

IT-supported accountability for sustainability in connected city societies: the interplay of integrated information systems and public corporate governance codes

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Abstract

Purpose – In the debate on the effects of digital transformation and accountability, this paper aims to analyse to what extent integrated information systems (IISs) in public administrations affect the use of social, ecological and economic performance information on state-owned enterprises (SOEs) by politicians and public administrators and to what extent public corporate governance codes (PCGCs) strengthen and balance the effects of IISs. The paper conceptually introduces PCGCs as frameworks for the design of IISs and sustainability-oriented performance information.

Design/methodology/approach – This paper draws on agency theory and uses a triangulation approach using data from an online survey of 337 public administrators and politicians in German cities, expert interviews and content analysis of cities' PCGCs.

Findings – Overall, the use of economic/financial performance information is higher than the use of non-financial performance information. IISs are associated with a higher use of economic but not of social performance information, indicating an unaccounted effect of digital transformation. Higher quality of PCGCs strengthens the effects of IISs on the use of social performance information.

Originality/value – This paper explores special chances and potential “dark sides” of IISs as key instruments for digital transformation and accountability in connected city societies. It innovatively differentiates between the three dimensions of sustainability for a more nuanced theoretical understanding in the scientific debate. The introduction and theorising of PCGCs as frameworks for IISs and sustainability-oriented performance information use have very high potential for scientific debates and to organise sustainable solutions for the grand challenges.

Keywords Digital transformation, Integrated information systems, Non-financial performance information, Public corporate governance codes, State-owned enterprises, Sustainability

Paper type Research paper

1. Introduction

Cities are especially relevant to the debate on accountability, digital transformation and sustainable development (Dumay *et al.*, 2010; European Commission, 2016a; United Nations, 2017; van Genugten *et al.*, 2023; Papenfuß, 2023). More than 50% of the world's population lives in cities, which deliver key public services to citizens (Argento *et al.*, 2020; Leixnering *et al.*, 2021; World Bank, 2022). As they are under special pressure to shape the digital transformation and to find sustainable solutions for the grand challenges, cities strive to develop innovative ways to improve public service delivery.

State-owned enterprises (SOEs) are central actors within cities and for connected city societies (Grossi *et al.*, 2015; Leixnering *et al.*, 2021; Papenfuß and Wagner-Krechlok, 2023;

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van Genugten *et al.*, 2023). SOEs are enterprises that are under the control of local, state, or federal governments, either by majority ownership of one or more governments or otherwise by exercising an equivalent degree of control (Papenfuß, 2023; European Commission, 2016b; Grossi *et al.*, 2015; OECD, 2015). These enterprises have largely taken over public service delivery on the local level in many countries (van Genugten *et al.*, 2023) and often operate in sectors of special environmental and social relevance (Grossi *et al.*, 2015; Leixnering *et al.*, 2021; OECD, 2017; Papenfuß, 2023). SOEs are hybrid organisations that face special “diversity tensions in accounting and accountability” (Grossi *et al.*, 2024, p. 1). In terms of the scientific debate on “business groups” (Aguilera *et al.*, 2025), city administrations and SOEs can be understood as a “city group”.

Accountability is a major challenge for cities in the context of SOEs, and previous research shows the severe accountability deficits of SOEs (Grossi *et al.*, 2015, 2024; Klausen and Winsvold, 2021; Voorn *et al.*, 2019; van Genugten *et al.*, 2023). Digital transformation and sustainability requirements add new accountability challenges (Papenfuß, 2020; Papenfuß and Wagner-Krechlok, 2023; Grossi and Welinder, 2024). The accountability deficits of SOEs have taken on increased importance considering the heightened expectations regarding the accountability of SOEs for sustainability (Giacomini *et al.*, 2020; Ruiz-Lozano *et al.*, 2022; Papenfuß, 2023) and cities’ goals in this regard (Argento *et al.*, 2020; Grossi *et al.*, 2020).

Integrated information systems (IISs), which are a recent technological innovation in accounting, are crucial performance measurement and control systems (Knudsen, 2020; Rom and Rohde, 2007). They represent digitalisation because they go beyond the mere digitising of existing processes (Mergel *et al.*, 2019) and have the potential to lead to digital transformation in the sense of cultural, organisational and relational changes (Mergel *et al.*, 2019; Knudsen, 2020). In particular, IISs can provide useful information and information processing to promote environmentally, socially and financially sustainable decision-making. However, it is important to understand under what conditions IISs have their intended effects (Grossi *et al.*, 2020) or when there might be an “unaccounted side of digital transformations” (Grossi *et al.*, 2022) in the effort “to organise sustainable solutions” (Grossi *et al.*, 2022).

Performance information use (PIU) is central to accountability (Lindermüller *et al.*, 2022; Steccolini *et al.*, 2020; Caruana and Farrugia, 2018; van Helden, 2016; Saliterer and Korac, 2013) and an important indicator of the effects of digital transformation that implies relational, organisational and cultural changes. SOEs achieve accountability by explaining and justifying their actions to citizens based on performance information. Politicians and public administrators often act as intermediaries between citizens and SOEs. Therefore, PIU by politicians and public administrators is a recurring subject in research (Caruana and Farrugia, 2018; Demaj and Summermatter, 2012; Korac *et al.*, 2020; Raudla, 2012; Saliterer and Korac, 2013; van Helden *et al.*, 2016).

Sustainability is often understood to comprise three dimensions: ecological, social and economic (Argento *et al.*, 2020; Grossi *et al.*, 2020; United Nations, 2021). Sustainability requires equal consideration of ecological, social and economic performance information (Karppi and Vakkuri, 2020; Timeus *et al.*, 2020; Papenfuß, 2023; Troshani and Rowbottom, 2024).

There are two central gaps in the literature that this paper addresses: the influence of technological innovations on performance management and PIU in the context of digital transformation as well as the type of performance information that is used (Agostino *et al.*, 2022; Grossi and Argento, 2022; Korsen and Ingvaldsen, 2022; Vial, 2019; Kroll, 2015; Liguori *et al.*, 2012; Lindermüller *et al.*, 2022; Henk *et al.*, 2024; Troshani and Rowbottom, 2024). For instance, a pertinent literature review on the drivers of PIU stresses, “More research is needed on the role of different information types” (Kroll, 2015, p. 479). It is crucial to distinguish between the different types of performance information to achieve a more nuanced understanding of PIU in terms of the different dimensions of sustainability and the effects of digital transformation. Moreover, recent research on business groups emphasises that “group-level corporate governance mechanisms have received less attention in the literature”

(Aguilera *et al.*, 2025, p. 17), and IISs are an important group-level element of city groups composed of public administration and SOEs.

The design and operational use of an IIS need to be accompanied by a context-appropriate framework that defines the roles and needs of the users of performance information and processes to derive the functional requirements to guide the design of the IIS (Granlund, 2011; Knudsen, 2020; Li and Chan, 2019; Pang *et al.*, 2014; Rom and Rohde, 2007; Wainwright and Waring, 2004). This study conceptually introduces public corporate governance codes (PCGCs) as a framework for the design/functional requirements of an IIS and sustainability-oriented PIU. PCGCs are a crucial concept within a city group consisting of public administration and multiple SOEs. They can condense recognised governance standards for the supervision and management of SOEs by political bodies, administrations, directors, executive directors, accountants and auditors (Papenfuß and Wagner-Krechlok, 2023; Papenfuß, 2023; Expert Commission G-PCGM, 2022; Cuomo *et al.*, 2016; OECD, 2015). Thus far, the literature has discussed PCGCs in terms of goals, such as good governance, accountability, focus on public service, clear actor roles and professional processes between SOE boards and public administration. Some studies show the positive effects of PCGCs on accountability (Papenfuß and Schmidt, 2021; Papenfuß, 2023). However, to date, PCGCs have not been conceptualised and empirically investigated as a potential moderator of IISs relative to sustainability-oriented PIU in the context of digital transformation.

