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We can work it out: A multilevel examination of relationships among group and individual technology workarounds, and performance

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Abstract

Despite the operational nature of enterprise system (ES) implementation and use, individual employees or work groups may deploy technology workarounds to circumvent inflexibility in or obstacles to using the ES. However, our understanding of the multilevel nature of technology workarounds and their performance implications remains limited. Drawing upon the multilevel theory of system usage and adaptive structuration theory, the current study examines the conditions under which group technology workarounds affect group performance, individual technology workarounds, and individual performance. Based on two studies with different research designs, we find that group technology workarounds have distinctive effects on short- and on long-term group performance. Specifically, while the impact of group technology workarounds on group performance is significantly positive in the short term, such effect diminishes over time. System failure and competition intensity strengthen the positive effect of group technology workarounds on short-term performance, whereas system failure and task nonroutineness lessen the negative effect of group technology workarounds on long-term performance. Our study further confirms the multilevel nature of technology workarounds, finding that group technology workarounds can influence individual technology workarounds and thereby individual performance. Our results support the view that technology workarounds as a group action should be considered alongside individual technology workarounds, as well as their positive and negative effects on both group and individual performance, in both the short- and long-term.

KEYWORDS

competition intensity, multilevel, short- and long-term performance, system failure, task nonroutineness, technology workarounds

1 | INTRODUCTION

An organization's enterprise system (ES), as an important technology investment for organizational managers, has received increasing attention by operations management (OM) and information systems (IS) practitioners and researchers (Bendoly et al., 2009; Ke et al., 2021; Krishnakumar et al., 2022; Tenhiälä & Helkiö, 2015).

Organizations rely heavily on the implemented ES to improve operational efficiency and financial performance (Hald & Mouritsen, 2013; Kumar et al., 2018). Prior OM and IS studies on ES have largely focused on prescribed use of ES in organizations (e.g., Bendoly et al., 2009; Ke et al., 2021; Liang et al., 2013; Tenhiälä & Helkiö, 2015). However, due to complexities of the system, or inflexibilities in or obstacles to the smooth or complete use of ES (Bendoly & Cotteleer, 2008; Tenhiälä & Helkiö, 2015), employees or groups often engage in using workarounds (Bendoly & Cotteleer, 2008; Heim et al., 2021; Tenhiälä & Helkiö, 2015). Technology workarounds represent an individual's or a work group's actions to accomplish the assigned work goals by circumventing one or more aspects of the prescribed use of ES (Bendoly & Cotteleer, 2008; Tucker et al., 2020). In particular, considering the existence of incongruences and contradictions between ES and operational practices, equilibrium is rare, and changes can be driven by tensions and local innovations (Bendoly & Cotteleer, 2008). Technology workarounds can be treated as a way to get work done, with short- or long-term advantages or disadvantages, when the corporate ES cannot satisfy, or even impedes, their local working requirements (Bendoly & Cotteleer, 2008; Tenhiälä & Helkiö, 2015).

According to the multilevel theory of system usage (Burton-Jones & Gallivan, 2007), system usage can be examined at both individual and group levels. Technology workarounds not only involve one person developing a personal and local workaround of using the ES, but may also be part of a system of processes and people that require joint development of alternative work processes (Burton-Jones & Gallivan, 2007; Malaurent & Karanasios, 2020). As such, technology workarounds can be conceptualized at the individual and/or group level. In order to fit their respective work requirements, for example, individuals may engage in individual technology workarounds (e.g., adapting or ignoring features, or using alternatives such as a shadow system) to bypass the implemented ES to save time or complete a necessary procedure. In contrast, group technology workarounds represent a shared perception, development, and application of alternative ways of using the ES to help achieve the work goals. For instance, when an ES is implemented in a top-down manner that may not fit local work practices, group members may collectively create workarounds to adjust the global ES and its related procedures to better fit their local practices (Malaurent & Karanasios, 2020). Morgeson and Hofmann (1999) argue that "to understand the structure of a collective construct, it may be helpful to identify the role the outcome plays in the collective, particularly in terms of how it facilitates goal accomplishment" (p. 259). Indeed, group-based work systems have been suggested as one of the most critical "soft issues" in OM (Pagell & LePine, 2002).

Prior studies emphasize a dialectical tension between the positive and negative effects of technology workarounds (Ferneley & Sobreperez, 2006; Morrison, 2015). Based on the multilevel theory of system usage (Burton-Jones & Gallivan, 2007), the potential mixed impacts (positive/negative) of group technology workarounds on performance should depend on their contexts. In particular, as explained in Section 2.1.3, adaptive structuration theory (AST) notes that time is an important factor that affects the role of technology use in a group, indicating that technology-triggered changes take time to occur (DeSanctis & Poole, 1994). Time is a critical contextual factor with collective properties tending to emerge and change more gradually than individual ones (Burton-Jones & Gallivan, 2007; Kozlowski & Klein, 2000). Thus, the use and implications of group technology workarounds may vary across time. Yet, the mechanisms by which technology workarounds' effects vary over time have received little attention (see Appendix S1A for a review).

Prior studies have also recognized the notion of temporal aspect of workarounds generally. For example, Patterson et al. (2006) found differences in the rate of workarounds between acute and long-term care, based on observational data. Tucker et al. (2020) indicated that "workarounds create self-reinforcing cycles that are difficult to end because they are effective in the short term" (p. 69), leading to dysfunctional "unusual routines" (Rice & Cooper, 2010). Technology workarounds can lead to more innovation and flexibility with an ES, and enable employees to come up with expedient and logical responses to problems in the short time (Petrides et al., 2004). But they may also increase process variation, leading to errors and safety risks that harm performance in the long time (Park et al., 2020; Tucker et al., 2020; Section 2.2 further elaborates these factors). Therefore, distinguishing short- and long-term performance not only theoretically helps explain paradoxical or inconsistent impacts related to group technology workarounds in the literature, but also provides practical implications for operations managers on how to manage group technology workarounds over time.

In addition to the context of time, AST further indicates that "the major sources of structure for groups as they interact with an advanced information technology are: the technology itself, the tasks, and the organizational environment" (DeSanctis & Poole, 1994, p. 128). In the current study, we thus investigate the influence on relationships between group technology workarounds and short-/long-term performance by representatives of the three contexts: technology (e.g., system failure), task (e.g., task nonroutineness), and environment (e.g., competition intensity; Section 3.2 elaborates reasons for choosing these representatives and their varying temporal implications). *System failure* occurs due to failures in hardware, software, or network. Failures in the ES implementation and use process may have very serious consequences, as they may bring about a collapse of operational capabilities (Hendricks & Singhal, 2003). *Task nonroutineness* refers to the extent to which tasks are (un)structured and (un)expected (Daft & Macintosh, 1981). Task nonroutineness influences group operations, as it may require more complex processes and uncertain outcomes, and may not be well supported by the operational structure (Gardner et al., 2015; Huckman & Staats, 2011). *Competition intensity* refers to the strength of competition that is reflected in the number of competitors in the local region (Jansen et al., 2006). Facing intensified competition, groups or organizations must act rapidly and proactively; otherwise, they will become vulnerable (Zhou et al., 2014). Our assumption is that in contexts of more system failure, task nonroutineness, and competition intensity, group technology workarounds should be more useful. As presented in Appendix S1A, although prior OM and IS studies have recognized some aspects of contextual factors related to the performance implications of workarounds, a more comprehensive understanding of the contexts of group technology workarounds is needed.

The multilevel theory of system usage also proposes that system usage, as a multilevel construct, should include relationships that cross levels (Burton-Jones & Gallivan, 2007). In practice, it is hard to identify instances of ES use generally and technology workarounds in particular that do not involve multilevel issues, even when considering systems designed specifically for individuals or for collectives (Burton-Jones & Gallivan, 2007; Malaurent & Karanasios, 2020). A multilevel approach can help better explain employees' technology workarounds behaviors at both group and individual levels as well as the linkages between levels. Realizing the importance of individual behavior in OM fields, Bendoly et al. (2006) highlight that "… the success of operations management tools and techniques, and the accuracy of its theories, relies heavily on our understanding of human behavior" (p. 737). Yet, few studies have examined the impact of group technology workarounds on individual technology workarounds and subsequent individual job performance. Employing a multilevel approach provides a richer understanding of the nature of technology workarounds and can help operations managers to better manage technology workarounds across and within groups over time. Therefore, the current study focuses on the following research questions:

RQ1: How do group technology workarounds influence short- and long-term group performance?

RQ2: How do system failure, task nonroutineness, and competition intensity influence the relationship between group technology workarounds and short- and long-term performance?

RQ3: How do group technology workarounds influence individual technology workarounds, and subsequently individual job performance?

To address the above research questions empirically, we use a multi-method and multilevel approach to test the model, through two studies. Specifically, in Study 1, we conducted a survey of 264 employees from 68 groups in one financial institution. The survey data were matched with archival data on performance of each group during multiple years following our survey administration. In Study 2, we collected three-wave longitudinal survey data in a large electronics company to conduct a robustness check for the cross-level effect from group technology workarounds to individual technology workarounds and individual performance, involving 275 respondents, also from 68 groups. In doing so, the current study contributes to the extant literature by responding to the call for conducting behavioral domain research in OM to gain practical insights relevant to employees/groups (Boudreau et al., 2003; Cantor & Jin, 2019), and by integrating theoretical perspectives from OM and IS to understand technology workarounds phenomena.

Specifically, first, our study provides a more nuanced understanding of the effects of group technology workarounds by differentiating short- and long-term performance. Our results show that the positive impact of group technology workarounds on short-term group performance vanishes in the long term. This finding confirms the temporal characteristics of technology workarounds (Morrison, 2015) and helps operations managers to better understand the implications of technology workarounds over time. Second, by exploring the moderating roles of the three contextual representatives of group-level system failure, task nonroutineness, and competition intensity, our study finds that the impact of group technology workarounds on short- or long-term group performance can be either strengthened or weakened by these factors, which provides a more comprehensive understanding of the contexts under which performance implications of group technology workarounds vary over time. Third, by unraveling both group- and individual-level technology workarounds, our study confirms and illuminates the multilevel nature of technology workarounds, which has received scant attention in the existing literature (see Appendix S1A). Our results indicate that group technology workarounds can positively affect individual technology workarounds and subsequent individual performance. Our study confirms the importance of incorporating behavioral issues into OM empirical studies, which helps provide more insights into the practical nature of extant theoretical models and presents a better understanding of how to achieve effective operations (Bendoly et al., 2006; Bendoly, Croson, et al., 2010). By considering the technical and operational aspects of ES use generally, and technology workarounds in particular, as well as their varying performance implications under different contexts, our study also extends previous interdisciplinary research in the OM-IS interface (Kumar et al., 2018; Setia & Patel, 2013).

2 | THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 | Toward a multilevel theory of technology workarounds

2.1.1 | Multilevel theory of system usage

Ployhart and Moliterno (2011) refer to multilevel theory as "theory that speaks to the connection that integrates two or more levels" (p. 127). Their exposition of multilevel theory emphasizes how processes and constructs relate across levels, notes how contexts affect these relationships, identifies fallacies associated with single-level organizational theories, and presents a variety of propositions. As organizational phenomena often operate across levels, adopting only one level of analysis, while ignoring the same phenomenon at another level, may lead to additional problems, incomplete understanding of phenomena, and insufficient generalizations (Hitt et al., 2007; Kozlowski & Klein, 2000; Ployhart & Moliterno, 2011). Multilevel theory defines principles that enable a more comprehensive understanding of phenomena that unfold at multiple levels in organizations (Kozlowski & Klein, 2000). Kozlowski and Klein (2000) indicate that "multilevel theory building presents a substantial challenge to organizational scholars trained, for the most part, to 'think micro' or to 'think macro' but not to 'think micro and macro'—not, that is, to 'think multilevel'" (p. 11). Although adopting single-level analyses can provide important insights into the relationship between organizational phenomena and outcomes of interest, they may obscure or overlook significant cross level relationships and causal mechanisms (Moliterno et al., 2010). Ketokivi (2019) highlights that it is crucial to understand the multilevel nature of theoretical concepts, and that confounding or confusing levels may result in biased and fallacious inferences. Prior OM and IS studies have used multilevel theory to examine various organizational phenomena. For example, Shalley and Gilson (2017) argue that creativity can emanate at the individual, group, and organizational levels. Ployhart and Moliterno (2011) apply the approach to understanding the emergence of social capital in organizations.

