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Transforming towards inclusion-by-design: Information system design principles shaping data-driven financial inclusiveness

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ABSTRACT

Digitalization and datafication of financial systems result in more efficiency, but might also result in the exclusions of certain groups. Governments are looking for ways to increase inclusions and leave no one behind. For this, they must govern an organizational ecosystem of public and private parties. We derive value-based requirements through a systematic research methodology and iteratively refine design principles for achieving inclusivity goals. This refinement process is enriched by interviews with field experts, leading to the formulation of key Design principles: the essential role of inclusive metrics, leveraging alternative data sources, ensuring transparency in loan processes and the ability for decision contestation, providing tailored credit solutions, and maintaining long-term system sustainability. The government's role is to ensure a level playing field where all parties have equal access to the data. Following the principles ensures that exclusion and discrimination become visible and can be avoided. This study underscores the necessity for system-level transformations, inclusion-by-design, and advocacy for a new system design complemented by regulatory updates, new data integration, inclusive AI, and organizational collaborative shifts. These principles can also be used in different data-driven governance situations.

1. Introduction

With the advent of the availability of more data and advanced AI technologies, governance is needed to ensure inclusion. Across the globe, governments are actively working to ensure that digital financial services are accessible to all, especially marginalized communities. The gap in financial access underscores the importance of financial innovation driven by advancements in data-driven AI (Beck, 2020; Hannig & Jansen, 2010) and governance to achieve financial inclusivity. By closing this divide, not only are individuals and micro-enterprises empowered (Beck, 2020; Tambunan, 2022), but broader goals of digital governance—such as increased economic participation and reduced disparities—are also supported. Digital technologies have played a transformative role in enhancing financial inclusion. For instance, M-Pesa in Kenya enables mobile money transfers, providing financial services to previously unbanked populations (Mbiti & Weil, 2016). Similarly, in India, mobile phones create new opportunities for women to access the digital world. Despite challenges such as financial constraints, technological illiteracy, and socio-cultural norms, these technologies are paving the way for greater digital inclusion and empowerment (Tusińska, 2021). Inclusion can be boosted through digital identity, acknowledging previously overlooked individuals (Addo & Senyo, 2021); the e-government system should incorporate privacy and data security policies to support inclusion for low-income individuals (Wilson, 2014); and government-backed initiatives fostering digital skills among the elderly have the potential to diminish digital inequality and improve Inclusion (Suchowerska & McCosker, 2022).

Building upon our earlier work identifying challenges within peer-to-peer lending systems (Sulastri & Janssen, 2023), this research focuses on developing design principles for inclusive systems. This paper demonstrates how governance can leverage technology to promote financial inclusion for all, addressing one of the most pressing issues while upholding societal values and responding to public concerns. As exemplified by Fu et al. (2015), design principles offer a structured and consistent framework within specialized fields of study. Bharosa and Janssen (2015) formulate design principles as *normative, reusable and directive guidelines, formulated towards taking action by the information system architects* (Bharosa & Janssen, 2015, p. 4). This paper emphasizes

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the importance of defining value-based requirements (VBR) to derive these design principles. These requirements outline the necessary attributes for building an inclusive system, aligning with overarching objectives. Each principle undergoes thorough iterative refinement to align with diverse requirements, fostering a continuous feedback loop and strengthening both. While VBRs highlight the specific *qualities* the system should embrace, design principles provide overarching *strategies* to consistently uphold those values in shaping the system.

By embedding inclusivity into every stage of system development, these principles can guide the responsible use of data-driven AI technologies in creating more equitable digital financial ecosystems. Focusing on the intersection of information systems and financial services, we seek to identify and articulate strategies to provide credit access for underserved populations often rejected in getting credit (Kumra et al., 2021; Yum et al., 2012). Our objective, guided by the research question, *"What design principles must be considered when developing a lending system that promotes inclusion?"* aims to propose principles that address the technological aspects of lending systems and underscore their pivotal role in advancing digital governance and inclusion. The rationale behind our study is two-fold. *Firstly,* leveraging the digital transformation of financial services offers a unique opportunity to redefine the distribution of financial resources, aiming to bridge the existing financial divide. In data-driven governance, it is vital to utilize these technological advancements to promote economic and social well-being through enhanced financial access. *Secondly*, by proposing design principles based on these challenges, this study ensures alternative lending systems address the needs of marginalized communities while aligning with digital governance objectives and supporting equitable, sustainable financial ecosystems.

Transitioning from this foundational rationale, we introduce *inclusion-by-design* inspired by the work of Janssen et al. (2017), who advocate for integrating transparency in system design as a seamless, inherent component. This adoption signifies a pivotal shift towards understanding inclusion as the comprehensive outcome of a thoughtfully designed ecosystem rather than the result of isolated technological interventions. This principle enables us to incorporate inclusivity into *every developmental stage* of alternative lending systems. In data-driven governance, our analysis of the online lending system highlights key areas where inclusivity is at risk, as illustrated in Fig. 1 and the Use Case diagram in Appendix A. Biases in data preparation can exclude marginalized groups, while AI-based scoring and prediction algorithms may unintentionally reinforce these biases. Loan recommendations and decisions also risk favoring the financially privileged unless designed with inclusivity in mind. The inclusion-by-design principles ensure that technological solutions prioritize inclusion within digital governance.

This paper is divided into seven sections. Following this introduction, Section 2 explores the literature background related to fundamental concepts in this study: design principles and value-based engineering (VBE). Section 3 outlines the research methodology. In Section 4, we conduct a comprehensive literature review on *design principles* in information systems. Concurrently, we systematically review existing literature for *the value-based requirements*, reinforcing this review with interviews and an information flow analysis. Section 5 formulates design principles based on identified requirements and literature review, utilizing an iterative process that aligns requirements with principles. Section 6 examines the government's role in fostering inclusivity. Finally, Section 7 provides insights, limitations, and recommendations.

2. Literature background

This section begins with the definition of inclusion, paving the way for an in-depth exploration into this domain. Setting the stage of this study, we explore design principles, presenting a concise review of their adaptable nature and significance in the design process. The discussion then shifts to exploring human values in value-sensitive design (VSD) and value-based engineering (VBE), emphasizing value ethics and intricacies in eliciting requirements. This study's formulation of design principles combines diverse practices, while VBE manages requirement elicitation. The iterative finalization of design principles and requirements allows for concurrent adjustments.

Inclusion is a widely used term in various contexts. Therefore, providing a clear and well-defined understanding is crucial to avoid misunderstandings. Inspired by Sen's concept of capability (Sen, 1990), which distinguishes between commodity, capability, functioning, and utility, it becomes apparent that possessing the same resources only automatically ensures achieving the desired utility with necessary actions. Moreover, individuals may aspire to attain utility, but limited access to essential commodities can hinder enhancing their capabilities. Financial inclusion is characterized by 'maximizing usage and access while minimizing involuntary financial exclusion' (Cámara & Tuesta, 2014). The evaluation of inclusion must consider the equitable allocation of resources across various segments of society, preventing excessive concentration within specific groups (Sulastri et al., 2024). Hence, more than merely increasing access is needed to demonstrate an enhancement in inclusion; it should be accompanied by a fair distribution of resources among different segments. In this study, we establish the concept of inclusion as *granting financial access to society, irrespective of social status and demographic background*. Technological advancement plays a pivotal role in the ongoing discourse on inclusion through the ability to lower the cost of reaching unserved segments (Hannig & Jansen, 2010). Progress in technology has catalyzed the evolution of credit-scoring algorithms, leading to innovations such as profit scoring (Xia et al., 2017; Ye et al., 2018) and poverty scoring (Bumacov et al., 2017). These advancements have revolutionized the credit landscape, enabling lenders to assess creditworthiness beyond traditional methods and expanding financial accessibility.