The research question of this paper is as follows: Do IIS in public administrations affect the use of ecological, social, and economic performance information on SOEs by politicians and public administrators differently and to what extent do PCGCs as frameworks for IIS strengthen and balance the effects of IIS?

The paper draws on agency theory and, methodologically, uses a triangulation approach by drawing on the results of an online survey of 337 public administrators and politicians in German cities, expert interviews on the diffusion of IISs in cities' shareholdings management, and a content analysis of cities' PCGCs.

The paper makes the following contributions. First, it responds to calls to investigate the effects of technological innovations and digital transformation regarding PIU (Agostino *et al.*, 2022; Grossi *et al.*, 2022; Korsen and Ingvaldsen, 2022; Troshani and Rowbottom, 2024; Vial, 2019). The paper innovatively differentiates between three types of performance information—ecological, social, and economic—and provides new empirical insights into principal-agent relations for a more nuanced theoretical understanding of financial and non-financial PIU as indicator for effects of sustainability-oriented digital transformation (Liguori *et al.*, 2012; Lindermüller *et al.*, 2022; van Helden, 2016).

Second, the paper introduces PCGCs as a framework for IISs and sustainability-oriented PIU into the scientific debate on digital transformation and sustainability (Troshani and Rowbottom, 2024; Grossi and Welinder, 2024). In view of the conceptual reasoning and significant moderation effect of PCGC quality on social PIU, PCGCs can play an important role in fostering digital transformation and sustainability-oriented PIU in interplay with IISs. This enhances the theoretical understanding of self-regulation with PCGCs to influence the awareness and behaviour of principals and agents and mitigate the challenges stressed by agency theory (Brennan and Solomon, 2008) in the context of digital transformation (Troshani and Rowbottom, 2024; Argento *et al.*, 2020; Pittaway and Montazemi, 2020).

Third, the paper enhances the theoretical understanding of public sector accountability and agency theory (Bovens *et al.*, 2014; Brennan and Solomon, 2008; Schillemans *et al.*, 2020; Voorn *et al.*, 2019) by theorising and empirically showing the intended effects and potential risks of IISs for accountability and digital transformation (Troshani and Rowbottom, 2024) regarding sustainability-oriented PIU and the promising interaction between PCGCs and social PIU.

Fourth, the paper derives perspectives for future research on accountability with IISs and the effects of digital transformation within the important and theoretically fruitful context of public administration and SOEs as city groups in connected cities.

2. Basic concepts, theoretical background and hypothesis development

2.1 Accountability, IISs and digital transformation with respect to sustainability-oriented PIU

Accountability is defined very differently in the literature depending on the viewpoint and focus of the research (Bovens *et al.*, 2014; Brennan and Solomon, 2008; Schillemans *et al.*, 2020). Accountability is often described as “a relationship between an actor and a forum, in which the actor has an obligation to explain and to justify his or her conduct, the forum can pose questions and pass judgement, and the actor may face consequences” (Bovens, 2007, p. 447). In the context of SOEs, a key aspect of accountability is that SOEs must be accountable to politicians, public administrators and citizens for the achievement of public objectives (Bovens *et al.*, 2014; van Genugten *et al.*, 2023; Papenfuß, 2023; Grossi *et al.*, 2024). A central policy goal related to SOEs is their accountability for sustainability. However, considering the severe accountability deficits of SOEs (van Genugten *et al.*, 2023; Grossi *et al.*, 2015; Klausen and Winsvold, 2021; OECD, 2015; Schillemans *et al.*, 2020; Voorn *et al.*, 2019), questions about what underlying mechanisms can improve it naturally arise.

The accountability of SOEs is a theoretically fruitful as well as a very critical context for the current debate on accountability and the effects of digital transformation. SOEs are an organisational form of public service provision and an alternative to the provision of public services by the administration on the one hand or contracts of the administration with private partners or total private service provision on the other hand (van Genugten *et al.*, 2023). Worldwide, SOEs are crucial providers of public services that account for approximately 10% of the global gross domestic product (Bruton *et al.*, 2015). They are most widespread at the local level and employ a large number of public-service employees (van Genugten *et al.*, 2023). The number of SOE employees in a city is often as high as the number of employees in public administration and sometimes even higher. Moreover, SOEs account for a large proportion of public investments, and the debts held by SOEs often exceed the public debt of local governments (Asatryan *et al.*, 2022; van Genugten *et al.*, 2023; Papenfuß, 2023).

Technological innovations can improve accountability, how decision-makers use information and, ultimately, digital transformation (Agostino *et al.*, 2022; Grossi and Argento, 2022; Korsen and Ingvaldsen, 2022). However, their influence can also be detrimental for reaching some sustainability goals insofar as they may guide users in a wrong direction or cause information overload (Beyes *et al.*, 2022; Caruana and Farrugia, 2018; Karunakaran *et al.*, 2022; van Helden *et al.*, 2016). IISs are a recent technological innovation in accounting (Knudsen, 2020). They are decision-support and accountability systems characterised by three dimensions of integration: data integration, which refers to the storage and maintenance of data in one place; hardware/software integration, which refers to communication within a network of computers; and information integration, which refers to information exchange between different divisions in an organisation (Knudsen, 2020; Rom and Rohde, 2007).

Conceptually, public administration and SOEs in cities are one organisation: a city group. An IIS can integrate various SOE-related performance information, a feature which can support the management of public service delivery by both public administrations and SOEs (Pittaway and Montazemi, 2020). In terms of accountability, IISs can improve or broaden the forum and make it easier for principals to make enquiries of agents. Moreover, agents may be aware that principals have easy access to information for control purposes or decision-making, which may impact their thinking and behaviour. An IIS can fundamentally improve organisational processes and structures and therefore the decision-making culture of supervisory bodies or city council committees that control SOEs. In addition, an IIS can foster collaborative action and innovations between public administrations and SOEs within a city group. In the context of public administration and SOEs within connected cities, an IIS is a key component of digital transformation and accountability that has disruptive potential to overcome major challenges related to sustainable service provision and democracy.

According to the pertinent literature, digitisation is “the transition from analog to digital services with a 1:1 change in the delivery more and the addition of a technological channel of delivery” (Mergel *et al.*, 2019). Digitalisation means “potential changes in the processes beyond mere digitizing of existing processes and forms”, whereas digital transformation means “the cultural, organizational, and relational changes” (Mergel *et al.*, 2019; see also Knudsen, 2020) that digitalisation triggers. Implementing standard software or an IIS are both forms of digitalisation. If PIU is strengthened by an IIS, this would mark the transition to digital transformation because PIU implies relational and organisational changes. In this respect, PIU is a proxy for measuring digital transformation that also affects accountability and decision-making within administrative processes.

Conceptually, an IIS can reconfigure accountability and decision support by influencing PIU. That is, for the key decision-makers in the principal-agent relationship, an IIS provides relevant information via a customised interface. In the case of a city group, these decision-makers include public administrators who must process and analyse performance information, in addition to politicians who sit on SOE boards or parliamentary committees and need to directly access performance information, reports and analyses prepared by public administrators and SOEs. Through its provision of easily accessible, timely, accurate and comprehensive performance information, an IIS can optimise the flow and quality of information between agents and principals. This, in turn, should mitigate information asymmetries and promote the intended behaviour-control effects on PIU.

PIU is central to accountability and is especially relevant for SOEs (Lindermüller *et al.*, 2022; Saliterer and Korac, 2013) to make cities sustainable (Zeemering, 2017; Karppi and Vakkuri, 2020; Timeus *et al.*, 2020). With respect to SOEs, principals and agents can use performance information to assess or demonstrate SOEs’ performance and service provision (Cristofoli *et al.*, 2010; Klausen and Winsvold, 2021). In the public sector, performance is a multidimensional concept (Saliterer and Korac, 2013). Traditionally, it encompassed economic and social criteria, such as rentability, liquidity, diversity and equity, while ecological criteria have become a further benchmark of public-sector performance (Marrone *et al.*, 2020). However, sustainability introduces new information relevant to accountability that needs to be integrated into decision-making (Enticott and Walker, 2008). Decision-making and accountability overlap “since those interested in accountability would be interested in the decision-making processes of agents entrusted with resources” (Caruana and Farrugia, 2018, p. 1124).