Building on multilevel theory, Burton-Jones and Gallivan (2007) develop a multilevel theory of system usage, proposing that system usage is a phenomenon that spans multiple levels, and highlight the need to investigate system usage at both group and individual levels. The multilevel theory of system usage argues that system usage should be conceptualized as a multilevel construct that includes the relationships that cross levels as well as multiple dependent variables at each level (Burton-Jones & Gallivan, 2007). Specifically, collective and individual system usage have the same functional relationship at each level, which can influence their respective collective and individual task performance (Burton-Jones & Gallivan, 2007; Morgeson & Hofmann, 1999). Furthermore, Burton-Jones and Gallivan (2007) suggest that researchers should identify different contextual factors that affect the relationship between system usage and outcomes.

2.1.2 | Group and individual technology workarounds

We adopt the multilevel theory of system usage approach to examine technology workarounds as a multilevel construct. Specifically, technology workarounds can be developed by, and operate at, the individual and/or group level (Tucker et al., 2020). Bendoly and Cotteleer (2008) indicate that individual employees often apply alternative solutions of ES to meet immediate and local needs. For example, our interview with some loan officers indicated that they often used Excel to help generate and send out customers' bills to collect payments when the credit management system occasionally froze or crashed. However, technology workarounds can also involve more than just one person developing a personal and local workaround to circumvent problems with the formal system use. They are part of a system of processes, people, and situated practices. For example, in some bank branches, loan officers often shared their system accounts with each other so that they could collectively provide better and more timely services for their customers in case the corresponding loan officers were not on duty that day. Thus, technology workarounds are often enacted not only individually, but also by groups of users, involving others willing and necessary to help, based on tacit knowledge, informal diffusion, observation, and emphasis on efficiency, and through seeking answers or solutions from others who are accessible and relationally close, while avoiding questioning competence during their ES use process (Debono et al., 2013). Often, technology workarounds require implicit or explicit collaboration and acceptance by others (Spierings et al., 2017). However, prior OM and IS studies have focused on either group- or individual-level workarounds (see Appendix S1A). It is thus valuable to use a multilevel perspective to explore performance implications of technology workarounds at group- and individual-levels as well as their cross-level relationship.

2.1.3 | Context of group technology workarounds

As discussed above, the multilevel theory of system usage suggests various contextual factors that may influence a collective system usage (e.g., group technology workarounds in our case) and its collective task performance (e.g., group performance in our case; Burton-Jones & Gallivan, 2007; Morgeson & Hofmann, 1999). Burton-Jones and Gallivan (2007) further discuss how DeSanctis and Poole's (1994) AST helps illustrate the importance of understanding the contextual factors when building a multilevel theory of system usage. Accordingly, we rely on the rationale of AST theory to justify our choice of key contexts, rather than strictly following the theory to develop our research model. AST describes the interplay between IT systems, social structures, and human actions (DeSanctis & Poole, 1994). According to AST, group performance results from the appropriation of IT systems by group members under the group structures and the context of IT systems use (DeSanctis & Poole, 1994; Poole & DeSanctis, 1990). AST has been widely used in OM as a theoretical lens for the effective deployment of IT systems to achieve organizational goals (e.g., Holweg & Pil, 2008). In particular, AST emphasizes the important contexts of time, technology, task, and environment.

Specifically, AST argues that *time* is a key factor that influences the relationship between collective system usage and its outcomes since appropriation of technology structures varies over time (DeSanctis & Poole, 1994). Indeed, "a given structure of collective usage could be associated with different outcomes because of differences in *time-scale* in the model being studied" (Burton-Jones & Gallivan, 2007, p. 671). The relationship between independent and dependent variables may take time to emerge, particularly for groups (Burton-Jones & Gallivan, 2007; McGrath et al., 2014). For instance, the change and implications of collective usage are likely to be gradual because the technology-triggered change in collective usage requires more coordination and interaction among group members and system components and processes (DeSanctis & Poole, 1994). As such, group technology workarounds may have different impacts on group performance over time.

More importantly, AST eschews a technocentric determinism view of IT use; rather, it highlights its social aspects because groups "mediate technological effects, adapting systems to their needs, resisting them, or not using them at all" (Poole & DeSanctis, 1990, p. 177). AST suggests that when groups interact with an advanced information technology, the major sources of structure are technology, task, and environment (DeSanctis & Poole, 1994). In the AST language, technology workarounds are a form of technology adaptation by users, and can be conceptualized as violating the spirit of the IT systems. By drawing on AST, we contend that the impact of group technology workarounds on short- or long-term group performance is (at least somewhat) contingent on those three contexts: *technology*, *task*, and *environment* characteristics. Specifically, in this study technology characteristics are manifested as *system failure*, task characteristics are manifested as *task nonroutineness*, and environment characteristics are manifested as *competition intensity*. Thus, it is necessary to examine how group technology workarounds influence group performance over time (in terms of short- and long-term performance) and across contexts (in terms of different technology, task, and environment characteristics).

2.2 | Technology workarounds

This section summarizes the reasons for, and nature of, technology workarounds.

2.2.1 | Main reasons for technology workarounds: ES complexity and misfits

An ES is inherently complex. Gasser (1986) notes many potential problems with ES, such as system changes; inappropriate designs; data inaccuracy; poor documentation; unreliability in operations, hardware, or software, as well as limited and unequally distributed individual and organizational resources; system degradation; constantly shifting work, social, and environmental situations; and misalignment among expertise, resources, norms, systems, and processes. Constant, appropriate, and timely problem identification, monitoring, maintenance, repair, and enhancement are unlikely (Gasser, 1986). Problems and fixes may not be diagnosable, too expensive, not in the designer domain, or too local. Problems or obstacles represent or create inefficiencies of ES use that influence the organization's operational excellence, customer intimacy, or product leadership (Bendoly et al., 2009).

For example, Bendoly, Perry-Smith, and Bachrach (2010) discuss challenges to task resource sharing due to increasing multi-project and variable work, increases in unanticipated resource constraints, vulnerability of work to unknown interdependencies across tasks and projects, concomitant need for resource sharing, and demands on and flexibility from project managers. An ES may be treated as embedding "best practices," but these may not fit well with actual operational processes (Bendoly & Cotteleer, 2008). Thus, there is no perfect or even stable fit between the ES and operational processes. The use of ES (especially if newly implemented) itself can be a disruption to current practices, preferences, and expectations, with areas of greater or lesser fit. Thus, system users and organizations must engage in adaptation behaviors (Bala & Venkatesh, 2015). One of the ways they do this is through technology workarounds.

The development and use of technology workarounds can be viewed as extensions or adaptations of ES developed by end users to keep business processes flowing and to improve operational efficiency (Bhakoo & Choi, 2013; Spierings et al., 2017). An identified and intentional technology workaround can provide the motivation and basis for backward compliance checking, as well as process redesign, data flow improvement, permission and control processes, redefinitions of roles, training, and sanctioning/disciplining. The cascading role of well-intended technology workarounds has been documented by prior OM scholars (Bendoly & Cotteleer, 2008; Bhakoo & Choi, 2013).

2.2.2 | Conceptualization of technology workarounds

The term "workarounds" and related research originated in the field of IS and is also well documented in computer use and technology implementation settings (Gasser, 1986; Koopman & Hoffman, 2003). In particular, technology workarounds were identified and proposed by Gasser (1986), who defined technology workaround behavior as non-standard procedures used by users/operators to compensate for the deficiencies found in the ES. Technology workarounds include both circumvention and user innovation, each "unfaithful" to the spirit of the system (DeSanctis & Poole, 1994). When facing a strong misfit between task and technology, employees are more likely to circumvent or adapt one or more of the prescribed uses of the implemented system (Bendoly & Cotteleer, 2008). Prior OM studies have examined hospital providers' general workarounds to circumvent processes in response to healthcare operational failures (Tucker et al., 2020) or workers' technology workarounds to alter system usage to deal with resource shortages (Morrison, 2015). In this study, we focus on technology workarounds, a subset of the general area of workarounds. Specifically, we define technology workarounds in the current study as attempts to accomplish work goals by circumventing or overcoming obstacles or exceptions of prescribed ES use when the formal ES does not recognize or cannot easily handle a task process.

We believe that technology workarounds are important to OM researchers and practitioners (Bendoly & Cotteleer, 2008; Tenhiälä & Helkiö, 2015) for two reasons. First, technology workarounds reflect the misfit between the operational process and the implemented ES. Employees often seek out alternatives to work around the prescribed path of system design for coping with the misfit between technological and operational processes (Bendoly & Cotteleer, 2008). Prior OM research has also suggested that "both human and technique considerations can be vital in the success of operations improvement programs" (Boudreau et al., 2003, p. 108). Considering the operational nature of ES implementation and use (Kumar et al., 2018), it is important to understand the performance implications of employees' or work groups' circumventing an inflexibility or obstacle in using the system.

Second, technology workarounds may provide a solution to the obstacles or exceptions but they do not, by themselves, solve the underlying ES problems. If some inadequate or inappropriate work processes, people, rules/policies, or equipment cause the obstacles or exceptions, managers may be able to change them, and consequently reduce the need for technology workarounds (Ejnefjäll & Ågerfalk, 2019). In contrast, a poor ES design might be too idiosyncratic, difficult to resolve, or too costly to address (Ejnefjäll & Ågerfalk, 2019; Tenhiälä & Helkiö, 2015). Frustrated with the poor system design, managers may wish to customize or replace the existing ES, but either is likely time- and cost-prohibitive (Tenhiälä & Helkiö, 2015). Under this condition, managers often prefer employees' technology workarounds of the prescribed system use over customization or replacement, and thus they need to be aware of how to better manage their subordinates' technology workarounds. As Bendoly and Cotteleer (2008) indicate, there is a paucity of attempts to explain technology workarounds, despite theory and anecdotal evidence suggesting complex contingencies can arise between these operational and technological issues. As a result, "of interest is theory and empirical evidence regarding how alternate paths of technology implementation translate into operational outcomes" (Heim et al., 2021, p. 921).

3 | RESEARCH MODEL AND HYPOTHESES

Figure 1 presents the research model. We postulate that group technology workarounds positively affect short-term performance, while negatively affecting long-term performance. Furthermore, we propose that system failure, task nonroutineness, and competition intensity moderate the above relationships. Moreover, we suggest that group technology workarounds positively affect individual workarounds, which consequently positively influence individual job performance.

