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INTEGRATING INFORMATION GOVERNANCE AS THE FOUNDATION FOR INFORMATION DASHBOARD DESIGN ONTOLOGY

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ABSTRACT

Aim/Purpose	This paper addresses the lack of a standardized approach to information dashboard design and the absence of integrated Information Governance (IG) principles in this context.
Background	This study addresses the critical role of IG principles in ensuring dashboards are reliable, secure, and effective. By integrating IG principles into the work-in-progress Information Dashboard Design Ontology (IDDO), the study aims to enhance the systematic development of dashboards, addressing real-world issues such as data governance failures in Healthcare.gov, security breaches in CRM systems and risk reporting gaps in the JPMorgan Chase "London Whale" incident.
Methodology	A narrative literature review (NLR) method was employed to synthesize insights from three established IG models and prior studies. NLR was chosen for its flexibility in exploring emerging topics, such as the integration of IG with dashboard design, where existing literature is scarce. The study acknowledges the limitations of NLR, including potential selection bias, while emphasizing its

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	value in identifying foundational insights and aligning IG principles with dashboard design needs.
Contribution	This study bridges the gap between IG and information dashboard design by proposing eight relevant IG principles for integration into the work-in-progress IDDO, providing a novel framework for governance-driven dashboard design.
Findings	The study derived eight IG principles aligned with common design principles: Quality, Security, Compliance, Integrity, Availability, Transparency, Accountability, and Effectiveness.
Recommendations for Practitioners	Practitioners should incorporate these IG principles into their dashboard design processes to enhance data quality, compliance, user trust, and decision-making support.
Recommendations for Researchers	Researchers should explore the practical application of these IG principles across various organizational contexts and assess their impact on dashboard effectiveness and user experience.
Impact on Society	This approach offers a potential solution to data quality, compliance, and user trust issues in enterprise information systems, which could lead to improved organizational decision-making and enhanced end-user experiences.
Future Research	Future studies should focus on the practical integration of the identified IG principles into the IDDO framework, including empirical testing and validation in real-world scenarios.
Keywords	information governance (IG), information dashboard design method (IDDO), design principles, foundational governance

INTRODUCTION

This study focuses on deriving relevant Information Governance (IG) principles as the foundation for the work-in-progress Information Dashboard Design Ontology (IDDO). Dashboards are not standalone visualization tools; the soul of all dashboards is the data. They depend heavily on accurate, governed data for reliable, actionable insights. Without proper governance, dashboards risk becoming unreliable, insecure, and ineffective for decision-making (Few, 2010).

Real-world failures underscore the critical role of IG principles in ensuring dashboards are reliable, secure, and effective. Examples include the operational and data integrity issues faced during large-scale projects like Healthcare.gov, where technical glitches and inadequate data governance hindered the system's ability to provide accurate and timely information, often through interfaces such as dashboards (Bleiberg & West, 2015). Similarly, security breaches exposing sensitive customer data in corporate CRM systems, where dashboards or similar tools are used to manage and report customer data, led to regulatory penalties and loss of user trust (Kouns & Minoli, 2010). Oversight failures in financial risk management, as seen in the JPMorgan Chase "London Whale" incident, where governance gaps and reliance on flawed reporting systems, potentially including dashboards, contributed to a $6.2 billion trading loss (Committee on Homeland Security and Governmental Affairs, 2013), further emphasize the need for robust IG principles.

The development of the IDDO is based on the synthesis of commonalities in information dashboard design-related works, unified using an ontology, a conceptual modeling approach that serves as a formal framework for knowledge representation (Nasir et al., 2024b). As highlighted by Ahmad et al. (2011), an ontology organizes and represents knowledge systematically. In this study, the ontology

acts as the structural backbone of the IDDO, facilitating intelligent reasoning, communication, interoperability between information systems or individuals, and promoting reusability, among other functions (Ahmad et al., 2011, 2021).

This unified dashboard design method uses an ontological approach, which is crucial to assist dashboard designers in systematically developing their dashboards and ensuring their reusability across diverse applications.

The IDDO is inspired by the Business Model Ontology (BMO). The BMO, developed through commonalities in the business domain by Osterwalder (2004), has become an important tool that assists and guides the development of comprehensive business models. Osterwalder (2004) further expanded this concept by introducing the Business Model Canvas (BMC) (Osterwalder & Pigneur, 2010), a widely adopted tool for visualizing and developing business models. The BMC concept was further refined through the Value Proposition Canvas, focusing on aligning value propositions with customer needs (Osterwalder et al., 2014). These works demonstrate the BMO's evolution from a theoretical framework to practical tools, inspiring the IDDO's development and suggesting its potential for similar applications in dashboard design and operations.

However, the development of IDDO is distinct from BMO as it underscores the use of Kernel Theory. Kernel Theory is a foundational concept in a field of study that can be expanded upon to form more intricate theories (Hevner et al., 2004). In this study, IG principles act as the Kernel Theory for IDDO, emphasizing how established concepts such as data integrity, compliance, and security can form the foundation for a new model that meets dashboard design requirements.

BACKGROUND

In this era of information overload, various forms of data presentation have emerged to meet users' diverse needs. One such form is the information dashboard, which consolidates and simplifies vast amounts of information into a unified visual display, providing users with immediate insight (Masiello et al., 2024). With the advent of the big data era, information dashboards have evolved to include an array of user-friendly visual data analytics tools within a single platform, serving as effective decision-making tools (Sarikaya et al., 2019).

The essence of the information dashboard lies in its data, making it imperative to ensure the integrity of the information presented in terms of accuracy, reliability, and security. Any deviation from these standards could potentially lead to confusion, misdirection, and even deceit (Cairo, 2019; Correll et al., 2020; Masiello et al., 2024; Susnjak et al., 2022). An effective information dashboard should be designed in accordance with established design principles. As Nasir et al. (2024a) suggest, these principles are fundamental guidelines in the context of information dashboard design. Key design principles such as user-centric design, simplicity, and clarity (Ahn et al., 2019; Toreini et al., 2022) should always be adhered to. Adherence to these principles could reduce the likelihood of errors (Matheus et al., 2020) and strike a balance between usability and aesthetics (Martins et al., 2022).

