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# Bridging Digital Gaps in Smart City Governance: The Mediating Role of Managerial Digital Readiness and the Moderating Role of Digital Leadership

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## Highlights

### What are the main findings?

- Despite robust IT infrastructure and skilled civil servants, public sector performance in Surabaya significantly improves only when government managerial staff exhibit strong digital readiness.
- Digital leadership plays a decisive role in amplifying the effect of both technology and digital skills—turning potential into measurable impact across smart city governance.

### What is the implication of the main finding?

- Theoretically, the study advances Dynamic Capability Theory and Upper Echelon Theory by demonstrating how managerial cognition and leadership behavior translate digital investments into public value.
- Practically, the study offers a scalable model for city governments, emphasizing leadership-based interventions to enhance managerial readiness and optimize e-government outcomes.

## Abstract

Indonesia's commitment to digital transformation is exemplified by the Gerakan 100 Smart City program, aiming to enhance public sector performance through technology integration. This study examines how information technology capability and 21st century digital skills influence public sector performance, mediated by managerial digital readiness and moderated by digital leadership. Grounded in Dynamic Capability Theory and Upper Echelon Theory, data from 1380 civil servants were analyzed using PLS-SEM via SmartPLS 4.1.0.9. Results show that both IT capability and digital skills significantly improve managerial digital readiness, which in turn positively impacts public sector performance. Managerial readiness mediates the effect of both predictors on performance, while digital leadership strengthens these relationships. Theoretically, this study frames managerial

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digital readiness as a dynamic capability shaped by leadership cognition. Practically, it highlights the importance of aligning infrastructure, skills, and leadership development to advance digital governance. Future research should consider longitudinal, multilevel, and qualitative designs to deepen insights.

**Keywords:** smart city; Smart Governance; information technology capability; 21st century digital skills; digital leadership; public sector; Indonesia

## 1. Introduction

Since it was first introduced at the Hannover Fair in 2011, the concept of Industry 4.0 (I4.0) has evolved into an umbrella term for a wide range of advanced technologies, including the Internet of Things (IoT), cyber-physical systems (CPSs), big data, system integration, simulation, autonomous robotics, and artificial intelligence [1–4]. These technologies promise significant benefits in terms of improving operational efficiency, productivity, and responsiveness [5]. However, many organizations—especially within the public sector—still face challenges in adopting these innovations, largely due to the absence of a standardized and universally accepted conceptual framework for implementation [6]. In response to these challenges, the smart city paradigm has emerged as a strategic approach to operationalize I4.0 principles in urban settings [7]. Smart cities aim to integrate science, digital technology, and IoT into daily human activities, while simultaneously enhancing governance, economic systems, and human capital [8,9]. As part of its broader agenda for sustainable development and its pursuit of a resilient digital economy, Indonesia is actively undergoing this digital transformation in accordance with global trends [10].

Indonesia has demonstrated a strong national commitment to digital transformation through the implementation of smart city initiatives, most prominently marked by the launch of the *Gerakan 100 Smart City program* in 2017 by the Ministry of Communication and Information Technology [11]. This nationwide program aimed to guide and assist 100 selected cities and regencies in designing long-term Smart City Masterplans over a 5- to 10-year horizon. The program unfolded in three phases—25 cities in 2017, 50 in 2018, and 25 in 2019—each selected through a competitive assessment and mentoring process [12]. The smart city agenda was further structured into three strategic pillars: Smart Connectivity (digital infrastructure), Smart Solutions (governance, education, transportation, environment, security, and health), and Smart Users (digitally literate communities). These pillars reflect the government's aspiration to harmonize digital innovation with urban development in order to improve public service delivery, quality of life, and regional competitiveness [13].

Despite this structured effort, implementation across regions remains fragmented. Evaluations conducted in 2020 revealed disparities in readiness, progress, and performance among the 100 participating cities, with several regions exhibiting stagnation or regression due to the absence of integrated planning frameworks, insufficient digital leadership, and inadequate performance measurement standards [14–16]. Furthermore, the Indonesian government has used the smart city agenda as a national strategy to improve public service delivery and digital governance capabilities [12]. However, successful smart city implementation relies heavily on public sector readiness to harness digital resources, lead digital transformations, and foster innovation [17]. To achieve this, public institutions must develop capabilities that extend beyond infrastructure investment [18].

The Indonesian government urgently requires a robust mechanism to bridge the gap between digital technology investment and measurable improvements in public sector

performance (PSP). That mechanism is managerial digital readiness (MDR)—a multidimensional capability that reflects both the psychological and behavioral preparedness of managers to embrace and drive digital transformation [19]. MDR is conceptualized through three core constructs—digital role readiness (DRR), digital transformation readiness (DTR), and digital strategy readiness (DSR)—to capture the full spectrum of managerial capability in fostering a successful and sustainable digital transformation process in Indonesia's public sector [20]. MDR builds upon the broader notion of change readiness, which is defined as the "cognitive precursor to the behavior of either resistance to, or support for, a change effort" [21]. It encompasses beliefs, attitudes, and intentions that facilitate successful organizational change [22] and is essential for navigating the complex and uncertain pathways of digital transformation [23–25].

In digital transformation, digital readiness becomes a context-specific extension of change readiness, emphasizing both the capacity and willingness to utilize digital technologies effectively [19,26]. Successful transformation thus hinges not only on infrastructure or policy but on the collective effort of managers and institutions to cultivate a forward-looking digital mindset [27–29]. Importantly, the literature highlights that readiness must be approached on multiple levels—both individual and organizational [30]. At the micro level, managerial digital readiness is particularly critical, as managers—unlike employees—hold decision-making authority, broader networks, and stronger influence over institutional behavior [31]. Their readiness to lead digital change often determines the overall digital maturity and responsiveness of public institutions. Therefore, MDR represents the starting point through which digital potential is translated into PSP. It includes not only technological and operational readiness but also financial, strategic, cultural, and human resource dimensions [27,32]. The development of MDR does not occur in isolation; it is shaped by two foundational antecedents, information technology capability (ITC) and 21st century digital skills (DS).

ITC refers to an organization's ability to mobilize and apply technological resources—such as IT infrastructure, technical expertise, and system integration—to support and enhance strategic and operational objectives [33,34]. In the public sector, strong ITC ensures that managers have access to reliable digital systems and data-driven tools, thereby enabling informed decision making, coordination across departments, and delivery of citizen-centric services. Without adequate IT infrastructure and technological flexibility, managers face considerable constraints in exercising digital leadership or initiating reform [35,36]. Meanwhile, DS represent a critical set of cognitive, technical, and socio-emotional competencies that allow individuals—particularly managers—to navigate complex digital environments [37,38]. These skills go beyond basic digital literacy, encompassing data interpretation, digital communication, problem solving, adaptability, and collaboration in digitally mediated contexts [39]. Managers equipped with such skills are better positioned to lead digital initiatives, respond to disruptions, and promote a culture of innovation within their institutions [40]. Inadequate digital skills, on the other hand, can result in resistance to change, misalignment of digital strategies, and failure to realize the intended benefits of digital transformation [41–43]. The relationship between ITC and DS with MDR is not always linear or automatic. Rather, it is substantially strengthened when moderated by digital leadership (DL)—a human-centric leadership capacity that enables managers to navigate complexity, drive innovation, and align digital efforts with strategic organizational goals [44].

DL, particularly when embodied through human-centric dimensions such as positive attitude, ethical use of AI, growth mindset, track record, transparent agenda, skills acquisition, and participative style [44], ensures that the technical and human capital embedded in ITC and DS are optimally activated. For instance, a leader with a transparent

agenda can help ensure that digital strategies are aligned with institutional vision and also clearly communicated across managerial levels [45,46]. Moreover, a growth-oriented and participative leadership style supports the cultivation of digital competencies and promotes adaptive behavior, which are crucial for achieving digital technology readiness [47]. Leo et al. [48] found that managerial readiness significantly mediates the relationship between IT capability and organizational agility, highlighting the importance of behavioral and strategic alignment. Similarly, Chen et al. [49] demonstrated that managerial digital readiness mediates the impact of technological infrastructure on public service performance. Nonetheless, in many public sector settings, even robust ITC and skilled personnel may fall short of driving transformation if leadership fails to inspire, align, and mobilize these assets effectively [50].

This complex interaction between technological capability, individual digital skillsets, and leadership behavior can be comprehensively explained through the lens of Dynamic Capability Theory (DCT) and Upper Echelon Theory (UET). DCT posits that organizations must continuously integrate, build, and reconfigure internal and external competencies to address rapidly changing environments [51]. In digital transformation within the public sector, MDR serves as a dynamic capability that enables managers to sense digital opportunities, seize technological innovations, and transform institutional routines in response to environmental volatility [52]. The interplay of ITC and DS reflects an organization's operational and asset-based resources, but it is MDR—as a higher-order capability—that channels these resources into strategic outcomes. When effectively moderated by DL, this capability is further elevated, allowing public managers not only to respond adaptively but to proactively shape digital transformation trajectories [53,54].

Meanwhile, UET provides a complementary behavioral perspective by positing that organizational outcomes are significantly shaped by the characteristics, experiences, and cognitive orientations of top managers [55]. DL, in this framework, is viewed as a manifestation of the cognitive values and behavioral tendencies of leaders that guide how digital capabilities are interpreted, prioritized, and implemented across institutional levels. The multidimensional nature of DL illustrates how individual-level traits such as ethical orientation, participative style, and growth mindset influence the translation of ITC and DS into managerial readiness. Leaders with a strong digital vision and human-centered orientation are more likely to reduce strategic misalignment, mitigate resistance, and facilitate cultural shifts necessary for sustainable digital reform [56–58].

Together, DCT and UET offer a dual theoretical foundation. DCT frames MDR as a capability that dynamically mobilizes resources and adapts strategies in response to change, while UET elucidates how managerial cognition and leadership orientation (i.e., DL) condition the effectiveness of such capabilities. By synthesizing these perspectives, this study positions DL not only as a moderating factor but as a behavioral mechanism that enhances the transformation of digital resources into public value. This integration of dynamic and behavioral theories provides a comprehensive explanation of how Indonesian public sector institutions can optimize digital transformation outcomes by investing not only in technology and skill but in leadership development.

Another gap lies in the contextual focus of existing research on digital transformation in the public sector. Much of the current empirical evidence on MDR, ITC, and DL originates from private sector contexts or developed economies with mature digital ecosystems, stable governance infrastructures, and abundant digital talent pools. These environments often provide a level of organizational agility and institutional support that differs significantly from conditions in developing countries. Consequently, the applicability of such findings remains limited in contexts where digital inequality, bureaucratic rigidity, and leadership fragmentation persist as structural barriers. While technological investments

and digital skill training are increasingly prioritized, the institutionalization of digital leadership remains underdeveloped, and the behavioral translation of digital capabilities into performance outcomes is not yet well understood. This study addresses these critical gaps by examining how ITC and DS influence MDR and how this relationship is moderated by DL—an approach that is both theoretically grounded in DCT and UET and contextually anchored in Indonesia's public governance realities.

## 2. Hypothesis Development

### *2.1. The Relationship Between Information Technology Capability (ITC) and Managerial Digital Readiness (MDR)*

Information technology capability (ITC) comprises five core dimensions: flexibility, integration, alignment, management, and reconfiguration [35]—each of which contributes to enhancing managerial digital readiness (MDR), which itself is defined by three dimensions: digital structure readiness, digital strategy readiness, and digital technology readiness [59]. First, IT flexibility enables organizations to adjust digital infrastructures in response to environmental changes, thus strengthening their structural readiness [59]. Flexible IT systems also allow managers to develop dynamic strategies that remain responsive to evolving digital landscapes, supporting strategic readiness [60]. Moreover, such flexibility ensures that organizations are capable of seamlessly integrating novel technologies, thereby improving digital technology readiness [61].

Second, IT integration ensures the cohesion of digital structures, promoting system consistency across business functions [60]. It also supports strategic planning by offering unified and reliable data that inform managerial decisions, a critical factor for effective digital strategy readiness [62]. From a technological standpoint, integration facilitates the adoption of diverse digital tools, thereby reinforcing an organization's technological readiness. Third, alignment of IT resources with organizational objectives ensures that digital infrastructures are purpose-built, enhancing structural readiness to support strategic initiatives [63]. Strategic alignment further ensures that digital strategies are effectively implemented, increasing digital strategy readiness [64]. Simultaneously, aligning technological investments with long-term goals ensures that organizations are adequately prepared to absorb and utilize new technologies [61]. Fourth, IT management capability plays a crucial role in sustaining digital systems that support ongoing transformation efforts [65]. Sound IT governance ensures that digital structures remain operable and scalable over time [66]. On the strategic front, it facilitates resource allocation, timelines, and monitoring mechanisms that support successful execution of digital strategies [61]. Technologically, robust management practices help optimize the deployment of digital resources, thereby enhancing digital readiness.