3.1 | Implications of group technology workarounds for group performance

3.1.1 | Short term

We propose that group technology workarounds can positively influence group performance in the *short term*. Group technology workarounds allow group members to continue their current work by providing a temporary solution to an obstacle of the ES (Ferneley & Sobreperez, 2006; Morrison, 2015; Park et al., 2020). Group technology workarounds can be viewed as an effective way for members to engage with the formal ES (Choudrie & Zamani, 2016). For example, when the formal ES does not fit the group's work requirements, group technology workarounds can enhance group members' efficiency and effectiveness in performing their job tasks in the short term, thereby improving group performance. Meanwhile, group technology workarounds might also help group members identify new ways of using the ES to accomplish job tasks. For example, group members may figure out other solutions to support the implementation of their activities when the formal ES does not work well (Bhakoo & Choi, 2013), thereby improving their group performance. Groups use technology workarounds to better obtain and apply information and save time, thereby supporting their daily activities in the short run (Choudrie & Zamani, 2016). For instance, in a financial institution, loan officers were overwhelmed by a backlog of orders, so they often engaged in alternative systems to serve customers concurrently (Bala & Venkatesh, 2015; Oliva & Sterman, 2001), and thus could make more loans. As a result, group technology workarounds should positively contribute to group performance, at least in the short term, because group members can accomplish necessary work as well as feel more positive toward their work (Park et al., 2020).

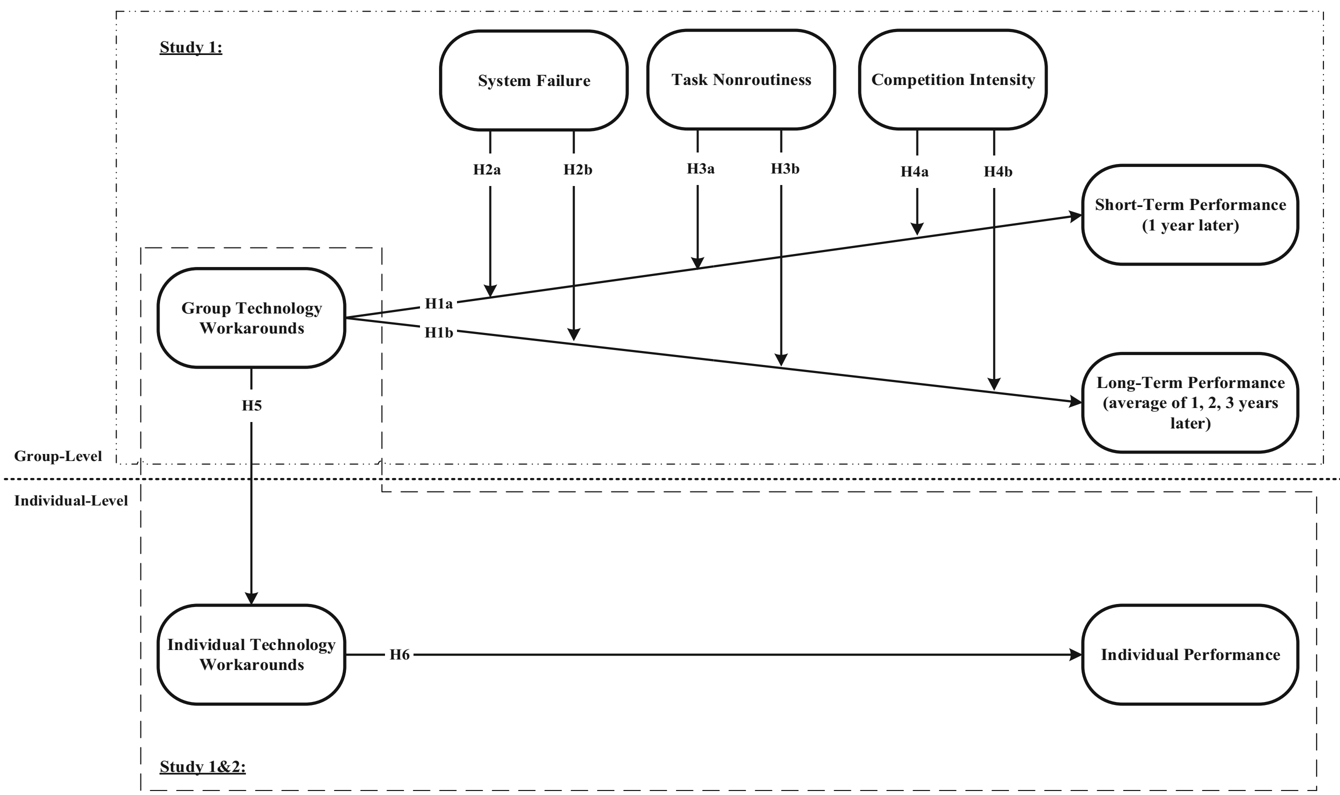

FIGURE 1 Research model.

3.1.2 | Long term

In contrast, we argue that group technology workarounds will tend to harm group performance in the *long term*. Some researchers have indicated that technology workarounds may generate a vicious cycle of deterioration and embedded unusual routines because group technology workarounds stimulated by blockages can disrupt system and task interdependencies, and promote the need for more new technology workarounds (e.g., Rice & Cooper, 2010; Tucker & Edmondson, 2003). For example, Malaurent and Karanasios (2020) suggest that "the congruency created through workarounds may be temporary rather than long-term, with new contradictions emerging and new workarounds needed" (p. 658). Over time, these new technology workarounds might require additional efforts and working hours for fixing the ES features created by previous technology workarounds that become out of date, slow down overall processing, or create obstacles or errors for subsequent processes or tasks. Moreover, the long-term use of group technology workarounds can create unnecessary or redundant processes in the group, which result in deviations from the optimal overall process of ES use and procedures and also incur significant costs (Park et al., 2020). An ongoing technology workaround can result in habituation that compromises safety attitudes or quality standards of ES use (Vaughan, 1999); in turn, the erosion of safety and standards practices can foster a high-risk operations system, resulting in near-accidents or actual accidents (Dekker, 2016). Morrison (2015) notes that "the building up of a stock, such as knowledge or proficiency with a skill, anchors the central notion in learning curve theory that performance improves with cumulative experience" (p. 86). However, when group members engage in technology workarounds, the benefits obtained from following formal procedures and prescribed ES use, such as improved skills and greater understanding of the ES, may be circumvented. Further, technology workarounds are seldom documented, thus preventing knowledge accumulation, ES improvement, or organization-wide learning (Fiol & Lyles, 1985). Thus, when groups engage in technology workarounds over time, the positive impacts of an implemented ES will likely be diminished because errors, inefficiency, or hazards and negative consequences on subsequent work activities can be induced by group technology workarounds (Boudreau & Robey, 2005; Laumer et al., 2017). For example, as noted earlier, loan officers may work around the formal rules or procedures of credit management systems collectively in order to more quickly satisfy customers' needs. However, such group technology workarounds may not better serve customers over time and thus can reduce the accumulated loans in the long run because the accumulated knowledge of customers learned through the formal system is also circumvented accordingly. Therefore, group technology workarounds can decrease the productivity of the group in the long term. Thus, we hypothesize that:

> **H1a.** Group technology workarounds are positively related to short-term group performance.

> **H1b.** Group technology workarounds are negatively related to long-term group performance.

3.2 | Contextual factors of group technology workarounds

3.2.1 | System failure

Among the various technology-related factors, this study includes system failure because of its fundamental connections with technology workarounds in our research context. First, an organization's/group's operational IT system is viewed as a critical, valuable business resource, supporting operational efficiency and competitive advantages (Lam et al., 2016), and enabling key strategic initiatives such as business process integration and customer relationship management (Ray et al., 2004). A large number of extant OM studies investigate the role of IT systems in organizational operations (Devaraj et al., 2007; Tenhiälä & Helkiö, 2015). These studies mainly assume that the corporate IT system is successful in supporting effective operations, while ignoring the possible occurrences of system failures. Yet IT systems can offer value to organizations only when they are successfully implemented and reliably used in daily operations and decision-making (Cao & Dowlatshahi, 2005; Sanders, 2008).

Second, a system failure indicates there are glitches with existing functional IT systems designed to support IT operations and business. IT systems failure can induce significant disruptions and costs to the organization's or group's business operations (Velmurugan & Dhingra, 2015). For instance, in the case of FoxMeyer Drugs (Bulkeley, 1996), the failure of ERP implementation resulted in significant disruptions in order fulfillment and logistics. As a well-publicized example, in 1993, Greyhound Lines launched a new reservation system; however, the system was slow and prone to crash (Tomsho, 1994). The failure of the Greyhound Trips system hampered the company's ability to sell tickets, resulting in trip delays and ultimately a 12% decrease in ridership. A higher frequency of system failure involves unplanned cessation or errors in operation systems (e.g., hardware, software, and network) or data assets that the system creates, processes, transmits, and safeguards (Benaroch & Chernobai, 2017), which should influence the need for and implications of group technology workarounds.

3.2.2 | The moderating role of system failure

Short term

Group members who experience system failure cannot continue at least some of their work in the short-term (Tucker, 2007). Thus, they may better accomplish their tasks by working around the system failure (Oliva & Sterman, 2001). In addition, system failures increase time pressure for group members (Morrison, 2015); the focus of group members is interrupted, and they have less time to complete the task or meet deadlines (Froehle & White, 2014). Therefore, when the frequency of system failure is high, the positive effect of group technology workarounds on short-term group performance is likely stronger, because group technology workarounds can help users better cope with time pressure while "getting work done" temporarily (Morrison, 2015; Park et al., 2020).

Long term

Under the condition of high frequency of system failure, over time group members might experience a loss of work control (Elie-Dit-Cosaque et al., 2011), and realize that their efforts to use the formal ES are unproductive (Tucker, 2004). Group members can minimize these negative consequences or potential harms in the long term by engaging in technology workarounds (Bala & Venkatesh, 2015). Group technology workarounds thus are innovative solutions to avoid resource losses in the case of long-term system failures (Laumer et al., 2017). As previous research indicated, in the longer term, if the situation of system failure does not change, technology workarounds may become routinized by the group to ensure their work can be accomplished (Wong et al., 2022), reducing attention to learning about causes of system failure, and increasing incompatibilities with other subsystems and organizational units, as noted above (Rice & Cooper, 2010). On the other hand, under the condition of low system failure, group members have more control over how they work to get their work done satisfactorily via the formal ES. However, in this situation, group members may still engage in technology workarounds for other reasons, such as time saving but quality-reducing shortcuts (i.e., process-avoiding), which might lead to lower group performance in the long term because the cumulative learning experiences through the formal ES can be also circumvented (Tucker et al., 2020). Therefore, we hypothesize that:

> **H2a.** System failure strengthens the positive relationship between group technology workarounds and short-term group performance.

> **H2b.** System failure weakens the negative relationship between group technology workarounds and long-term group performance.

3.2.3 | Task nonroutineness

Although various task characteristics have been investigated in the extant OM literature (Alblas, 2022; Pagell & LePine, 2002), we focus on task nonroutineness because it has a high level of theoretical and practical relevance. First, task nonroutineness includes task (un)analyzability and variety, reflecting the extent to which the tasks are not routine or understandable (Majchrzak et al., 2005; Perrow, 1967). Nonroutine tasks are less structured, uncertain, or have no predefined solutions (Huckman & Staats, 2011; Jehn, 1995). Nonroutine tasks are not systematized and structured and thus are novel or equivocal (Daft & Macintosh, 1981; Gardner et al., 2015). Such tasks can significantly affect group operations and performance (Bendoly, Croson, et al., 2010; Huckman & Staats, 2011; Perrow, 1967). In particular, Perrow (1967) argues that task routineness directly influences the capability of employees to turn inputs into outputs. Rice (1992) indicates that task nonroutineness is a causally prior task factor, and may have persistent and frequent implications for the task/technology match.

Second, group task environments consisting of higher-level routine tasks tend to have very clear guidelines and rules available (Rice, 1992). In such cases, group operations are able to follow a standard, objective procedure to solve problems (Gardner et al., 2015). Group members do not need to engage in workarounds to solve simple problems. However, tracking tasks that are nonroutine often requires group members to exert substantial efforts, and longer time to interact with the system (Faraj & Yan, 2009), leading to lower effectiveness. This may lead to the development of technology workarounds to accomplish goals faster and more simply.