Therefore, in the pursuit of designing an effective information dashboard and mitigating the risk of confusion, misdirection, and deceit, the design and development process of the dashboard must adhere to these design principles. Furthermore, this process must be systematically governed to ensure the information displayed is accurate, reliable, secure, and compliant with the standards of IG (Susnjak et al., 2022). The application of IG to information dashboards is particularly crucial given the sensitive and often mission-critical nature of the data they present. IG principles ensure that dashboards not only display information effectively but also handle data responsibly throughout its lifecycle. This encompasses aspects such as data quality, security, compliance, and ethical use, all of which are essential for maintaining the integrity and trustworthiness of dashboard-based decision-making tools.

While both IG and dashboard design have been studied extensively in isolation, there is a notable gap in research exploring their integration. This study aims to bridge this gap by proposing a framework that systematically incorporates IG principles into the dashboard design process. For instance, applying the IG principle of data quality to dashboard design could involve implementing real-time data validation checks and clear indicators of data freshness. This would not only enhance the dashboard's visual presentation but also increase user confidence in the displayed information, ultimately leading to more informed decision-making.

This study builds upon existing theories in IG and dashboard design by proposing a novel integration of these two domains. While previous research has established the importance of IG in various contexts (Datta et al., 2019; Rouzbahani et al., 2020), and separate studies have focused on effective dashboard design principles (Bach et al., 2022; Sarikaya et al., 2019), this work bridges these areas.

It is argued that the application of IG principles to information dashboard design can enhance the reliability, security, and effectiveness of these tools. This theoretical proposition challenges the current approach to dashboard design, which often focuses solely on visual and functional aspects without explicit consideration of governance principles.

Research Question and Objective

In the endeavor to develop the IDDO, a structured and unified approach to the design and development of information dashboards, it becomes essential to incorporate principles that guarantee data accuracy, reliability, and security at each stage of the design and development process. This paper aims to answer the following research question: *What are the suitable IG principles for the IDDO, and how do they benefit information dashboard design?* To achieve this aim, this paper has the following objective: *to propose the relevant IG principles as the foundational building blocks for IDDO based on the synthesis of existing IG models and a literature review of previous studies and to demonstrate their applicability and advantages for information dashboard design by aligning it with common design principles.*

Significance of the Study

In a broader context, numerous governance frameworks have been established, such as corporate governance (Tricker, 2015), information governance (Smallwood, 2014), operational governance (Rizwan, 2024), and financial governance (Van Der Waldt, 2022). All these governance frameworks are established with a common aim – to provide a structured, effective, and efficient approach to managing a particular domain or set of activities (Datta et al., 2019). Each of these governance frameworks is designed to guide the management of respective areas in a systematic, effective, and efficient manner.

In the context of the information dashboard, IG is a holistic approach to managing information by implementing practices, roles, standards, and metrics (Smallwood, 2014) that can be integrated into the governance framework of the information dashboard. IG has been used in many areas, such as healthcare (Rouzbahani et al., 2020), education (Williamson, 2016), and information technology (Oñate-Andino et al., 2019). This widespread application of IG suggests it could also be integrated into IDDO as its governance foundation. At this stage of the study, there is a noticeable absence of research directly linking IG and information dashboards. This research gap is one of the significant areas that this study aims to address.

As a work in progress, IDDO employs the Design Science Research (DSR) methodology. The integration of IG as the governance foundation of the IDDO is in line with the view of "Kernel Theory fundamentalists" who advocate for the necessity of incorporating Kernel Theories into DSR artifacts (Gregor, 2006; Gregor & Jones, 2007; Walls et al., 1992) (where in this research context, the work in progress IDDO is the artifact). Kernel Theories in the DSR context are descriptive theories that guide the creation of artifacts and ideally should be integrated into an established body of design knowledge (Knutas et al., 2019).

However, it is important to note that, apart from Kernel Theory fundamentalists, there are also two more distinct perspectives on the necessity of applying Kernel Theories: "Design Theory Opponents" who opine that Kernel Theories are not necessary for DSR artifact development (Hevner et al., 2004; March & Smith, 1995) and "Kernel Theory Pragmatists" who adopt a moderate stance and opine that the Kernel Theory is optional but, if applied, will further strengthen the outcome of the research (Goldkuhl, 2004; Venable, 2006a, 2006b).

To illustrate these varying perspectives, Figure 1 depicts the three schools of thought on Kernel Theories as the foundational basis for DSR artifacts (Fischer et al., 2010). This visual representation helps to clarify the theoretical landscape within which this study positions itself.

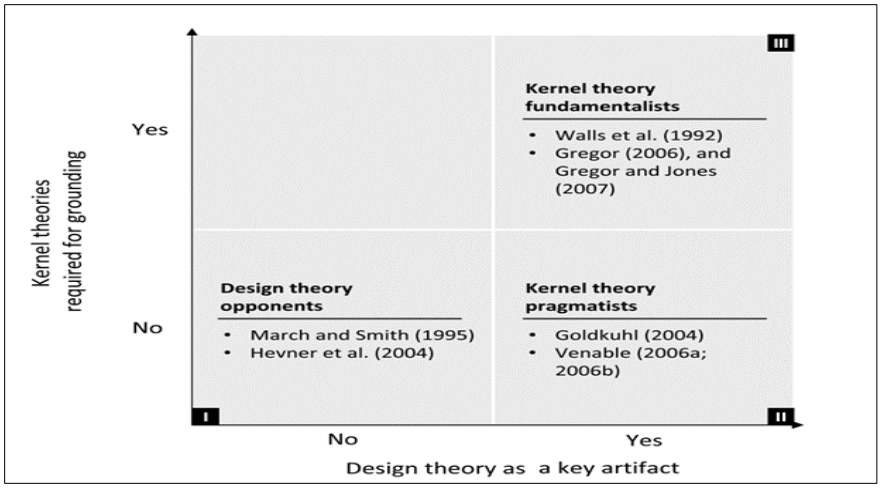

Figure 1. DSR Schools of Thoughts on Kernel Theory (Fischer et al., 2010)

METHODOLOGY

This study employs a narrative literature review (NLR) method to provide a comprehensive and interpretative synthesis of previous studies related to Information Governance (IG). The NLR was chosen for its effectiveness in synthesizing varied sources of literature and providing a holistic understanding of the topic (Basheer, 2022; Snyder, 2019). Unlike systematic approaches such as PRISMA, which focuses on well-defined research questions (Moher et al., 2009; Page et al., 2021), the NLR provides flexibility in exploring diverse domains and synthesizing interdisciplinary insights (Torraco, 2016). This flexibility is essential for addressing the emerging intersection of IG and dashboard design, where existing research is limited.