In this study, we define 'inclusion-by-design' *as a strategic effort to ensure that inclusivity is identified and integrated at various key stages in system development, encompassing both technological and non-technical aspects*. This means we actively evaluate information flow and identify potential points where exclusivity may occur, involving technical adjustments like system architecture, algorithm modifications, and non-technical review of policies and procedures. Through this definition, we underline the importance of inclusivity not just as an end goal but as a guiding principle that underpins the entire system design process.

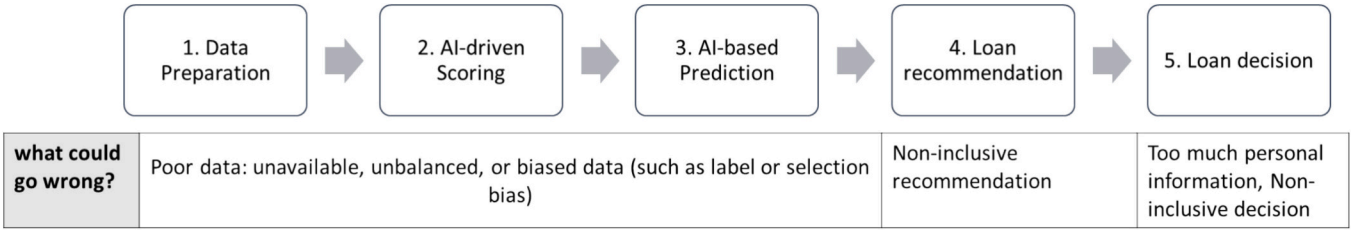

Fig. 1. Stages of inclusion issues in online lending system.

2.1. Design principles in information system

The literature review explores the role of design principles within the design theory framework. Gregor and Jones (2007) provided a foundational analysis by establishing eight key elements of Information Systems Design Theory. This framework provides a foundation for understanding design theories in information systems, including design principles. It also highlights the complexities of design and the distinctions between design theories and natural science methodologies. Yang et al. (2012) further elaborate on the integral role of design principles within design theory, emphasizing their seamless integration with user requirements and system features. This holistic specification is designed to guide developers, streamline the development process, and improve overall outcomes, positioning design principles as a crucial element of design theory. According to Möller et al. (2020), design principles can be described using nouns and verbs, underscoring the role of design principles in influencing both the creation process and the resulting functionalities of a system. The principle could be inductively derived from experience and empirical evidence. Fu et al. (2015), aligned with Turaga et al. (2010), highlighting the importance of experiential knowledge in the development of design principles. In this study, principles serve as guidance that will lead to a particular direction.

The identified design principles definitions from the literature are consolidated in Table 1. These principles serve as normative guidelines for action (Bharosa & Janssen, 2015), addressing both the design process and system functionalities (Möller et al., 2020). They have been applied in diverse contexts, such as online learning (Sezgin & Yüzer, 2022) and middleware systems development (Turaga et al., 2010). Additionally, they provide a practical template for broader solution implementation (Seidel et al., 2018).

In our definition, Design principles represent *distilled knowledge, drawing from literature and practical experience guiding the design process*. This distilled knowledge encapsulates the multifaceted role of design principles in driving both the creative process and the operational effectiveness, reinforcing their pivotal position in advancing digital governance and financial inclusion objectives.

Table 1
Definitions of design principles from selected papers in information system.

Category	Explanation
Definition	"Normative, reusable, and directive guidelines, formulated towards taking action by the information system architects" (Bharosa & Janssen, 2015, p. 4).
Description	"Following the duality of the term design, as both a verb and a noun, design principles may both address the process of designing an artifact (i.e., the development process), as well as its functionalities (i.e., the system features)" (Möller et al., 2020, p. 210)
Description	"…the formulation design principles that follow a nomothetic approach about how to design a class of things and their idiosyncratic use in highly contextual design practice" (Kruse et al., 2016, p. 39)
Description	"…principles in online course design and in a well-conceived way can significantly contribute to the solution of problems, such as low learning performance, attendance, motivation, engagement, social presence, etc., that can be experienced in online courses" (Sezgin & Yüzer, 2022, p. 486)
Description	We base these principles on our experience in developing the IBM System S middleware, a stream processing runtime system; Spade, its accompanying distributed application composition language; as well as our hands-on work in building several real-world applications from diverse domains using this computational infrastructure (Turaga et al., 2010, p. 1074)
Template	Provide the system with [material properties such as specific features] to afford users [activity of user/group of users], given that [boundary conditions] (Seidel et al., 2018)
Description	"…design principles as common ground for implementing corresponding solutions" (Nadj et al., 2020, p. 140)
Description	"A set of design principles can assist her in traversing this problem space and in identifying feasible solutions efficiently and effectively" (Schneider et al., 2023, p. 66)

2.2. Value-based engineering as a baseline in defining value-based requirements

In this study, the formulation of design principles and system requirements is carried out iteratively. These requirements are derived by applying the concept of value-based engineering (VBE) in the literature review and information flow investigation.

Scholars have long recognized the importance of human value in the design process. Value-sensitive design (VSD), introduced by Friedman in the 1990s, aims to prioritize human values in designing information systems and human-computer-aided tools (Friedman, 1996). VSD focuses on identifying values and ethical concerns during system design. Over the years, VSD has been adopted in various design processes. A systematic review by Winkler and Spiekermann (2021) shows that from 1996 to 2016, VSD was implemented by 219 different studies, even though only 17 publications have consistently applied three design cycles of VSD. That review also concludes that there is a need to provide methodological guidance to conduct VSD in the design process systematically. Value ethics and moral philosophy significantly influence the design process and the formulation of value propositions, emphasizing the necessity of maintaining consistency in value principles through the active involvement of relevant stakeholders (Spiekermann, 2021). In a value-based design requirement, we must comprehensively elucidate the concept of the intended value and associated norms because different conceptions can lead to other requirements (Veluwenkamp & Hoven, 2023). For instance, as Veluwenkamp and Hoven (2023) explained, a social media platform that prioritizes voting as a central value will entail a different set of requirements than a system that places contestation as a core value.