The theoretical debates on the use of ecological, social and economic performance information and the use of non-financial and financial performance information are closely connected. Non-financial performance information relates to social and environmental issues, sustainability and corporate social responsibility (Monteduro and Allegrini, 2020). Ecological and social performance information can thus be summarised under the heading of “non-financial performance information”, while economic performance information can also be referred to as financial performance information. By differentiating between the performance information types along the three sustainability dimensions, this paper nuances the category of non-financial PIU as studied in previous research (Liguori *et al.*, 2012; Lindermüller *et al.*, 2022).

2.2 PCGCs as a framework for IISs and sustainability-oriented PIU

A context-appropriate framework is crucial for the design and use of IISs. It is often argued that a definition of roles and information requirements is required for the implementation of information systems (Granlund, 2011; Knudsen, 2020; Li and Chan, 2019; Pang *et al.*, 2014; Rom and Rohde, 2007; Wainwright and Waring, 2004). Studies note, however, that many cities still “lack clear frameworks prescribing how sustainability should be integrated into the practice of management” (Zeemering, 2017, p. 136) and “lack clear frameworks for integrating sustainability concerns into their regular decision-making processes” (Timeus *et al.*, 2020, p. 729).

This paper argues that PCGCs can fulfil this framework function for the design/functional requirements of IISs for public administrations and SOEs in a city group and can positively moderate the effects of the IIS on sustainability-oriented PIU. As outlined above, literature has not yet conceptualised this important moderating mechanism to foster and balance the effects of IISs in the context of digital transformation. In a city group comprising a public administration and several SOEs, PCGCs are a crucial concept that can cover all relevant governance fields (Expert Commission G-PCGM, 2022; Papenfuß and Wagner-Krechlok, 2023). In many countries, PCGCs are developed by governments and approved by the responsible political body (e.g. a city council). PCGCs are intended to summarise the basic characteristics of the public corporate governance system and address recurring governance questions, ambiguities and legal gaps. A PCGC condenses regulations for the management and supervision of SOEs and should contain recognised standards of responsible governance. It addresses the goals, responsibilities, duties, rights, instruments and processes of the public authority as shareholder, political bodies, public administration, boards, auditors and further actors for various areas (Papenfuß, 2023; Papenfuß and Wagner-Krechlok, 2023).

Although there are many similarities between the corporate governance of private-sector enterprises and SOEs, standard-setters emphasise the need for special public corporate governance codes for SOEs that appropriately consider the context of government ownership (Papenfuß and Wagner-Krechlok, 2023; Papenfuß, 2023; Expert Commission G-PCGM, 2022; OECD, 2015). Aspects of democratic legitimacy and processes of the control of parliaments and public administration must be taken into consideration. For example, the regulatory field owner must be completely different regarding the political bodies involved and many specific processes in the political-administrative system. In numerous other regulator fields, specific regulations are also required due to the constitutive public purpose of SOEs, the politicians who serve on SOE boards and the information processes of the administration (Papenfuß and Wagner-Krechlok, 2023; Expert Commission G-PCGM, 2022; OECD, 2015).

PCGCs can serve as a framework to guide the design of IISs in public administrations as decision-support and accountability systems regarding SOEs. In this sense, they can fulfil two basic functions. First, PCGCs can define how an IIS should be designed and implemented, what functional requirements it must fulfil and what information should be entered into the IIS (Granlund, 2011; Knudsen, 2020). This can be especially important if IIS are transferred from the private sector with a pronounced focus on economic performance information to public administrations in the context of SOEs and long-standing problems in the field of SOEs regarding a lack of non-financial performance information (Lindermüller *et al.*, 2022; Papenfuß, 2023; Troshani and Rowbottom, 2024). Second, PCGCs can clarify what type of performance information should be used in decision-making processes by certain actors, which makes the information requirement particularly visible, relevant for control and influential on the behaviour of the principals and agents who use the IIS (Papenfuß and Wagner-Krechlok, 2023; Papenfuß and Schmidt, 2023).

The design of an IIS and how PIU is used can theoretically be influenced by the governance standards of multiple regulatory fields of PCGCs, such as governance standards regarding control and reporting issues or accounting. Many governance standards in PCGCs are indirectly related to IT—to which actors look while designing and using an IIS—so they do not need to address IT directly to moderate the effects of an IIS. In addition, PCGCs often formulate goals regarding public purpose and environmental and social sustainability, which can also draw further attention to these issues.

There are many governance standards in PCGCs (Papenfuß and Wagner-Krechlok, 2023) and the German Public Corporate Governance-Modelcode (Expert Commission G-PCGM, 2022) that theoretically imply moderating effects on the design and use of IISs and the use of performance information. The following examples illustrate potential interactions.

High-quality PCGCs formulate standards such as “the government shall review regularly if it complies with the legal requirements for ownership of an enterprise”, “as owner, the

government sets the object/purpose of the enterprise”, “as owner, the government shall also define specific objectives for the enterprise” and “the responsible political body (e.g. parliament, local council, etc.) shall be regularly informed about matters relevant to the political monitoring of the objectives for the enterprise” (Papenfuß and Wagner-Krechlok, 2023). These types of standards imply a need to design an IIS in terms of these requirements and to integrate information into the IIS that is necessary for completing the required tasks. The political goal-setting and monitoring of objectives often also encompass ecological and social objectives and corresponding performance information. PCGCs can draw attention to these issues and can influence the design of IISs to include features and dashboards to monitor progress towards political goals. In addition, ecological and social performance information needs to be incorporated into the IIS and provided to the different actor groups. Consequently, IISs should provide reporting templates and corresponding interfaces for data entry and permit the definition of key performance indicators as well as recording progress and allowing for calculations and visualisation while achieving the highest possible degree of automation.

Another example of high-quality PCGCs are standards such as “the shareholdings management shall carry out regular monitoring of the objectives for the enterprise” and “the government shall provide the entity responsible for shareholdings management with adequate human and material resources” (Papenfuß and Wagner-Krechlok, 2023). Such governance standards are likely to affect the design and use of IISs in terms of how they use different types of performance information. In particular, the use of ecological and social performance information could be affected because the public authority delegates a public purpose as an objective to the enterprise, and such governance standards help ensure a focus on these issues.

High-quality PCGCs recommend that the management of an SOE set up an internal risk management system and report regularly on risks to the city (Papenfuß and Wagner-Krechlok, 2023). The city’s shareholdings management, in turn, should ensure that the reported risks are incorporated into an integrated view of public administration and SOEs. These recommendations call for an IIS which provides interfaces for recording risks and a standardised method for their assessment. The tasks of reporting and monitoring risks should be as automated as possible.

Another governance standard found in high-quality PCGCs is “the board keeps the shareholders informed during the financial year by means of interim reports, e.g. quarterly reports” (Papenfuß and Wagner-Krechlok, 2023). This standard again draws attention to the reporting to the public shareholder, who conceptually should be especially interested in ecological and social performance information. The reporting demand implies a need for an IIS to integrate different types of performance information and to also use non-financial information, which is crucial for the objectives of the shareholder.

A recommendation to prepare a business plan indicates that an IIS needs to allow for preparation and decision-making by facilitating the input of the necessary data, coordination of the workflow process and the provision of user interfaces with direct access options for the members of SOE boards. Moreover, there are several governance standards in high-quality PCGCs that relate to diversity issues, such as the representation of women in leadership positions, which points towards a need for social performance information to be captured in an IIS.