NLR has been widely accepted and applied in recent research across various fields, reinforcing its credibility and relevance as a robust research methodology. For instance, Gonzales et al. (2023) utilized NLR to explore the role of synthetic data in healthcare applications, while Al-kfairy (2024) examined factors influencing the adoption of ChatGPT in educational settings. Similarly, Dierickx et al. (2024) applied NLR to analyze the balance of using large language models for fact-checking. Beyond its recent applications, foundational studies such as Fernández-López and Gómez-Pérez (2002) on methodologies for building ontologies remain evergreen, offering systematic approaches for developing structured and reusable frameworks. The adaptability of NLR across both emerging and foundational topics further validates its application in this study. In particular, the methodology aids in systematically identifying IG principles, which serve as the foundational building blocks for the work-in-progress IDDO. This integration of IG principles into the IDDO framework is intended to establish a unified, scalable, and reusable methodology for effective dashboard design across diverse domains. The literature search covered a wide range of sources, including academic journals, conference pro-

ceedings, and reputable online databases such as Scopus, Web of Science, and Google Scholar. Supplementary sources, including industry reports and governmental publications, were also included where relevant. Search terms used included "Information Governance," "dashboard design," "data visualization frameworks," and combinations thereof. The selection of studies was guided by the following criteria:

- Relevance to IG principles and practices
- Application across various domains (e.g., healthcare, education, business)
- Recency (preference given to studies published within the last decade)

Articles were excluded if they were non-English, published more than 10 years ago (unless foundational), or lacked relevance to IG principles or their practical implications for dashboard design. A total of six articles were selected for detailed review. This limited number reflects the exploratory nature of this study, which seeks to identify commonalities in IG principles rather than conduct an exhaustive survey.

Upon identifying the relevant literature, each source was thoroughly analyzed to identify common IG principles across different domains and understand their practical applications. This analysis also involved a detailed review of three established IG models: the Information Governance Reference Model (IGRM), the Information Governance Implementation Model (IGIM), and the Information Governance Maturity Model (IGMM). These models were chosen for their wide applicability and demonstrated utility in organizational contexts (Borgschulte, 2016; Kooper et al., 2011; Smallwood, 2014). The insights derived from these models were synthesized and aligned with common design principles identified in the literature to develop the foundational IG building blocks for the IDDO.

While the NLR approach provides a flexible and effective framework for synthesizing interdisciplinary insights, it is not without limitations. Potential selection bias may arise from the subjective nature of study selection and the accessibility of certain literature (Snyder, 2019; Torraco, 2016). Furthermore, the evolving nature of IG practices may not be fully captured within the reviewed studies, as literature reviews are inherently dependent on existing research at the time of analysis (Baethge et al., 2019). Despite these limitations, the NLR method offers a strong foundation for identifying IG principles and aligning them with dashboard design, serving as a preliminary step toward developing a comprehensive framework (Snyder, 2019).

LITERATURE REVIEW

AN OVERVIEW OF INFORMATION DASHBOARD DESIGN

Information dashboards, as initially defined by Few (2006), are visual displays that consolidate essential information onto a single screen, enabling users to monitor key metrics at a glance. Few emphasize the importance of actionable insights, clarity, and a minimalist approach in dashboard design, ensuring that critical information is immediately accessible without overwhelming the user. This concept has evolved over time, with Sarikaya et al. (2019) noting that contemporary dashboards encompass interactive interfaces with multiple views and purposes, including communication, learning, motivation, monitoring, and decision support. Tufte (2001) further refines this approach by introducing the concept of the "data-ink ratio," advocating for dashboards to focus on presenting data with minimal visual distractions, enhancing clarity and interpretability.

Bach et al. (2022) describe dashboards as amalgamations of visual representations and graphical embellishments that provide layers of abstraction and simplification for related data points. Iliinsky and Steele (2011) expand on this by emphasizing the importance of narrative and context in dashboards, highlighting how design choices should guide the user in interpreting and acting upon the data presented. In addition, Kriebel and Murray (2018) contribute by emphasizing iterative design processes, particularly within interactive platforms like Tableau, to enhance dashboard usability and user engagement.

In today's world, information dashboards have found widespread use across various industries, serving as powerful tools to enhance decision-making (Bach et al., 2022; Few, 2012). The academic interest in this subject is growing, as evidenced by numerous studies conducted in diverse domains such as big mobility data (Conrow et al., 2023), healthcare (Pestana et al., 2020), tourism (Balletto et al., 2020), and community informatics (Young & Kitchin, 2020). Despite these advancements, Subotin (n.d.) points out that many dashboards fail due to a lack of adherence to fundamental principles such as simplicity, consistency, and prioritization of actionable data.

While interest in dashboard design is growing, research dedicated to a unified IDDO remains limited. The majority of studies have concentrated on the development of dashboards specific to certain domains (Balletto et al., 2020; Elshehaly et al., 2020; Young & Kitchin, 2020). The escalating diversity and ubiquity of information dashboards pose a significant challenge in formulating universally applicable design methods (Sarikaya et al., 2019). This lack of standardization hinders the dashboard design process, compromising its overall effectiveness. To address this issue, a well-informed, standardized, and unified IDDO is imperative to establish a systematic and structured methodology. This approach eliminates ad-hoc practices and promotes knowledge sharing and reuse.

To ensure the reliability of the IDDO, it must be built with a strong foundation. Adherence to fundamental design principles such as user-centricity, simplicity, usability, data integrity, actionable insights, and visual hierarchy is paramount in designing effective dashboards (Few, 2012; Kriebel & Murray, 2018; Tufte, 2001). Iliinsky and Steele (2011) advocate for dashboards that not only inform but also guide decision-making through well-designed visual narratives. In this context, to create a robust IDDO, in addition to the established design principles, information governance (IG) can be integrated as the foundation and play a pivotal role in governing the information displayed in the dashboard. The following section will briefly discuss the role of IG and its potential integration into supporting the information dashboard design.

Information Governance and Its Significance

Lomas et al. (2019) define IG as a comprehensive framework that provides the policies, standards, processes, metrics, and defined roles necessary to effectively manage an organization's information assets. These elements are fundamental for supporting the design and development process of information dashboards.

The primary goal of IG is to ensure information is managed effectively and efficiently while complying with all relevant legal and regulatory requirements and supporting the organization's overall goals and objectives (Datta et al., 2019). By establishing clear policies, standards, and processes, IG enables organizations to optimize the value of their information assets.