Researchers recognize the complexity of eliciting values and principles, noting challenges distinguishing between ends and means, objectives, targets, and constraints (Keeney, 1996). To address this challenge, scholars continually enhance conceptual approaches and methodology for translating values into design requirements, exemplified by the development of Value-Based Engineering (VBE). VBE is a structured methodology to translate *value principles* into *system features*, also called *value dispositions* in IEEE 7000 (Spiekermann & Winkler, 2022). VBE comprises three layers of value ontology: core value, value qualities, and value dispositions (Spiekermann & Winkler, 2022). Core values, like privacy, represent intrinsic value, while value qualities, like informed consent, offer practical interpretations. Value dispositions, or system features, encompass technical elements like layered privacy policies (Spiekermann & Winkler, 2022). To facilitate the translation of core values and value qualities into system requirements, Spiekermann and Winkler (2022) introduced the concept of Ethical Value Requirements (EVRs), which cover both organizational and technical aspects. In this study, focusing on inclusion as the guiding value for architectural requirements, we aim to identify associated value qualities and EVRs.

3. Research methodology

This section delves into the methodological stages to address the research question: "*What design principles must be considered when developing a lending system that promotes inclusion*?". This study employs two research stages: (1) delineating value-based requirements (VBR) and (2) formulating design principles. These stages are mutually reinforcing and undergo iterative refinement, ensuring mutual enhancement. *The first stage* involves identifying value-based requirements through multiple methods, including a systematic literature review, flow-based assessments, and expert interviews. These steps ensure a comprehensive understanding of the core values and requirements relevant to financial inclusion. *The second stage* involves formulating and refining design principles through iterative expert feedback, including structured interviews and evaluation sessions. This structured approach ensures that the principles are theoretically sound and practically applicable.

3.1. Elaborate value-based requirements

We adopted an approach aligned with Fu et al. (2015), emphasizing the inductive derivation of principles from empirical evidence. Our method is also inspired by Turaga et al. (2010), which is grounded in industry experiences and involves revisiting previously identified requirements and translating them into system components. We explore value-based requirements through a literature review, flow analysis, and interviews. The adoption of VBE for requirement elicitation is motivated by its structured methodology, offering a systematic approach to transform core values into tangible system features.

We apply VBE to systematically translate values into tangible propositions, connecting value-based requirements with technical specifications across four stages, as depicted in Fig. 2. Following an initial literature review and information flow analysis, interviews were conducted in Indonesia to elicit requirements, as listed in Appendix B. Two key factors were considered: Indonesia's successful microfinance credit programs before the 1997 global financial crisis (Tambunan, 2015) and the significant growth of Fintech Lending companies since 2016. Based on data from Indonesia Financial Services of Authority (OJK), as of December 2022, there are 102 registered fintech lending in Indonesia, with total lending of 225.55 trillion rupiahs. This amount increased compared with 155.97 trillion rupiahs in 2021, 81.5 trillion rupiahs in 2019, and 22.7 trillion rupiahs in 2018 (OJK, 2023). Engaging with stakeholders, including policymakers, fintech companies, and end-users, aimed to gather insights and identify system improvements to enhance financial inclusion. Analysis was conducted using Atlas.TI software to extract actionable insights.

3.2. Formulate design principles

Having obtained a list of value-based requirements, we utilize them as a baseline for formulating design principles. The subsequent steps are illustrated in Fig. 3.

Following identifying value-based requirements in step 1, we proceed to step 2, where we specify system requirements and components, laying the groundwork for our design principles. Here, we delve into technical specifics beyond the normative list of requirements. In step 3, we formulate design principles. This stage begins with a review of design principle trends in existing literature.

Approaches in this paper align with several works on design principles, such as Dolk and Drnevich (2011) which underscore the importance of defining requirements before crafting design principles, tailoring them to meet specific needs; Nobre et al. (2019) that establish design principles for systems that lack pre-existing reference architecture, using simulations based on previously defined principles; Salmon and Ray (2017) which identify challenges, derive principles from these challenges, propose a system architecture, and outline system scenarios; and Pan et al. (2021) that apply Action Design Research (ADR), presenting principles and focusing on product requirements and system features in the artifact creation. Steps 4 and 5 ensure iterative evaluations to align principles with objectives and values consistently.

In Step 6, the conceptual principles were assessed through targeted interviews with IS domain architects, as detailed in Appendix D, which was conducted from August to September 2023. This expert group, spanning areas like IT architecture, large-scale payment systems, and data management, responded to carefully crafted questions to avoid confirmation bias. Step 7 refined the design principles based on their feedback. The involvement of diverse experts was strategic due to several factors: the limited availability of inclusion specialists in Indonesia, their substantial experience with microenterprise systems, and the need for a well-rounded evaluation of the principles. Their varied backgrounds provided a multifaceted assessment, reducing bias and ensuring the principles' relevance across different contexts.

4. Design principle in the literature

This section delves into the literature on design principles, emphasizing their importance at the intersection of technology and human behavior (section 4.1). It further explores the literature on Value-Based Requirements, followed by information flow analysis and interviews (section 4.2).

4.1. Overview of IS design principles

Considering the intersection of technology and human behavior in IS design theory, inspired by Gregor and Jones (2007), our initial search for articles with "design principles" and related keywords generated 1687 results.

Narrowing it down to computer science, we found 349 articles. Focusing on the relevance of information systems, we refined the selection to 165 documents through keyword analysis, abstract scrutiny, and citation reviews. Exhaustive backward and forward searches on highly cited articles identified 23 papers offering valuable insights into design principles in Information Systems, as in Fig. 4. Our literature review focused on computer science and information systems, targeting the overlap of technology with digital government relevant to financial inclusion. This specific emphasis enabled us to identify technologies and systems critical to promoting digital government efforts for financial inclusivity. We excluded topics unrelated to this intersection, such as "Design principles in medical contexts." Similarly, while crucial in cybersecurity, topics like "GDPR compliance" and "Identification of malware in RFID systems" were omitted due to misalignment with our study's focus." This focused approach was crucial for efficiency, given the initial pool of 1687 papers, making a comprehensive review impractical.

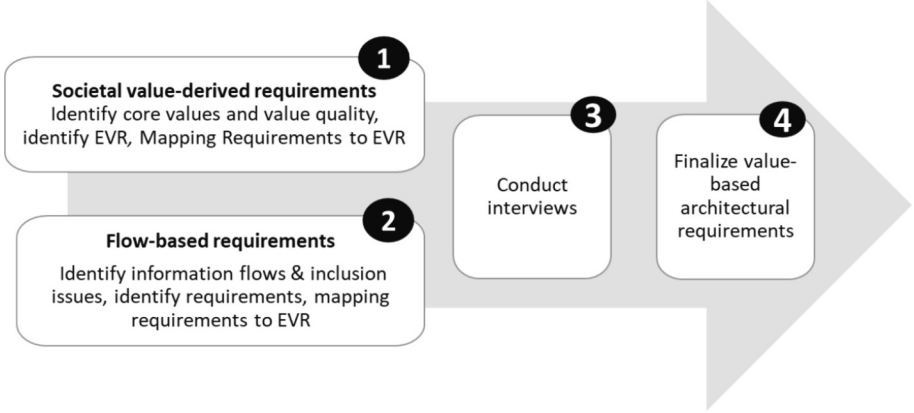

Fig. 2. Steps of formulating value-based requirements.