Additionally, the greater the number of features of an ES, the greater the difficulty of finding the right features to accomplish various work tasks, especially for tasks that are nonroutine (Huckman & Staats, 2011; Jehn, 1995). When a task is less analyzable and thus nonroutine, existing work methods are not as applicable, and groups cannot rely on existing methods or codified processes as easily, but instead need more personal and richer information processing methods (Gardner et al., 2015). As such, task nonroutineness possibly increases the value of group technology workarounds, as it creates or requires opportunities for groups to exercise more innovative processes. Group members who engage in technology workarounds will try to explore more features of the system, and therefore are more likely to identify the right features or develop a new feature or procedure to accomplish nonroutine tasks. Therefore, incorporating task nonroutineness as a contingency factor can help shed light on the relationship between group technology workarounds and group performance.

3.2.4 | The moderating role of task nonroutineness

Short term

Given that an ES is a large-scale and complex system, using such a system to accomplish especially nonroutine tasks is unlikely to be simple (Huckman & Staats, 2011; Zhang, 2017). It might be not easy to accomplish a nonroutine task via prescribed use of ES, because there may be unexpected or exceptional aspects of the task (Faraj & Yan, 2009; Rice, 1992). Nonroutine tasks require group members to think creatively and differently and explore various potential solutions of using the ES to accomplish the tasks (Gardner et al., 2015; Rice, 1992). When using the ES to perform a nonroutine task, group technology workarounds may become more effective in helping how group members complete the task, leading to better group performance within a short time. In contrast, a routine task can be solved by using prescribed rules and procedures of ES. In this situation, spending time on technology workarounds may distract group members from accomplishing their job tasks, thus resulting in decreased group performance in the short term (Zhang, 2017).

Long term

As Jia et al. (2014) noted, nonroutine tasks increase the importance of generating and evaluating alternative solutions and fit between ES features and tasks (Keller, 1994; Menor & Roth, 2007) and approaches of ES use among group members, and therefore may mitigate the detrimental effect of group technology workarounds on long-term performance. Over time, group members can come to better understand the strengths and weaknesses of different ES features, and are able to identify optimal solutions when dealing with nonroutine tasks, leading to less decreased job performance (Zhang, 2017). Moreover, nonroutine tasks may trigger group members' innate desire for challenges, which motivates them to learn about and develop technology workarounds to deal with unexpected incidents at work. Such increased learning motivation should contribute to long-term effectiveness (Fiol & Lyles, 1985; Hult et al., 2003). Therefore, when group members perform nonroutine tasks, the negative effect of group technology workarounds on long-term performance will be weakened. Hence, we hypothesize that:

> **H3a.** Task nonroutineness strengthens the positive relationship between group technology workarounds and short-term group performance.

> **H3b.** Task nonroutineness weakens the negative relationship between group technology workarounds and long-term group performance.

3.2.5 | Competition intensity

While prior research has identified different types of organizational environmental contexts such as competition intensity, munificence, and dynamism (Gligor, 2018; Jansen et al., 2006; Song et al., 2020), we focus on competition intensity because competition has long been considered the most significant environmental factor influencing group operational capabilities and resource allocation (Porter, 1985; Zhou et al., 2014). First, competition intensity represents the degree of competition faced by a business unit (Gao et al., 2015; Porter, 1985). In the past decades, scholars have explored the moderating role of competition intensity in the effectiveness of innovation strategies. For example, Jansen et al. (2006) point out that in more competitive environments, exploitative innovation is more conductive to the financial performance of a unit. Sahi et al. (2019) report that competition intensity positively moderates the effects of innovativeness/risk-taking on operational responsiveness. Some studies have also indicated that the more intensive competition in the environment, the more likely that innovative solutions for IT systems (including technology workarounds) will be developed (e.g., Farrell, 2003; Schoenherr et al., 2010; Zahra, 1995). In general, competition intensity shapes technology-performance relationships (Dong et al., 2009; Porter, 1991).

Second, high levels of competition intensity may amplify the effectiveness of group technology workarounds. When there is less intense competition, groups can rely on prescribed use of an ES to achieve performance goals. However, when there is more intense competition, groups have to adapt accordingly and find ways to respond to the threat. As such, under conditions of intense competition, it may be more useful for a group to employ technology workarounds to innovatively support its process flow and information integration.

3.2.6 | The moderating role of competition intensity

Short term

The implications of group technology workarounds on performance can be influenced by the context of competition intensity within which the group operates (Massimino & Lawrence, 2019). In the absence of intensive competitive pressure, groups can engage in prescribed use of the ES to serve their consumers in the short term because consumers have less bargaining power. However, in intense competition contexts, there are more competing providers (Song et al., 2020), so consumers can have more choices and thus may become more demanding. Under this context, groups need to be more responsive in meeting consumers' needs in a timely manner (Alyakoob et al., 2021; Zhou et al., 2014), and to act proactively and to adapt to the changing environment rapidly (Zhou et al., 2014). Thus, high competition intensity could make groups focus more on survival and short-term profitability (Massimino & Lawrence, 2019). Group members would then engage in technology workarounds to complete tasks so as to better obtain effective competitive response and better performance within a short time.

Long term

More competitive markets may also reduce the negative effect of group technology workarounds on long-term performance. First, although technology workarounds may erode safety and standards practices of ES use in the long run (Park et al., 2020; Tucker et al., 2020), differentiation in service and products can mitigate the potential threat of intense competition (Ding et al., 2019). Maintaining long-term profitability is difficult for groups in competitive environments (Massimino & Lawrence, 2019). Groups with high technology workarounds are more likely to expand current solutions to problems and build differentiation benefits in the long term. Second, from the information processing perspective (Zhou et al., 2014), groups with high levels of technology workarounds are in a favorable position in the long run because they need to continuously access and interpret various information about customers and then develop creative responses to customers' changing needs. As competition becomes fiercer, the need for acquiring and analyzing customers' information and needs increases (Zhou et al., 2014). Accordingly, increased competition may place a premium on group technology workarounds in the long term. Therefore, the general negative influences of group technology workarounds can be reduced somewhat in the context of high competition intensity in the long run. Thus, we hypothesize that:

H4a. Competition intensity strengthens the positive relationship between group technology workarounds and short-term group performance.

H4b. Competition intensity weakens the negative relationship between group technology workarounds and long-term group performance.

3.3 | Effects of group technology workarounds on individual technology workarounds

The multilevel theory of system usage highlights the influence of system usage at one level of analysis on system usage at a different level of analysis. The cross-level influences emphasized by multilevel theory can be conceptualized as top-down and bottom-up models; here, the current study focuses on top-down models because top-down effects are more prevalent, powerful, and immediate compared to bottom-up effects (Kozlowski & Klein, 2000). The multilevel principle of bond strength (Kozlowski & Klein, 2000) stresses that social collectives with clearly defined boundaries, such as groups, can be more likely to exert significant impacts in influencing lower level relationships and outcomes of interest. These situations are more likely to create top-down effects than bottom-up effects and can create more homogeneity within groups, and heterogeneity between groups, in how employees engage in technology workarounds (Kozlowski & Klein, 2000).

Specifically, we argue that group technology workarounds are expected to positively affect individual technology workarounds. First, group technology workarounds are likely to influence an individual's own technology workarounds because they offer external validation by which self-perception regarding technology workarounds can be further developed and reinforced. Group technology workarounds may increase the value of individual technology workarounds in individuals' eyes and facilitate their use of them. Second, individuals often identify with their groups (Hoggy & Terry, 2000), and thereby behave similarly to group members as a way to reinforce their membership and the group's identity (Pagell & LePine, 2002; Wang et al., 2013). Individuals who see themselves as members of a group may self-impose group meanings and expectations and try to minimize discrepancies between their own actions and that of the group (Wang et al., 2013). Third, to maintain a shared knowledge base for collaborative work, individuals may need to keep up with certain knowledge that their groups are accessing (Alavi & Leidner, 2001). Individuals who accomplish their tasks through interaction with most members of the group who engage in group technology workarounds would be more likely to also engage in individual technology workarounds. This is because continuing prescribed use of the corporate ES without participating in the group technology workarounds would likely incur high costs for that person and their tasks. Therefore, we hypothesize that:

> **H5.** Group technology workarounds are positively related to individual technology workarounds.

3.4 | Effects of individual technology workarounds on individual performance

Most technology workarounds result from individual employees attempting to achieve task goals and job performance, at least from the individual's perspective (Bhakoo & Choi, 2013). As reviewed in Section 2.2.2, technology workarounds can help overcome some restrictions, anomalies, or obstacles in the ES that prevent efficient, effective, or complete task accomplishment (Bhakoo & Choi, 2013). Technology workarounds enable employees to proactively explore possible and appropriate ways of ES use to accomplish their tasks and address ad hoc challenging tasks, thereby mitigating some of the negative outcomes of an imperfect ES (Bhakoo & Choi, 2013). As a result, when employees identify problems, they tend to improvise on the job, adapting the system and/or their processes for better performance. Thus, individual technology workarounds are expected to enhance individual job performance.

> **H6.** Individual technology workarounds are positively related to employees' individual job performance.

4 | RESEARCH METHODOLOGY

4.1 | Overview of studies

In Study 1, we matched the survey data collected from one of the largest financial institutions in China with archival data on short- and long-term group performance to examine the direct effects of group technology workarounds on group performance (H1) and how such direct effects were moderated by system failure, task non-routineness, and competition intensity (H2, H3, and H4). Moreover, we also explored how group technology workarounds influence individual technology workarounds and individual performance (H5 and H6). In Study 2, we used a time-lagged cross-level field study to test the direct impacts of group technology workarounds on individual technology workarounds and individual performance (H5 and H6). Results from the two studies corroborated each other, thus strengthening both the internal and external validity of our conclusions.

4.2 | Study 1

In Study 1, we collaborated with one of the largest financial institutions in China, a large and state-owned commercial bank. The bank has 78 branches, each in a different region, each constituting one of the study's work groups. In order to streamline the business process, this institution had implemented a credit management system (CMS) across all the branches at the same time. CMS is a system for handling credit accounts that provides many features, such as assessing risk, supporting customers, determining how much credit to offer, and sending out bills to collect payments. These branches have similar sizes and structures, and they perform similar tasks and each branch has 5 to 10 loan officers. The loan officers of each branch have common goals. Loan officers in each branch can interact with each other to assess new applications for loans, create account databases, and adjust accounts in response to changing financial risk and interest rates by using the CMS. Data were collected from branch loan officers about 12 months after the implementation of CMS. To obtain the branch goals, branch loan officers should perform functionally interdependent roles, coordinate their activities, and work closely with each other through the CMS. Accordingly, the bank branches studied in our study can be treated as effective work groups (González-Romá & Hernández, 2014). Prior OM studies have also used banking examples to examine the design of effective and efficient back-room operations and highlight that the major concern of back-room operations is the management of support systems (e.g., Roth & Van Der Velde, 1991).

With the help of the headquarters' human resource (HR) department, we contacted all 600 loan officers across the 78 branches and invited them to participate in our survey through the email. We selected loan officers as the key informants for two reasons. First, they had participated in the CMS implementation process and used the CMS on a regular basis to support their job tasks, and thus were knowledgeable about the issues on group and individual-related technology workarounds. Second, as full-time employees, they had a good understanding of their branches' business process, specific job tasks, as well as the environment in which their branches operated. We received 311 responses across all 78 groups (51.8% response). Since we wished to match group technology workarounds with short- and long-term performance, we sought to ensure the stability of groups during our survey administration. Thus, if any groups' members or leaders changed, they were removed from our sample, resulting in 264 respondents in 68 groups.