According to Mikalef et al. (2020), the application of IG is essential for managing information throughout its entire lifecycle, from creation to disposal. Without a robust IG framework in place, information may be inconsistently managed, leading to data quality issues, security risks, and potential misuse (Rouzbahani et al., 2020). de Abreu Faria et al. (2013) support these arguments, underscoring that improper IG practices will potentially expose organizations to reputational damage, financial losses, regulatory penalties, and legal liabilities.

By contrast, effective IG helps maintain data integrity, ensures appropriate access controls, and promotes the ethical and compliant use of information (Isa et al., 2019). This, in turn, supports better decision-making, improved operational efficiency, and reduced risk exposure for the organization.

In summary, IG provides the foundational framework to manage information as a strategic asset. Its policies, standards, processes, and roles are critical for enabling organizations to derive maximum value from their data while mitigating associated risks (Isa et al., 2019; Mikalef et al., 2020; Rouzbahani et al., 2020). Integrating IG principles into the information dashboard design process is crucial for ensuring the accuracy, reliability, and security of the data presented to decision-makers.

Integrating IG as the Foundation of the IDDO

The role of IG assumes paramount importance as it guides the overall strategy for the efficient and effective development of dashboards. IG encompasses a comprehensive framework comprising policies, standards, processes, metrics, and defined roles, all of which are crucial in supporting the design process. As highlighted by Mikalef et al. (2020), IG serves as a pivotal mechanism for orchestrating data. It ensures that the information displayed on the dashboard aligns with organizational objectives and enhances the overall capabilities of the organization.

Data, a fundamental component in an information dashboard, gains significant value when IG is embedded in the IDDO process. By incorporating IG principles, the management and utilization of data are facilitated, allowing for the delivery of valuable insights to users. Isa et al. (2019) emphasize that IG enhances the trustworthiness of the data, ensuring the accurate display of information at the right time and place. This further enhances the reliability of the dashboard as a dependable source for providing at-a-glance information. Moreover, Liu et al. (2022) highlight the role of IG in guaranteeing information quality, thereby providing meaningful insights to users.

By integrating IG within the IDDO process, organizations can ensure that their dashboards are built upon a solid foundation of reliable data, adhere to information quality standards, provide valuable insights to users, and maintain compliance with data security and privacy regulations.

There are many IG principles, such as accountability, transparency, quality, accessibility, compliance, retention, and many more. The selection of IG principles varies, depending on the specific application domain and its underlying objectives. Liu et al. (2022) further noted that different organizations may adopt distinct IG principles, standards, and regulations, along with IG model frameworks suited for various application scenarios. Based on this, it can be concluded that the application of IG principles is flexible, and their applicability depends on the objectives and the needs to which they are applied. The following section reviews a few information governance models and IG principles to find the commonalities in determining the IG foundational building blocks for IDDO.

Review of Established IG Models

In this section, three established IG models will be reviewed for their applicability to information dashboard design: the Information Governance Reference Model (IGRM), the Information Governance Implementation Model (IGIM), and the Information Governance Maturity Model (IGMM). These three IG models have been selected due to their wide applicability across various domains and demonstrated utility in numerous organizations.

The IGRM, for example, provides a comprehensive framework that facilitates cross-functional cooperation and executive dialogue, making it effective in supporting corporate information governance programs of any scale (EDRM [Electronic Discovery Reference Model], 2022). The IGRM's ability to link value and duty to information assets highlights its flexibility and broad applicability in various organizational contexts (EDRM, 2022). Additionally, the IGIM offers detailed guidelines for developing and executing IG strategies, which have been successfully applied across different sectors to streamline information management processes and role definitions (Association of Records Managers and Administration International [ARMA International, n.d.-b]). The IGMM is also widely used to assess and improve IG practices, helping organizations from diverse fields to enhance their information governance capabilities incrementally (Pulsipher, 2023). The applicability and proven effectiveness of these models justify their selection for informing the design of information dashboards.

Information Governance Reference Model (IGRM)

According to EDRM (2022), the IGRM is a model that focuses on the collaboration among three key stakeholders: business users, IT departments, and legal, risk, and regulatory departments. It also defines the information lifecycle stages and the governance objectives for each stage. The IGRM aims to provide a common framework and language for IG and to align the interests and goals of the

stakeholders. The IGRM covers the IG principles of compliance, protection, integrity, availability, retention, transparency, accountability, quality, and effectiveness (EDRM, 2011). These principles could be particularly relevant to IDDO by ensuring robust governance practices are integrated within the design and development process. Adopting these principles can enhance the accuracy, reliability, and security of the data presented in dashboards, ultimately supporting better decision-making and aligning with organizational goals. The IGRM is depicted in Figure 2.

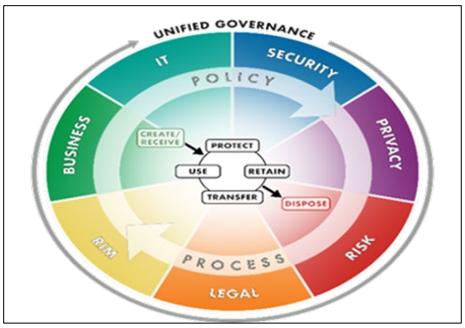

Figure 2. Information Governance Reference Model (IGRM)

Information Governance Implementation Model (IGIM)

The IGIM, developed by the Association of Records Managers and Administrators (ARMA), is a model that guides organizations in assessing and improving their IG program based on eight key areas: steering committee, authorities, supports, procedural framework, capabilities, information lifecycle, architecture, and infrastructure (Abdul Malak, 2022). The keyword here is "implementation," which provides guidance and resources for measuring and benchmarking the IG performance and tracking the implementation progress of the organization. It offers a functional approach to IG, exploring the elements that need to be developed in each of the eight key areas necessary to implement a successful IG program (ARMA International, n.d.-a). Through these eight well-defined areas and elements, the IGIM is capable of building a common understanding and unified implementation approach that integrates people, policy, technology, etc., across these eight critical areas (Access, n.d.). These IG principles are likely to be applicable to the IDDO because they offer a structured approach to implementing governance practices. Incorporating these principles ensures comprehensive coverage of all aspects necessary for effective information management, leading to more reliable, secure, and user-friendly dashboards that align with organizational goals. The IGIM framework is depicted in Figure 3.