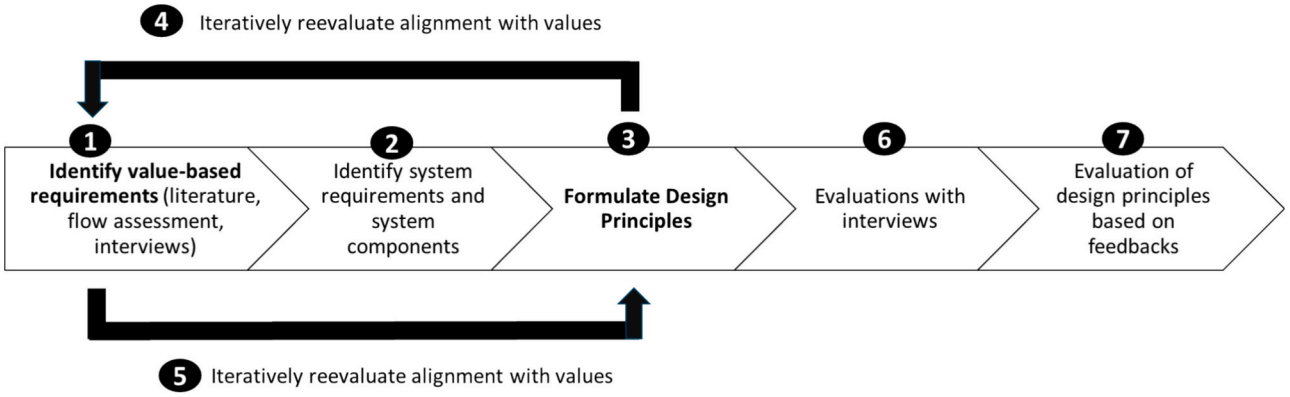

Fig. 3. Steps of formulating design principles.

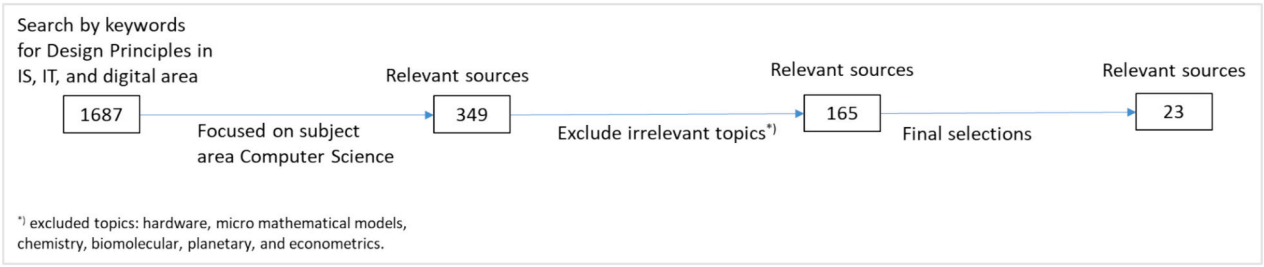

Fig. 4. Literature review about research trend of design principles in Information system.

One of our critical references for identifying research trends in design principles in information systems is the research conducted by Möller et al. (2020). They systematically developed a taxonomy for examining design principles, categorizing them based on dimensions, i.e., perspective, research design, meta-requirement source, design principles design, iterations, evaluation, and formulation. This work offers valuable insights into the multifaceted nature of research on design principles in information systems. Building on Möller et al. (2020), who categorize design principles across seven dimensions, our focus narrows to two key dimensions: perspective and research design. *Perspective* refers to when design principles are developed—before the artifact exists (supportive) or during its development or availability (reflective). *Research design* includes Design Science Research (DSR), action design research, qualitative research, and case studies. Additionally, we introduce a new dimension: *methodology*, which covers frameworks and systematic procedures for developing design principles.

Appendix F summarizes our findings on various approaches to formulating design principles in information systems. Researchers use a range of research designs, such as qualitative, deductive, and case studies, often combining methods for more comprehensive evaluations. For instance, Matheus et al. (2021) adopt a deductive approach within the DSR framework, systematically aligning challenges with design principles. Other studies, like Lindgren et al. (2004), build a prototype to test proposed design principles, while Nadj et al. (2020) use a purely qualitative approach with a literature review to identify design principles without interviews or prototyping.

4.2. Overview of value-based requirements for inclusive lending system

This section explains how we derive value-based requirements through a literature review, flow analysis, and interviews. A deductive approach was employed to identify societal requirements, focusing on core values, value qualities, and ethical value requirements (EVRs). By analyzing 40 relevant papers, we identify EVRs relevant alternative lending systems, ensuring a comprehensive understanding of the ethical value landscape (Fig. 5).

We then analyzed the lending system's *information flow* to identify inclusion-related issues, such as data handling and model creation. Simple approaches like Use Case and State Diagrams were used to understand functional requirements, information flow, and system behavior. Next, we validated requirements through interviews in Indonesia from July to August 2022. Engaging with stakeholders in the financial ecosystem, including policymakers, fintech companies, and end-users, provided insights into the current progress and requirements needed to enhance inclusion.

Detailed breakdowns of this stage are omitted to maintain the paper's focus on design principles. Appendix G summarizes the value-based requirements from literature reviews, information flow analysis, and interviews, labeled "LitX" for literature review, "UsrX" for information flow analysis, and "ExpX" for interview respondents.

5. Design principles for inclusions

Identifying design principles initially posed challenges due to gaps between methodology and outcomes in previous studies. Notably, several studies offered more transparent methodologies; for example, Salmon and Ray (2017) directly converted challenges into principles, Schneider et al. (2023) applied a Data Mining framework for organizing principles, Matheus et al. (2021) used a deductive approach from literature to align principles with barriers, leading to a validated list through comparative case studies, Matheus et al. (2020) mapped design principles from literature findings by mapping risks/challenges/threats, and Nobre et al. (2019) categorized principles into system, network, and service clusters from the outset.

Bharosa and Janssen (2015) emphasize principle-based design as normative guidelines for system architects, aligning with our approach to inclusive lending systems. Their focus on transparency and fairness in decision-making informed our design principles. Similarly, Fu et al. (2015) advocate for deriving principles inductively from empirical evidence, influencing our iterative refinement through expert interviews

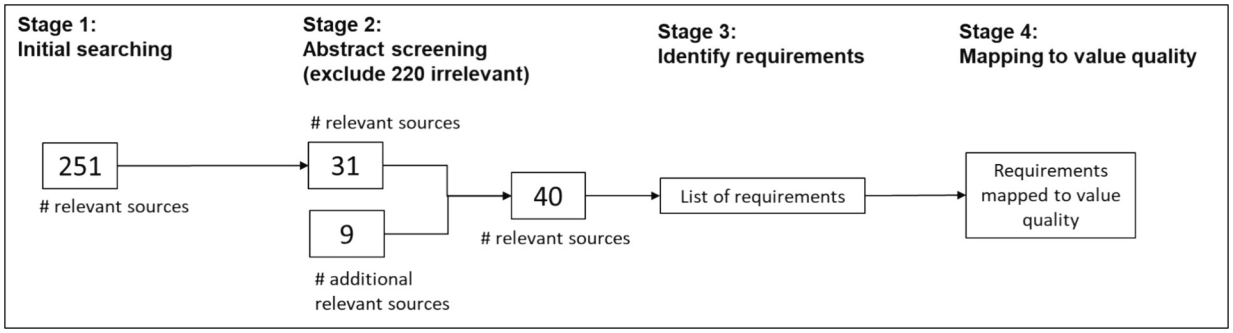

Fig. 5. Identification of ethical value requirements from the literature.

and literature reviews. Building on the work of Fu et al. (2015) and Turaga et al. (2010), we used an inductive approach to translate Value-Based Requirements into system components. Table 2 illustrates this process, mapping the progression from high-level system requirements to specific components. For instance, the "non-biased access" requirement was refined into high-level system requirements and specific components, following an iterative translation process applied to all value-based requirements.