Finally, IT reconfiguration capability empowers organizations to reshape existing systems in response to emerging demands or disruptions. This adaptability allows for restructuring digital infrastructures to meet new operational requirements, thereby boosting structure readiness [59]. Reconfiguration also supports strategic agility, enabling managers to pivot or adjust strategies under conditions of uncertainty [60]. In terms of technological readiness, the ability to reconfigure systems accelerates the integration of newer technologies and mitigates technological obsolescence. As such, we propose the following hypothesis:

**Hypothesis 1 (H1).** *Information technology capability positively influences managerial digital readiness.*

### 2.2. The Relationship Between 21st Century Digital Skills (DS) and Managerial Digital Readiness (MDR)

21st century digital skills (DS) have emerged as a critical determinant of managerial effectiveness in the era of digital transformation. These skills encompass a broad array of competencies—including information management, information evaluation, expressive and strategic communication, collaboration, critical thinking, creativity, and problem solving—that collectively equip managers to lead digital initiatives with agility and precision [67]. The ability to manage and evaluate information is foundational for modern managers navigating complex digital ecosystems [68]. These skills enable them to process large volumes of data, extract relevant insights, and assess the utility of digital tools, which directly contributes to their digital technology readiness [69,70]. By mastering data literacy and evaluative judgement, managers are better prepared to adopt, implement, and oversee digital systems that align with organizational goals [71]. Expressiveness and relationship-building skills allow managers to articulate coherent digital strategies and engage stakeholders, thereby bolstering digital strategy readiness [19,72]. In parallel, communication through networking and content sharing facilitates the dissemination of digital best practices, creating a shared understanding and culture of digital adoption that strengthens digital structure readiness [69]. Collaborative skills further reinforce this foundation by enabling managers to work effectively in digitally networked environments [73]. These skills promote synergy across remote or cross-functional teams and ensure that digital initiatives are co-developed and co-owned, enhancing digital structure readiness at the organizational level [19,72].

Meanwhile, critical thinking and problem-solving abilities are indispensable for confronting the dynamic and often ambiguous challenges of digital transformation [74]. Managers must identify bottlenecks, analyze multifaceted scenarios, and construct evidence-based solutions, processes that are essential for both digital strategy readiness and digital technology readiness [69,70]. Complementing these cognitive skills, creativity enables managers to imagine novel digital pathways and to lead innovation in both technological implementation and strategic development [75]. Creativity, therefore, supports the exploration of new technologies, contributing to digital strategy and technology readiness alike [72]. As emphasized by recent studies, digital leadership is most effective when grounded in these multidimensional digital skills, supported by continuous training and an agile organizational environment [39,76]. Given the central role of these skills in equipping managers to lead, adapt, and innovate in digitally intensive contexts, it is reasonable to posit the following hypothesis:

**Hypothesis 2 (H2).** *Twenty-first century digital skills positively influence managerial digital readiness.*

### 2.3. The Relationship Between Managerial Digital Readiness (MDR) and Public Sector Performance (PSP)

Managerial digital readiness (MDR) represents the extent to which public sector managers are prepared—structurally, strategically, and technologically—to lead and implement digital transformation initiatives [20]. This readiness is operationalized through three key dimensions: digital structure readiness (DRR), digital strategy readiness (DSR), and digital technology readiness (DTR). MDR has been increasingly recognized as a critical antecedent of public sector performance (PSP), which can be evaluated along two principal dimensions: quantitative performance (e.g., efficiency, productivity, cost-effectiveness) and qualitative performance (e.g., service quality, employee satisfaction, and stakeholder engagement) [77].

DRR reflects the organization's infrastructural and procedural preparedness to embed and support digital initiatives. It encompasses IT infrastructure, process automation, and

institutional frameworks necessary for technology integration [19]. A structurally ready organization facilitates smoother digital transitions, minimizes resistance to change, and supports continuous improvement in service delivery [78]. This foundational readiness directly contributes to quantitative performance by enabling greater efficiency and effectiveness in internal operations [79]. Moreover, by enhancing the robustness of back-end systems and organizational processes, digital structure readiness lays the groundwork for improved qualitative outcomes, such as better coordination across units and more responsive public services. DSR refers to the ability of public managers to craft, communicate, and implement coherent digital strategies aligned with institutional goals [80]. It entails visionary leadership, a clear understanding of digital transformation roadmaps, and the capacity to align digital projects with long-term performance targets [81]. Strategically ready managers are more likely to cultivate a culture of innovation, drive behavioral change, and promote digital literacy across the organization [82]. As a result, digital strategy readiness enhances quantitative performance by improving policy implementation and resource optimization and qualitative performance by boosting employee engagement, satisfaction, and stakeholder trust [83,84].

DTR involves the availability and integration of modern digital tools, platforms, and systems within managerial practices [85]. This dimension highlights the capability to implement and utilize emerging technologies such as cloud computing, AI-enabled analytics, and digital dashboards for decision making and service delivery [86]. High technology readiness ensures that digital tools are effectively deployed within management control systems, thereby improving real-time monitoring, reducing administrative burden, and facilitating performance feedback loops [87]. These outcomes directly strengthen quantitative indicators (e.g., timeliness, accuracy, cost-efficiency) and qualitative indicators (e.g., evidence-based decision making, enhanced service quality, and policy responsiveness). Finally, MDR improves process efficiency, minimizes operational redundancies, and enhances output quality through data-informed decision making. In the qualitative domain, MDR elevates citizen experience, supports knowledge sharing, and improves employee morale and innovation, all of which are crucial for public value creation [87,88]. As such, we propose the following hypothesis:

**Hypothesis 3 (H3).** *Managerial digital readiness positively influences public sector performance.*

### *2.4. Managerial Digital Readiness (MDR) as a Mediator*

Managerial digital readiness enhances the effective exploitation and deployment of IT capabilities to achieve strategic organizational goals [89,90]. MDR facilitates the conversion of technical capabilities into tangible performance improvements by providing a comprehensive framework for managers to effectively integrate digital strategies into organizational processes. For example, DRR allows institutions to swiftly adapt their technology resources towards service improvement and operational efficiency [45]. DSR ensures that technology deployments align strategically with organizational vision and public demands [46]. DTR ensures managers possess the requisite technological tools and competencies to effectively capitalize on IT capabilities, thereby enhancing both quantitative and qualitative aspects of PSP, such as service delivery efficiency, responsiveness, transparency, and citizen satisfaction [47].

Previous empirical studies have validated the mediating role of digital readiness constructs in public sector management. For instance, Leo et al. [48] indicated that digital managerial readiness significantly mediates the relationship between IT capability and organizational agility, thereby positively influencing performance outcomes. Similarly, Chen et al. [49] demonstrated that managerial readiness towards digitalization mediates the impact of technological infrastructures and capabilities on organizational performance,

particularly in public sector institutions aiming to improve citizen-centric services. In the public sector, digital readiness among managers amplifies the impact of IT capability on performance outcomes because it ensures that technological resources and strategic alignment are not only present but effectively operationalized to meet organizational goals and public expectations [50]. Without adequate managerial digital readiness, the mere possession of robust IT capabilities may not fully translate into performance improvements due to potential strategic misalignment, resistance to change, or underutilization of technological assets [89,90]. As such, we propose the following hypothesis:

**Hypothesis 4 (H4).** *Information technology capability positively affects public sector performance through managerial digital readiness as a mediator.*

MDR, encompassing DRR, DSR, and DTR, channels the benefits derived from enhanced employee digital skills into tangible improvements in both quantitative and qualitative performance measures within public institutions [45,89]. Firstly, DS, which include technological proficiency, digital literacy, critical thinking, collaborative communication, and adaptability in digital environments [37,91], directly contribute to enhancing organizational capabilities when managerial readiness exists. Employees possessing advanced digital skills are more adept at effectively utilizing technological resources, innovating processes, and addressing complex organizational challenges [92]. However, these skills alone may not automatically lead to improved performance outcomes unless managerial structures and strategies are explicitly designed to foster, integrate, and capitalize on these capabilities [89,93].

In this mediation process, MDR acts as an essential intermediary. DRR, reflecting agile governance, adequate infrastructure, and organizational processes supportive of digital integration, facilitates the seamless translation of digital skills into enhanced public sector efficiency and effectiveness [90]. In parallel, DSR ensures strategic alignment between digital initiatives and institutional objectives, thus leveraging the employees' digital competencies to achieve measurable performance improvements, such as service responsiveness, improved citizen interaction, and overall process efficiency [45]. Additionally, DTR, characterized by the availability of appropriate digital tools and managerial competencies, ensures that employee digital skills are supported and amplified, ultimately enhancing both quantitative performance indicators (e.g., productivity, service delivery rates) and qualitative outcomes (e.g., transparency, public trust, user satisfaction) [47,94].

Empirical evidence from previous studies supports this mediation relationship. For example, van Laar et al. [37] identified that digital skills significantly impact organizational performance only when management readiness enables employees to apply these skills strategically. Similarly, research by Kane et al. [93] emphasizes that digital competencies among the workforce substantially improve organizational performance outcomes when managerial strategies, infrastructure, and technological resources align effectively with digital transformation goals. Furthermore, recent studies within the public sector context demonstrate that digital skills among employees positively influence organizational outcomes predominantly through the presence of managerial digital readiness, ensuring strategic alignment and comprehensive utilization of employee capabilities [50,91]. Therefore, based on these theoretical justifications and empirical findings, it is proposed that.

**Hypothesis 5 (H5).** *Twenty-first century digital skills positively affect public sector performance through managerial digital readiness as a mediator.*

### 2.5. Digital Leadership (DL) as Moderator

Digital leadership (DL) encompasses leaders' competencies in harnessing digital technologies strategically, fostering an organizational culture receptive to digital transformation, and motivating teams to adopt and integrate advanced IT systems effectively [95,96]. This leadership approach is characterized by vision-driven decision making, agility in responding to digital disruption, and the capability to promote innovative technology utilization within organizational operations [97]. The core premise behind the moderating role of DL lies in its potential to enhance the value derived from an organization's ITC. ITC provides the essential technological foundation required to facilitate managerial preparedness for digital transformation [98]. However, without the presence of effective DL, these capabilities might remain underutilized or misaligned with strategic objectives, thereby limiting their contribution to MDR [99].

DL amplifies the effectiveness of ITC by clearly articulating a strategic digital vision, thus fostering DRR [100]. Through proactive communication, these leaders help integrate and align IT resources with organizational goals, thereby facilitating a coherent and strategic approach to digital adoption [101]. Leaders' expertise in digital matters further ensures that technological investments are not only effectively managed but continuously reconfigured to adapt to rapidly changing technological environments, thus supporting sustained managerial readiness [102]. Moreover, DL facilitates a supportive digital culture, encouraging collaboration, knowledge sharing, and innovation. This nurturing environment ensures ITC is leveraged optimally to build comprehensive DSR, thus enhancing managerial awareness and commitment towards strategic digital initiatives [103]. Leaders who exhibit digital fluency can significantly mitigate resistance to technological change, promoting adaptability and enhancing managers' openness to utilizing sophisticated digital technologies [104]. Empirical evidence substantiates the moderating role of DL, for instance, Li et al. [103] demonstrated that DL positively moderated the relationship between technology integration and organizational agility, a dimension closely associated with MDR. Similarly, Cortellazzo et al. [99] found that leaders' digital competencies significantly enhanced the utilization of IT resources, thereby improving organizations' readiness to adopt and integrate digital strategies. In light of this theoretical reasoning and empirical support, the following hypothesis is proposed:

**Hypothesis 6 (H6).** *Digital leadership strengthens the influence of information technology capability toward managerial digital readiness.*

DL plays a role in optimizing and leveraging the existing digital competencies of employees and managers, ultimately enhancing organizational preparedness for digital transformation [96,99]. DL is characterized by an ability to articulate a coherent digital vision, facilitate adaptive organizational cultures, and strategically implement digital innovations within managerial processes [104].

The presence of DL amplifies the impact of DS by creating an enabling environment where these skills can be effectively applied and further developed. Leaders who embody DL traits demonstrate not only technical fluency but also the capacity to inspire managers to utilize their digital competencies proactively in strategic contexts, thus significantly increasing MDR [97]. DL fosters MDR by promoting an organizational culture that prioritizes continuous learning and adaptability [105]. Leaders adept in digital strategies encourage managers to actively engage with emerging technologies and innovative solutions, thus maximizing the potential of their digital skills in practice [103]. Consequently, managers within organizations that exhibit strong DL are likely to exhibit enhanced readiness in formulating digital strategies, implementing structural transformations, and effectively de-

ploying technological resources for improved organizational outcomes [102]. Furthermore, DL actively encourages experimentation and facilitates collaborative environments that leverage digital competencies to address complex organizational challenges [106]. Through effective communication and strategic alignment, digital leadership enables managers to translate their DS into tangible managerial initiatives, enhancing DRR, DSR, and DTR—key dimensions of MDR [99,101].