Figure 3. Information Governance Implementation Model (IGIM)

Information Governance Maturity Model (IGMM)

Another IG model widely used by many organizations is the IGMM. Proença et al. (2016) describe IGMM as a framework that helps organizations assess their current state and provides guidance for

continuous improvement in managing their data as a strategic asset. The main focus of IGMM is to measure the maturity level of the IG initiatives in the organization by indicating how advanced an organization is in its approach to information governance, from initial awareness to optimized processes. There are several information governance maturity models available, including those developed by OvalEdge, IBM, and Gartner. Although the framework is presented differently, all IGMM collectively provide structured frameworks for assessing information governance maturity across various dimensions covering IG principles such as data quality, data security, data lineage, and data stewardship (Varshney, 2021). The IBM IGMM, one of the most comprehensive and flexible IGMM frameworks available, consists of five maturity levels, as depicted in Figure 4. These IG principles may be pertinent to the IDDO because they offer a structured approach to evaluating and improving the maturity of information governance practices. Embracing these principles ensures that dashboards are developed with a focus on continuous improvement in data management, enhancing data quality, security, and stewardship. This alignment helps in creating more reliable and effective dashboards that serve as strategic assets for the organization.

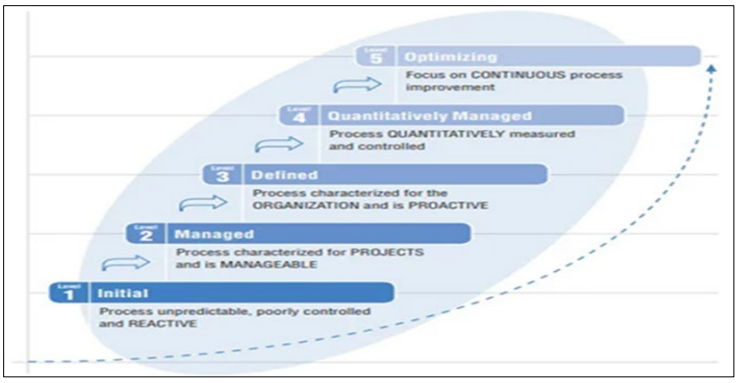

Figure 4. Information Governance Maturity Model (IGMM)

Based on the review of the three IG models discussed above, it can be concluded that IG is a complex and multidimensional discipline that necessitates the collaboration and alignment of various stakeholders, processes, and technologies. Each IG model serves a distinct purpose within IG initiatives, providing unique insights and approaches to governance. The IGRM emphasizes the importance of cross-functional cooperation among business, IT, and legal stakeholders, highlighting the need for a unified framework to manage information governance effectively. The IGIM, on the other hand, focuses on the practical aspects of implementing IG, offering detailed guidelines and resources for measuring and benchmarking IG performance. Lastly, the IGMM assesses and improves the maturity level of IG practices, providing a structured approach to continuous improvement in information governance.

Understanding the strengths and limitations of each IG model is crucial for their integration with the IDDO. The IGRM's focus on stakeholder collaboration ensures that dashboards are developed with input from all relevant parties, enhancing their utility and relevance. The IGIM's structured approach to implementation helps ensure that governance practices are systematically incorporated into the dashboard design process. The IGMM's emphasis on maturity assessment supports the continuous improvement of dashboard functionality and data quality.

In summary, the integration of these IG principles into IDDO can enhance the accuracy, reliability, and security of the information presented in dashboards, ultimately supporting better decision-making and aligning with organizational goals. The next section explores the diversity of IG principles and their practical applications in the context of information dashboard design.

DIVERSITY OF INFORMATION GOVERNANCE PRINCIPLES

The narrative literature review has uncovered numerous principles related to IG. However, research indicates that IG principles vary depending on the specific application domain and its underlying objectives. According to Liu et al. (2022), different organizations may adopt distinct IG principles, standards, and regulations, along with IG model frameworks suited for various application scenarios. Previous studies (Datta et al., 2019; Isa et al., 2019; Lomas, 2020; Mohd Nordin et al., 2022; Mukherjee, 2019; Rouzbahani et al., 2020) have documented several IG principles. Table 1 summarizes the IG principles identified in previous studies, providing an overview of each study's key findings, methodologies, and applications.

Table 1. Summary of IG principles identified in previous studies

Study	Title	Domain application	IG principles
(Mohd Nordin et al., 2022)	Information Governance for Enhancing the Performance of Higher Education Institutions	Higher Education	Policy Compliance, Risk Management, Data Classification, Information Quality, and Security.
(Rouzbahani et al., 2020)	Developing a Model for the National Health Information Governance Program in Iran	National Health Information	Information Resource Management, Security, Privacy, Accountability, Trust, Access and Use, Resource Management, Information Organization, Governance Provision, Leadership.
(Datta et al., 2019)	Information Governance: A Necessity in Today's Business Environment	Business	Governing Employee Performance, Adhering to Regulations, Evaluating Policy Effectiveness, Creating IG policies, Governing Contractors and Workers, responsibility handling, enabling eDiscovery, and utilizing technological updates.
(Isa et al., 2019)	Managing Evidence of Public Accountability: An Information Governance Perspective	Public Accountability	Accountability, Responsibility, Responsiveness, Participation, Information Quality, Information Value, Information Compliance, and People
(Lomas, 2020)	Information Governance and Cybersecurity: Framework for securing and managing information effectively and ethically	Cybersecurity	Information Management, Privacy, Cybersecurity, Ethical Delivery, Compliance with Laws and Regulations, and Stakeholder Needs
(Mukherjee, 2019)	Information Governance for the Implementation of Cloud Computing: A Review	Cloud Computing	Compliance, Business Objectives, Collaborative Contracts, Change Management, and Constant Improvement

Table 1 provides a list of IG principles extracted from six previous studies across a variety of domains, underscoring their extensive applicability and critical importance. Different studies have proposed various IG principles tailored to a specific domain and context. In their study on higher educa-

tion, Mohd Nordin et al. (2022) identified IG principles such as Policy Compliance, Risk Management, Data Classification, Information Quality, and Security. These principles emphasize the need for institutions to adhere to policies, manage risks, classify data, ensure information quality, and secure information (Mohd Nordin et al., 2022).

In the health sector, Rouzbahani et al. (2020) emphasized principles like Information Resource Management, Security, Privacy, Accountability, Trust, Access and Use, Resource Management, Information Organization, Governance Provision, and Leadership. These principles highlight the importance of managing information resources, ensuring security and privacy, being accountable, building trust, managing access and use of information, organizing information, providing governance, and demonstrating leadership (Rouzbahani et al., 2020).