Table 2
Mapping of value quality, high-level system requirements, and system components.

Value Quality	High-level system requirements	System components	Types of components	Code
1. Non-biased access	Leveraging alternative data sources to attain a more comprehensive individual profile that reflects creditworthiness	Collaborative and distributed data-capturing module	Data capturing technology (structured data)	T1
		Data crawling agents	Data capturing technology (unstructured data)	T2
	Assessment of payment capability utilizing alternative data sets	Payment capacity module	Financial analysis module	M1
	Providing inclusion criteria	Inclusion criteria rule engine	Business rule engine	M2
2. Non-biased distribution	The diverse distribution of credit across income segments	Non-biased distribution mechanism	Distribution model	M3
3. Inclusive scoring	Individual scoring based on inclusion criteria	Inclusive scoring model	Scoring model	M4
4. Credit schema for marginalized segments	Developing loan products tailored for marginalized segments, addressing their unique needs	Credit configuration and custom repayment	Loan configuration module	M5
5. Perceived benefits	Provide simulation tools for user understanding and introduce a contestation room for borrower arguments, though decisions are not guaranteed to change.	Users' simulation tools	Simulation tool	S1
		Contestation component	Feedback and resolution module	M6
6. Transparent operational	Guaranteeing clarity in decision and formulation to foster user understanding	Users' simulation tools	Simulation tool	S1
		Contestation component	Feedback and resolution module	M6
7. Enhanced trust for increased participation	Log activities related to inclusion criteria and bookkeeping	Auditable Logging Mechanism	Audit trail	M7

The table illustrates the value-based engineering approach, showing the progression from values to high-level requirements and system components, as outlined by Spiekermann and Winkler (2022). Components are categorized into Technology (T), System Modules (M), and Simulation Tools (S). For example, T1 and T2 ensure non-biased access through structured and unstructured data collection, M1 evaluates payment capability, M5 customizes loans for marginalized groups, and M3 ensures fair credit distribution. The Simulation Tool (S1) and Feedback Module (M6) improve user comprehension and transparency. System components are subsequently clustered into ***five domains***: Data, User-customized, Analytical, User Engagement, and Audit and Oversight (Fig. 6).

In light of these domains, we formulated *candidate Design principles*, recognizing their pivotal role in ensuring functionalities meet technical requirements while advancing inclusivity. These principles underwent iterative refinement, guided by expert feedback, resulting in a comprehensive list, with one example in Appendix H. We interviewed experts from various fields, including information technology architecture, financial systems, and data analytics. Although not all directly focused on inclusivity, their expertise in marginalized groups like micro-enterprises added valuable insights. These interviews helped mitigate confirmation bias and shaped the final list of Design principles (see Table 3), which is organized to guide system development according to the Open Group framework template (TOGAF, 2024).

Fig. 6 illustrates how Design principles drive the development of system components within the context of inclusivity. It shows the connections between each **principle** and its corresponding system components derived from **Value-Based Requirements**. Each principle is associated with **Requirements Domains**, including *Data Domain, User Customized Domain, Analytical Domain, User Engagement Domain,* and *Audit & Oversight Domain*. This figure sets a benchmark for equitable lending governance by embedding inclusivity into system design. Continuous enhancements are crucial to ensure the principles and requirements evolve with societal norms and technological advancements.

Principle 1: Formulate a comprehensive set of *inclusion metrics* to promote inclusive access and performance evaluation.

Inclusion metrics in alternative lending combine quantitative and qualitative measures to ensure non-biased access and evaluate performance. Monitoring and adapting these metrics allows decision-makers to respond to societal shifts and correct biases. For example, if metrics reveal disparities in loan distribution to underserved communities, decision-makers can adjust lending strategies or implement targeted financial literacy programs.

How are inclusion metrics defined? Despite lacking comprehensive literature, the interviews suggest a dual approach to inclusion metrics (R7). At the *macro level*, these metrics involve quantitative data that

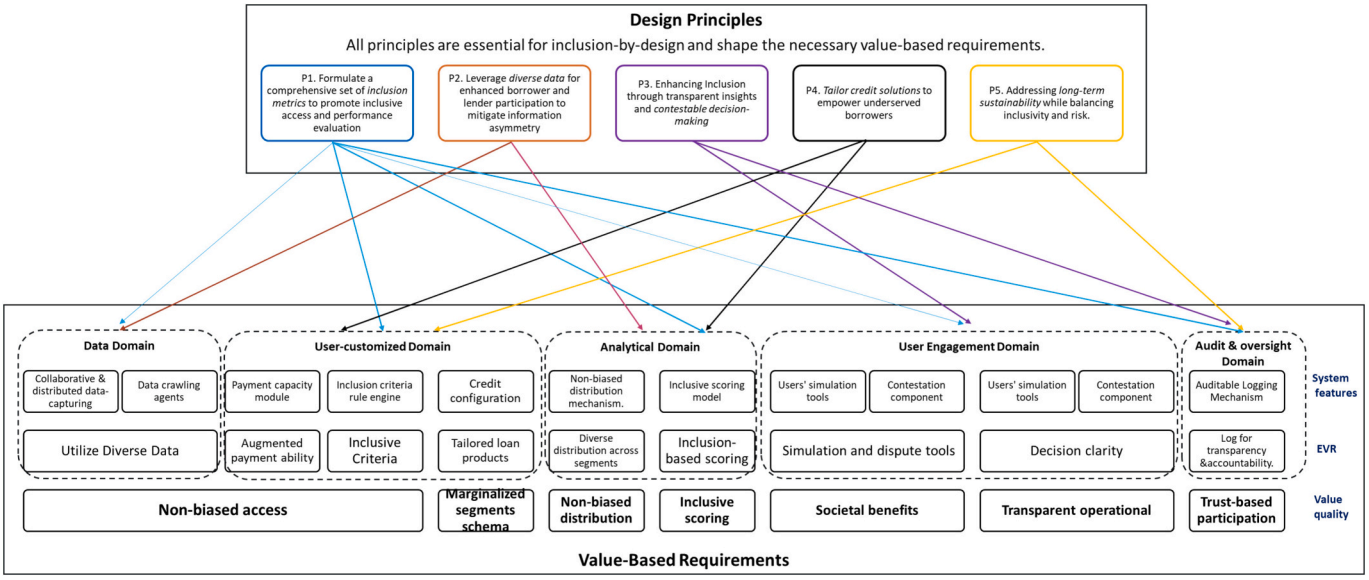

Fig. 6. Interconnections between design principles and VBR-derived system components.