There are various sustainability frameworks, such as the United Nations’ sustainable development goals (SDGs), triple bottom line (TBL), environmental, social and governance (ESG) criteria, planetary boundaries, corporate social responsibility (CSR) and the global reporting initiative (GRI) standards or sustainability codes. All of these frameworks have their strengths, but they cannot be sufficiently precise to provide a framework for public administration IISs in the specific context of a given city with the different actors, working structures and information processes of SOEs. Moreover, these overarching sustainability frameworks lack effective anchoring in the rules-based system of public administrations and SOEs that exists to ensure the application of the standards by the shareholdings management of

public administrations, the boards of SOEs and in terms of the provision of information by SOEs for integration into an IIS (Zeemering, 2017).

PCGCs can support the functioning of the overarching frameworks and sustainability goals as they can point to individual crucial requirements for sustainability and the sustainability-oriented PIU that actors review while using the IIS. Furthermore, PCGCs can provide necessary impulses for the sustainability-oriented design of IISs in terms of their features and dashboards and the performance information that is integrated into an IIS for all of the sustainability dimensions. PCGCs can condense the central governance standards for economic, ecological and social sustainability and are a useful starting point from which to discuss which standards and performance information are crucial for incorporating sustainability into the “DNA” of the shareholdings management of cities and SOE boards.

2.3 Hypothesis development

To develop its hypotheses, this paper uses agency theory, which is “the dominant theoretical framework associated with performance management” (Moynihan *et al.*, 2012, p. 464; see also Raudla, 2012) and accountability (Bovens *et al.*, 2014; Brennan and Solomon, 2008; Schillemans *et al.*, 2020). Between cities and their SOEs, a multilevel chain of principal-agent relationships exists (Ennser-Jedenastik, 2014; Voorn *et al.*, 2019). Along this chain, the supervision and control of SOEs are delegated from citizens to politicians and further to public administrators (Ennser-Jedenastik, 2014). Every principal-agent relationship involves the risk of information asymmetries and opportunistic behaviour (Moynihan *et al.*, 2012; Voorn *et al.*, 2019) which the agents can exploit to pursue their own interests instead of their principals’ interests. Performance management allows cities to collect information about the activities of their SOEs which they can use to steer and monitor SOEs and, thus, increase their accountability (Voorn *et al.*, 2019; Papenfuß, 2023). Consequently, the use of ecological, social and economic performance information is a means of increasing SOEs’ accountability for sustainability. Given that politicians and public administrators represent cities on the boards of their SOEs (Voorn *et al.*, 2019), it is especially enriching to enhance the understanding of their PIU.

As outlined, it is important to investigate the use of different types of performance information, given that sustainability is a multidimensional concept. SOEs have heterogeneous and often ambiguous performance targets which can be both non-financial and financial (Lindermüller *et al.*, 2022). SOEs’ financial accountability relates to financial goals and figures. Non-financial accountability, on the other hand, consists of delivering results concerning the public purpose (Monteduro and Allegrini, 2020). The focus of politicians and public administrators as principals is likely to be on financial accountability because the funding of SOEs largely depends on public resources (Ruggiero *et al.*, 2021). This assumption has been supported by empirical research showing that in decisions on the allocation of budgetary resources to SOEs, non-financial performance information receives much less attention than financial performance information (Lindermüller *et al.*, 2022; van Genugten *et al.*, 2023). Therefore, to develop a more nuanced theoretical understanding of PIU, this paper differentiates between the use of ecological, social and economic performance information. It follows from the reasoning above that evaluation of SOEs’ economic performance information is generally likely to be more common than evaluation of their ecological and social performance information.

Against this background, it is important to better understand how a balanced use of ecological, social and economic performance information can be achieved to fully account for the sustainability of SOEs (Giacomini *et al.*, 2020; Ruiz-Lozano *et al.*, 2022; Papenfuß, 2023; van Genugten *et al.*, 2023). Considering the cultural, organisational and relational changes as well as potentially adverse effects IISs can have on accountability (Grossi *et al.*, 2022), it is paramount to distinguish the effects of IISs on the use of SOEs’ ecological, social and economic performance information.

From the perspective of agency theory, IISs can reduce information asymmetries between principals and agents by providing easy access to information and user-oriented information processing. The literature shows easy access as a main driver of PIU (Kroll, 2015). Moreover, IISs can safeguard against the manipulation of performance information and improve its reliability. That is, being self-interested and opportunistic, agents may manipulate performance information to help them increase rewards and avoid punishments from their contracts (Anessi-Pessina and Sicilia, 2020; Moynihan *et al.*, 2012). Consequently, principals may refrain from using the performance information provided by agents because they do not trust it (Demaj and Summermatter, 2012; Raudla, 2012). By providing direct and timely access to performance information and enabling its automated processing (Rom and Rohde, 2007), IISs can be expected to improve information availability and increase the principals' trust in SOEs' performance information, which is thus likely to be used more frequently.

However, the way IISs are designed and affect the principal-agent interaction may not promote the use of ecological, social and economic performance information in a balanced manner. IT-supported decision-support and accountability systems in the public sector, such as IISs, are often adopted from the private sector and usually designed in line with the interests of their users (Knudsen, 2020; Rom and Rohde, 2007). IISs in the private sector tend to focus on financial performance information, which is easier to measure than non-financial performance information (Troshani and Rowbottom, 2024; Knudsen, 2020; Korsen and Ingvaldsen, 2022). In addition, users' interests often align primarily with economic performance information when it concerns SOEs; indeed, when the financial resources of cities are scarce, SOEs' economic performance information receives even more attention (Lindermüller *et al.*, 2022; Papenfuß, 2023). These issues could lead to a customisation and implementation of IISs for public administrations that systematically promote the use of economic performance information to evaluate SOEs at the expense of social and ecological performance information.

Furthermore, economic information ratios are often readily available for SOEs because they are easier to collect and measure than non-financial information. Moreover, politicians and public administrations sometimes strive for money for the public budget and financial distributions from the SOEs. A one-sided focus on financial information is therefore a traditional challenge to accountability and control in the context of SOEs (van Genugten *et al.*, 2023; Lindermüller *et al.*, 2022; Papenfuß, 2020, 2023). Conceptually, ecological and social performance information should play a special role in the public sector, and governments and administration are ascribed a "role model function" in the societal debate. However, as shown in many empirical studies (van Genugten *et al.*, 2023; Papenfuß, 2023), public authorities often do not meet the requirements and crucial areas, and the goals formulated by politicians are often not realised. There is a risk and potential "dark side" of IISs in that ecological and social PIU may not be imported into an IIS to a comparable degree as economic PIU. As a result, only economic PIU is easily accessible. Thus, IISs reinforce the use of economic performance information at the expense of ecological and social PIU, thereby reinforcing a structural problem with one-sided economic PIU. From the perspective of principal-agent theory, the emphasis on SOEs' economic performance information could incentivise principals and agents, who strive for utility maximisation (Moynihan *et al.*, 2012; Voorn *et al.*, 2019), to prioritise its use in comparison to ecological and social performance information. This leads to the following hypotheses.

- H1a.* IISs are not positively associated with a higher use of ecological performance information.
- H1b.* IISs are not positively associated with a higher use of social performance information.
- H1c.* IISs are positively associated with a higher use of economic performance information.

As already argued and explained in detail in [Section 2.2](#) above, PCGCs can function as a framework for IISs and positively moderate the effect of IISs on sustainability-oriented PIU. However, to fulfil this strengthening function for economic, ecological and social PIU, the quality of the PCGCs is likely to play a key role. In many decentralised countries, the principles of subsidiarity and local autonomy play an important role. As a result, local, state and federal governments have established different PCGCs of diverging quality ([Papenfuß and Wagner-Krechlok, 2023](#); [Papenfuß, 2023](#)). From the perspective of agency theory, PCGCs can concretise incomplete contracts between principals and agents. Precisely and comprehensively phrased PCGCs can strongly influence how politicians and public administrators use an IIS. Empirical research conducted in other contexts for various issues has shown that the quality of PCGCs is a decisive factor ([Papenfuß and Schmidt, 2021](#)). Quality is crucial for defining how an IIS should be designed and implemented, what functional requirements it must fulfil and what information should be entered into it. In addition, only high-quality PCGCs can make clear what type of performance information should be used in decision-making processes and by what actors, which makes the information requirement additionally visible. High-quality PCGCs strengthen the behaviour control on the principals and agents as they work with the IIS.