Empirical evidence strongly supports the moderating role of DL. For instance, Cortellazzo et al. [99] demonstrated that leaders possessing robust digital competencies significantly enhance organizational capabilities to adapt digital skills to strategic initiatives [107], thereby increasing overall digital readiness. Similarly, Benitez et al. [104] provided empirical insights into how DL capabilities positively moderate the relationship between individual-level digital competencies and organizational agility, a critical aspect closely aligned with managerial digital readiness. Zhu et al. [97] also underscored that DL significantly contributes to organizational learning capabilities, ensuring digital skills translate effectively into preparedness for transformative organizational change. Thus, based on theoretical frameworks and corroborating empirical research, the following hypothesis is proposed:

**Hypothesis 7 (H7).** *Digital leadership strengthens the influence of 21st century digital skills toward managerial digital readiness.*

The research model of this research is shown in Figure 1:

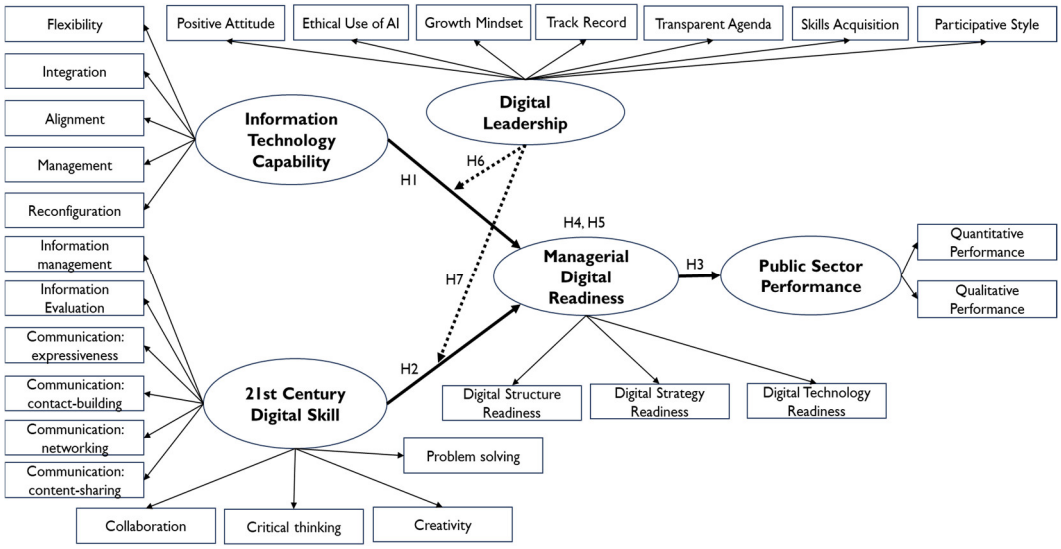


**Figure 1.** Research Model.

## 3. Methodology

### *3.1. Research Subjects and Sampling Techniques*

This study adopts a quantitative survey design to empirically test the proposed theoretical framework within the context of public sector digital transformation [108]. The survey was administered over a four-month period, from September to December 2024, targeting civil servants (State Civil Apparatus/ASN) of Surabaya City Government—a municipality known for its progressive implementation of smart city initiatives [109]. The target population consisted of personnel from Surabaya's City Apparatus Organizations, including 17 Departments, 6 Agencies, 2 Secretariats, the Inspectorate, the Municipal Police, 31 Districts, and 154 Subdistricts. In total, these institutions employ 22,882 civil servants. To ensure adequate representation across administrative levels and institutional units,

this study employed a stratified proportional random sampling technique [110]. This method was chosen to enhance representativeness and statistical power by proportionally selecting participants from each echelon and organizational unit based on their population size [111]. Through this structured sampling approach, a total of 1380 respondents were successfully selected and completed the survey, providing comprehensive demographic and perceptual data.

Table 1 presents the profile of these respondents. In terms of age distribution, the majority of respondents were in the 41–50 years age group (44.57%), followed by those aged 31–40 years (36.38%), indicating that the survey captured mature employees likely to hold key leadership or managerial roles. A smaller proportion of respondents were under 30 years (11.45%) or above 50 years (7.61%). Gender representation in the sample was relatively balanced, with male respondents comprising 51.96% (717 individuals) and female respondents accounting for 48.33% (667 individuals), suggesting a relatively equitable gender participation rate. With regard to educational attainment, the majority of the respondents held a bachelor's degree (76.74%), followed by master's degree holders (14.49%), and a minority possessing a doctoral degree (0.22%). This distribution reflects a well-educated public workforce with a significant proportion having completed higher education, which is conducive to digital transformation readiness. The remainder of the sample held diplomas (2.10%) or completed high school education (6.45%). In terms of tenure, more than half of the respondents had worked in the public sector for more than 15 years (51.09%), indicating substantial institutional knowledge and organizational experience. Those with 11–15 years of tenure represented 27.83%, while the remainder had worked 5–10 years (10.22%) or less than 5 years (10.87%). Regarding hierarchical classification, the largest group of respondents held Echelon IV.b positions (45.94%), followed by IV.a (23.19%) and functional positions equivalent to Echelon IV (15.58%). The remaining respondents were distributed among Echelon III.b (8.04%), III.a (5.29%), and a small proportion at the Echelon II.b level (1.96%). This echelon distribution suggests that the majority of the data was drawn from middle to lower managerial levels, which are often operationally significant in executing digital strategies within local governments.

**Table 1.** Respondent Characteristics.

| Category | Frequency | % | Category | Frequency | % |
|---|---|---|---|---|---|
| Age (years) | | | Tenure (years) | | |
| <30 | 158 | 11.45 | <5 | 150 | 10.87 |
| 31–40 | 502 | 36.38 | 5–10 | 141 | 10.22 |
| 41–50 | 615 | 44.57 | 11–15 | 384 | 27.83 |
| 51–60 | 105 | 7.61 | >15 | 705 | 51.09 |
| Gender | | | Echelon | | |
| Male | 717 | 51.96 | II.b | 27 | 1.96 |
| Female | 667 | 48.33 | III.a | 73 | 5.29 |
| Education | | | III.b | 111 | 8.04 |
| Doctoral | 3 | 0.22 | IV.a | 320 | 23.19 |
| Master's | 200 | 14.49 | IV.b | 634 | 45.94 |
| Bachelor's | 1059 | 76.74 | IV Functional | 215 | 15.58 |
| Diploma | 29 | 2.10 | N Total | 1380 | 100 |
| High School | 89 | 6.45 | | | |

### *3.2. Research Instruments*

This study employed five core constructs: the independent variable, information technology capability (ITC), was measured using a multidimensional framework adapted from Marchiori et al. [35], comprising 21 items across five dimensions: Flexibility (4 items), Integration (3 items), Alignment (5 items), Management (5 items), and Reconfiguration

(4 items). The variable 21st century digital skills (DS) was operationalized based on the framework developed by van Laar et al. [67], consisting of 58 items across dimensions such as Information Management, Information Evaluation, Communication (subdivided into Expressiveness, Contact-Building, Networking, and Content-Sharing), Collaboration, Critical Thinking, Creativity, and Problem Solving. The moderating variable, digital leadership (DL), was adapted from Abbu et al. [44], covering 21 items grouped into seven dimensions: Positive Attitude, Ethical Use of AI, Growth Mindset, Track Record, Transparent Agenda, Skills Acquisition, and Participative Style. Managerial digital readiness (MDR), serving as the mediating variable, was measured using 13 items based on the scale by Yang et al. [20], encompassing Digital Structure Readiness (3 items), Digital Strategy Readiness (6 items), and Digital Technology Readiness (4 items). Lastly, the dependent variable public sector performance (PSP) was derived from Verbeeten [77] and consisted of two dimensions: Quantitative Performance (3 items) and Qualitative Performance (4 items).

To ensure cultural and semantic validity, all instruments were subjected to a rigorous back-translation process [112,113]. Initially, the English versions of the questionnaires were translated into Indonesian by bilingual experts proficient in public administration and digital governance terminology. Subsequently, an independent expert retranslated the Indonesian version into English to confirm semantic equivalence [114]. The translated instruments were pretested with a small group of civil servants in Surabaya to verify contextual clarity and linguistic precision [115]. Minor adaptations were made to ensure relevance to the public sector and to reflect the administrative terminologies used in Indonesian government institutions.

The data collection was conducted via a structured online questionnaire using Google Forms, allowing for wide accessibility across city municipal departments. A five-point Likert scale was utilized for all items, ranging from 1 (strongly disagree) to 5 (strongly agree), and analysis was performed using SmartPLS 4.1.0.9, a robust statistical tool suitable for testing complex structural equation models involving mediation and moderation [116].

To mitigate common method bias (CMB), this study employed both statistical and procedural remedies. Harman's single-factor test showed no dominant factor, and all variance inflation factor (VIF) values were within acceptable limits, indicating low multicollinearity [117]. Procedurally, data were collected from multiple sources (supervisors and subordinates) and across different sectors (various departments in the Surabaya City Government), thus minimizing single-source and single-sector bias [118]. Respondent anonymity was preserved by not collecting names or personal identifiers, which helped to reduce social desirability bias and enhance the honesty of responses [119], and questionnaire items were randomly ordered to minimize response pattern and contextual bias, following recommendations by Podsakoff et al. [120]. These strategies have been widely validated in prior research as effective methods for controlling CMB and ensuring the validity and reliability of self-reported survey data.

### *3.3. Data Analysis Technique*

The data analysis in this study involved two primary steps: evaluation of the measurement model and assessment of the structural model, both conducted using structural equation modeling (SEM) with SmartPLS 4.1.0.9 software [121]. SmartPLS was selected for its suitability in analyzing complex models involving multiple latent constructs [122], flexibility with moderate sample sizes [123], and robustness to violations of normality assumptions [124].

The measurement model was evaluated by examining factor loadings (FLs), convergent validity using average variance extracted (AVE), and reliability through composite reliability (CR) and Cronbach's alpha (CA) (Table 2). Indicators were considered acceptable

if FLs exceeded 0.70 [125], AVE values were above 0.50 [126], and CR and CA values surpassed the recommended threshold of 0.70 [127]. Discriminant validity was confirmed using the Fornell–Larcker criterion, ensuring the square root of each construct's AVE was greater than its correlations with other constructs (Table 3) [128]. Additionally, discriminant validity was reinforced through cross-loading analysis, ensuring each indicator loaded most strongly on its intended construct [129,130]. These analyses collectively established strong construct validity and internal consistency of the measurement model [131].

**Table 2.** Results of Factor Loading, Convergent Validity, and Reliability Testing.

| Item/Variable | | FL | CA | CR | AVE |
|---|---|---|---|---|---|
| Information Technology Capability (21 items) (Marchiori et al., 2022) [35] | | | 0.969 | 0.969 | 0.618 |
| Flexibility Dimension (4 items) | | | 0.894 | 0.894 | 0.760 |
| The information systems in this government organization... | | | | | |
| FLE1 | ... are capable of expanding flexibly to accommodate increasing public service demands. | 0.900 | | | |
| FLE2 | ... are well-integrated and compatible with other internal and external systems. | 0.898 | | | |
| FLE3 | ... are designed with modular architecture, allowing individual components to be developed or updated independently. | 0.842 | | | |
| FLE4 | ... are extensively utilized to share and distribute information. | 0.846 | | | |
| Integration Dimension (3 items) | | | 0.836 | 0.838 | 0.753 |
| This government organization... | | | | | |
| INT1 | ... shares data with external parties such as other public agencies or service providers. | 0.890 | | | |
| INT2 | ... integrates its information systems with those of external entities (e.g., other public institutions or partners), enabling real-time information exchange. | 0.859 | | | |
| INT3 | ... consolidates information from external entities to support decision-making processes. | 0.854 | | | |
| Alignment Dimension (5 items) | | | 0.890 | 0.892 | 0.695 |
| The IT planning in this government organization... | | | | | |
| ALI1 | ... aligns with the objectives of each public service unit or department. | 0.856 | | | |
| ALI2 | ... supports the overall organizational strategy. | 0.856 | | | |
| ALI3 | ... takes into account external environmental dynamics, such as national policy changes, emerging technologies, and public needs. | 0.773 | | | |
| ALI4 | Does the government organization's strategic planning explicitly refer to or incorporate IT planning? | 0.822 | | | |
| ALI5 | Each unit within this government organization holds realistic expectations regarding the capabilities and role of information technology. | 0.856 | | | |
| Management Dimension (5 items) | | | 0.899 | 0.900 | 0.713 |
| Compared to other city governments, this city government stands out... | | | | | |
| MAN1 | ... in the effectiveness of its information technology planning. | 0.835 | | | |
| MAN2 | ... regarding IT project management practices. | 0.840 | | | |
| MAN3 | ... regarding security control planning, standardization, compliance, and disaster recovery. | 0.852 | | | |
| MAN4 | ... in terms of the effectiveness of IT policies. | 0.823 | | | |
| MAN5 | ... regarding IT assessment and control systems. | 0.870 | | | |