Table 3
Design principles.

Principle Statement	Rationale	Implications
P1. Formulate a comprehensive set of *inclusion metrics* to promote inclusive access and performance evaluation	Providing metrics across all system domains ensures a comprehensive evaluation of equitable access and performance.	Define and adapt inclusive metrics in all system domains to assess the outcome of access and performance.
P2. Leverage *alternative data* for enhanced borrower and lender participation to mitigate information asymmetry	Incorporating alternative data is expected to reduce information asymmetry and encourage greater participation.	Identify reliable alternative data sources, utilize advanced technology for data analysis, and apply data protection and privacy compliance.
P3. Enhancing Inclusion through transparent insights and *contestable decision-making*	Personalized insights, audits, and dispute resolution boost trust and user loyalty. These are necessary for misunderstandings to erode trust.	Provide personalized simulation tools. Enable lender-borrower communication, including the ability to contest decisions.
P4. *Tailor credit solutions* to empower underserved borrowers	Lack of customized credit schema can sustain financial inequality, hindering economic growth and stability for these individuals.	Recognize the unique needs of underserved borrowers, create customized products, and provide financial education.
P5. Addressing *long-term sustainability* while balancing inclusivity and risk.	This principle prevents prioritizing short-term inclusivity over long-term stability, avoiding heightened risks and instability.	Establish a comprehensive risk management, adapt to regulatory changes, and implement data-driven decision-making.

capture statistical representations of inclusion, such as increased credit recommendations and improved payment capacity for microenterprises across diverse income segments. At the *micro level*, inclusion metrics delve into philosophical and mathematical aspects, focusing on algorithms designed to enhance inclusivity by reducing potential biases in evaluating individual creditworthiness. *Macro-level inclusion metrics* are relatively prevalent, especially in research that utilizes World Bank surveys on financial inclusion, despite a need for more analysis on distribution aspects. However, *micro-level inclusion metrics* tied to algorithms and mathematics formulations are not readily available, unlike extensively researched and established fairness metrics in machine learning, such as Binns (2018), Hardt et al. (2016), and Koumeri et al. (2023). Another example is a study by Kozodoi et al. (2022) revisiting fairness research in machine learning and categorizing it into various intervention methods and criteria evaluation perspectives.

Given the underexplored nature of *micro-level inclusion metrics*, one suggestion is to adopt fairness measures considering the relational and contextual nature of the measurement. This is also in recognition that, in defining inclusion metrics, the emphasis should not solely be on mathematical or statistical interpretations but on addressing existing inequalities and issues with exclusions. Lee and Floridi (2021) underscore the importance of a relational and contextual approach to measurement, allowing decision-makers flexibility. Their framework evaluates the equilibrium between enhancing financial access and its effects on minority groups, aiding decision-makers in choosing algorithms that match their ethical standards and risk capacity. The concept of trade-off inclusion metrics can also be adapted to match the risk appetite of the decision-makers. Table 4 outlines proposed inclusion metrics across all Requirement Domains.

Principle 2: Leverage *alternative data* for enhanced borrower and lender participation to mitigate information asymmetry.

Table 4
Inclusion metrics.

Requirements Domain	Inclusion Metric	Description
Data Domain	Diverse data collection	Measures a variety of data sources for comprehensive financial profiles.
	Representational data	Ensures data representativeness across all user groups.
User-customized Domain	Inclusive criteria rule engine	Incorporates inclusion rules for equitable access.
Analytical Domain	Loan recommendation distribution index	Reflects the distribution of loan recommendations across various segments.
	Diverse data utilization score	Assesses the use of varied data in credit assessments.
User Engagement Domain	User satisfaction & empowerment index	Evaluate the system's effectiveness in meeting diverse needs and empowering users.
Audit & Oversight Domain	Transparency and accountability metrics	Monitors decision logging and auditing for transparency with users.

Principle 2 underscores the importance of alternative data in enhancing borrower and lender participation and mitigating information asymmetry. Alternative data, including digital transaction histories and data from service providers, offers valuable insights into a borrower's financial behavior (Aitken, 2017; Roa et al., 2021). Unlike traditional credit metrics, alternative data provides a more holistic view, incorporating factors beyond standard credit assessment criteria. Integrating alternative data into the credit assessment enables systems and lenders to make more informed lending decisions. Interviews highlight the complexities of relying solely on primary data, particularly when serving marginalized populations (R1, R8). In some cases, primary data may be entirely unavailable (R1). However, leveraging alternative data requires careful consideration of inclusion and data privacy risks. Balancing these factors is essential to safeguarding individuals' privacy, securing sensitive data, and promoting financial inclusion.

Alternative data is of great value when assessing the payment capacity of microenterprises and individuals with limited banking histories, offering insights into revenue patterns and financial stability. This data enables systems to develop predictive models and enhance payment capacity assessments. For example, in South Africa, TymeBank utilizes AI-driven technologies to provide digital banking services through kiosks and online platforms, overcoming traditional barriers such as the high costs associated with physical banking infrastructure (Tyagi, 2023). This supports our principle of using AI to enhance access and reduce operational costs, fostering inclusiveness. Similarly, in the United States, digital banks and loan applications employ AI to assess loan eligibility using alternative data sources like smartphone usage patterns, enabling credit access for individuals without formal financial histories (Tyagi, 2023). This demonstrates the principle of leveraging diverse data sources to extend credit opportunities to underbanked populations.

Real-time monitoring of borrower payment capacity, facilitated by alternative data, helps identify early signs of financial distress and manage risk proactively, aligning with a data-driven transparency cycle (Matheus et al., 2021). However, obtaining alternative data for microenterprises presents challenges, particularly in regions needing digital transaction connections. Establishing a collaborative and sustainable data collection system is essential, especially in countries like Indonesia, where reliable microenterprise data remains scarce despite fintech advancements. Collaboration with regional government authorities and the appointment of agents to oversee data collection could address this limitation.

Recognizing milestones in integrating alternative data into system design is vital for enhancing inclusivity. Optimization points may include data collection, algorithm design, operational phases, or alignment with regulatory considerations. As the lending landscape evolves, continuous refinements and collaborative efforts will be crucial to fully harness the potential of alternative data in promoting financial inclusion.

Principle 3: Enhancing Inclusion through transparent insights and contestable decision-making.

Principle 3 emphasizes transparent insights to prioritize accessibility and clarity in loan details, especially for those with limited financial literacy or unfamiliarity with formal financial systems. These insights empower individuals to navigate financial transactions confidently, addressing information asymmetry and fostering inclusivity. Trust-building emerges as a crucial aspect of inclusive credit access promoted by this principle. Participants, including borrowers in marginalized segments, can audit transactions, instilling confidence in lending. Trust extends beyond lenders and investors to encompass the fundamental business model. Transparency, as highlighted by (Matheus et al., 2021), plays a key role in building trust within complex systems. Interviews underscore the central role of trust in encouraging participation, particularly among borrowers in marginalized segments. In these segments, predatory online lending practices are prevalent, leading borrowers to prioritize loans despite concerns about personal data privacy, even when faced with high interest rates (R1). This principle aligns seamlessly with Nadj et al. (2020), emphasizing the importance of user engagement.