To test for possible non-response bias, we used a procedure common in OM research (Clottey & Benton, 2013, 2020), a comparison between participating respondents and non-participating respondents. Specifically, we compared the participating respondents ($n1 = 264$) and the non-participating respondents ($n2 = 366$) on the gender and age to test for nonresponse bias. The t tests indicated that there were no significant differences on gender ($t = 0.60$, $p = .55$) or on age ($t = -0.30$, $p = .76$) between the two groups. Moreover, we also compared the differences between the participating bank branches ($n1 = 68$) and nonparticipating bank branches ($n2 = 10$) in terms of branch performance and size. The t tests indicated that there were no significant differences on accumulated loans (i.e., branch performance; $t = -0.77$, $p = .46$) or on branch size ($t = 0.95$, $p = .36$) between the two groups. In addition, we also conducted follow-up calls with some of the nonresponding employees; they indicated that they did not participate in the survey due to the lack of time. All these results suggested non-response bias was unlikely a major concern in our study. The loan officers' average years of experience in the branch were about 4.1 years, which further implied that they had appropriate knowledge on issues under study. Table 1 describes the information of the samples.

4.2.1 | Operationalization of constructs

Considering that we conducted the survey in China, four researchers with related knowledge translated the English questionnaire into Chinese (Van de Vijver & Leung, 1997). We also back-translated the survey to ensure equivalence. We used 7-point scales to measure the items (from 1- "strongly disagree" to 7- "strongly agree").

Following the guidelines outlined by previous studies (Block, 1956; Moore & Benbasat, 1991; Tang & Rai, 2012), we developed measures for group technology workarounds and individual technology workarounds. Specifically, we refined the questionnaire by sequentially following a three-step procedure: (1) two-stage Q-sorting conducted by 10 PhD students in OM and IS areas to evaluate content validity and face validity (Block, 1956; Moore & Benbasat, 1991). Five sorters successfully classified 93.9% and 98.3% of the items into the intended constructs at each stage (details about the sorting process and results are in Appendix S1B); (2) peer review by a panel of 10 CMS users and four academic experts for content validity, format of the survey, as well as the clarity of instructions; and (3) a pilot study with 86 MBA students who used ES to support job tasks in their daily work to assess the new scales' validity and reliability. Then, we further improved and refined the items based on the feedback received from these steps. Finally, six similar items at each of the two levels represented the construct with sufficient reliability and validity (Bala & Venkatesh, 2015).

Although we conceptually distinguished technology workarounds from its related constructs, such as innovative use and avoidance use, we additionally conducted a confirmatory factor analysis (CFA) to test whether technology workarounds can be empirically differentiated from its related constructs. We collaborated with a marketing research company in China that helped us to

TABLE 1 Demographic information of the respondents for Study 1 ($N = 264$).

Demographics	Categorization	Number of respondents	Percentage (%)
Gender	Male	173	65.5
	Female	91	34.5
Age	25 or below	100	37.9
	26–35	92	34.8
	36–45	54	20.5
	46 or above	18	6.8
Education	Senior high school or below	4	1.5
	College	48	18.2
	Bachelor's degree	203	76.9
	Master's degree or above	9	3.4

recruit 295 participants who used ES on a daily basis as part of their jobs. Appendix S1C shows that technology workarounds can be discriminated from related constructs such as innovative use and avoidance use, both conceptually and empirically.

We operationalized *individual technology workarounds* (ITW) as an individual-referent construct in the survey. In contrast, to measure *group technology workarounds* (GTW), we used the referent-shift design to make sure that the constructs properly capture the group-level phenomena using group-reference items (van Mierlo et al., 2008), by measuring the respondents' perceptions of the group's traits or behaviors rather than the perceptions of their own behaviors. Following the suggestion by Hofmann (2002), we used "we as a group" instead of "I" in the items to help shift the referent of the GTW from an individual focus to a group focus. Both measures consisted of the six appropriately worded items.

We used archival data to measure *short-term* and *long-term group performance*. Specifically, we used the financial institution's branch-based accumulated loans and loans balance as two measures of each branch's group performance. Accumulated loans represent the accumulated amount of loans provided by the branch and loans balance represent the amount of loans that have left to pay in the branch. These two measures were the key performance metrics that the financial institution used to assess the performance of each branch and had been also widely used for measuring banking performance in prior studies (e.g., Davis & Albright, 2004; Posen & Chen, 2013; Zhang et al., 2019). Moreover, these measures are also suggested as the critical factors for firms' risk control and growth in the financial/fintech industry. For example, according to a recent report by DBS Group Research, accumulated loans indicator is one of the crucial indicators for financial institutions to conduct risk control in China's fintech sector (Gong et al., 2020). We obtained these measures from three consecutive annual group performance evaluations to measure short- and long-term performance ($t+1$, $t+2$, and $t+3$). To reduce the issue of reverse causality, we used group performance 1 year after the data collection as short-term performance ($t+1$) and the three-year average unit performance ($t+1$ through $t+3$) as long-term performance (Bamberger et al., 2021; Feng et al., 2015). Similarly, we used the five-year average unit performance ($t+1$ through $t+5$) as a long-term performance measure for a robustness check (Bamberger et al., 2021; Feng et al., 2015).

Regarding the three group-level moderators, we measured *system failure* as the frequency of each failure based on each group's record of system disruptions during the past year. Each group annually recorded the frequency of system error/downtime, such as failure of an operating system, the disabling of the file management system, or the destruction of a piece of hardware. We used three items adapted from Majchrzak et al. (2005) to measure *task nonroutineness*. For *competition intensity*, we used the number of similar and competing financial institutions within 5 km and within 10 km for each local branch within a region (Massimino & Lawrence, 2019; Song et al., 2020).

For *individual job performance*, we used a four-item self-reported measure, adapted from Kraimer et al. (2005) and Welbourne et al. (1998).

We also included controls for several factors that could influence group performance. Specifically, following prior studies (De Vries et al., 2018), these included *group size* and *group age*. We also controlled the focal group's *geographic distance from the headquarters*. We obtained the latitude and longitude coordinates of each group's location as well as that of the headquarters and computed the distance between coordinate pairs (Massimino & Lawrence, 2019). Due to potential "halo effects" (Shah & Shin, 2007), we also included the *prior year's group performance* (t) in our model. Considering employees' identification with and tenure in the group represent two of the most important individual characteristics that shape how employees internalize group norms/actions (Kim & Toh, 2019; Xu et al., 2017), they may influence individual technology workarounds and job performance. Specifically, we used four items adapted from Kim and Toh (2019) to measure *employees' identification with the group*, and used years in the employee's group as *tenure*. In addition, we included *gender*, *age*, and *education level*, as these may affect employees' individual technology workarounds and job performance. Appendix S1D provides the items for each construct.

4.2.2 | Measurement model

Table 2 shows that composite reliability and Cronbach's alpha for all items were higher than the recommended 0.70, indicating good reliability. We assessed convergent validity using the value of loadings and the average variance extracted (AVE). Table 2 shows that the loadings of all items on their construct were higher than the recommended 0.60, and the AVE values were above the 0.50 recommended level, indicating high convergent validity.

As Table 3 shows, the square roots of AVEs of constructs were greater than the correlations, indicating good discriminant validity. Furthermore, we followed Gerbing and Anderson (1988) and performed two separate CFA models (unconstrained and constrained) for all pairs of constructs to further assess discriminant validity.

TABLE 2 Results of confirmatory factor analysis for Study 1.

Constructs	Items	Loadings	Composite reliability	Cronbach's alpha	AVE	Mean	*SD*
Group technology workarounds	6	0.851–0.939	0.957	0.946	0.788	3.95	1.18
Individual technology workarounds	6	0.874–0.938	0.963	0.978	0.812	5.01	1.04
Task nonroutineness	3	0.933–0.953	0.962	0.940	0.893	3.08	1.11
Identification with the group	4	0.900–0.962	0.967	0.961	0.881	4.81	1.13
Individual performance	4	0.628–0.857	0.850	0.881	0.590	3.58	1.37

Abbreviation: AVE, average variance extracted.

All of the chi-square differences were statistically significant at $p < .001$ level, providing additional evidence of sufficient discriminant validity. In addition, Table E1 in Appendix S1 shows that the items loaded well on their own constructs but poorly on other constructs, indicating both good convergent and discriminant validity.

4.2.3 | Assessment of group-level constructs

Our model included individual- and group-level constructs. We tested whether aggregation was viable by assessing within-and between-group homogeneity (Bliese, 2000). Within-group homogeneity was assessed by $r_{wg(j)}$ statistic, which should be higher than 0.70 (James et al., 1984); the mean $r_{wg(j)}$ of group technology workarounds was 0.875 and the mean $r_{wg(j)}$ of task nonroutineness was 0.888. We also computed an analysis of variance and associated intraclass correlation coefficients (ICC). The ANOVA indicated that there were significant differences across groups for group technology workarounds ($F_{67,196} = 1.539$, $p < .05$) and for task nonroutineness ($F_{67,196} = 1.764$, $p < .001$). The ICC(1) value reflects between-group variance in individual responses, and ICC(2) is an estimate of the reliability of the group-level means (Raudenbush & Bryk, 2002). It is acceptable when ICC(1) values are higher than 0.12 and ICC(2) values are higher than 0.50 (Liao & Rupp, 2005). The ICC(1) and ICC(2) for group technology workarounds were 0.13 and 0.54 and for task nonroutineness were 0.16 and 0.76, respectively. Thus, aggregating the individual scores for group technology workarounds and task nonroutineness was acceptable.

4.2.4 | Group-level effect

Table 4 shows the results of OLS analysis for the impacts of group technology workarounds on short- and long-term group performance. Group technology workarounds positively influence short-term performance (Model 1: $\beta = .117$, $p < .05$), supporting H1a. The 0.117 coefficient implies that an increase of one *SD* in the 7-point scale measuring group technology workarounds would generate an increase in accumulated loans by an average of 13.8%. Group technology workarounds did show a negative impact on long-term performance, but not significantly (Model 5: $\beta = -.010$, $p > .10$), rejecting H1b.

As expected, system failure interacted positively significantly with group technology workarounds to affect both short-term performance (Model 2: $\beta = .191$, $p < .05$) and long-term performance (Model 6: $\beta = .388$, $p < .001$), thus supporting H2a and H2b. Figure 2a,b displays these two interactions. We followed Aiken and West (1991) to further test the simple slopes for the interactions. Figure 2a shows that group technology workarounds were positively and significantly related to short-term performance for high system failure ($b = .187$, $p < .01$), and they were negative but insignificant for low system failure ($b = -.057$, $p = .638$). Figure 2b shows that the relationship between group technology workarounds and long-term performance was negative and significant for low frequency of system failure ($b = -.226$, $p < .05$) while positive and significant for high frequency of system failure ($b = .275$, $p < .10$).

Task nonroutineness positively significantly interacted with group technology workarounds in affecting long-term performance (Model 6: $\beta = .328$, $p < .01$), supporting H3b, as also portrayed in Figure 3a. Figure 3a shows that group technology workarounds were significantly positively related to long-term performance for high task nonroutineness ($b = .199$, $p < .10$), and they were negative but insignificant for low task nonroutineness ($b = -.015$, $p = .901$). However, the moderating role of task nonroutineness in the relationship between group technology workarounds and short-term performance, while positive, was nonsignificant (Model 2: $\beta = .073$, $p > .10$), rejecting H3a.