**Table 2.** *Cont.*

| Item/Variable | | FL | CA | CR | AVE |
|---|---|---|---|---|---|
| Reconfiguration Dimension (4 items) | | | 0.854 | 0.856 | 0.697 |
| This city government can reconfigure. . . | | | | | |
| REC1 | . . . its existing IT resources to design new services or solutions for its internal departments. | 0.847 | | | |
| REC2 | . . . its current IT resources to develop new services for citizens. | 0.879 | | | |
| REC3 | This city government effectively defines its course of action when new demands for IT solutions arise. | 0.827 | | | |
| REC4 | This city government is able to improvise during the execution of its activities to respond to organizational demands. | 0.784 | | | |
| 21st Century Digital Skills (58-item) (van Laar et al., 2019) [67] | | | 0.986 | 0.987 | 0.565 |
| Information Management Dimension (3 items) | | | 0.856 | 0.856 | 0.777 |
| At city government, I often . . . | | | | | |
| INM1 | . . . save useful digital files directly into the appropriate folders. | 0.849 | | | |
| INM2 | . . . maintain consistency in naming digital files. | 0.892 | | | |
| INM3 | . . . organize digital files using a hierarchical folder structure. | 0.902 | | | |
| Information Evaluation Dimension (3 items) | | | 0.827 | 0.831 | 0.744 |
| At city government, I often . . . | | | | | |
| INV1 | . . . verify the reliability of a website before using its information. | 0.876 | | | |
| INV2 | . . . cross-check information by consulting alternative websites. | 0.821 | | | |
| INV3 | . . . ensure that the information I find is current and up to date. | 0.888 | | | |
| Communication: Expressiveness Dimension (3 items) | | | 0.865 | 0.867 | 0.787 |
| At city government, I often . . . | | | | | |
| COE1 | . . . achieve my intended outcomes from interactions on the internet. | 0.893 | | | |
| COE2 | . . . use the internet effectively to accomplish my objectives. | 0.884 | | | |
| COE3 | . . . know how to clearly express my ideas through the internet. | 0.884 | | | |
| Communication: Contact-Building Dimension (3-item) | | | 0.804 | 0.806 | 0.719 |
| At city government, I often . . . | | | | | |
| CCB1 | . . . initiate new collaborations by reaching out to online contacts. | 0.865 | | | |
| CCB2 | . . . establish online connections for the purpose of collaboration. | 0.834 | | | |
| CCB3 | . . . identify and approach experts on the internet to initiate projects. | 0.844 | | | |
| Communication: Networking Dimension (8 items) | | | 0.918 | 0.933 | 0.636 |
| At city government, I often . . . | | | | | |
| CON1 | . . . invest time and effort in online networking with professionals in my field. | 0.847 | | | |
| CON2 | . . . utilize my online network to gain practical benefits. | 0.833 | | | |
| CON3 | . . . leverage my online network to support business-related activities. | 0.791 | | | |
| CON4 | . . . build and maintain professional relationships through online platforms. | 0.750 | | | |
| CON5 | . . . use the internet to approach new professional contacts. | 0.793 | | | |
| CON6 | . . . employ my online network to enhance brand or organizational visibility. | 0.769 | | | |
| CON7 | . . . initiate conversations with other professionals via the internet. | 0.852 | | | |
| CON8 | . . . use my online network to support the achievement of policy goals. | 0.736 | | | |
| Communication: Content-Sharing Dimension (3 items) | | | 0.851 | 0.851 | 0.770 |
| At city government, I often . . . | | | | | |
| CCS1 | . . . post new messages on the internet related to my professional activities. | 0.883 | | | |
| CCS2 | . . . publish blogs or articles on the internet to share knowledge or insights. | 0.888 | | | |
| CCS3 | . . . share information online with the intention of initiating discussions. | 0.862 | | | |

**Table 2.** *Cont.*

| | Item/Variable | FL | CA | CR | AVE |
|---|---|---|---|---|---|
| | Collaboration Dimension (9 items) | | 0.932 | 0.932 | 0.647 |
| At city government, I often . . . | | | | | |
| COL1 | . . . share important information with my team via the internet. | 0.780 | | | |
| COL2 | . . . use the internet to share information that supports others' work. | 0.806 | | | |
| COL3 | . . . distribute digital resources online to help my team complete tasks. | 0.828 | | | |
| COL4 | . . . exchange work-related information through the internet to advance our progress. | 0.808 | | | |
| COL5 | . . . receive support from colleagues through internet-based communication. | 0.793 | | | |
| COL6 | . . . communicate online with co-workers across different disciplines. | 0.832 | | | |
| COL7 | . . . share professional knowledge with colleagues via internet platforms. | 0.810 | | | |
| COL8 | . . . provide constructive feedback to colleagues using digital channels. | 0.780 | | | |
| COL9 | . . . utilize the internet to access and apply other professionals' expertise. | 0.799 | | | |
| | Critical Thinking Dimension (12 items) | | 0.943 | 0.944 | 0.617 |
| At city government, I often . . . | | | | | |
| CRT1 | . . . present substantiated arguments and logical reasoning in discussions. | 0.770 | | | |
| CRT2 | . . . provide evidence or examples to support my arguments. | 0.824 | | | |
| CRT3 | . . . articulate clear justifications for my points of view. | 0.817 | | | |
| CRT4 | . . . reframe discussions by introducing new perspectives. | 0.796 | | | |
| CRT5 | . . . ask questions to better understand others' viewpoints. | 0.764 | | | |
| CRT6 | . . . consider multiple arguments before forming my own conclusions. | 0.785 | | | |
| CRT7 | . . . connect different viewpoints to redirect the flow of discussion. | 0.768 | | | |
| CRT8 | . . . contribute new and relevant ideas during discussions. | 0.800 | | | |
| CRT9 | . . . identify and emphasize the most important points in a discussion. | 0.802 | | | |
| CRT10 | . . . generate fresh input based on the direction of the conversation. | 0.744 | | | |
| CRT11 | . . . remain open to ideas that challenge my existing beliefs. | 0.734 | | | |
| CRT12 | . . . use internet sources to support and justify my decisions. | 0.818 | | | |
| | Creativity Dimension (6 items) | | 0.899 | 0.901 | 0.666 |
| At city government, I often . . . | | | | | |
| CRE1 | . . . apply creative approaches to existing processes using the internet. | 0.834 | | | |
| CRE2 | . . . use the internet to generate innovative ideas relevant to my field. | 0.800 | | | |
| CRE3 | . . . demonstrate originality in my work through digital tools. | 0.787 | | | |
| CRE4 | . . . complete my tasks creatively by leveraging online platforms. | 0.855 | | | |
| CRE5 | . . . follow digital trends to inspire and develop original ideas. | 0.851 | | | |
| CRE6 | . . . utilize the internet to assess the practicality of my ideas. | 0.762 | | | |
| | Problem solving Dimension (8 items) | | 0.909 | 0.910 | 0.612 |
| At city government, I often . . . | | | | | |
| PRO1 | . . . use the internet to identify the most effective way to solve problems. | 0.788 | | | |
| PRO2 | . . . resolve work-related problems by utilizing online resources. | 0.776 | | | |
| PRO3 | . . . formulate solutions to problems through internet-based information. | 0.801 | | | |
| PRO4 | . . . explore various problem-solving methods with the help of the internet. | 0.827 | | | |
| PRO5 | . . . encounter problems that I feel confident solving using online tools. | 0.820 | | | |
| PRO6 | . . . make decisions using internet-sourced information that lead to personal satisfaction. | 0.787 | | | |
| PRO7 | . . . do you find the solution via the internet even though initially no solution is immediately apparent. | 0.721 | | | |
| PRO8 | . . . does the actual outcome you achieved via the internet match what you expected. | 0.730 | | | |

**Table 2.** *Cont.*

| | Item/Variable | FL | CA | CR | AVE |
|---|---|---|---|---|---|
| | Digital Leadership (21 items) (Abbu et al., 2025) [44] | | 0.966 | 0.967 | 0.599 |
| | Positive Attitude Dimension (3 items) | | 0.873 | 0.873 | 0.798 |
| PA1 | I consistently advocate for the best interests of the city government in every policy and program. | 0.850 | | | |
| PA2 | I take full accountability for my actions and decisions as a public leader. | 0.926 | | | |
| PA3 | I am committed to the success and advancement of this public organization. | 0.903 | | | |
| | Ethical Use of AI Dimension (3 items) | | 0.820 | 0.823 | 0.736 |
| EUA1 | I ensure that senior leaders understand the need for building trustworthy AI that ensures fairness, accuracy, and compliance. | 0.867 | | | |
| EUA2 | I put processes in place to prevent human biases from entering algorithms and affecting outcomes. | 0.877 | | | |
| EUA3 | I develop and encourage participation in training related to AI ethics in the public sector. | 0.828 | | | |
| | Growth Mindset Dimension (3 items) | | 0.788 | 0.788 | 0.702 |
| GM1 | I don't view failure as disappointment, but as a learning experience that can lead to change. | 0.839 | | | |
| GM2 | I believe that everyone, including myself, can grow their capabilities regardless of background. | 0.838 | | | |
| GM3 | I accept new challenges, take advantage of feedback, and provide timely feedback to subordinates. | 0.837 | | | |
| | Track Record Dimension (3 items) | | 0.891 | 0.891 | 0.820 |
| TR1 | I have changed aspects of public services using digital methods. | 0.896 | | | |
| TR2 | I have significantly reduced cycle time or operational costs through digitization. | 0.904 | | | |
| TR3 | I have created an overall better public service experience. | 0.917 | | | |
| | Transparent Agenda Dimension (3 items) | | 0.825 | 0.825 | 0.741 |
| TA1 | I never hide my intentions; I reveal all aspects of our digital strategy to the organization. | 0.839 | | | |
| TA2 | I ensure the digital strategy is documented and accessible to all stakeholders. | 0.865 | | | |
| TA3 | I ensure that the benefits of our digital strategy are quantifiable and clearly understood by everyone. | 0.877 | | | |
| | Skills Acquisition Dimension (3 items) | | 0.903 | 0.904 | 0.838 |
| SA1 | I am personally involved in our efforts to recruit digital talents for the public organization. | 0.906 | | | |
| SA2 | I influence efforts to retrain and rebalance digital skills within the organization. | 0.943 | | | |
| SA3 | I have initiated active programs with local universities to recruit digitally talented individuals into government. | 0.896 | | | |
| | Participative Style Dimension (3 items) | | 0.882 | 0.882 | 0.809 |
| PS1 | I require that we celebrate both small wins and major accomplishments to motivate employees. | 0.885 | | | |
| PS2 | I prefer to roll up my sleeves and work directly with development teams. | 0.914 | | | |
| PS3 | I make time for people who have questions. | 0.899 | | | |

**Table 2.** *Cont.*

| | Item/Variable | FL | CA | CR | AVE |
|---|---|---|---|---|---|
| | Managerial Digital Readiness (13 items) (Yang et al., 2024) [20] | | 0.944 | 0.945 | 0.620 |
| | Digital Structure Readiness Dimension (3 items) | | 0.823 | 0.824 | 0.740 |
| I support . . . | | | | | |
| DRR1 | . . . the hiring of digitally competent officials to drive digital transformation in this city government. | 0.866 | | | |
| DRR2 | . . . designing agile and flexible structures to effectively engage in digital transformation. | 0.896 | | | |
| DRR3 | . . . cultivating an open culture of idea and knowledge sharing to facilitate digital transformation. | 0.817 | | | |
| | Digital Strategy Readiness Dimension (6 items) | | 0.895 | 0.896 | 0.655 |
| DSR1 | I rely on technology to stay informed about topics relevant to my responsibilities. | 0.829 | | | |
| DSR2 | I keep up with the latest technological developments in my area of responsibility. | 0.777 | | | |
| DSR3 | I support the adoption of new digital technologies or tools in my department. | 0.825 | | | |
| DSR4 | I encourage employees to acquire new digital skills. | 0.811 | | | |
| DSR5 | I value improving data availability for better decision-making. | 0.809 | | | |
| DSR6 | I pay close attention to shifts in citizen expectations driven by digital technologies. | 0.806 | | | |
| | Digital Technology Readiness Dimension (4 items) | | 0.874 | 0.875 | 0.726 |
| DTR1 | I am capable of formulating strategic goals for digital transformation in my organization. | 0.847 | | | |
| DTR2 | I can rapidly allocate sufficient resources to support digital strategy execution. | 0.878 | | | |
| DTR3 | My organization's strategic goals are relevant and influential in my digital transformation efforts. | 0.849 | | | |
| DTR4 | I am well-informed about the strategic goals of my organization related to digital transformation. | 0.835 | | | |
| | Public Sector Performance (7 items) (Verbeeten, 2007) [77] | | 0.888 | 0.891 | 0.600 |
| | Quantitative Performance Dimension (3 items) | | 0.818 | 0.821 | 0.733 |
| To what extent would you compare the performance of your department or organization to that of other comparable city governments in the following areas. . . | | | | | |
| QNP1 | The quantity or amount of work produced. | 0.879 | | | |
| QNP2 | Attainment of unit service goals. | 0.839 | | | |
| QNP3 | Efficiency of unit operations. | 0.849 | | | |
| | Qualitative Performance Dimension (4 items) | | 0.847 | 0.850 | 0.685 |
| QLP1 | The quality or accuracy of work produced. | 0.820 | | | |
| QLP2 | The number of innovations or new ideas by the unit. | 0.838 | | | |
| QLP3 | Reputation of "work excellence." | 0.798 | | | |
| QLP4 | Morale of unit personnel. | 0.855 | | | |

The structural model analysis examined relationships among latent variables using path coefficients (β), coefficients of determination ($R^2$), and their significance levels [132]. Multicollinearity among predictors was assessed through variance inflation factor (VIF) values to ensure validity of the structural relationships [131,133]. The regression and hypothesis testing processes assessed the explanatory power of the structural model, with $R^2$ values interpreted as indicating substantial (0.75), moderate (0.50), or weak (0.25) explanatory power [134]. Path coefficients (β) were analyzed to quantify direct relationships, with statistical significance determined using t-statistics and *p*-values at a 95% confidence level [135,136]. This structural analysis approach thus substantiates the hypothesized relationships, validating the overall predictive capability of the proposed model.