In terms of ensuring accountability, PCGCs can improve or broaden the forum and make it easier for the principals to ask questions of the agents. Conceptually, one would assume a positive moderation of PCGC quality on IISs regarding economic, ecological and social PIU because the goal of PCGCs theoretically is to foster the use of all types of performance information in a balanced manner for all dimensions of sustainability. Aside from assessing the typical economic information on SOEs, the goal of PCGCs is to especially address the environmental and social issues which could encounter the potential one-sided effects of an IIS. [Section 2.2](#) outlined examples of governance standards within PCGCs that actors can review while designing and using an IIS. It also explained the mechanisms how this affects their consciousness and behaviour. With a PCGC as a framework of lower quality, the design, dashboards and features of an IIS play a more important role in daily life for PIU compared to a situation with a high-quality PCGC. PCGC quality is decisive in addressing the typical agency problems that can arise in the context of IISs and PIU ([Voorn et al., 2019](#)). PCGC quality is likely to affect how unintended behaviour and the reluctance to use performance information are observed, assessed and addressed ([Papenfuß and Schmidt, 2021](#)). This reasoning leads to the following hypotheses.

- H2a.* The quality of PCGCs as a framework for IISs and sustainability-oriented PIU strengthens the effects of IISs on the use of ecological performance information.
- H2b.* The quality of PCGCs as a framework for IISs and sustainability-oriented PIU strengthens the effects of IISs on the use of social performance information.
- H2c.* The quality of PCGCs as a framework for IISs and sustainability-oriented PIU strengthens the effects of IISs on the use of economic performance information.

3. Empirical design

3.1 Methodology and data collection

The paper uses a triangulation approach to avoid common method bias. It draws on data collected during an online survey, which was carried out in March and April 2021 and sent via email to mayors, heads of shareholdings management, heads of audit authorities and chairpersons of political fractions in the city councils of cities with at least 30,000 inhabitants in Germany. All of these functions fulfil key roles in the public corporate governance of SOEs ([Expert Commission G-PCGM, 2022](#); [OECD, 2015](#)).

The first step in preparing the online survey involved identifying the individual functions for each of the 393 cities in the sample via the websites of the cities and the political parties before collecting names and email addresses. In cases where the shareholdings administrator could not be identified, the chief financial administrator was contacted instead, whose professional work also involves the use of performance information on SOEs in the preparation of city budgets, financial statements and accounting reports. Concerning the chairpersons of city council fractions, only those of the political parties also represented in the German Bundestag were considered.

The second step in preparing the online survey involved sending the survey, which was successfully delivered to 2,917 email addresses. A total of 337 respondents completed the survey, which corresponds to a response rate of 11.6%. Considering the time restraints of the high-level target group and other published studies with similar target groups (Allegrini *et al.*, 2022; Korac *et al.*, 2020; Liguori *et al.*, 2012; Nitzl *et al.*, 2019), 337 responses provide a meaningful dataset for the research question and intended contributions of this paper. To check for nonresponse bias (Korac *et al.*, 2020), a chi-square test on the individual (gender) and organisational characteristics (PCGC existence) of the respondents was conducted.

The chi-square test shows that the respondents and nonrespondents do not differ in terms of gender ($X^2(1) = 0.02, p = 0.877$) or in terms of the existence of PCGCs in their cities ($X^2(1) = 2.93, p = 0.087$). Table 1 provides a summary of the respondents' profiles.

Thirdly, data were obtained through interviews with experts and shareholdings administrators to determine the status of IT diffusion in the shareholdings management of German city administrations in March and April 2022. To ensure inter-interviewer reliability, a structured interview guide was used (Mergel *et al.*, 2019) with the categories of specialised or self-developed shareholdings management software (IIS), standard software (e.g. Excel) for shareholdings management or paper-based shareholdings management. Because the data from these online and telephone surveys were self-reported, positivity bias may be an issue. To mitigate the possible effects of social desirability, the questions were formulated in a style conducive to honesty, and the respondents were assured that their data would be analysed confidentially and anonymously.

Fourth, data were obtained through a content analysis of the PCGCs of German cities that were in force at the time of the online survey in 2021 and that were accessible via the cities' websites. Table 2 provides the results of the content analysis of the PCGCs.

The following subsection outlines how the variables included in the model were operationalised.

Table 1. Profile of the respondents of the online survey

<i>Individual characteristics</i>			
Profession	Public administrators	128	38%
	Politician	209	62%
Age	Average	55	–
Gender	Male	259	77%
	Female	76	23%
<i>Organisational characteristics</i>			
IT	Integrated information system (IIS) for shareholdings management	64	19%
	Standard software (e.g. Excel) for shareholdings management	175	52%
	Paper-based shareholdings management	98	29%
PCGC existence	Yes	50	15%
	No	287	85%

Source(s): Authors' own creation/work

Table 2. Quality of PCGCs

	<i>N</i>	Min	Max	<i>M</i>	<i>SD</i>
PCGC quality overall	337	0	93	7.52	18.86

Source(s): Authors' own creation/work

3.2 Operationalisation of variables

The dependent variables of ecological, social and economic PIU are measured using two-item measures each. The respondents to the online survey were asked whether performance indicators related to energy, emissions (ecological), employment, diversity, equal opportunity (social), and liquidity and asset ratios (economic) are used in their organisational contexts. All of these indicators are taken from the GRI reporting standards (Global Reporting Initiative, 2021), which is the most widely used standard for sustainability reporting in both the public and nonprofit sectors (Dumay et al., 2010). The items used to measure the dependent variables are based on a 5-point Likert scale ranging from 1 = totally disagree to 5 = totally agree.

The independent variable *IT* is equal to 2 if an IIS was used in the shareholdings management of a city, which is the case for cities that use specialised and self-developed shareholdings management software. It is equal to 1 if standard software (e.g. Excel) is used for shareholdings management. Finally, the independent variable *IT* is equal to 0 if the shareholdings management is conducted based on paper record-keeping.

The moderator variable *PCGC quality* is measured using a measurement framework (Papenfuß and Wagner-Krechlok, 2023) to assess the influence of PCGCs on the dependent variables. The variable can take a value between 0 and 150. Using this measure is a particular strength because it allows for a more nuanced analysis of the effects of PCGCs than by measuring their existence alone. The variable *PCGC quality* is coded 0 if the city does not have a PCGC in place. To test the idea of a PCCG as a framework and moderator of the effects of an IIS on the different types of performance information, it is important and logical to use a measurement approach and variable which is applicable to all three types of PIU addressed in the paper to provide comparable results for the information types. To take account of the design and rules of PCGCs of public administrations at the time of the investigation, the measurement framework has only a single criterion directly related to ecological sustainability. The measurement framework reflects the reality of the PCGCs very precisely, and there were no important rules in the PCGCs which were not measured by the measurement framework. To conduct an empirical test of the conceptual idea, it is not an obstacle if the criteria do not relate specifically to one sustainability dimension or another, particularly because it can be difficult to clearly determine if a criterion belongs more to one dimension than another. The overall quality of a PCGC is a very good indicator for testing the conceptual framework idea with an overall view of the measurement framework.

The model includes five control variables, most of which were used in previous empirical research on PIU. The analysis considers *age*, *gender* and *individual capabilities* (Dimitrijevska-Markoski and French, 2019; Korac et al., 2020; Kroll, 2015). *Individual capabilities* are measured using a 5-item measure that reflects individual factors that are likely or have been shown to influence PIU, "including technical knowledge, skills, training, experience, . . . and personal buy-in" (Dimitrijevska-Markoski and French, 2019, p. 702).