Finally, competition strengthened the impact of group technology workarounds on short-term performance (Model 2: $\beta = .199$, $p < .001$), supporting H4a, shown in Figure 3b. Similarly, Figure 3b shows that the

TABLE 3 Correlations and discrimination validity of constructs for Study 1.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Individual level														
1. Gender	–													
2. Age	−0.255**	–												
3. Educational level	0.197**	−0.545**	–											
4. Individual technology workarounds	−0.129*	−0.017	0.016	0.901										
5. Identification with the group	−0.016	−0.183**	0.086	0.337**	0.939									
6. Tenure in the group	0.135*	−0.225**	0.147**	0.260**	0.571**	–								
7. Job performance	−0.141*	−0.058	−0.007	0.237**	0.187**	−0.042	0.768							
Group level														
8. Group technology workarounds	−0.201**	0.090	−0.122*	0.365**	0.163**	−0.038	0.518**	0.888						
9. System failure	−0.175**	0.064	−0.083	0.001	0.068	−0.014	0.044	−0.169**	0.945					
10.Task nonroutineness	−0.016	0.094	−0.069	−0.225**	−0.477**	−0.425**	−0.125*	0.084	−0.091					
11. Competition intensity	−0.026	−0.066	0.187**	0.019	0.010	0.016	0.030	0.068	0.118	−0.044				
12. Short-term performance	−0.015	−0.037	0.178**	0.049	0.033	−0.043	0.060	0.048	00.235**	−0.105	0.636**			
13. Long-term performance	0.040	−0.082	0.181**	0.036	0.003	−0.003	0.031	−0.002	0.195**	−0.131*	0.547**	0.871**		
14. Group size	−0.060	0.123*	−0.167**	−0.072	0.011	−0.073	−0.031	−0.101	0.073	−0.024	−0.129*	0.036	0.042	
15. Group age	−0.308**	0.616**	−0.310**	0.002	−0.141*	−0.196**	0.026	0.054	0.059	0.070	−0.038	0.008	−0.045	0.148*

Note: 1. The diagonal elements are the square root of the AVE. 2.
$^{**}p < .01$; $^{*}p < .05$; 2-tailed.

TABLE 4 Results of regression analyses for Study 1 ($N = 68$).

Independent variable	Short-term performance				Long-term performance (3-year average loans)				Long-term performance (5-year average loans)			
	Accumulated loans		Loans balance		Accumulated loans		Loans balance		Accumulated loans		Loans balance	
	$t + 1$		$t + 1$		$(t + 1–3)$		$(t + 1–3)$		$(t + 1–5)$		$(t + 1–5)$	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Group size	0.007	0.012	−0.104	−0.097	−0.005	0.006	−0.083	−0.077	0.011	0.018	−0.073	−0.068
Group age	0.067	0.072	0.064	0.069	−0.058	−0.006	−0.098	−0.069	−0.118	−0.069	−0.108	−0.075
Geographic distance	0.068	0.120*	0.180*	0.275***	0.141†	0.167*	0.265*	0.317***	0.111	0.140†	0.272*	0.324**
Prior year performance	0.923***	0.867***	0.922***	0.832***	0.852***	0.733***	0.756***	0.551***	0.843***	0.714***	0.698***	0.488***
Group technology workarounds (**H1**)	**0.117***	**0.144***	**0.124†**	**0.191****	−0.010	0.071	0.073	0.175†	−0.004	0.084	0.054	0.154
System failure		−0.037		−0.096		0.073		0.277**		0.083		0.277*
Task nonroutineness		−0.109*		−0.139*		−0.196*		−0.265**		−0.198*		−0.276**
Competition intensity (5 km)		0.047		0.270***		0.114		0.354***		0.142†		0.359***
Group technology workarounds × System failure (**H2**)		**0.191***		**0.145†**		**0.388*****		**0.355****		**0.311****		**0.377***
Group technology workarounds × Task nonroutineness (**H3**)		0.073		0.099		**0.328****		**0.230†**		**0.281***		**0.246†**
Group technology workarounds × Competition intensity (**H4**)		**0.199*****		**0.133***		−0.007		−0.086		−0.036		−0.099
R^2	0.830	0.881	0.725	0.833	0.685	0.768	0.480	0.692	0.689	0.762	0.411	0.633
Adjusted R^2	0.816	0.857	0.702	0.800	0.659	0.723	0.438	0.632	0.664	0.715	0.363	0.561
F	60.386***	37.578***	32.621***	25.423***	26.919***	16.868***	11.434***	11.440***	27.484***	16.282***	8.636***	8.790***

†$p < .10$;
*$p < .05$; **$p < .01$; ***$p < .001$.

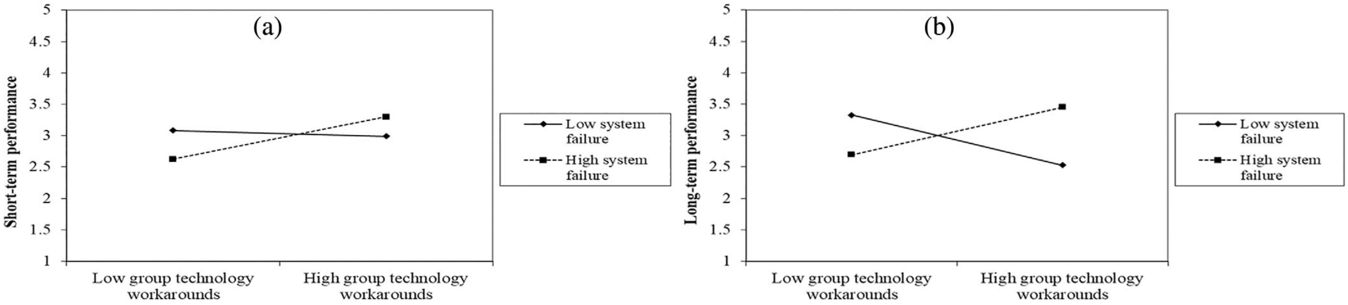

FIGURE 2 (a) The moderating role of system failure for short-term performance. (b) The moderating role of system failure for long-term performance.

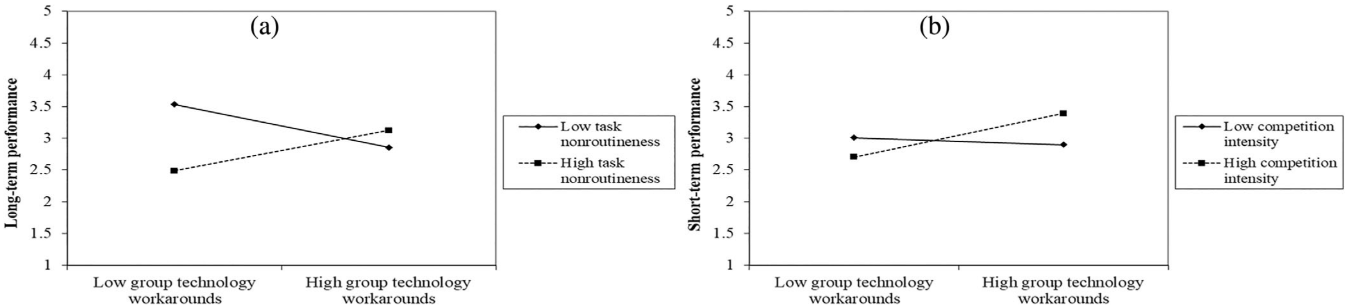

FIGURE 3 (a) The moderating role of task nonroutineness for long-term performance. (b) The moderating role of competition intensity for short-term performance.

relationship between group technology workarounds and short-term performance was positively significant for high competition intensity ($b = .240$, $p < .01$) while negative and insignificant for low competition intensity ($b = -.048$, $p = .689$). However, we found no significant moderating role of competition intensity in the relationship between group technology workarounds and long-term performance (Model 6: $\beta = -.007$, $p > .05$), not supporting H4b.

4.2.5 | Robustness check

We also conducted additional post-hoc analyses to ensure the robustness of our findings. First, following Bamberger et al. (2021), we repeated the analyses with long-term performance measured as the future 5-year average accumulated loans. As shown in Models 9 and 10 in Table 4, the results show additional support for H2b and H3b. Second, we also used loan balance instead of accumulated loans as a dependent variable. In particular, we re-conducted the analyses with short-term loans balance, future 3-year average loans balance, and future 5-year average loans balance. As shown in Table 4 (see Models 3, 4, 7, 8, 11, and 12), the results provided additional and consistent support for our main results. In addition to the discussion in the above section on the magnitude of the effect of group technology workarounds on accumulated loans, an increase of one SD in the group technology workarounds increases loans balance by an average of 14.6%. Third, when assessing competition intensity, we also used 10 km as an alternative threshold. As shown in Appendix S1F, the results were generally consistent with our main results in Table 4.

4.2.6 | Cross-level effect

We employed HLM 6.02 to examine the cross-level effects of group technology workarounds on individual technology workarounds and thus indirectly on individual performance. We first set a null model for individual technology workarounds and individual performance. The results revealed that 20.07% of the variance for individual technology workarounds was explained by the between-group variance (χ^2 (67) $= 131.00$, $p < .001$) and 26.32% of the variance for individual performance by the between-group variance (χ^2 (67) $= 159.06$, $p < .001$). We thus proceeded to test the subsequent models.

Table 5 provides the results of the HLM analysis. In Models 1 and 2, the main effects of the level 2 factors (i.e., group technology workarounds), level 1 control variables, and level 2 control variables were entered. We found that group technology workarounds had a significant cross-level impact on individual technology

TABLE 5 HLM results for Study 1.

	Individual technology workarounds		Individual performance	
	Model 1	Model 2	Model 3	Model 4
Intercept	5.002***	4.997***	3.563***	3.563***
Individual level				
Level 1 control variables				
Gender	−0.262†	−0.262†	−0.282	−0.206
Age	0.046	0.046	−0.115	−0.128
Education level	0.196	0.196	−0.122	−0.179
Identification with the group	0.289**	0.289**	0.380*	0.296*
Tenure in the group	0.083	0.083	−0.268**	−0.293*
Level 1 predictors				
Individual technology workarounds				**0.290****
Group level				
Level 2 control variables				
Group size	0.059	0.221	−0.085	−0.086
Group age	−0.127	−0.152	−0.005	−0.005
Level 2 predictors				
Group technology workarounds		**0.355****	0.469†	0.466†
Chi-square	149.580***	132.152***	140.780***	147.291***
Deviance	745.698	738.192	881.545	876.828

Note: Individual-level $n = 264$; group-level $n = 68$.
†$p < .1$;
*$p < .05$; **$p < .01$; ***$p < .001$.

workarounds (Model 2: $\beta = .355$, $p < .01$), supporting H5. Furthermore, Model 4 tested the effect of individual technology workarounds on individuals' job performance, showing support for H6 (Model 4: $\beta = .290$, $p < .01$).

Although we have theoretically argued why we focus on how group technology workarounds influence individual technology workarounds, it is also possible that individual technology workarounds would lead to group technology workarounds. To accommodate the potential endogeneity bias, we used an instrumental-free method using the Gaussian Copula approach (Park & Gupta, 2012). Consistent with prior studies (Alblas, 2022; Salvador et al., 2021), we first conducted a Shapiro–Wilk test to assess whether the endogenous regressor (e.g., group technology workarounds) is non-normally distributed. The results of this test indicated that the endogenous regressor was non-normally distributed ($W = 0.938$, $p < .001$). Then, by including the Gaussian copulas in the model, we re-ran the model and found the results were consistent with our main findings shown in Table 5, suggesting that endogeneity bias was not a concern in our model.