**Table 3.** Fornell–Larcker criterion.

| Variable | DL | DS | ITC | MDR | PSP |
|---|---|---|---|---|---|
| Digital Leadership | 0.774 | | | | |
| 21st Century Digital Skills | 0.308 | 0.752 | | | |
| Information Technology Capability | 0.243 | 0.625 | 0.786 | | |
| Managerial Digital Readiness | 0.270 | 0.601 | 0.432 | 0.787 | |
| Public Sector Performance | 0.079 | 0.394 | 0.279 | 0.641 | 0.774 |

## 4. Results

### *4.1. Common Method Bias*

To assess the potential risk of common method bias (CMB), this study employed both Harman's single-factor test and variance inflation factor (VIF) analysis, consistent with methodological recommendations by Podsakoff et al. [120] and Fuller et al. [137]. The unrotated factor analysis, conducted using principal axis factoring, revealed that the first factor accounted for 37.717% of the total variance, as shown under the initial eigenvalues section. This value is below the conservative threshold of 50%, indicating that no single factor dominates the total variance, which is a key indication that common method variance is unlikely to significantly bias the results. Furthermore, the extraction sums of squared loadings show that the variance explained by the extracted factors is widely distributed, with the first factor explaining only 37.259% of the extracted variance. Since this is below the threshold and no overwhelming single factor emerges, this reinforces the notion that the data do not suffer from significant common method bias.

To complement the procedural remedies, this study also examined the inner model collinearity through VIF values for all latent variables and interaction terms. As shown in the output, all VIF scores—including those for digital leadership (DL = 1.192), digital skills (DS = 1.828), information technology capability (ITC = 1.761), managerial digital readiness (MDR = 1.579), public sector performance (PSP = 2.107), and interaction terms DL × ITC (1.760) and DL × DS (1.764)—were significantly below the threshold of 3.3 [131]. This demonstrates the absence of multicollinearity and confirms that each construct contributes distinct explanatory power to the structural model. Thus, the results from both Harman's test and VIF analysis conclusively indicate that the model is free from serious common method bias and multicollinearity.

### *4.2. Measurement Model Test Results*

The outcomes of the outer loading assessment, as depicted in Figure 2, along with the results of convergent validity and reliability tests shown in Table 2, collectively confirm the strength and adequacy of the measurement model across all examined constructs. Each latent variable was well represented by multiple indicators that satisfied the criteria for factor loadings, reliability, and convergent validity, confirming the appropriateness of the model for subsequent analysis. Specifically, information technology capability (ITC) effectively captured essential organizational capabilities such as system flexibility, integration, strategic alignment, and reconfiguration. Likewise, the construct of 21st century digital skills (DS) reliably reflected critical managerial competencies, including information management, digital communication, collaboration, critical thinking, creativity, and problem solving. Digital leadership (DL), structured as a higher-order latent construct, adequately represented critical leadership traits such as positive attitude, ethical AI use, growth mindset, transparency, skill acquisition, and participative management style. Managerial digital readiness (MDR) was effectively captured through dimensions related to digital infrastructure readiness, strategy formulation, and technological capability. Finally, the public sector performance (PSP) construct effectively represented both quantitative and qualitative

performance indicators, such as productivity, service quality, innovation, and employee morale. Overall, these findings affirm the validity and reliability of the measurement instrument and support the suitability of the constructs for further structural analyses.

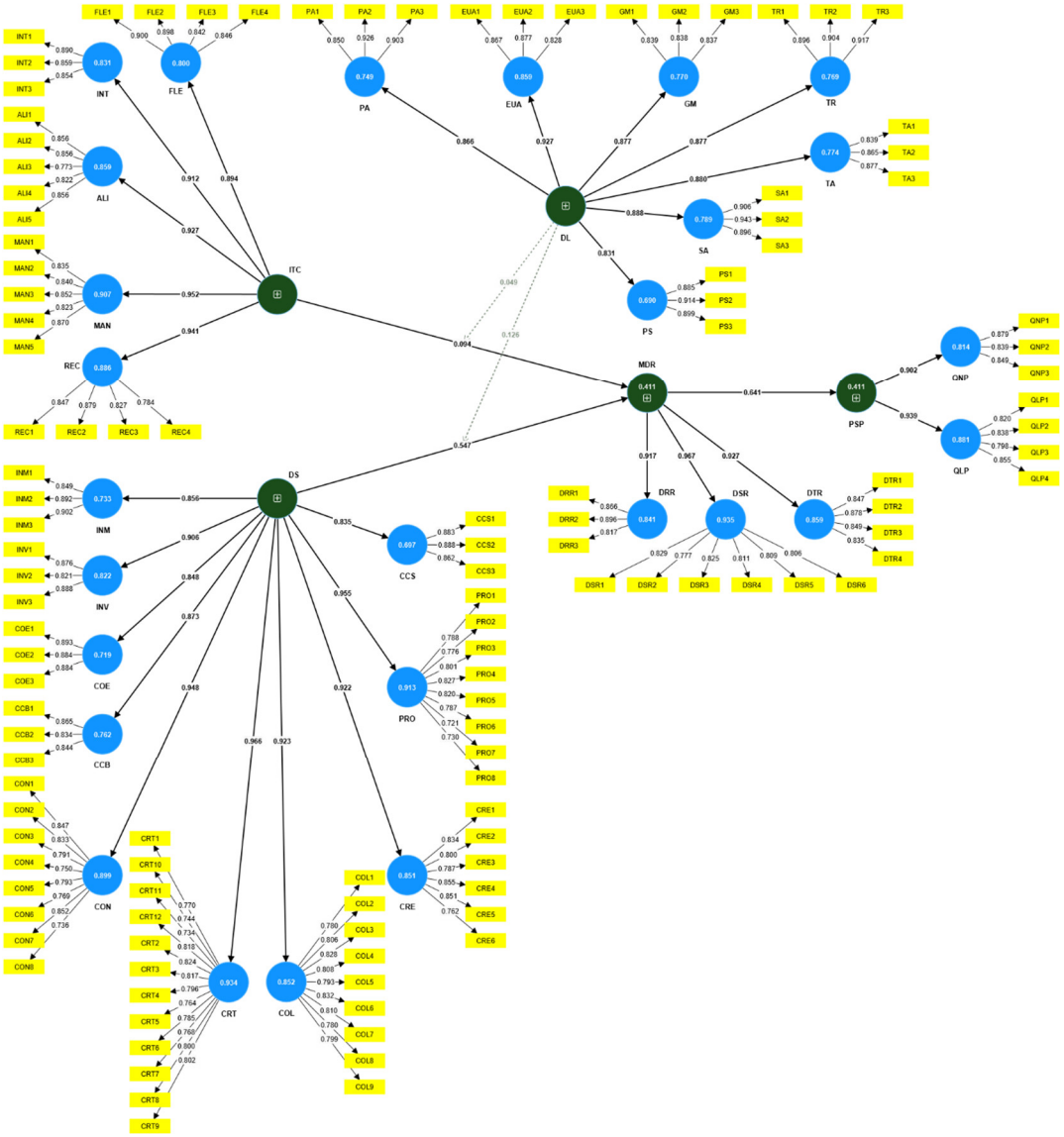


**Figure 2.** Outer Loading Test Result.

The discriminant validity of the latent constructs was evaluated using the Fornell–Larcker criterion (Table 3). This analysis confirmed that all constructs were empirically distinct, as evidenced by the square root of AVE values consistently exceeding the inter-construct correlations. Specifically, DL, DS, ITC, MDR, and PSP demonstrated clear conceptual differentiation. These findings affirm that each construct within the structural model is empirically distinct and theoretically well defined. The clear separation among constructs not only supports the conceptual soundness of the measurement model but also strengthens the interpretive clarity of the structural relationships. This discriminant validity ensures that each latent variable contributes uniquely to the overall explanatory power of the model, thus enhancing the reliability and theoretical precision of the conclusions derived from this research.

The discriminant validity of the constructs was further substantiated through the heterotrait–monotrait (HTMT) analysis presented in Table 4. The results indicate that all HTMT values remain consistently below the widely accepted threshold of 0.85, thus demon-

strating robust empirical differentiation among constructs [124]. In particular, the analysis distinctly differentiates between DL, DS, ITC, and MDR. The HTMT values indicated that MDR represents a distinct managerial capability related to digital preparedness, separate from its antecedents. Additionally, PSP was confirmed to be conceptually distinct from the capability and leadership variables, reinforcing the robustness of the constructs and their relationships as proposed in the model.

**Table 4.** Heterotrait–Monotrait Ratio (HTMT).

| Variable | DL | DS | ITC | MDR | PSP | DL × ITC | DL × DS |
|---|---|---|---|---|---|---|---|
| Digital Leadership | | | | | | | |
| 21st Century Digital Skills | 0.317 | | | | | | |
| Information Technology Capability | 0.252 | 0.639 | | | | | |
| Managerial Digital Readiness | 0.284 | 0.623 | 0.452 | | | | |
| Public Sector Performance | 0.104 | 0.420 | 0.301 | 0.698 | | | |
| Digital Leadership × Information Technology Capability | 0.281 | 0.140 | 0.243 | 0.085 | 0.043 | | |
| Digital Leadership × 21st Century Digital Skills | 0.295 | 0.252 | 0.148 | 0.077 | 0.071 | 0.618 | |

### *4.3. Structural Equation Test Results*

The results of the bootstrapping procedure and structural path analysis are summarized in Table 5 and illustrated in Figure 3, offering comprehensive evidence for the hypothesized relationships among the constructs in the proposed model. Each structural path is evaluated based on its coefficient (β), standard deviation (STDEV), t-statistic, and *p*-value, which collectively determine the strength and significance of the relationships.

**Table 5.** Path Coefficient and Significance Test.

| Hypotheses | Path | β | STDEV | t-Values | *p*-Values | Results |
|---|---|---|---|---|---|---|
| H1 | ITC → MDR | 0.094 | 0.032 | 2.897 | 0.004 | Accepted |
| H2 | DS → MDR | 0.547 | 0.032 | 17.159 | 0.000 | Accepted |
| H3 | MDR → PSP | 0.633 | 0.021 | 30.094 | 0.000 | Accepted |
| H4 | ITC → MDR → PSP | 0.059 | 0.020 | 2.931 | 0.003 | Accepted |
| H5 | DS → MDR → PSP | 0.347 | 0.025 | 13.983 | 0.000 | Accepted |
| H6 | DL × ITC → MDR | 0.049 | 0.025 | 1.979 | 0.048 | Accepted |
| H7 | DL × DS → MDR | 0.126 | 0.026 | 4.843 | 0.000 | Accepted |

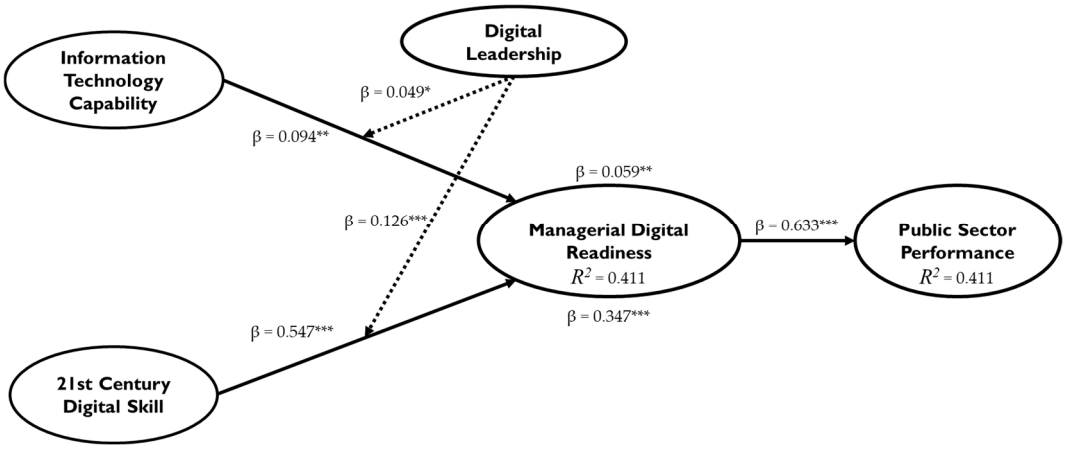


**Figure 3.** Structural Equation Test Result. Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

The test results reveal that ITC has a significant and positive effect on MDR (β = 0.094, t = 2.897, $p = 0.004$), supporting H1. This implies that the presence of strong IT systems in the public sector contributes positively to managerial preparedness in digital environments.