In addition, the model includes *technology acceptance* and *profession* as control variables. *Technology acceptance* is measured using an 8-item measure of the perceived ease of use and perceived usefulness of software and was previously validated in empirical research (Schmidhuber et al., 2020). *Profession* is a binary-coded variable equal to 1 if the respondent was a public administrator, that is, if they fulfil the function of head of shareholdings management, chief financial administrator or head of an audit authority. The variable is equal

to 0 if the respondent is a politician, that is, if they fulfil the function of mayor or chairperson of a political fraction in the city council.

To test the measures for the dependent and control variables and confirm the reliability of the items included, Cronbach's alpha is used (Black *et al.*, 2017). Values for Cronbach's alpha "above 0.7 are considered strong, and values above 0.6 are respectable" (Black *et al.*, 2017, p. 402). Cronbach's alpha for the five measures is above the threshold level of 0.6. The measures used in the survey are provided in Table 3, which also shows the descriptive statistics and results of the scale reliability analysis of each measure.

4. Empirical results

PIU differs in terms of the three sustainability dimensions. Overall, the use of economic performance information is the highest ($M = 3.67$, $SD = 1.21$), the use of ecological performance information the second highest ($M = 2.91$, $SD = 1.21$) and the use of social performance information the lowest ($M = 2.73$, $SD = 1.16$). Table 4 reports the descriptive statistics for the dependent variables and the control variables.

OLS multiple regression models are used to test the hypotheses. To account for the fact that some respondents to the online survey come from the same cities—the average number of respondents per city is 1.32—clustered standard errors with weighted clusters are used. Models 1–3 show the main effects of the independent variable *IT* on the three dependent variables, while models 4–6 show the interaction between *IT* and *PCGC quality*. Tables 5 and 6 report the results of the regression analyses.

Model 3 shows a significant positive effect of IISs on the use of economic performance information ($p = 0.019$), and model 1 on the use of ecological performance information ($p = 0.077$), while model 2 does not show significant effects of IISs on the use of social performance information. Models 1–3 also show a significant positive effect of individual capabilities on all three dependent variables ($p < 0.001$). Moreover, there is a significant negative effect of profession on the use of ecological performance information ($p < 0.001$), while its effect on the use of economic performance is positive ($p = 0.023$).

Furthermore, there is a significant negative effect of *PCGC quality* on the use of economic performance information ($p = 0.068$). There are also significant positive effects of standard software on the use of ecological performance information ($p = 0.030$) and of gender on the use of social performance information ($p = 0.015$). Finally, model 5 shows a significant positive effect of the interaction between IISs and *PCGC quality* on the use of social performance information ($p = 0.001$). There is also a significant interaction between standard software and *PCGC quality* ($p < 0.001$).

5. Discussion and perspectives for future research

Overall, the findings imply that principals and agents in the multiple principal-agent chain use economic, ecological and social performance information very differently. In the context of the study, the use of economic (financial) performance information is more frequent than the use of non-financial (i.e. ecological and social) performance information, which differs from the findings of other studies regarding the use of financial and non-financial information (Liguori *et al.*, 2012; Lindermüller *et al.*, 2022). To a certain extent, this can be seen as a severe problem because SOEs have a dual goal system with a public service provision goal that is only measurable with non-financial data and economic/financial goals. The findings indicate that IISs affect digital transformation in terms of relational, organisational and cultural changes as it relates to PIU.

The findings do not support Hypothesis 1a, but they do support Hypotheses 1b and 1c by showing that IISs are positively associated with a more frequent use of economic and ecological performance information relative to SOEs. The slightly significant effect of IISs on ecological PIU indicates, contrary to expectations, that ecological performance information is

Table 3. Survey items and results of scale reliability analysis

		Min	Max	M	SD	Cronbach's α
<i>Dependent variable: ecological PIU</i>						
	In my organisational context, performance information on ... is used					
ECOL1	Energy, e.g. electricity consumption, reductions in energy consumption	1	5	3.13	1.39	
ECOL2	GHG emissions, e.g. direct/indirect GHG emissions, reduction of GHG emissions	1	5	2.49	1.27	
Total						0.787
<i>Dependent variable: social PIU</i>						
	In my organisational context, performance information on ... is used					
SOCI1	Employment, e.g. employee turnover, benefits provided for employees (e.g. retirement provision, stock ownership)	1	5	2.60	1.22	
SOCI2	Diversity and equal opportunity, e.g. percentage of women in leadership positions, ratio of remuneration of women to men	1	5	2.62	1.34	
Total						0.692
<i>Dependent variable: economic PIU</i>						
	In my organisational context, performance information on ... is used					
ECON1	Liquidity, e.g. 1st degree liquidity, 2nd degree liquidity	1	5	3.57	1.33	
ECON2	Asset ratios, e.g. investment ratio, depreciation ratio	1	5	3.77	1.27	
Total						0.830
<i>Control variable: individual capabilities</i>						
CAP1	I have adequate technical knowledge to use performance information	1	5	3.39	1.15	
CAP2	I have the necessary skills to interpret performance information	1	5	3.67	1.15	
CAP3	I have sufficient training on how to use performance information	1	5	3.13	1.25	
CAP4	I have sufficient work experience to use performance information	1	5	3.55	1.18	
CAP5	I support the use of performance information in decision-making in my area of responsibility	1	5	3.44	1.18	
Total						0.935
<i>Control variable: technology acceptance</i>						
PUS1	Using software improves the course of my daily work	1	7	5.80	1.30	
PUS2	Using software in my daily work increases my productivity	1	7	5.79	1.37	
PUS3	Using software enhances the effectiveness of my daily work	1	7	5.86	1.30	
PUS4	I find software to be useful in my daily work	1	7	6.07	1.22	
PEU1	The use of software is easy and understandable	1	7	4.99	1.36	
PEU2	The use of software is not difficult for me	1	7	5.46	1.43	
PEU3	I find software to be easy to use	1	7	5.50	1.39	
PEU4	I find it easy to get software to do what I want it to do	1	7	5.09	1.45	
Total						0.932
Note(s): The items are retranslated from the German questionnaire						
Source(s): Authors' own creation/work						

Table 4. Descriptive statistics for dependent and control variables

	<i>N</i>	Min	Max	<i>M</i>	<i>SD</i>
<i>Dependent variables</i>					
Ecological performance information use	287	–	–	2.91	1.21
Social performance information use	289	–	–	2.73	1.16
Economic performance information use	301	–	–	3.67	1.21
<i>Control variables</i>					
Individual capabilities	331	1.0	5.0	3.44	1.06
Technology acceptance	333	1.5	7.0	5.55	1.13

Source(s): Authors' own creation/work**Table 5.** Results linear regressions (models 1–3)

	DV: ecological performance information use	DV: social performance information use	DV: economic performance information use
<i>Independent variable</i>			
<i>IT</i>			
Integrated information system (IIS) for shareholdings management	0.429 ^a (0.241)	–0.089 (0.224)	0.625* (0.264)
Standard software (e.g. Excel) for shareholdings management	0.406* (0.186)	–0.062 (0.166)	0.090 (0.174)
Paper-based shareholdings management	RC	RC	RC
<i>Control variables</i>			
PCGC quality	–0.004 (0.005)	–0.001 (0.004)	–0.006 ^a (0.003)
<i>Profession</i>			
Public administrators	–0.627*** (0.180)	–0.226 (0.152)	0.313* (0.137)
Politician	RC	RC	RC
Individual capabilities	0.290*** (0.069)	0.354*** (0.071)	0.500*** (0.081)
Technology acceptance	0.031 (0.066)	0.049 (0.064)	0.074 (0.060)
Age	–0.006 (0.007)	–0.009 (0.006)	–0.007 (0.006)
Gender	0.173 (0.204)	0.508* (0.206)	0.016 (0.149)
<i>N</i>	272	276	284
<i>R</i> ²	0.138	0.130	0.247
<i>F</i>	5.182	6.623	10.546
Significance	<0.001	<0.001	<0.001