4.3 | Study 2

Although Study 1 generally supports our research hypotheses, some features limit the applicability of our findings to the full explanatory model. First, although Study 1 combined both survey data and archival data, the relationships among group technology workarounds, individual technology workarounds, and individual performance were cross-sectional in nature. As such, a cross-level longitudinal study is needed to test the causality of such relationships. Second, although self-reported employee job performance is acceptable in the existing literature, it would be more accurate and objective, and avoid common method bias, to ask the leaders to provide ratings of the employees' job performance.

With these issues in mind, we conducted Study 2 by collecting data from one of the largest electronics companies in China, which had implemented an enterprise resource planning (ERP) system, and conducting a cross-level longitudinal study using leader-rated employees' job performance. Thus, we improved internal validity issues by collecting data from two different organizations, and external validity issues by using two different research settings with different types of ES.

4.3.1 | Data collection

This electronics company is a large company located in the middle of China. It is famous for producing various electronic products such as smart phones, televisions, LED panels, and mobile communication products across different regions in China. In order to strengthen and streamline the marketing and manufacturing management for further growth, the company had implemented the same ERP across different business units located in different regions. There are about four to five salespersons who were the end users of the ERP system in each business unit. These salespersons need to coordinate with each other within each business unit to manage day-to-day business activities such as order processing, accounting, procurement, and supply chain operations, and thus depended on the ERP system to accomplish their daily job tasks. The HR department manager of the company provided us with a list of 424 salespersons and 98 leaders from 98 business units who were willing to participate in the survey. Then, we invited each respondent by a customized invitation email with a unique survey URL. When the respondent clicked the URL, a unique ID was created for the respondent. We matched the group member-leader data, and the over-time data, based on the IDs.

The survey lasted about 6 months, with three waves, each 3 months apart. Specifically, we conducted the first wave (T1) of data collection 6 months after the implementation of ERP, the second wave (T2) of data collection 9 months after the implementation of ERP, and the third wave (T3) of data collection 12 months after the implementation of ERP. At T1, participants were asked to provide their demographic information, extent of group technology workarounds, and responses for control variables. We received 334 usable responses from 82 groups at T1. Three months later, at T2, participants were asked to offer information on individual technology workarounds. We received 294 usable responses from 73 groups at this stage. Then, 3 months later, at T3, the leader of each group was asked to provide performance evaluations for the subordinates who were users of the ERP system. The group leader did not know which subordinates participated in the survey or how the subordinates responded. Similarly, the subordinates could not access the leader-rated performance data. The group members were informed that their answers would be confidential. The authors securely stored the data files and the company was not allowed to obtain any identifying information. We received 275 valid responses from 68 groups, yielding a 69.4% response rate at the individual level and a 64.9% response rate at the group level. Considering that we did not have information about the nonrespondents, we thus conducted a comparison between the early 25% respondents and late 25% respondents (Clottey & Benton, 2013, 2020). It is assumed that late respondents were most similar to non-respondents because their responses required more stimuli and a longer time (Clottey & Benton, 2013, 2020). Following the recommendation of Clottey and Benton (2013), we selected two survey items (i.e., GTW4 and ITW2) at random from all the survey items to assess nonresponse bias with t tests. Specifically, we compared the first 25% of respondents ($n1 = 69$) and the last 25% of respondents ($n2 = 68$) on the indicators of GTW4 and ITW2 to test for nonresponse bias. The individual power and complete power of t tests were 0.83 and 0.70, achieving the adequate power levels for t tests used to assess nonresponse bias (Clottey & Benton, 2013, 2020). The t tests indicated that there were no significant differences on GTW4 ($t = 0.83$, $p = .41$) or on ITW2 ($t = 1.55$, $p = .12$) between the two groups, suggesting no serious non-response bias (Armstrong & Overton, 1977; Clottey & Benton, 2013, 2020). The salespersons' average years of experience in the group were about 5.3 years, and thus they had a good knowledge on issues under study. Table 6 shows the respondents' basic information.

4.3.2 | Measurement

The measures for group technology workarounds, individual technology workarounds, control variables, and group size and age, were similar to those in Study 1. For Study 2, we also asked leaders at T3 to rate each of their group members' *job performance* in terms of quantity,

TABLE 6 Demographic information of the respondents for Study 2 ($N = 275$).

Demographics	Categorization	Percentage
Gender	Male	33.1
	Female	66.9
Age	18–25	4.0
	26–35	36.0
	36–45	31.3
	46–55	22.5
	56 or above	6.2
Education	Below College	8.4
	Junior College	24.4
	Bachelor's degree	51.3
	Master's degree or above	16.0

quality, and accuracy of work as well as the extent to which they work well with others.

4.3.3 | Common method bias

This study incorporated some recommendations to reduce common method bias. In particular, we conducted a longitudinal design by using three waves of data (Podsakoff et al., 2003). Further, the items were randomized within blocks on the survey, and the surveys were anonymous, linked across time only by the provided ID (Podsakoff et al., 2003). In addition, we applied the marker variable technique to examine common method bias (Lindell & Whitney, 2001). We used a three-item scale adapted from Pavlou and Gefen (2004) as the marker variable, which asked the respondents about their purchase intentions in an online platform and was unlikely to be theoretically related to our model's constructs. We used the lowest positive correlation ($r = .001$: the correlation between the marker variable and identification) to correct the correlations among the constructs. Given the nearly zero correlation the revised correlations did not show a significant change, indicating common method bias was not a serious issue. We also checked for multicollinearity by assessing the variance inflation factor (VIF; Mason & Perreault, 1991). The highest VIF was 1.763, indicating that multicollinearity was not a significant issue.

4.3.4 | Assessing the measurement model

Table 7 shows the construct reliability and validity of the measures. The values of Cronbach's alpha and composite reliability were above the benchmark value of 0.70, suggesting good reliability (Carmines & Zeller, 1979; Fornell & Larcker, 1981). Moreover, the AVE values were higher than 0.50 and items' loadings were above 0.60, suggesting good convergent validity. Table 8 shows that the square roots of the AVEs were greater than the correlations, and that the items loaded well on their respective constructs but poorly on any other constructs (see Table E2 in Appendix S1), demonstrating good discriminant validity (Carmines & Zeller, 1979; Fornell & Larcker, 1981). We also followed Gerbing and Anderson (1988) and performed two separate CFA models, providing further evidence of discriminant validity.

4.3.5 | Cross-level effects

To justify the group aggregation, similar to Study 1, we also examined ANOVA differences and ICC value. The results of one-way ANOVA showed significant differences across groups for group technology workarounds ($F_{67,207} = 3.488$, $p < .001$). The ICC(1) estimate was 0.383, and the ICC(2) estimate was 0.713. To evaluate the within-group agreement, the $r_{wg(j)}$ index of agreement was calculated. The average $r_{wg(j)}$ was 0.855. Thus, aggregating technology workarounds as a group-level variable is appropriate.

To test the cross-level effects of group technology workarounds on individual technology workarounds and individual job performance, we employed HLM 6.02. We tested whether there was substantial between-group variation in individual technology workarounds and performance by setting a null model. The results revealed that 48.75% of the variance was explained by the between-group variance for individual technology workarounds (χ^2 (67) = 26.084, $p < .001$) and 69.70% of the variance was explained by the between-group variance for individual performance (χ^2 (67) = 87.544, $p < .001$).

Table 9 presents the results of the HLM analysis. For Models 1 and 2, the main effects of the level 2 factors (i.e., group technology workarounds), level 1 control variables, and level 2 control variables were entered. Group technology workarounds had a significant cross-level impact on individual technology workarounds (Model 2: $\beta = .848$, $p < .001$), supporting H5.

For Models 3 and 4, the control variables and main effect of individual technology workarounds for leader-rated job performance were entered. Individual technology workarounds were positively associated with the leader-rated individual job performance (Model 4: $\beta = .063$, $p < .05$), supporting H6.

TABLE 7 Results of confirmatory factor analysis for Study 2.

Constructs	Items	Loadings	Composite reliability	Cronbach's alpha	AVE	Mean	*SD*
Group technology workarounds	6	0.797—0.849	0.925	0.933	0.673	3.777	1.333
Individual technology workarounds	6	0.663—0.835	0.887	0.910	0.570	3.384	1.352
Identification with the group	4	0.908—0.931	0.956	0.947	0.844	5.442	1.219
Job performance	4	0.838—0.886	0.922	0.891	0.748	6.424	0.685

Abbreviation: AVE, average variance extracted.

TABLE 8 Correlations and discrimination validity of constructs for Study 2.

	1	2	3	4	5	6	7	8	9	10
Individual level										
1. Gender	–	0.028**	−0.015*	0.293**	−0.073	0.022	0.180**	0.141*	−0.085	−0.028
2. Age	0.209**	–	−0.599**	0.142*	−0.221**	0.645**	−0.016	0.041	−0.075	0.056
3. Educational level	−0.149*	−0.597**	–	−0.084	0.078	−0.481*	−0.032	−0.043	0.112	−0.004
4. Individual technology workarounds	0.294**	0.143*	−0.083	**0.755**	−0.249**	0.149*	0.102	0.641**	−0.071	−0.099
5. Identification with the group	−0.072	−0.220**	0.079	−0.248**	**0.919**	−0.143*	0.076	−0.156**	0.078	−0.042
6. Tenure in the group	0.023	0.645**	−0.480**	0.150*	−0.142*	–	−0.035	0.089	−0.096	0.004
7. Job performance	0.181**	−0.015	−0.031	0.103	0.077	−0.034	**0.865**	0.014	0.113	−0.017
Group level										
8. Group technology workarounds	0.142*	0.042	−0.042	0.641**	−0.155**	0.090	0.015	**0.820**	0.012	−0.036
9. Group size	−0.084	−0.075	0.112	−0.070	0.079	−0.095	0.114	0.013	–	−0.032
10. Group age	−0.027	0.056	−0.004	−0.098	−0.041	0.004	−0.016	−0.035	−0.031	–
11. Marker variable	0.047	0.062	−0.040	0.172**	0.001	0.045	0.082	0.033	−0.039	−0.027

Note: 1. Unadjusted correlations appear below the diagonal; correlations adjusted for the common method appear above the diagonal. 2. The diagonal elements are the square root of the AVE.
**$p < .01$; *$p < .05$ level; 2-tailed.

TABLE 9 HLM results for Study 2.

	Individual technology workarounds		Leader-rated performance	
	Model 1	Model 2	Model 3	Model 4
Intercept	3.349***	3.331***	6.429***	6.429***
Individual level				
Level 1 control variables				
Gender	0.456**	0.456**	0.029	−0.000
Age	−0.019	−0.019	−0.039	−0.038
Education level	0.069	0.069	0.006	0.001
Identification with the group	−0.170*	−0.170*	0.047	0.058*
Tenure in the group	0.036	0.036	−0.034	−0.036
Level 1 predictors				
Individual technology workarounds				**0.063***
Group level				
Level 2 control variables				
Group size	−0.065	−0.068	0.100	0.100
Group age	−0.062	−0.074	−0.007	−0.007
Level 2 predictors				
Group technology workarounds		**0.848*****	−0.019	−0.019
Chi-square	338.915***	122.256***	697.628***	712.433***
Deviance	870.510	810.587	425.933	424.200

Note: Individual-level $n = 275$; group-level $n = 68$.
*$p < .05$; **$p < .01$; ***$p < .001$.