A more substantial effect was found for DS on MDR (β = 0.547, t = 17.159, $p < 0.001$), affirming H2 and indicating that state civil apparatus digital skill proficiency is a major driver of managerial readiness. Furthermore, MDR significantly influences PSP (β = 0.633, t = 30.094, $p < 0.001$), as hypothesized in H3, confirming the mediating role of digital managerial capacity in improving public sector outcomes. The analysis also confirmed the significance of two indirect effects. The indirect path from ITC to PSP through MDR was statistically significant (β = 0.059, t = 2.931, $p = 0.003$), validating H4 and supporting the view that IT capabilities in the public sector must be internally leveraged through managerial readiness to impact government performance. Likewise, H5, which posits an indirect effect from DS to PSP through MDR, was supported (β = 0.347, t = 13.983, $p < 0.001$), underscoring the critical mediating function of digital readiness in converting individual skillsets into broader institutional performance.

Additionally, the study explored two interaction effects to test potential moderation mechanisms. The interaction term DL × ITC showed a modest but significant positive effect on MDR (β = 0.049, t = 1.979, $p = 0.048$), confirming H6. This suggests that the influence of IT capabilities on digital readiness is enhanced when state civil apparatus digital leadership is present. A more pronounced moderating effect was found for DL × DS (β = 0.126, t = 4.843, $p < 0.001$), supporting H7, indicating that the impact of state civil apparatus digital skills on managerial readiness is significantly stronger in the presence of effective digital leadership. Overall, the structural model explains a substantial portion of the variance in the endogenous variables. The $R^2$ value for MDR is 0.411, and the same value applies to PSP ($R^2 = 0.411$), reflecting that the model captures 41.1% of the variance in both constructs. These findings highlight the central role of MDR as a mediator and reinforce the significance of both technological infrastructure and human capital—particularly digital skillsets and leadership—in enhancing government performance.

## 5. Discussion

### *5.1. The Relationship Between Information Technology Capability (ITC) and Managerial Digital Readiness (MDR) (Hypothesis 1 Accepted)*

The first hypothesis (H1), which posits that information technology capability (ITC) positively influences managerial digital readiness (MDR), is supported by the results, with a statistically significant path coefficient (β = 0.094, t = 2.897, $p = 0.004$), as shown in Table 5. This finding emphasizes the critical role of IT capability in equipping the public sector with the necessary digital readiness to effectively lead and adapt to ongoing digital transformation initiatives within city government institutions.

ITC reflects an institution's ability to mobilize technological resources—ranging from infrastructure to expertise—in a way that supports strategic and operational objectives. In the context of city government, ITC functions as a foundational enabler for managerial readiness across three interrelated domains: digital structural readiness, digital strategy readiness, and digital technology readiness [59]. First, the flexibility inherent in modern IT infrastructures allows municipal agencies to dynamically adjust systems and services in response to evolving public needs and policy changes. This adaptability reinforces structural readiness by equipping managers with infrastructure that supports operational efficiency and service responsiveness [60]. Second, IT integration ensures consistency across departments by connecting disparate systems and enabling centralized access to public data. This cohesion is essential for strategic readiness, as it allows managers to formulate evidence-based decisions and ensures that digital initiatives are coordinated across government functions [62]. Third, alignment between IT capabilities and public service objectives ensures that technology investments are not only reactive but also proactively support long-term development plans. Strategic alignment fosters clarity in managerial roles, simplifies

digital implementation pathways, and embeds accountability mechanisms into digital governance processes [63,64]. Fourth, effective IT management capability reinforces the institutional sustainability of digital initiatives. Strong IT governance frameworks ensure reliability, scalability, and risk management of digital systems, all of which are crucial to managerial confidence in leading digital projects [65,66]. Finally, IT reconfiguration capability allows governments to repurpose existing systems to meet emergent demands. This ability is particularly important for local governments operating in volatile policy environments, where responsiveness and agility are crucial [61].

In Surabaya City Government, for example, aligned IT initiatives have enabled neighborhood-level service digitalization, synchronized with *Rencana Pembangunan Jangka Menengah Daerah* (RPJMD) (local development plans), thereby increasing readiness among civil servants to enact those initiatives. The positive influence of ITC on MDR is also evident in real-world practices within the Surabaya City Government. One notable example is the Surabaya Single Window (SSW) system—an integrated digital platform developed to manage licensing and public services across multiple departments [138]. This system demonstrates IT integration at scale, allowing managers across sectoral units to access uniform data, synchronize inter-departmental workflows, and make timely, informed decisions. By eliminating redundancies and centralizing service delivery, SSW enhances structural and strategic readiness among mid- and high-level managers who are tasked with ensuring public satisfaction and service continuity. Another example is the use of Command Center Surabaya, a digital monitoring and coordination hub equipped with real-time dashboards, CCTV networks, and analytics to track citywide infrastructure, disaster response, and traffic management [139]. This platform reflects high IT flexibility and reconfiguration capability, as it allows managers to swiftly respond to emerging issues—such as flooding, traffic congestion, or security threats—by adjusting digital systems and reallocating resources [140]. The availability of such adaptive infrastructure increases managerial confidence in leading urgent and strategic initiatives, which is a core aspect of MDR.

### *5.2. The Relationship Between 21st Century Digital Skills (DS) and Managerial Digital Readiness (MDR) (Hypothesis 2 Accepted)*

The second hypothesis (H2), which posits that 21st century digital skills (DS) positively influence managerial digital readiness (MDR), is strongly supported by the empirical results, with a statistically significant path coefficient ($\beta = 0.547$, $t = 17.159$, $p = 0.000$), as presented in Table 5. This indicates that DS serve as a fundamental enabler for public managers in city governments to develop the readiness necessary to lead, adapt to, and implement digital transformation efforts.

DS encompass a multidimensional set of competencies, including information management, data evaluation, digital communication, collaboration, critical thinking, creativity, and problem solving [69]. These competencies collectively provide the cognitive, technical, and socio-emotional foundation required for public sector managers to operationalize digital reforms. In the context of municipal governance—where decision making is increasingly data-driven—information management and evaluation skills are crucial. They enable managers to interpret complex datasets, assess the relevance of digital tools, and ensure technological choices are aligned with public service goals [68,71]. These competencies directly contribute to digital technology readiness, one of the key dimensions of MDR. In addition, DS equip managers with expressive and strategic communication abilities, which are essential for translating digital visions into actionable plans. These skills enhance digital strategy readiness by enabling leaders to build consensus, articulate change narratives, and mobilize support from both internal teams and external stakeholders [19,72]. Furthermore, communication through digital networking and content-sharing platforms

helps disseminate innovations and encourages best practice exchange, thus strengthening digital structure readiness through collective learning [69]. Collaborative digital skills are equally essential in local government settings, where cross-functional coordination is vital. These skills enable managers to work across departments and administrative silos, fostering synergy and shared accountability in digital projects [73]. Moreover, critical thinking and problem solving allow managers to navigate the dynamic, ambiguous, and often politically complex environment of public administration. In the face of shifting policies, budget constraints, and technology disruptions, these skills empower managers to analyze trade-offs, troubleshoot implementation barriers, and adapt strategies in real time [70,74]. This analytical agility supports both digital strategy and technology readiness, which are central components of MDR. Lastly, creativity plays a transformative role by fostering innovation in both strategic planning and technological experimentation. Creative managers are instrumental in initiating breakthrough ideas, designing citizen-centric digital services, and continuously reimagining public sector value creation [72,75]. In line with prior research, the presence of DS significantly improves managerial capability to absorb and apply digital resources effectively [39,76].

The positive association between 21st century digital skills (DS) and managerial digital readiness (MDR) is further substantiated by several initiatives undertaken by the Surabaya City Government. A notable example is the WARGAKU (*Wadah Aspirasi Rakyat Gotong Royong untuk Kesejahteraan Surabaya*) application, a participatory governance tool that enables citizens to submit complaints, suggestions, and community concerns directly to municipal authorities [141]. Managers utilizing this system are required to possess expressive communication skills, digital networking competence, and the ability to synthesize feedback into policy action. These digital communication competencies facilitate managerial readiness in aligning digital strategies with citizen expectations, thereby reinforcing digital strategy readiness through enhanced stakeholder engagement [142].

Another pertinent case is the implementation of the Digital Waste Bank Program under the Surabaya Smart Environment Initiative. This digital service platform enables households to categorize and exchange waste for credit via a mobile application, integrated with local waste collection units [143]. Government managers responsible for this program—particularly those in district-level environmental offices—must demonstrate problem-solving skills, data interpretation abilities, and creativity to promote adoption, analyze participation trends, and tailor environmental education to digital formats [144]. These capabilities directly contribute to digital structure and technology readiness, empowering managers to lead eco-innovation through digital means.

Furthermore, the deployment of the E-Office System across Surabaya's public agencies showcases the importance of collaborative digital skills. Through this platform, official correspondence, internal memos, meeting minutes, and task assignments are handled digitally, requiring managers to effectively operate within cloud-based systems, manage shared files, and coordinate virtually across units [15]. In addition, many line departments in Surabaya, such as the Department of Transportation and the Department of Health, have adopted daily performance dashboards to monitor service efficiency and response metrics in real time [145]. To operate and interpret these dashboards effectively, managers must utilize advanced information evaluation and critical thinking skills, enabling them to detect inefficiencies, respond to operational anomalies, and adjust service strategies [144]. These data-driven managerial actions exemplify digital technology readiness, particularly in environments that require real-time decision making and performance accountability.

### *5.3. The Relationship Between Managerial Digital Readiness (MDR) and Public Sector Performance (PSP) (Hypothesis 3 Accepted)*

The third hypothesis (H3), which posits that managerial digital readiness (MDR) positively influences public sector performance (PSP), is strongly supported by the empirical results, with a statistically significant path coefficient (β = 0.587, t = 14.705, $p$ = 0.000), as reported in Table 5. This finding highlights the crucial role of managerial preparedness—across structural, strategic, and technological domains—in driving both the quantitative and qualitative dimensions of performance in city governments.

MDR reflects the extent to which public managers are equipped to lead digital transformation through three interrelated dimensions: digital structure readiness (DRR), digital strategy readiness (DSR), and digital technology readiness (DTR) [20]. Structurally, DRR reflects the readiness of an institution's infrastructure and operational systems to support digital operations. A high level of DSR indicates the presence of interoperable IT platforms, streamlined business processes, and digital standard operating procedures that reduce friction in public service delivery [19,78]. DSR enhances quantitative performance through improvements in efficiency, turnaround time, and cost-effectiveness [79]. At the same time, it fosters qualitative performance by promoting consistency, responsiveness, and seamless coordination across departments. Strategically, DSR embodies a manager's capacity to conceptualize, communicate, and operationalize digital transformation strategies that align with institutional objectives. This readiness ensures that digital initiatives are not isolated efforts but are embedded within long-term governance goals [80]. Managers with strong DSR are more likely to inspire digital innovation, encourage cross-unit collaboration, and develop agile responses to policy challenges [81,82]. DSR enabled public managers to align monitoring systems, management digitization, and urban transport platforms with government development plans [145]. The outcomes of this strategic alignment are twofold: improved quantitative performance via better resource allocation and project delivery and enhanced qualitative performance through increased stakeholder trust and citizen satisfaction [83,84]. Technologically, DTR focuses on the availability and effective use of advanced digital tools in managerial practices, such as digital dashboards, AI-powered analytics, and cloud-based services [85]. High DTR ensures that managers are not only capable of adopting emerging technologies but also integrating them into decision-making and service processes [86,87].

The positive effect of MDR on PSP in Surabaya City Government is clearly illustrated by several strategic initiatives implemented. One prominent example is the operation of the Surabaya Command Center, which functions as a centralized monitoring and coordination hub integrating data streams from CCTV networks, traffic sensors, environmental indicators, and disaster early warning systems [146]. To manage and derive actionable insights from such complex and dynamic data environments, public managers must exhibit a high degree of DTR—one of the core dimensions of MDR. Managers with adequate digital readiness use these data analytics tools to make evidence-based decisions, allocate emergency resources in real time, and track performance indicators across city departments. This has led to improved quantitative performance, such as faster response times to incidents and more efficient inter-agency coordination, as well as qualitative improvements, including enhanced public trust and transparency.

Another compelling example is the city's implementation of e-Budgeting and e-Planning Systems, which are aligned with Surabaya's participatory governance model [147,148]. Managers tasked with leading these initiatives must demonstrate DSR, which includes the ability to align technological deployments with long-term development plans, such as those set forth in the *Rencana Pembangunan Jangka Menengah Daerah* (RPJMD) [149]. The integration of strategic planning with digital platforms has allowed

managers to optimize resource allocation, prioritize citizen-submitted proposals, and track program implementation progress in a transparent manner [150]. These efforts have significantly increased efficiency and productivity while also fostering employee engagement and citizen satisfaction—clear indicators of enhanced PSP [151].

Surabaya's e-Office System provides another example of how DRR supports administrative efficiency and performance. Through this platform, all internal communication, document processing, and approval workflows are digitized across departments [15]. Managers are expected to use this system to coordinate tasks, delegate responsibilities, and monitor output in real time. The digital infrastructure reduces bureaucratic delays, minimizes paper-based redundancies, and standardizes decision-making processes. As a result, quantitative performance improves through reduced turnaround times and cost savings, while qualitative performance is enhanced through better internal accountability, more structured communication, and faster public service delivery [152].