Note(s): ^a<0.1. **p* < 0.05. ***p* < 0.01. ****p* < 0.001. Standard error in parentheses**Source(s):** Authors' own creation/work

also integrated into IISs and promoted by certain features. This is in line with current findings in the literature on how information infrastructure can affect sustainability reporting (Troshani and Rowbottom, 2024). Going beyond, according to the results in this study, IISs also influence the behaviour and awareness of agents and principals in single sustainability dimensions of PIU and accountability. This influence is crucial with regard to the criticised weak PIU in the literature, especially by politicians (Caruana and Farrugia, 2018; Budding and van Helden, 2022; Desmidt and Meyfroot, 2024; van Helden, 2016; Korac *et al.*, 2020). IISs with adequate design and user-oriented information processing can be promising for mitigating typical agency problems in the context of PIU (van Helden, 2016; Allegrini *et al.*, 2022; Voorn *et al.*, 2019; Troshani and Rowbottom, 2024), and IISs can especially help

Table 6. Results moderated regressions (model 4–6)

	DV: ecological performance information use	DV: social performance information use	DV: economic performance information use
<i>Independent variable</i>			
<i>IT</i>			
Integrated information system (IIS) for shareholdings management	0.588* (0.252)	–0.242 (0.228)	0.724* (0.338)
Standard software (e.g. Excel) for shareholdings management	0.377* (0.190)	–0.164 (0.170)	0.075 (0.182)
Paper-based shareholdings management	RC	RC	RC
IIS * PCGC quality	–0.004 (0.012)	0.024** (0.007)	0.007 (0.011)
Standard software * PCGC quality	0.007 (0.011)	0.020*** (0.005)	0.003 (0.008)
<i>Control variables</i>			
PCGC quality	–0.007 (0.011)	–0.020 (0.005)	–0.003 (0.008)
<i>Profession</i>			
Public administrator	–0.623*** (0.182)	–0.192 (0.148)	0.314* (0.136)
Politician	RC	RC	RC
Individual capabilities	0.285*** (0.068)	0.367*** (0.069)	0.495*** (0.081)
Technology acceptance	0.048 (0.068)	0.048 (0.062)	0.083 (0.059)
Age	–0.007 (0.007)	–0.010 ^a (0.006)	–0.007 (0.006)
Gender	0.166 (0.205)	0.501* (0.205)	0.006 (0.150)
<i>N</i>	272	276	284
<i>R</i> ²	0.144	0.148	0.249
<i>F</i>	4.154	6.640	8.225
Significance	<0.001	<0.001	<0.001
Note(s): ^a <0.1. * <i>p</i> < 0.05. ** <i>p</i> < 0.01. *** <i>p</i> < 0.001. Standard error in parentheses			
Source(s): Authors' own creation/work			

politicians with direct access to IISs and dashboards to use performance information if they have little time and lack sound qualifications to interpret and analyse PIU.

However, the insignificant relationship between IISs and social PIU also indicates an unaccounted and potentially “dark side” of digital transformation. IISs do not seem to influence the awareness and behaviour of principals and agents in a balanced manner. This is important in recent debates on smart cities and propositions “to locate sustainability as an outcome of smartness” (Grossi and Welinder, 2024, p. 2012). The identified imbalance in fostering PIU with regard to social sustainability is not in line with the multidimensional understanding of accountability for sustainability (Argento *et al.*, 2020; Grossi *et al.*, 2020; United Nations, 2021). In some cases, IISs could even reinforce the neglect of non-financial performance information if an IIS predominantly draws attention to financial information. As Beyes *et al.* put it: “Technology organizes and is organized” (Beyes *et al.*, 2022, p. 1004).

The findings imply a need to more clearly differentiate between the performance information types with regard to all of the sustainability dimensions to develop a more nuanced theoretical understanding of the effects of digital transformation on accountability for sustainability (Grossi *et al.*, 2024; Caruana and Farrugia, 2018; Karunakaran *et al.*, 2022; van Helden *et al.*, 2016).

Another implication for the research debate on IISs and digital transformation (Troshani and Rowbottom, 2024; Agostino *et al.*, 2022; Grossi *et al.*, 2022; Korsen and Ingvaldsen, 2022; Vial, 2019) is the need to better understand the accompanying frameworks to compensate for the potentially one-sided effects of IISs and similar technological innovations

in the social sustainability dimension and to increase the transformative chances of such systems.

Regarding [Hypotheses 2a](#), [2b](#) and [2c](#), the findings support [Hypothesis 2b](#) with respect to the moderation effect of PCGCs on IISs relative to social PIU, whereas they do not support [Hypotheses 2a](#) and [2c](#). This points to the potential of PCGCs to influence the behaviour of principals and agents while using IISs to mitigate the challenges stressed by agency theory ([Papenfuß and Schmidt, 2021](#)) and the ability of frameworks to influence the effects of IISs on digital transformation ([Knudsen, 2020](#); [Pittaway and Montazemi, 2020](#); [Rom and Rohde, 2007](#); [Vial, 2019](#)).

PCGCs of high quality can have the potential to fulfil an accompanying framework function for IISs and sustainability-oriented PIU. This finding enriches the debates on self-regulation with PCGCs ([Papenfuß and Schmidt, 2021](#); [Papenfuß and Wagner-Krechlok, 2023](#); [Aragón-Correa et al., 2020](#)), on PIU ([Caruana and Farrugia, 2018](#); [Demaj and Summermatter, 2012](#); [Korac et al., 2020](#); [Raudla, 2012](#); [Saliterer and Korac, 2013](#); [van Helden et al., 2016](#)) and on IISs ([Granlund, 2011](#); [Knudsen, 2020](#); [Wainwright and Waring, 2004](#)). Especially, in upcoming debates on smart city governance and its multiple dimensions ([Grossi and Welinder, 2024](#)), PCGCs can play a crucial role.

A possible explanation as to why the interaction between PCGCs and IISs affects only the use of social performance information could be that there remains considerable room for improvement in the quality of existing PCGCs in German cities ([Papenfuß and Wagner-Krechlok, 2023](#); [Papenfuß, 2023](#)). Although most PCGCs formulate the goal of promoting the sustainability of SOEs, few contain governance standards that concretise this goal with regard to ecological performance information. In comparison, governance standards on diversity and related social performance information are already far more widely diffused ([Papenfuß and Wagner-Krechlok, 2023](#)). Overall, the findings are plausible regarding the data and the status quo of PCGCs. To achieve the intended behaviour-control and framework effects of PCGCs on IISs, principals need to pay more attention to the quality of PCGC recommendations ([Papenfuß and Schmidt, 2021](#)). Of course, if PCGCs draw attention to certain information, such as economic performance information, then attention and time allocated to other information can also be impaired. Therefore, PCGCs, like nearly all concepts and instruments, can also have detrimental effects on individual dimensions of PIU if they are inadequately designed and used.

With regard to research gaps and prevailing debates, the core of this paper is the use of different information types, whereas other papers in the context of PIU focus on single aspects of the debate. Nevertheless, further statistical assessments regarding the purpose of information use with dependent variables for purposeful and legitimising PIU ([Korac et al., 2020](#); [Saliterer and Korac, 2013](#)) were made. Here the analysis shows a significant positive association of IISs and purposeful PIU on a 5% significance level but no significant association between IISs and legitimising PIU. This seems to indicate that IISs influence purposeful PIU more strongly than legitimising PIU. For the moderation effect of PCGC quality, the supplemental model shows a significant positive association of the interaction between IISs and PCGC quality on both purposeful and legitimising PIU. Regarding the conceptual idea of this paper, this additionally indicates that PCGCs can serve as a framework for IISs to integrate PIU.

