitoring to support integrated project delivery and long term asset management. Nevertheless, the study is limited by its qualitative scope and the purposive sampling of RISM members. Future research should validate the proposed framework through broader industry participation and case based implementation studies across different built environment projects in Malaysia.

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DISCLOSURE

The authors declare that there is no conflict of interest associated with this research.

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