### *5.4. Managerial Digital Readiness (MDR) as a Mediator (Hypothesis 4 and Hypothesis 5 Accepted)*

Hypothesis 4 (H4), which posits that managerial digital readiness (MDR) mediates the relationship between information technology capability (ITC) and public sector performance (PSP), is empirically supported, with a statistically significant indirect effect ($\beta = 0.055$, $t = 2.693$, $p = 0.007$), as shown in Table 5. This finding highlights that IT capabilities alone do not automatically translate into superior public sector performance unless they are effectively channeled through the digital readiness of public managers.

Information technology capability (ITC) refers to an organization's capacity to mobilize digital resources—such as infrastructure, systems integration, flexibility, and governance—to support strategic goals [33,34]. However, this strategic potential can only be realized when such resources are absorbed and operationalized by digitally competent and strategically aligned managers. MDR functions as a crucial transmission mechanism that transforms the technical promise of IT systems into organizational agility and service excellence. MDR is composed of several key capacities: DRR aligns IT investments with evolving policy goals and citizen expectations [153]; DSR ensures system flexibility is synchronized with institutional workflows to enhance efficiency and responsiveness [45]; and DTR enables evidence-based decision making through digital dashboards, big data, and real-time service platforms [47]. Without these managerial capabilities, ITC risks becoming an underutilized asset, resulting in fragmented implementation, stakeholder resistance, and misaligned digital adoption [89,90]. Empirical studies have confirmed this mediating role: digital readiness has been shown to bridge the impact of ITC on organizational agility and public service outcomes [48,49], particularly when supported by data-driven, digitally literate leadership [50].

In the Surabaya City Government, this is evident in several integrated initiatives programs. The SSW system, for instance, enables cross-departmental coordination by centralizing licensing services and eliminating administrative redundancies—strengthening managers' structural and strategic readiness to deliver efficient services [138]. Similarly, the Command Center Surabaya empowers managers with real-time monitoring tools, enabling rapid decisions during emergencies like floods or traffic congestion, reflecting high IT flexibility and enhancing managerial responsiveness [139,140]. The e-Musrenbang platform further illustrates IT alignment with city planning processes, helping managers align citizen proposals with RPJMD targets—thus increasing digital strategy readiness [154–157]. Supporting these systems, *Dinas Komunikasi dan Informatika* (Diskominfo) (Department of Communication and Information) Surabaya plays a key role in sustaining IT governance and digital infrastructure, equipping managers with training and SOPs, and thereby

enhancing their digital readiness to convert IT potential into measurable performance outcomes [158–160].

Moreover, Hypothesis 5 (H5), which posits that MDR mediates the relationship between DS and PSP, is statistically supported, as shown by the significant indirect effect (β = 0.321, t = 8.426, $p$ = 0.000). This result demonstrates that, while DS are essential to driving digital transformation, their influence on performance outcomes is significantly amplified when mediated by MDR.

Employees' ability to utilize DS effectively to enhance institutional performance is highly contingent on the readiness of their managers to strategically harness and operationalize these capabilities [89,92]. Without a digitally competent managerial layer, even a highly skilled workforce may underperform due to the absence of structural support, strategic alignment, and technological enablement [93]. MDR serves as the key enabling mechanism through which DS are translated into quantitative and qualitative performance outcomes. Through DRR, managers provide agile governance frameworks and responsive infrastructures that enable employees to apply their digital skills efficiently in public service delivery. For instance, adaptive process automation and cloud-based workflows allow digitally skilled employees to improve productivity and reduce redundancy, directly impacting quantitative indicators such as speed, accuracy, and cost-effectiveness [90]. Simultaneously, DSR allows public managers to ensure that digital skills among staff are aligned with institutional goals and policy priorities. This alignment ensures that digital initiatives—such as citizen portals, feedback systems, or data dashboards—are strategically implemented to enhance service responsiveness, transparency, and citizen interaction [45,47]. Finally, DTR ensures that employees are not only digitally skilled but also technologically supported. For example, in a city government that adopts AI-assisted citizen complaint triaging, the effectiveness of such a system depends not only on the staff's ability to use the tool but on whether managers have provided the training, oversight, and integration strategies necessary for its full adoption. As a result, DS can lead to better qualitative outcomes, including user satisfaction, increased public trust, and innovation in service delivery [94].

Empirical studies support the mediating role of MDR, as evidenced by several initiatives in the Surabaya City Government. The WARGAKU application, for instance, enables citizen feedback through digital channels and requires managers to apply expressive communication and networking skills to translate inputs into responsive policy actions—demonstrating digital strategy readiness [141,142]. Similarly, the Digital Waste Bank Program, part of the city's Smart Environment Initiative, depends on managerial problem solving, data interpretation, and creativity to convert citizen participation into measurable eco-innovation outcomes, reflecting both digital structure and technology readiness [143,144]. The city's e-Office System also illustrates this dynamic, where managers must coordinate digital correspondence and supervise real-time workflows—requiring collaboration, information evaluation, and critical thinking [15,146]. MDR is further evident in-service areas like transportation and health, where performance dashboards are used to monitor outputs and public responsiveness. These cases affirm that digital skills among employees only enhance organizational performance when embedded within strategic managerial infrastructures [37,50,91,93]. In Surabaya's case, MDR ensures that digital capabilities are absorbed, aligned, and operationalized into tangible service improvements.

### *5.5. The Moderating Effect of Digital Leadership (DL) (Hypothesis 6 and Hypothesis 7 Accepted)*

The sixth hypothesis (H6), which posited that digital leadership (DL) strengthens the positive relationship between ITC and MDR, is supported by the empirical findings of this study. As shown by the statistically significant interaction coefficient (β = 0.049, t = 1.979, $p$ = 0.048) in Table 5 and visualized in Figure 4, the presence of high DL amplifies the

influence of ITC on MDR. Specifically, the slope for high DL increases from 3.000 to 3.286 as ITC rises, compared to a smaller increase from 2.812 to 2.902 under low-DL conditions. This divergence indicates that DL plays a moderating role by enhancing the translation of IT capabilities into managerial readiness, thereby validating Hypothesis 6 (H6).

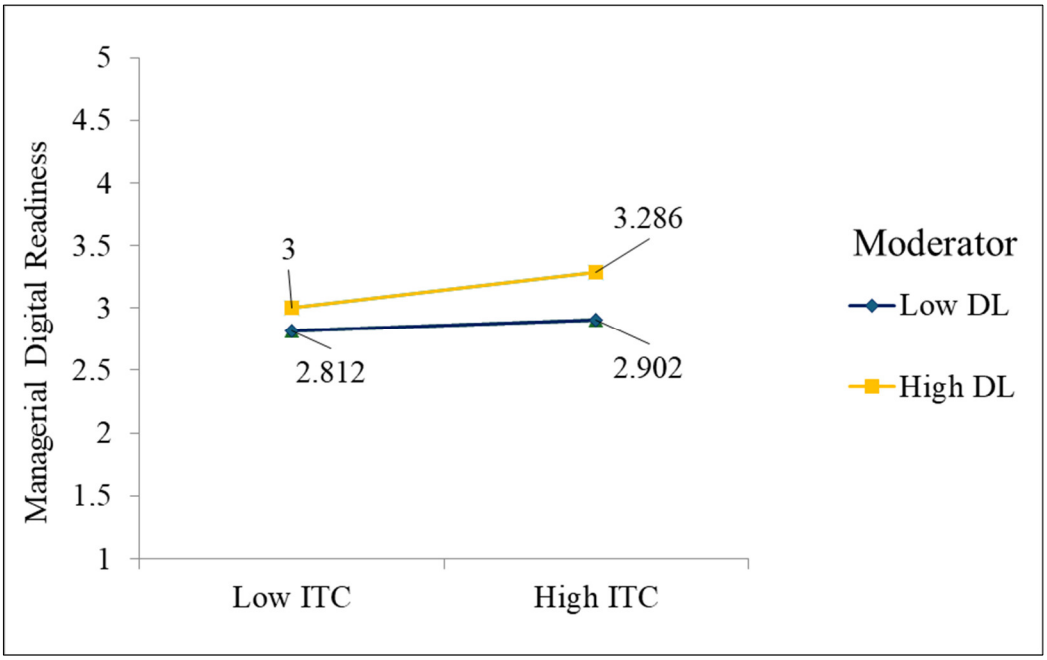


**Figure 4.** DL's moderating effect on relationship between ITC and MDR.

This finding aligns with theoretical and empirical evidence suggesting that DL acts as a catalytic force that translates IT investments into organizational readiness. Leaders' competencies are needed in crafting strategic visions for technology use, fostering a culture of digital innovation, and enabling teams to integrate digital tools effectively [95,97]. Without such leadership, even robust ITC remains underutilized, as managers lack the strategic direction and cultural support to transform these capabilities into actionable readiness [99]. In a city government, leaders who can articulate a vision, align digital tools with service goals, and support continuous adaptation are required [100,102]. Leaders who exhibit strong digital fluency not only manage these tools but create environments that support collaboration, innovation, and ongoing digital capacity building [103,104].

One cornerstone of Surabaya's strategy has been the digitization of its bureaucracy to accelerate and improve public services. In 2021, Surabaya City Government pushed the administration to adopt an Electronic-Based Government System (SPBE). It began by educating civil servants on digital tools and the need to modernize, then issued a directive ending all manual processes—from official correspondence to front-line services—across city agencies [161]. Key services that once took days now take hours. For example, issuing a new ID card (KTP) in Surabaya was streamlined to 1 × 24 h, with a policy that any delay beyond that results in a fine paid to the citizen [162]. This clear accountability (a fine of IDR 50,000 per hour of delay) underscores the leadership's commitment to leveraging IT systems for speed and reliability. By 2023 the city had fully integrated all departmental applications into a unified platform, eliminating data silos between agencies [163]. This integration—achieved under strong policy guidance—ensured that the city's IT capabilities translated into faster, transparent, and accountable services. It also earned Surabaya national recognition: in 2023 the city won Indonesia's top Digital Government Award with an SPBE implementation score of 4.49 (the highest among cities, up from 3.69 in 2022), reflecting its digital transformation success [164].

Surabaya's digital leadership has also excelled in breaking down silos between sectors through IT integration, especially to address social and health issues. A notable example is the city's fight against stunting (chronic malnutrition in children) [165]. Surabaya city government linked data systems across agencies—including the Health Department, local clinics, and even the Ministry of Religious Affairs—to proactively identify and assist at-risk families. One innovation was integrating the health records of local clinics (puskesmas) with the Ministry of Religion's data on soon-to-be married couples, so that the city can intervene before high-risk parents even have children. With this digital infrastructure, when a couple registers for marriage, their information is cross-checked for health indicators (like anemia or underweight status of the mother-to-be). City health workers then reach out during premarital courses to educate them on nutrition and child health. This leadership-driven use of integrated IT has yielded measurable results. Surabaya's stunting prevalence dropped to among the lowest in Indonesia—by one measure just 1.6%, the lowest nationally [166]. Additionally, Surabaya's Transportation Department has operated an Adaptive Traffic Control System (ATCS) as part of its smart mobility plan, using CCTV and sensors to adjust traffic light patterns in real time across the city [167]. This system, initiated in the 2010s, enables quicker response to congestion and accidents by centrally monitoring intersections [168]. While largely a technical implementation, it was the city leadership's sustained support (budgeting for CCTV, integrating the feeds into the command center, assigning staff to monitor) that turned the ATCS into a functional tool for reducing gridlock [169]. Commuters in Surabaya have benefitted through shorter travel times and more timely information, showing how digital infrastructure guided by strategic leadership improves day-to-day city management.

The seventh hypothesis (H7), which posited that DL strengthens the positive relationship between DS and MDR, is supported by the empirical results of this study. As indicated by the statistically significant interaction coefficient ($\beta = 0.126$, $t = 4.843$, $p = 0.000$) in Table 5 and visualized in Figure 5, the relationship between DS and MDR is notably amplified under high-DL conditions. Specifically, when DL is high, MDR increases sharply from 2.47 (low DS) to 3.816 (high DS). In contrast, under low DL, the increase is more modest—from 2.436 to 3.278. This steeper slope under high-DL conditions suggests that digital leadership substantially enhances the capacity of public sector managers to translate digital competencies into managerial readiness. This finding is consistent with Guenduez and Mergel's study [170] which emphasizes dynamic managerial capabilities—such as sensing, seizing, innovation, integrative, and empowering—as critical to enabling strategic adaptation and transformation in the smart city.

DL enhances this relationship by providing the organizational scaffolding necessary for digital skills to thrive and evolve. Digital leaders possess not only technical fluency but also the strategic capacity to cultivate an environment conducive to experimentation, cross-functional collaboration, and continuous digital upskilling [96,104]. In such settings, DS are more likely to be leveraged beyond operational tasks and integrated into strategic decision-making processes. Managers in these environments are thus empowered to formulate, lead, and sustain digital transformation initiatives with greater confidence and competence [97].