In the business environment, Datta et al. (2019) identified principles such as Governing Employee Performance, Adhering to Regulations, Evaluating Policy Effectiveness, Creating IG policies, Governing Contractors and Workers, Responsibility Handling, enabling eDiscovery, and utilizing technological updates. These principles underscore the need for businesses to govern employee performance, adhere to regulations, evaluate policy effectiveness, create IG policies, govern contractors and workers, handle responsibilities, enable eDiscovery, and utilize technological updates (Datta et al., 2019).

In the public accountability sector, Isa et al. (2019) proposed principles like Accountability, Responsibility, Responsiveness, Participation, Information Quality, Information Value, Information Compliance, and People. These principles stress the need for accountability, responsibility, responsiveness, participation, information quality, information value, information compliance, and people (Isa et al., 2019).

In the cybersecurity domain, Lomas (2020) identified principles such as Information Management, Privacy, Cybersecurity, Ethical Delivery, Compliance with Laws and Regulations, and Stakeholder Needs. These principles emphasize the need for information management, privacy, cybersecurity, ethical delivery, compliance with laws and regulations, and meeting stakeholder needs (Lomas, 2020).

In the cloud computing domain, Mukherjee (2019) proposed principles like Compliance, Business Objectives, Collaborative Contracts, Change Management, and Constant Improvement. These principles highlight the importance of compliance, aligning with business objectives, having collaborative contracts, managing change, and constantly improving (Mukherjee, 2019).

Based on the above, there is a variety of IG principles, and each domain adopts distinct principles that address its specific needs. For instance, Data Classification is unique to higher education (Mohd Nordin et al., 2022), Trust is unique to the national health information domain (Rouzbahani et al., 2020), Governing Employee Performance is unique to the business environment (Datta et al., 2019), Responsiveness is unique to the public accountability sector (Isa et al., 2019), Ethical Delivery is unique to the cybersecurity domain (Lomas, 2020), and Business Objectives are unique to the cloud computing domain (Mukherjee, 2019). This underscores the importance of a context-specific approach in addressing IG challenges. Above all, based on the literature review of the previous study, there is no research on IG, and its application to the information dashboard has not been found. This indicates a clear knowledge gap and an opportunity for further research.

The next section discusses and synthesizes all these IG principles and derives the relevant IG principles as the building blocks of the IDDO.

DISCUSSION AND RESULTS

COMPARATIVE ANALYSIS OF IG MODELS

A comparative analysis of the three IG models, namely the Information Governance Reference Model (IGRM), Information Governance Implementation Model (IGIM), and Information Governance Maturity Model (IGMM), as discussed previously in the literature review section, has led to the discovery of several common IG principles within them. Despite their unique objectives and approaches, these models share several foundational principles.

The IGRM, developed by the Electronic Discovery Reference Model (EDRM), emphasizes cross-functional cooperation among key stakeholders, providing a unified framework for effective IG. The IGIM, developed by the Association of Records Managers and Administrators (ARMA), offers a practical approach to IG implementation, providing detailed guidelines and resources for measuring and benchmarking IG performance. The IGMM, on the other hand, focuses on assessing and improving the maturity level of IG practices, providing a structured approach to continuous improvement in IG. Based on the synthesis of these three IG models, it can be concluded that there are nine common IG principles: (1) Compliance, (2) Protection/Security, (3) Integrity, (4) Availability, (5) Retention, (6) Transparency, (7) Accountability, (8) Quality, and (9) Effectiveness. These principles are universally applicable across different domains and contexts, and they provide a robust foundation for effective information governance.

The principles of Compliance, Protection/Security, Integrity, Availability, Retention, Transparency, Accountability, Quality, and Effectiveness are common among the three models – IGRM, IGIM, and IGMM – because they form the fundamental guidelines for effective information governance, regardless of the specific context or domain. On the one hand, transparency and accountability are about the governance processes themselves, ensuring they are visible and understandable and that there is clear ownership and responsibility for IG tasks. On the other hand, quality and effectiveness are outcome-oriented principles, focusing on the results of the IG processes in terms of the accuracy, completeness, timeliness, relevance of the information, and whether the IG processes achieve their intended outcomes. A brief explanation of these commonalities is provided in Table 2.

Table 2. Summary of commonalities in IG models

IG model	Main focus	Common principles	Brief explanation
Information Governance Reference Model (IGRM)	Emphasizes cross-functional cooperation among key stakeholders, providing a unified framework for effective IG	1. Compliance 2. Protection/Security 3. Integrity 4. Availability 5. Retention 6. Transparency 7. Accountability 8. Quality 9. Effectiveness	These principles are common as they form the fundamental guidelines for effective IG, ensuring cross-functional cooperation and a unified framework.
Information Governance Implementation Model (IGIM)	Offers a practical approach to IG implementation, providing detailed guidelines and resources for measuring and benchmarking IG performance	1. Compliance 2. Protection/Security 3. Integrity 4. Availability 5. Retention 6. Transparency 7. Accountability 8. Quality 9. Effectiveness	These principles are common as they provide a practical approach to IG implementation, with a focus on measuring and benchmarking IG performance.

IG model	Main focus	Common principles	Brief explanation
Information Governance Maturity Model (IGMM)	Focuses on assessing and improving the maturity level of IG practices, providing a structured approach to continuous improvement in IG		These principles are common as they focus on assessing and improving the maturity level of IG practices, providing a structured approach to continuous improvement.

Comparative Analysis of IG Principles

Upon examining Table 1 in the Literature Review section, which extracts all the IG principles from previous studies, we can observe a variety of IG principles listed. As asserted by Liu et al. (2022), it is not surprising that different organizations may adopt distinct IG principles, standards, and regulations, along with IG model frameworks suited for various application scenarios. Table 3 shows a comparison of these IG principles among previous studies.