While initially addressing personalized loans and audit capabilities, principle 3 should be extended to providing contestation options when credit is denied. Two-way feedback promotes understanding and inclusivity, embracing a holistic approach beyond increased credit provision to encompass awareness, literacy, and attachment. Contestation options empower borrowers to challenge decisions, reinforcing fairness and collaboration. A more inclusive system does not necessarily imply the approval of credit to everyone; rather, it signifies an improvement in awareness, literacy, and long-term attachment. Introducing contestation options takes the system a step further towards inclusivity.

Principle 4: Tailor credit solutions to empower underserved borrowers.

This principle underscores the need to identify underserved borrower profiles to customize credit solutions effectively. By tailoring credit options to address their specific challenges and limitations, the system ensures these individuals can access suitable credit, promoting financial inclusion. The interview highlighted the importance of perceived benefits, including profit and sustainability, as the main drivers (R1). It emphasized the necessity of adapting credit solutions to the unique needs of micro-enterprises, with consideration for sector-specific nuances.

The discussion also highlighted the importance of categorizing micro-enterprises based on risk evaluations and implementing a strategic approach to improve credit schemes in targeted sectors (R8). For example, the credit requirements of street food vendors and agricultural businesses may differ significantly (R8). Another notable example is the increasing attention to specialized productive credit for women (Noreen et al., 2022). In addition to addressing economic inequality, Principle 4 contributes to sustainable business practices by aligning credit solutions with the unique needs of individuals. This approach not only fosters financial growth and stability for the targeted demographic but also supports long-term viability. By prioritizing tailor-made solutions, the principle catalyzes economic empowerment, driving positive social impact and ensuring a more resilient and inclusive financial landscape.

Principle 5: Addressing the long-term sustainability while balancing inclusivity and risk.

Principle 5 emphasizes the importance of avoiding short-term strategies and prioritizing inclusivity without considering its potential impact on the industry's stability and risk management. The rationale behind this principle lies in promoting a proactive and measurable approach that acknowledges both the benefits and risks associated with inclusive lending practices. The interview underscores the significance of balancing profitability and sustainability, recognizing that non-biased resource distribution may not always be sustainable (R1). Achieving equality may involve strategies like cross-subsidies, highlighting their connection with diversity and sustainability (R1). This principle promotes a balanced ecosystem that fosters sustainability and inclusivity through prudent risk management, diversified lending approaches, and ongoing risk monitoring. It encourages continuous evaluation and adaptation to ensure the industry remains robust while actively contributing to greater inclusivity.

The five Design principles presented here are crucial for shaping an inclusive alternative lending system. Derived from thorough research examination, they address key design aspects and align with specific value qualities. These principles stem from earlier identified Value-Based Requirements and provide a clear direction for system development, prioritizing inclusivity. As alternative lending evolves dynamically, new principles or research areas may emerge to enhance inclusivity further. Therefore, it's vital to remain open to adapting and refining these principles to ensure continual progress towards greater inclusivity and sustainability.

6. Governing inclusive and sustainable alternative lending system

The government's role is essential in ensuring the use of design principles and driving positive changes. Literature underscores the broader dimensions of financial inclusion facilitated by government initiatives, such as collaborations with industries (Staschen & Nelson, 2013). Government efforts to promote financial inclusion through fintech adoption, seen as a catalyst for fundamental changes, have been observed in countries like Ghana (Coffie & Hongjiang, 2023) and Pakistan (Noreen et al., 2022). Governments also contribute significantly to encouraging the use of formal financial accounts (Aggarwal & Klapper, 2013), and addressing inclusion and inequality challenges by establishing rural banks, Self-Help Groups, and Micro Finance Institutions (Krishanadevaraya, 2013). Nevertheless, there is a notable oversight regarding alternative lending systems. In addition, integrating AI technologies like LLMs can further support these initiatives by providing advanced analytical capabilities to monitor inclusion metrics, predict financial behavior, and identify underserved areas more effectively.

Our research recommends the government's role (Table 5) to enhance financial inclusion, particularly in lending to marginalized segments, aligning with our design principles.

Government intervention could significantly influence the design principles by shaping and aligning them with national priorities. As highlighted during the interviews, inclusion strategies are dynamic and adapt to shifting economic priorities. This adaptation may involve transitioning from supporting micro-enterprises to small enterprises or other sectors (R8). As explained by (Staschen & Nelson, 2013), governments have the authority to require financial institutions to establish particular objectives, such as increasing financing or providing basic banking services to underserved groups. The government assumes a central role by establishing regulatory frameworks that enforce the reporting of inclusion metrics to guarantee commitment to inclusivity and continual evaluation against predefined benchmarks. As underscored by academic sources, including Coffie and Hongjiang (2023), Noreen et al. (2022), and Staschen and Nelson (2013), regulations in the lending industry are crucial to boost inclusion, despite the direct discussion of inclusion metrics remains somewhat underdeveloped. Governments can also incentivize equitable access by offering rewards or tax benefits to entities surpassing established metrics.

Government intervention is also essential for *leveraging alternative data* to address information asymmetry. By issuing directives for collaborative data collection involving regional authorities and contributors, governments can encourage responsible data sharing, ensuring diverse and reliable sources while upholding privacy. In addition to directives, governments can expedite financial inclusion by strengthening infrastructure (Staschen & Nelson, 2013), including support for collaborative infrastructure. Guidelines for the ethical and secure use of alternative data serve as an additional layer of protection for consumers, ensuring that institutions respect privacy rights (Staschen & Nelson, 2013).

In fostering inclusion, governments also play a crucial role in ensuring *transparency* and supporting *contestable decision-making*. They can facilitate this by promoting accessible technologies and platforms for loan monitoring and auditing. Such platforms help enforce transparency around loan approval, interest rates, repayment schedules, and audit trails. Noreen et al. (2022) argue that a well-functioning credit information mechanism strengthens microfinance networks, with these measures contributing to the trust-building process within financial systems.

Addressing the financial needs of underserved borrowers is another vital function of governments. The literature highlights the government's role in enhancing financial capability through initiatives such as financial literacy programs, education, and regulation (Staschen & Nelson, 2013). This may involve expanding rural banks, establishing microfinance, or directly providing capital (Krishanadevaraya, 2013). In this paper, we propose that improving financial capability can also be achieved by regulating lending structures to provide tailored credit schema for marginalized segments. Anticipating that innovative services and products for underserved groups will expedite inclusion (Coffie & Hongjiang, 2023), governments can further stimulate innovation by providing incentives or regulatory support, encouraging the development of financial products for the needs of underserved groups. For instance, in Pakistan, the government has launched special loan schemes for micro-borrowers and the underprivileged in rural areas, including special programs for women (Noreen et al., 2022).