The findings also yield important insights for relevant control variables. In terms of the individual capabilities of the survey respondents, the findings reveal a significant positive association with economic, ecological and social performance information. This association highlights the need to develop capabilities ([Kroll, 2015](#)) and training measures related to IISs ([Troshani and Rowbottom, 2024](#)) if the use of all types of performance information was to be increased. In contrast to politicians, public administrators are significantly negatively associated with ecological and social PIU, while the association with economic PIU is positive. This indicates that politicians' and public administrators' views on the relevance of performance information are different, which calls for further research. In the agency theory

debate on accountability (Schillemans *et al.*, 2020; Bovens, 2007; van Helden, 2016; Budding and van Helden, 2022; Korac *et al.*, 2020) it implies severe challenges for policymaking and control if principals and agents prioritise different types of performance information and sustainability dimensions. Regarding politicians, it would be especially important to better understand their rationales and the purposes of their information use in different organisational contexts and to explore their implications. Regarding prevailing debates, research could investigate mechanisms to facilitate a balanced use by politicians of performance information regarding all of the sustainability dimensions (van Helden, 2016; Budding and van Helden, 2022). Future research should also seek insights into the boundaries and behaviour differences between public administrators and politicians (Budding and van Helden, 2022; Desmidt and Meyfroodt, 2024; Grossi *et al.*, 2016; van Helden, 2016).

Moreover, there is a significant positive association of the female gender with the use of social performance information. This highly relevant finding draws greater attention to the gendered nature of PIU. From a theoretical perspective, the characteristics of principals and agents play a key role for PIU (Dimitrijevska-Markoski and French, 2019).

In addition to the quantitative core findings, in the interviews the participants mentioned that information that is easily available and adapted to the target group via dashboards or similar features without the need for great time expenditure is particularly important. Amongst other reasons, they explained that the qualifications and prior knowledge of public administrators and politicians on SOE boards or political bodies relative to interpreting performance information and performance management vary greatly, especially in this context. As in other areas, the respondents perceived clear legal regulations and guidelines as very important in the administrative context as some actors seem to only do what the rules clearly state or guide. According to these exploratory findings, the use of and demand for information on SOEs increases when a so-called scandal brings SOEs into broader public discussions or when topics relating to the services or prices of SOEs are discussed in a city, all of which are of interest to larger groups of citizens.

For practitioners and policymakers, the study indicates some suggestions as to how PCGCs can be enhanced. For example, PCGCs can better address the responsibilities of the public administrators, the directors on boards and the external auditors to promote accountability for all of the sustainability dimensions (see also Section 2.2). To integrate sustainability into the practice of management as demanded in the literature (Zeemering, 2017), PCGCs can recommend governance standards or point to reporting requirements that are in line with policy initiatives on non-financial reporting (European Commission, 2021; Directive, 2014/95/EU; Regulation, 2023/2772) to create the necessary condensed overview of crucial governance requirements and to apply governance standards to various legal forms of SOEs. As regards shareholdings management by the city administrations and the boards of SOEs, their strategy formulation and implementation responsibilities should include monitoring all of the sustainability dimensions, the inclusion of non-financial and financial performance targets in their plans and the consideration of sustainability risks (Government Commission GCGC, 2022; Papenfuß, 2023). To support the directors on boards in executing this responsibility, PCGCs should incorporate governance standards that increase their sustainability expertise. This could be achieved by requiring the directors on boards to form a sustainability committee or delegate the auditing and monitoring of sustainability reports and underlying information systems to their audit committees, which should expand the mandate of external auditors to also cover sustainability reports.

Like all empirical studies, the paper has some limitations. First, by analysing the interaction between IISs and PCGCs, the paper does not consider other organisational, contextual and individual factors that may influence the effects of IISs on the use of performance information (Steccolini *et al.*, 2020). Future research could investigate additional factors. Second, the paper draws on data from cities with at least 30,000 inhabitants, thus neglecting local governments under this size threshold. Consequently, the generalisability of the findings, especially to

countries where most local governments are smaller (Saliterer and Korac, 2013) should be reflected. This also applies to the third limitation of being a single-country study. Future research could analyse the use of ecological, social and economic performance information in other organisational, legal and administrative contexts or comparatively.

As derived from the conceptual reasoning and the empirical findings of the paper, there are several further rewarding research perspectives regarding accountability with IISs and the effects of digital transformation in the important and theoretically fruitful context of public administration and SOEs in connected cities. The context of IISs in public administrations with user groups in the political arena, public administration and SOEs is extraordinarily fruitful for investigating the PIU of different user groups, for instance in the debate on smart cities (Grossi and Welinder, 2024). It is important to better understand how IISs can strengthen accountability and digital transformation in terms of all of the information types that are important for sustainability and sustainable solutions (Troshani and Rowbottom, 2024; Liguori *et al.*, 2012; Lindermüller *et al.*, 2022) and PIU in general (Korac *et al.*, 2020) as well as the interplay of these factors with artificial intelligence (Bankins *et al.*, 2024).

In addition to the type of performance information that is used, it is important to enhance the knowledge of the effects of IISs and digital transformation in the debate on the purposes of PIU (Kroll, 2015; van Helden, 2016; Korac *et al.*, 2020). For which purpose and why actors utilise PIU stays very fruitful for the future debate on accountability and digital transformation (Moynihan and Pandey, 2010; Micheli and Pavlov, 2020; Korac *et al.*, 2020; Henk *et al.*, 2024; Troshani and Rowbottom, 2024). Moreover, it must be better understood under what conditions frameworks are needed to counterbalance the unintended effects of digital transformation. In this sense, research should investigate the interplay between IISs and such frameworks more closely to increase the knowledge of sustainable solutions (Troshani and Rowbottom, 2024).

Finally, the findings underline the need to investigate how technological innovations like IISs can contribute to better connect cities and SOEs to bridge the accountability gaps between them and allow for a concerted effort—including knowledge-sharing, collaborative learning and the implementing of measures—towards sustainable development. From an overarching perspective, IISs could be “institutions of public-sector change” (Moynihan, 2022) in this critical accountability context. IISs have a high transformative potential, but research needs to understand the crucial triggers that are necessary to accompany the implementation of IISs.

6. Conclusion

Drawing on triangulated data from an online survey of 337 public administrators and politicians in German cities, expert interviews on the diffusion of IT in cities’ shareholdings management and a content analysis of cities’ PCGCs, the paper shows that IISs are associated with a more frequent use of economic as opposed to social performance information. IISs have a crucial potential related to digital transformation and accountability, particularly in the critical context of SOEs and connected city societies. However, the findings also indicate an unaccounted and potentially “dark side” of digital transformation as IISs do not appear to influence the awareness and behaviour of principals and agents for different types of performance information in a balanced manner. In some cases, IISs could reinforce the neglect of non-financial performance information if they predominantly draw attention to financial performance information.

PCGCs condense central governance standards and can serve as a necessary framework for IISs. Their quality strengthens the effects of IISs on social PIU, which balances the one-sided effect of an IIS comparing economic PIU and social PIU. Moreover, the identified associations between the individual capabilities and PIU highlight the need for additional capability development. Further, differences in PIU between politicians and public administrators imply crucial challenges for policymaking and accountability as well as future research needs.

To achieve a nuanced theoretical understanding for the ongoing scientific debate on accountability, digital transformation and PIU, it is crucial to differentiate between the three sustainability dimensions. Overall, the paper increases the understanding of the effects of technological innovations on digital transformation, control systems and PIU regarding the different dimensions of sustainability. This offers perspectives for sustainable solutions.

Practitioners and policymakers could make use of the conceptual reasoning and empirical findings to better develop connected cities with public administrations, SOEs, sustainable IISs and PCGCs that foster sustainable public service provision. Actors need to design and use IISs that incorporate all of the sustainability dimensions in a balanced manner. The responsible players should put the PCGC issue on the agenda and connect their reform efforts with powerful IT and sustainability reporting developments. PCGCs can support sustainability goals as they can point to individual crucial requirements for sustainability and sustainability-oriented PIU on which actors rely while using an IIS.

There are many challenges in public administration and the public sector. However, in the context of SOEs and the integrative governance of public administrations and SOEs, the opportunities at the intersection of the market, the public sector and politics are extraordinarily high for fostering democratic, economic and social stability. IT-supported accountability is a crucial issue for the future of sustainability and the integrated governance of public administration and SOEs in connected cities.

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