Table 3. Comparison of IG principles among previous studies

IG principles	Previous study					
	Mohd Nordin et al. (2022)	Rouzbahani et al. (2020)	Isa et al. (2019)	Datta et al. (2019)	Lomas (2020)	Mukherjee (2019)
Policy Compliance	✓					
Risk Management	✓					
Data Classification	✓					
Information Quality	✓		✓			
Security	✓	✓			✓	
Information Resource Management		✓				
Privacy		✓			✓	
Accountability		✓	✓			
Trust		✓				
Access and Use		✓				
Resource Management		✓				
Information Organization		✓				
Governance Provision		✓				
Leadership		✓				
Governing Employee Performance				✓		
Adhering to Regulations				✓		
Evaluating Policy Effectiveness				✓		
Creating IG policies				✓		
Governing Contractors and Workers				✓		

IG principles	Previous study					
	Mohd Nordin et al. (2022)	Rouzbahani et al. (2020)	Isa et al. (2019)	Datta et al. (2019)	Lomas (2020)	Mukherjee (2019)
Responsibility handling				✓		
Enabling eDiscovery				✓		
Utilizing technological updates				✓		
Responsibility			✓			
Responsiveness			✓			
Participation			✓			
Information Value			✓			
Information Compliance			✓			
People			✓			
Information Management					✓	
Ethical Delivery					✓	
Compliance with Laws and Regulations					✓	
Stakeholder Needs					✓	
Compliance	✓					✓
Business Objectives						✓
Collaborative Contracts						✓
Change Management	✓					✓
Constant Improvement	✓					✓

In Table 3, an analysis of 37 sets of IG principles and six previous studies was conducted. Based on the analysis that has been made, it was found that there is only one IG principle used by three previous studies, namely security. Security is a core principle that is critical in today's digital age, where data breaches are increasingly common (Lomas, 2020; Mohd Nordin et al., 2022; Rouzbahani et al., 2020). These findings indicate that security can be considered a universal IG principle and is used in several different domains.

In addition to security, the application of other IG principles depends on the objectives and suitability of a domain. Policy Compliance, for example, is quite specific to be applied in the higher education domain, healthcare, and the like, which emphasizes compliance with established policies and regulations. In the context of this analysis, Mohd Nordin et al. (2022) use this IG principle in the higher education domain. Information Resource Management in the context of this analysis is emphasized by Rouzbahani et al. (2020) in the health information domain and involves the effective management of information as a valuable resource. The application of Information Resource Management is certainly very important in the medical field because there are many data, especially patient records, that need to be managed systematically and carefully. It is also important in other fields, such as education, because it involves a large number of student records.

Governing Employee Performance, for example, might be relevant to the business domain, especially Human Resource Management, because it involves monitoring and managing the performance of employees in relation to information governance (Datta et al., 2019).

Accountability, although it seems to be applicable generally in any domain, is very important and unique to the public accountability domain and emphasizes the need for accountability in managing public information (Isa et al., 2019). Information Management might be more specific to the cybersecurity domain and involves the systematic management of information to ensure its security and integrity (Lomas, 2020). However, this does not mean that it is not suitable to be applied in other domains because the principle of information management itself is broad and universal. Lastly, in the analysis of previous studies, compliance is considered important and unique to the cloud computing domain and involves ensuring compliance with legal and regulatory requirements in the context of cloud computing (Mukherjee, 2019).

Nevertheless, based on the discussion above, it can be concluded that IG principles are diverse, and their application is flexible, subject to the objectives and needs of a domain. Even though only two IG principles seem to be quite universal, this does not mean that all IG principles are exclusive to a certain domain. This flexibility allows for the diversity of IG principles, as argued by Liu et al. (2022) and Isa et al. (2019).

Nonetheless, it is imperative to elucidate that the conclusions drawn herein are limited to the insights from six previous studies. The IG principles, as well as their application, may vary if more literature studies are conducted. As of the present juncture, no previous studies have been conducted to associate the application of this IG with the Information Dashboard.

From the analysis of previous studies, it's clear that a wide range of IG principles are used, and there is a noticeable gap in research linking IG principles with information dashboards. This makes the task of suggesting suitable IG principles for information dashboards even more challenging. However, the discovery of basic IG principles derived from the synthesis of three key IG models – IGRM, IGIM, and IGMM – can be utilized as a strong foundation and guide in this process.

An initial study on unified information dashboard design by Nasir et al. (2024a) has identified common elements in dashboard design principles. These shared elements, which are relevant to information dashboards, can be instrumental in determining the IG principles that would be most suitable for the future development of the IDDO. Therefore, the IG principles for the forthcoming IDDO will be based on a combination of two components: (1) the synthesis of three established IG models and insights from previous studies, and (2) the common design principles identified by Nasir et al. (2024a). This approach is illustrated in Figure 5.

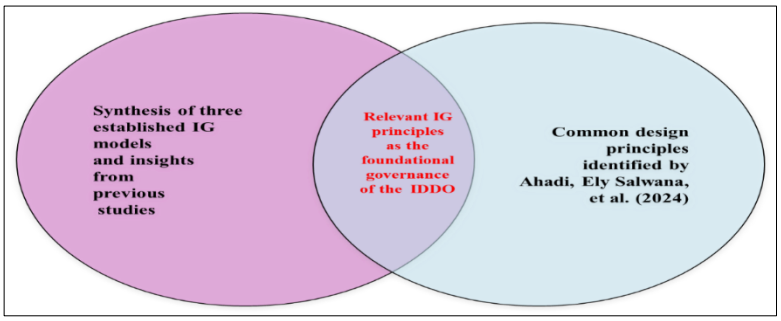

Figure 5. Derivation of IG Principles for IDDO

In their studies, Nasir et al. (2024a) have identified eight commonalities in design principles: (1) systematic page organization, (2) use of appropriate color, (3) use of appropriate typography, (4) easy to understand, (5) avoid unnecessary details, (6) avoid too much text, (7) ensure functionality, and (8) ensure flexibility.

The identification of these commonalities in design principles underscores the potential for a more streamlined and unified approach to information dashboard design. In the context of this study, these common design principles will serve as the basis for the derivation of the relevant IG principles in the context of the information dashboard.

Based on these eight commonalities of design principles discussed above, eight relevant IG principles in the context of the information dashboard, which can be adopted as the foundational governance of the IDDO, are suggested, as depicted in Figure 6.

Figure 6. Proposed relevant IG Principles as the Foundational Governance of the IDDO

A summary of the derivation of these IG principles, which are common design principles it aligns to, and a brief explanation are in Table 4.