Governments also contribute by balancing inclusivity with risk to *ensure the long-term sustainability* of lending systems. This role includes providing essential non-financial infrastructure such as roads and electricity, which significantly impact the operations of financial institutions, particularly in underserved regions (Staschen & Nelson, 2013). Governments also set regulations, such as those governing non-performing loan thresholds, and offer incentives to lenders that prioritize serving underserved groups. By regulating competition, particularly from rising foreign fintech players, governments can help ensure that inclusive lending systems remain viable and competitive, as discussed by Coffie and Hongjiang (2023).

In summary, governments play an instrumental role in promoting both inclusivity and sustainability within the financial system. The collaboration between the government and the industry is crucial for effective and responsible financial inclusion (Staschen & Nelson, 2013). While our research focuses on Indonesia, government roles may vary across countries based on their regulatory frameworks, economic priorities, and governance structures. The proposed design principles are inherently transformative, demanding a comprehensive re-evaluation of existing systems. This transformation requires a fundamental shift in mindset to foster meaningful change and ensure the long-term sustainability of inclusive lending practices.

Table 5
Government's role in fostering inclusive alternative lending system.

Design principles	Government roles
Enforce a comprehensive set of *inclusion metrics* to promote inclusive access and performance evaluation	1. Establishing inclusion metrics and reporting guidelines. 2. Offering incentives for compliance with these metrics
Leverage *alternative data* for enhanced borrower and lender participation to mitigate information asymmetry	1. Government mandate for collaborative data collection involving regional government and data contributor 2. Developing guidelines on the safe and ethical use of alternative data.
Enhancing Inclusion through *transparent insights* and contested decision-making	1. Providing accessible technology for monitoring and auditing 2. Enforcing transparency regulations in lending and auditing.
Tailor credit solutions to empower underserved borrowers	1. Interest rate, lending schema, payment regulation 2. Promoting innovative credit products for underserved groups.
Addressing *long-term sustainability* while balancing inclusivity and risk	1. Regulation about non-performance-loan threshold 2. Incentives or financial support to providers focusing on lending to these groups

7. Conclusion and recommendations

7.1. Conclusions

Inclusion requires the transformation of current systems, and the principles derived in this paper can shape these. Our analysis concludes that profound *system-level transformations* are indispensable. We advocate for a new system to transform the current one, encompassing

structural changes, regulatory updates, and integrating various information sources. This transformation demands a change in organizational practices and collaboration, aiming to create a system that is both innovative and responsive to societal needs, aligned with the principles of inclusivity.

This paper presents several key insights. *First, we introduce an innovative approach for embedding inclusiveness into information systems* by adopting Value-Based Engineering (VBE). VBE allows us to operationalize inclusivity as a foundational element in system design. This approach is particularly relevant for government agencies seeking to ensure that their digital services—especially those powered by Artificial Intelligence (AI)—are both accessible and equitable. We highlight *the importance of Design principles* within system design and illuminate a key differentiation by distinguishing them from Value-Based Requirements (VBRs). This understanding is essential, as it clarifies that VBRs specify *the qualities* the system should embody, while Design principles offer *strategies* to align the system with those values consistently. Moreover, AI technologies, such as Large Language Models (LLMs), can enhance the implementation of these principles through advanced data analysis and decision-making capabilities.

Second, our study unveils *a systematic approach to derive Design principles*. This involves translating value-based requirements into high-level system requirements, which are then transformed into system components and five requirement domains. These domains form the foundation for identifying Design Principles prioritizing inclusivity over purely technical functionality. To our knowledge, this method remains underexplored in existing literature. It offers valuable inspiration for future research in Information Systems (IS) domains, particularly those focused on formulating Design Principles.

Third, this study underscores *the crucial role of government* in shaping an inclusive and sustainable lending landscape. Governments can actively shape the industry by enforcing inclusion metrics, providing incentives, and ensuring that inclusivity remains a priority. Moreover, they address information disparities by promoting responsible data-sharing practices and establishing clear ethical guidelines for using alternative data. Government contributions extend to advocating accessible tech solutions, imposing transparency regulations, and customizing credit solutions for underserved demographics while balancing inclusivity and risk management.

Fourth, our study recognizes the importance of balancing inclusivity with profitability and data privacy. We acknowledge the inherent challenge of addressing these multiple dimensions simultaneously. For example, striving for income-based inclusivity may inadvertently impact other factors, such as age or regional representation. While achieving full inclusivity may be difficult, we argue for a pragmatic, incremental approach, incorporating regular assessments to evaluate the system's inclusivity and identify areas for continuous improvement. Drawing from Herbert Simon's work in "The Sciences of the Artificial," as referenced by Gregor and Jones (2007), we emphasize that solutions need not be perfect; adequacy is often sufficient, and the ability to adapt is of great value. Simon's insights also reinforce the idea that systems should be designed with the capacity to evolve.

7.2. Limitations and future recommendations

While this study provides a solid foundation for future research, several limitations should be acknowledged. First, the focus on Indonesia offers valuable, context-specific insights, but this geographic focus may limit the generalizability of the findings. Second, the rapidly evolving digital finance and government information systems sectors could affect the long-term applicability of the proposed design principles. As technologies evolve and policy landscapes shift, continuous refinement of these principles may be needed to ensure their relevance. Third, expert interviews, though essential, might capture only a partial view of stakeholder perspectives, leading to possible selection bias. A broader set of perspectives, including more diverse stakeholders, could have enhanced the comprehensiveness of the findings. Fourth, integrating these principles into the broader landscape of data-driven governance in the AI era presents additional challenges, including regulatory adaptation, new forms of digital exclusion, and ethical concerns around alternative data use. Further exploration is needed to assess how these principles can be practically implemented within existing governmental and financial infrastructures, especially considering the dynamic nature of digital governance, influenced by technological advancements and shifting policy priorities. Moreover, the frameworks are specifically tailored to alternative lending systems and may not fully apply to other financial services, such as savings or insurance. However, the inclusion-by-design concept underlying these principles can be adapted for broader use across various systems, with necessary modifications to address the specific context of each system.

Our study presents a comprehensive approach to advancing financial inclusiveness through designing government information systems in the era of data-driven governance and AI, offering a novel approach to creating inclusive digital ecosystems that cater to all citizens. Future research could also evaluate the adaptability and effectiveness of these design principles across different domains, such as security crowdfunding, banking credit, or traditional micro-lending, while concurrently refining and testing them. Additionally, further investigation into the ethical, privacy, and security implications of employing AI and alternative data in government information systems will be crucial to ensure that efforts to enhance financial inclusivity do not inadvertently exacerbate existing inequalities or introduce new forms of exclusion. Furthermore, balancing financial inclusion with risk management is crucial for sustainability. Although briefly addressed in the conclusion and Principle 5, emphasizing competing values such as accountability and efficiency throughout the study would enhance our analysis. We recognize this importance and suggest incorporating more in-depth discussions in future research.

CRediT authorship contribution statement

Reni Sulastri: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Marijn Janssen:** Writing – review & editing. **Ibo van de Poel:** Writing – review & editing. **Aaron Ding:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.giq.2024.101979.

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