Furthermore, DL plays a crucial role in establishing a learning-oriented culture, where innovation and adaptability are embedded in managerial practice. Leaders who embody DL traits actively encourage managers to engage with new technologies, align digital tools with policy objectives, and foster feedback loops that continuously refine digital initiatives [105,106]. This cultural reinforcement increases digital structure readiness, by streamlining workflows and creating adaptive infrastructures; digital strategy readiness, by aligning skills with institutional visions; and digital technology readiness, by supporting tool adoption and integration [102]. Cortellazzo et al. [99] showed that leaders with strong

digital competencies significantly enhance the ability of organizations to apply DS within strategic contexts. Likewise, Benitez et al. [104] found that DL capabilities positively moderate the impact of individual digital competencies on organizational agility—a core outcome associated with MDR. Similarly, Zhu et al. [97] emphasized that DL boosts organizational learning capacity, thereby ensuring that DS among managers do not stagnate but evolve into readiness for transformational change. Li et al. [103] further demonstrated that DL fosters strategic alignment between digital tools and policy implementation, enhancing both leadership legitimacy and system usage.

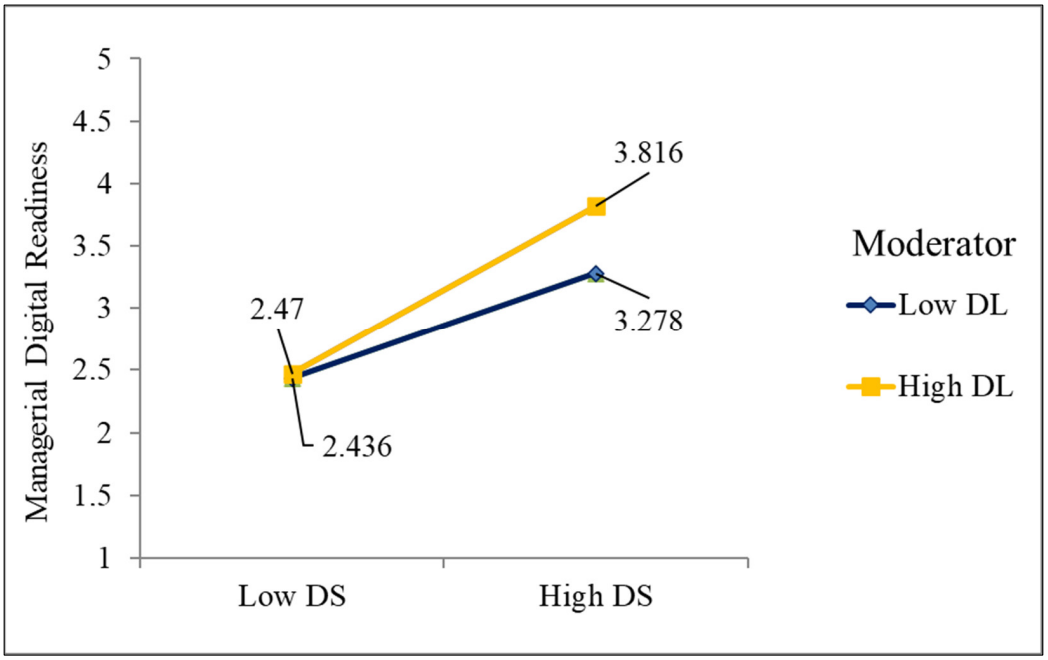


**Figure 5.** DL's moderating effect on the relationship between DS and MDR.

Surabaya's city leadership has spearheaded a sweeping digital transformation since 2020, actively cultivating 21st century digital skills among its State Civil Apparatus. From the mayor down, leaders emphasized that those who fail to adapt to new technologies "could disappear from the system," instilling a sense of urgency for ASN to embrace digital tools [171]. This top-down push included extensive digital training and education for staff, followed by a mayoral circular ordering all departments to cease manual processes—from correspondence to service delivery—and go fully digital. One of the most concrete examples of Surabaya's digital leadership is the implementation of an SPBE across the city administration. Surabaya's city government began this initiative by socializing digital awareness among all employees and then opening avenues for formal digital upskilling by established internal programs to educate ASN on new applications and workflows, ensuring they had the necessary technical skills and mindset for e-government [172].

Additionally, Surabaya's strategic leaders have also explicitly tied digital skill development to the broader Smart City framework, ensuring ASN not only use new tools but also work in new ways. A hallmark initiative in this vein is the policy allowing ASN to Work from Anywhere (WFA) to leverage the fully digitalized public services [173]. By 2023, virtually all municipal services were accessible online via mobile apps, enabling civil servants to serve citizens without being tethered to their office desk [174]. This policy shift is fundamentally a leadership-driven cultural change: it entrusts ASN with flexibility but demands accountability through digital means. To make it viable, the city equipped each community center (Balai RW) with computers and network access and trained staff to use their smartphones or laptops to handle work tasks securely from the field. For example,

an administrator can meet citizens in their neighborhood and process a birth certificate or handle a complaint on the spot using the online system, rather than requiring the person to visit City Hall. If residents struggle with an online form, they can simply WhatsApp their documents to the assigned ASN for assistance. Such scenarios illustrate ASN exercising digital communication and collaboration skills outside the traditional office—they must coordinate via messaging apps, access cloud-based databases remotely, and perhaps use digital signatures to finalize documents. The leadership's role was crucial in orchestrating this, instilling a new mindset that measures performance by outcomes, not physical presence [175].

## 6. Conclusions

This study establishes that managerial digital readiness (MDR) serves as a crucial link connecting information technology capability (ITC) and 21st century digital skills (DS) to enhanced public sector performance (PSP) in Indonesian city governments. Anchored in Dynamic Capability Theory [51] and Upper Echelon Theory [55], the research provides empirical evidence that both ITC and DS significantly contribute to increasing MDR, which subsequently leads to substantial improvements in PSP. These findings underscore MDR's role as an indispensable mechanism through which digital capabilities and skills are translated into tangible organizational outcomes.

Moreover, MDR mediates the relationships between ITC and PSP and between DS and PSP. This highlights the importance of not only investing in technological infrastructure and developing digital skills but also ensuring that managerial readiness is strategically fostered. Managers equipped with adequate digital readiness are better able to operationalize digital resources and competencies, leading to significant gains in both quantitative and qualitative dimensions of public sector performance.

Furthermore, digital leadership (DL) emerges as a pivotal moderating factor, amplifying the effectiveness of both ITC and DS on MDR. Effective DL, characterized by a clear digital vision, ethical use of technology, growth mindset, transparency, and participatory management style, strengthens the capability of managers to integrate and utilize digital tools and competencies strategically. Surabaya's successful digital transformation initiatives—such as SPBE integration, smart dashboards, and mobile governance—exemplify how digital vision, robust infrastructure, and strong leadership collectively drive meaningful transformation aligned with broader institutional objectives.

## 7. Theoretical Implication

This study contributes significantly to the theoretical development of digital governance and public sector transformation by advancing and integrating two foundational perspectives: Dynamic Capability Theory (DCT) and Upper Echelon Theory (UET).

First, drawing on DCT [51], the study demonstrates that managerial digital readiness (MDR) functions as a dynamic capability that enables public organizations to integrate, build, and reconfigure digital resources in response to rapidly evolving technological and administrative demands. Unlike prior literature that predominantly treats ITC or DS in isolation, this research conceptualizes MDR as a higher-order integrative mechanism that translates digital inputs into organizational performance outcomes, thereby extending DCT's applicability to the public governance domain.

Second, the study deepens the application of UET [55] by showing that digital leadership (DL)—embodying the cognitive style, digital fluency, and strategic vision of top public managers—moderates the relationship between ITC/DS and MDR. This reinforces the UET proposition that organizational outcomes are largely a reflection of the values and capabilities of its key decisionmakers. DL is shown to shape how digital capabilities are

perceived, deployed, and institutionalized, highlighting the behavioral and psychological dimensions of digital transformation.

Third, the study contributes to digital readiness literature by offering an empirically validated multilevel mediation–moderation model in the context of city government. Unlike previous models that focus on either individual skills or organizational infrastructure, this research integrates both resource-based (ITC, DS) and leadership-based (DL) antecedents into a unified framework centered on MDR. This model fills a critical gap by capturing how managerial cognition and structure jointly mediate the link between digital enablers and public service outcomes.

Finally, the study provides empirical support for extending the discourse on public sector innovation. While innovation in public administration has traditionally focused on policy and process redesign, this research highlights the importance of managerial readiness and digital competencies as the underlying engine of public sector performance in the digital era. This shifts the focus from purely technical innovation to capability-based transformation, opening new avenues for theoretical inquiry in public sector reform, strategic HRM, and e-governance.

## 8. Practical Implication

This study offers several practical implications for policymakers, digital transformation leaders, and public managers—particularly within local government institutions undertaking a smart city initiative. First, the results emphasize that information technology capability (ITC) must be accompanied by managerial digital readiness (MDR) to translate infrastructure investments into improved public service delivery. Therefore, local governments should not only prioritize procurement and system development but also invest in managerial training programs aimed at enhancing digital structural, strategic, and technological readiness. For example, routine workshops on IT alignment, cross-departmental data integration, and adaptive governance frameworks can elevate managerial confidence and system utilization.

Second, the study shows that 21st century digital skills (DS) are essential but not self-activating; their impact on performance is actualized only when managers are ready to apply them strategically. Thus, practical interventions must go beyond basic digital literacy and instead focus on cultivating higher-order skills such as data-driven decision making, collaborative digital communication, and digital problem solving. Municipalities like Surabaya can replicate the success of programs such as WARGAKU or the e-Office System by embedding digital competency frameworks into employee development plans.

Third, MDR emerges as a critical capability that should be institutionalized across all e-government initiatives. Local governments are advised to incorporate MDR assessments into leadership appraisal systems and performance-based budgeting to ensure readiness becomes a standard for managerial promotion and strategic delegation. Fourth, the moderating role of digital leadership (DL) suggests that leadership development must evolve to reflect the demands of digital transformation. Municipal leaders should be selected and developed not only based on administrative experience but also on their ability to mobilize digital tools, inspire innovation, and navigate change. Programs focused on participative leadership, ethical digital governance, and continuous upskilling will be vital to sustaining long-term reform momentum.

Finally, this research validates a scalable digital governance model. Cities outside Surabaya can adapt the framework—by aligning ITC and DS initiatives with MDR priorities and fostering DL—to replicate similar gains in transparency, responsiveness, efficiency, and public trust. National ministries, such as the Ministry of Internal Affairs (*Kementerian Dalam Negeri*/Kemendagri) and Minister of State Apparatus Empowerment and Bureaucratic

Reform (*Menteri Pendayagunaan Aparatur Negara dan Reformasi Birokrasi*/KemenPAN-RB), could incorporate this framework into the evaluation rubric for Electronic-Based Government System (*Sistem Pemerintahan Berbasis Elektronik*/SPBE) implementation across Indonesian municipalities.

## 9. Limitation and Future Research Directions

Despite offering significant theoretical and practical contributions, this study has several limitations that open avenues for future research. First, the use of a cross-sectional design limits the ability to infer causality among the variables. Future research should consider longitudinal studies to observe how managerial digital readiness (MDR) evolves over time in response to shifts in information technology capability (ITC), digital skills (DS), or digital leadership (DL). A pre–post-intervention design or time-series tracking of digital initiatives within government units would strengthen the causal inference of the model. Second, this study focuses on a single local government—Surabaya. While the city provides a leading case in Indonesia's digital governance, future studies should extend this work across multiple regional governments, provincial administrations, or national institutions to improve external validity. Cross-municipal comparative case studies can uncover contextual dynamics that shape digital transformation effectiveness.

Third, the study focuses exclusively on mid- to top-level managers, thereby omitting the perspectives of lower-level staff and frontline field officers. While managerial insights are vital for understanding strategic intentions and planning, they do not fully capture the organizational realities in which smart city initiatives unfold. Frontline employees play a critical role in operationalizing digital policies, engaging directly with technologies, and delivering services to citizens. Their day-to-day experiences, such as system usability issues, administrative hurdles, and inter-departmental frictions, can offer invaluable insights into the practical challenges and enablers of digital transformation. Excluding their voices may lead to an overestimation of organizational readiness, as assessments based solely on top-level perspectives risk overlooking implementation barriers at the ground level. Future research should therefore adopt a multilevel approach that integrates both individual-level and organizational-level variables to reveal cross-level dynamics, especially the interaction between managerial direction and operational capacity.

Fourth, while this study employed a quantitative design, future studies could benefit from qualitative approaches—such as case study, focus groups, or ethnographic methods—to capture the nuances of leadership behavior, organizational culture, and the lived experience of digital transformation among civil servants. A mixed-methods design could enrich the interpretation of digital readiness mechanisms and leadership influence.

Fifth, while the role of DL was modeled as a moderator, the study did not unpack the microfoundations or developmental pathways of DL. Future research could investigate how DL is cultivated, sustained, or diffused across public organizations—possibly by integrating theories of organizational learning, public entrepreneurship, or transformational leadership. Finally, contextual variables such as regulatory complexity, political dynamics, or citizen digital literacy were not included in the model. Future research could integrate contextual moderators to better understand the boundary conditions under which digital transformation succeeds or fails.

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