Table 4. Proposed IG principles for IDDO: alignment and explanations

Proposed IG principles	Alignment with common design principles	Brief explanation
Quality	Easy to understand, Avoid unnecessary details	Ensures that the data presented on the dashboard is accurate, reliable, and timely, forming the basis for informed decision-making and effective operations.
Security	Ensure functionality	Involves protecting the information on the dashboard from unauthorized access or breaches, guiding the implementation of access controls, encryption, and other security measures.
Compliance	Systematic page organization	Ensures that the dashboard adheres to all relevant laws, regulations, and standards, guiding the design and operation of the dashboard.
Integrity	Avoid unnecessary details, Easy to understand	Ensures the completeness and wholeness of the data presented, guiding the data collection and management processes.
Availability	Ensure functionality	Makes sure the dashboard is accessible when needed, guiding the design of the dashboard to ensure it is reliable and available.

Proposed IG principles	Alignment with common design principles	Brief explanation
Transparency	Easy to understand	Provides clear and understandable data, guiding the presentation of data on the dashboard.
Accountability	Systematic page organization	Assigns responsibility for different data and processes, guiding the assignment of roles and responsibilities for data management and governance.
Effectiveness	Ensure functionality, Ensure flexibility	Ensures the dashboard fulfills its intended purpose efficiently, guiding the design and operation of the dashboard to ensure it effectively supports decision-making and operations.

To conclude, the integration of IG as the foundation of the IDDO also aligns with Kernel Theory. Kernel theory, a type of descriptive theory that informs artifact construction, is a key component of design theory. It is defined as any descriptive theory that informs design research, particularly Design Science Research (DSR). It should ideally be part of a mature body of design knowledge (Knutas et al., 2019).

In the context of the IDDO, the integration of IG can be seen as an application of Kernel Theory. Within the DSR framework, Kernel Theory refers to the foundational theories that reinforce artifact construction. Initially defined as governing design requirements, it has evolved to include "any knowledge that informs design science research, including informal knowledge from the field" (Möller et al., 2022).

As the work-in-progress IDDO is developed using a DSR method, IG in this study is explored as the foundation of the IDDO. In this context, the role of IG aligns with the definition of Kernel Theory. It serves as a foundational theory governing the design of the information dashboard when integrated into the IDDO. IG is not merely a component of the IDDO's building blocks; it forms the foundational governance of the work-in-progress artifact, the IDDO. This illustrates the practical application of Kernel Theory and justifies the integration of the IG in the design and development of the IDDO.

Having established the relevance and potential of integrating IG principles into the IDDO, it is crucial to consider the practical implications of this approach for organizations implementing information dashboards. The following section briefly explores these implications, highlighting how this integration can enhance data quality, improve compliance, increase user trust, and support better decision-making processes in various organizational contexts.

Practical Implications

The integration of IG principles into the IDDO presents several significant practical implications for organizations. Primarily, this integration can lead to enhanced data quality in dashboard presentations. By applying IG principles such as data integrity and quality, organizations can ensure that their dashboards present accurate and reliable information (Isa et al., 2019; Rouzbahani et al., 2020). For instance, a financial dashboard could incorporate data quality indicators, showing the confidence level of financial projections based on the quality of input data.

The consequences of insufficient IG have been observed in real-world failures. For example, the Healthcare.gov rollout experienced operational and data governance failures that hindered its ability to provide accurate and timely health insurance information. Similarly, the JPMorgan Chase "London Whale" incident demonstrated how flawed reporting systems and gaps in governance could result in massive financial losses. These cases highlight the necessity of embedding IG principles into dashboards to ensure reliability and mitigate risks associated with data mismanagement.

Furthermore, the incorporation of IG principles can significantly improve compliance with regulatory requirements, particularly in industries with strict data governance standards (Datta et al., 2019; Lomas, 2020). A healthcare dashboard, for example, could be designed with built-in compliance features that adhere to healthcare data protection regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States, ensuring that patient data is handled and displayed under privacy laws.

The application of IG principles through the IDDO can also support more effective decision-making processes. By ensuring data availability and integrity, IG-informed dashboards provide decision-makers with reliable, up-to-date information (de Abreu Faria et al., 2013; Mikalef et al., 2020). A supply chain dashboard, for instance, could incorporate data freshness indicators, allowing managers to make decisions based on the most current information available.

Another key implication is the standardization of the dashboard design process. The IDDO, with integrated IG principles, potentially provides a consistent approach to dashboard design. This can lead to more uniform, high-quality information management practices across an organization (ARMA International, n.d.-b.; Smallwood, 2014), potentially reducing development time and improving overall information management.

From a risk management perspective, embedding security and privacy principles from IG into dashboard design can help organizations mitigate risks associated with data breaches or misuse (Lomas et al., 2019; Mohd Nordin et al., 2022). For example, a CRM dashboard could incorporate role-based access controls, ensuring that sensitive customer data is only visible to authorized personnel, reducing the likelihood of data exposure or abuse.

Lastly, IG principles can guide the entire data lifecycle within dashboards, from data creation to archival or deletion (EDRM, 2022; Proença et al., 2016). This could be implemented in a project management dashboard that automatically archives or deletes data from completed projects after a specified period in compliance with data retention policies.

These practical implications demonstrate that integrating IG principles into the IDDO can significantly enhance the effectiveness, reliability, and trustworthiness of information dashboards. Organizations adopting this approach can expect to see improvements in data quality, compliance, user trust, and decision-making processes, ultimately leading to better operational outcomes and reduced information-related risks (Isa et al., 2019; Rouzbahani et al., 2020). As such, the IDDO with integrated IG principles offers a potential framework for organizations aiming to enhance the benefits of their information dashboards while maintaining robust governance practices.

CONCLUSION

This paper has proposed the integration of IG as the foundation of the IDDO. The proposed IG principles are derived from the synthesis of three established IG models and insights from previous studies. These principles have been aligned with the common design principles identified by Nasir et al. (2024a), thereby ensuring their applicability and relevance in the context of information dashboard design. These proposed IG principles aim to form the foundational governance of the IDDO, which is currently under development. This integration has the potential to enhance the robustness of the IDDO by grounding it in sound governance principles, supporting its reliability and effectiveness.

LIMITATION

This study represents an initial effort to associate IG with information dashboard design, drawing upon insights from a limited set of six prior studies. While this provides preliminary insights, the IG principles identified and their applications may vary with a broader review of the literature. Despite these limitations, the study establishes a foundation for future research in this emerging field.

FUTURE RESEARCH

Future research is intended to focus on integrating the identified IG principles into the work-in-progress IDDO. This may include exploring the practical application and testing of these principles within the IDDO framework to evaluate their feasibility and effectiveness in real-world scenarios.

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