5 | DISCUSSION, IMPLICATIONS, LIMITATIONS, AND FUTURE RESEARCH

5.1 | Discussion

Successful applications and use of ES can help organizations achieve competitive advantage and performance (Hald & Mouritsen, 2013; Kumar et al., 2018). However, due to the misfits between the technological and operational processes, organizational employees often deploy technology workarounds to deviate from the prescribed "rules of engagement" (Bhakoo & Choi, 2013; Heim et al., 2021; Tenhiälä & Helkiö, 2015). By theoretically conceptualizing and operationalizing technology workarounds at both group and individual levels, and empirically testing proposed relationships among group technology workarounds, individual technology workarounds, short- and long-term group performance, and individual performance, including moderating and control measures, across two organizations, the current study helps explain how group technology workarounds influence short- and long-term group performance; how system failure, task nonroutineness, and competition intensity influence the above relationship; and how group technology workarounds influence individual technology workarounds and individual job performance. Our study yields a rich set of insights.

First, our results indicate that group technology workarounds influence short- and long-term group performance in different ways. By examining the effects of group technology workarounds over time, we find that group technology workarounds positively affect short-term performance but do not significantly influence long-term performance (although the sign of the coefficient is negative). These findings confirm previous propositions that technology workarounds might be effective only in the short term (Morrison, 2015). Such findings also confirm the varying performance implications of different problem-solving approaches (e.g., fire-fighting vs. process-avoiding) proposed by Tucker et al. (2020). In the short term, group technology workarounds act as a fire-fighting approach to ensure the continuity of the operations by circumventing the inflexibility in using the ES. For example, our interviews with the loan officers in some bank branches indicated that they sometimes used a prior loan officer's open account or used the account of the loan officer who had higher access levels so as to more quickly create an account database for the customers in a short time. However, in the long term, group workarounds more likely act as a process-avoiding approach that strays from the prescribed ES use procedures, and may thus subtly generate other problems and resulting technology workarounds over time.

Second, the frequency of system failure significantly interacts with group technology workarounds to influence short- and long-term group performance. More system failure not only strengthens the positive effect of group technology workarounds on short-term performance but also somewhat mitigates the detrimental effect of group technology workarounds on long-term performance. Considering the operational nature of ES implementation and use, successful system application is critical to the success of organizational operations and business processes (Lam et al., 2016). As such, group technology workarounds in systems experiencing more frequent failure can both enable the groups to continue to work immediately in the short-term as well as provide an available non-prescribed alternative approach of ES use to work in the long-term. Our results confirm that group technology workarounds, in the short term, can be an effective way of circumventing dysfunctional systems while struggling to get the work accomplished, particularly in situations when the system has a high frequency of failure (Pine & Mazmanian, 2017; Tucker et al., 2020). For example, some loan officers in our sample complained that they usually found the CMS slow to operate during the upgrading period, so these loan officers thus collectively extracted the data and information from the CMS and manipulated the information with Excel to generate some bills and reports so that they could send out invoices to collect payments from customers.

Third, task nonroutineness significantly interacts with group technology workarounds to influence long-term group performance. This means that high task nonroutineness can provide a context in which the potential harms of group technology workarounds on long-term performance are reduced. Nonroutine task execution provides (or requires) space for group members to flexibly accomplish their tasks in different ways to deal with system limitations or difficulties. In particular, in the long term, technology workarounds can be handled appropriately by using their rationales and procedures to better integrate system design with existing workflows and by ensuring enough time for system or task process redesign (Pine & Mazmanian, 2017). However, we do not find a significant moderating role of task nonroutineness in the relationship between group technology workarounds and short-term performance. A plausible explanation is that although group technology workarounds can help improve the group performance in a relatively short time, nonroutine tasks do not necessarily strengthen such a positive effect further because such tasks and their processes typically cannot be effectively changed in a relatively short time (Majchrzak et al., 2005). This result is also consistent with prior OM research on improvement practices that standardized and routine task execution combined with learning behaviors can generate better performance improvement (Linderman et al., 2004).

Fourth, we find a significant moderating role of competition intensity in the relationship between group technology workarounds and short-term performance. That means that groups facing fiercer competition might need ways to circumvent or adapt the prescribed system use to maintain their competitiveness. For example, to prevent new major customers from going to other financial institutions, some branches' loan officers in our sample used some procedures in the CMS out of their formal sequence, for example, creating the account databases for new customers in advance, while waiting for the CMS to provide necessary information to assess the possible risk. However, we find no significant moderating effect of competition intensity on the relationship between group technology workarounds and long-term performance. A possible explanation is that increased competition leads financial institutions to provide more nontraditional banking services and risky loan provisioning (Alyakoob et al., 2021). Under the context of such intensive competition, group technology workarounds might cause the financial institution to increase loans for lower quality borrowers and thus might not reduce the harms of technology workarounds on long-term performance. Indeed, high competition intensity might aggravate the harms of group technology workarounds on the long-term performance (the interaction term of group technology workarounds and competition intensity is negative although it is not significant).

Fifth, group technology workarounds have a positive impact on individual technology workarounds and thereby on both self-reported and leader-rated individual job performance. These results confirm the multilevel nature of technology workarounds and the cross-level relationship between group and individual technology workarounds. Our study echoes the call of Burton-Jones and Gallivan (2007) that system usage should be examined in a multilevel fashion and researchers should "conceptualize and analyze system usage at more than one level in the same study" (p. 659). Our empirical findings highlight that group technology workarounds and individual technology workarounds are different but interdependent constructs. Operations managers may consider assessing employees' technology workarounds within and across the groups over time in order to better coordinate group and individual technology workarounds.

5.2 | Theoretical implications

The current study contributes to the existing OM and IS literature in four main ways. First, it contributes by addressing ambiguity in the implications of group technology workarounds for group performance (Malaurent & Karanasios, 2020; Tucker et al., 2020). Previous studies are divided on whether technology workarounds affect performance positively or negatively (Bhakoo & Choi, 2013; Petrides et al., 2004); more generally, they show that both outcomes are possible, often for the same workarounds. We theorize and empirically test how the effect of group technology workarounds varies over time and by contextual differences. Our results indicate that the potential positive impact of group technology workarounds on short-term group performance vanishes in the long run. This finding confirms the notion of Bendoly, Croson, et al. (2010) that identifying anomalies of human behavior in the OM context should not necessarily lead to limiting the such behavior, since some anomalies of human behavior such as technology workarounds may positively improve certain performance (e.g., short-term group performance). By illustrating the differences in how group technology workarounds lead to differing short- and long-term consequences, our research provides insights into the paradoxical nature of technology workarounds in terms of how they can be both potentially helpful and harmful (Morrison, 2015).

Second, by exploring the moderating roles of the contexts of system failure, task nonroutineness, and competition intensity, our study finds that the strength of effects of group technology workarounds on group performance are at least somewhat contextual. Our study contributes to the OM and IS literature on ES use generally, and technology workarounds in particular, by including at least one representative of the each of the three AST main contexts into theory development, as called for in numerous studies (Holweg & Pil, 2008; Johns, 2006), finding distinctive roles for each. Our study thus extends AST by not only confirming the importance of the contextual factors of technology, task, and environment, and how they interact with group technology workarounds in influencing group performance, but also by highlighting the critical role of time in the appropriation of collective system usage in general and group technology workarounds in particular.

Third, by distinguishing both group technology workarounds and individual technology workarounds, our study sheds light on the multilevel nature of technology workarounds, which has been less analyzed in the existing literature (see Appendix S1A). We empirically confirm that group technology workarounds directly influence individual technology workarounds and thus indirectly further affect individual job performance. Although using a multilevel approach is not new to the OM and IS domains (Hitt et al., 2007; Ketokivi, 2019), applying it to understanding technology workarounds is novel. The current study is among the first to integrate the micro and macro views of technology workarounds found in the existing literature and further to empirically test their interrelationships, thus responding to Burton-Jones and Gallivan's (2007) call for building multilevel theories of system usage. Our study confirms Boudreau et al. (2003) proposition that both human and technical considerations are critical to the success of an operational improvement program, so it is important to integrate these two viewpoints. Taken together, our study not only responds to the call of Bendoly, Croson, et al. (2010) for including behavioral factors into OM empirical studies that can contribute to the practical nature of extant theoretical models and our understanding of effective operations, but also helps illustrate that OM is not a purely technical issue but also involves behavioral considerations (Linderman et al., 2006).

Finally, the current study further contributes to the OM-IS interface (Kumar et al., 2018; Setia & Patel, 2013) by considering the technical and operational aspects of ES use generally and technology workarounds in particular and their varying performance implications under different technology, task, and environmental conditions. The current study builds upon and extends prior OM and IS literature on workarounds in general and technology workarounds in particular. For example, our results highlight the temporal characteristics of technology workarounds proposed by Morrison (2015) and suggest that technology workarounds can be both helpful and harmful in different timeframes. Our study also extends work by Tucker et al. (2020). Differing from Tucker et al. (2020), who focus on non-technology workarounds and the moderating role of operational failures, the current study focuses on technology workarounds and provides a more complete understanding of the different contexts (e.g., system failure, task nonroutineness, and competition intensity) under which the technology workarounds vary over time. By conceptualizing technology workarounds at both individual and group levels and exploring their cross-level relationship, our study further provides empirical evidence for the notion of Malaurent and Karanasios (2020) that technology workarounds are not simple individual behaviors but are collectively developed activities. Through exploration of the interdisciplinary mechanisms of OM-IS interface, the “OM field would benefit from interface research as it would bring new challenges and situations where the ideas of operational efficiency can be improved” (Kumar et al., 2018, p. 1920).

5.3 | Practical implications

Regarding operational practice, our research also provides some implications for operations managers who strive to effectively manage technology workarounds at group and individual levels. First, our study helps operations managers recognize the important (both positive and negative, short-term and long-term) roles of group technology workarounds in group operations and performance. Although many OM techniques highlight the importance of optimizing business processes and instilling best practices by deploying an ES, the ES may also create challenges to conducting tasks, and impede business processes due to its inflexibility and variations from prior practices. As such, employees might adapt, circumvent, or “misuse” the system, via technology workarounds, to help accomplish their work tasks. However, managers have little knowledge about whether they should prohibit or tolerate their subordinates' technology workaround behaviors. In the short-term, group technology workarounds could improve group performance. This finding confirms the notion of prior OM research on ES-induced process variation that “‘misuse’ of a system relative to the ‘use’ initially intended by management is not necessarily a bad thing” (Bendoly & Cotteleer, 2008, p. 39). Nevertheless, in the longer term, group technology workarounds do not improve or can even harm group performance, for a variety of reasons noted earlier. Our findings help managers note that it is important to differentiate short- and long-term performance when considering the implications of group technology workarounds.

Second, managers should note the contextual characteristics of technology (e.g., system failure), task (e.g., task nonroutineness), and environment (e.g., competition intensity) when considering the short- or long-term performance implications of group technology workarounds. For example, managers may need to tolerate their subordinates' group technology workaround behaviors in the short-term, particularly when the formal system has a higher frequency of failure or the group faces more intense competition. Meanwhile, managers may tolerate group technology workarounds in the longer term if the frequency of the system failure is high or the group's tasks are not routine. Managers should realize that whether group technology workarounds improve or inhibit group performance depends to some extent on which type of group performance they shape, the time frame under consideration, and a variety of technology, task, and environmental contexts in which their groups operate.

Third, this study can help managers realize that group technology workarounds and individual technology workarounds are two different yet interrelated practices, suggesting that managers may wish to take a more proactive role in group-level technology workarounds to influence the use and impacts of individual technology workarounds. Managers need to consider when and how to leverage group technology workarounds to influence their subordinates' individual technology workarounds. Moreover, considering individuals can benefit from their own individual technology workarounds, while group technology workarounds might be harmful to group performance particularly in the long-term, managers should think strategically on how to balance the tensions between the cross-level technology workarounds. On the one hand, managers can provide more training in "faithful" use of the ES to match operational and strategical goals, and might also consider linking individual and group prescribed use of the ES to performance evaluation (Bendoly & Cotteleer, 2008). On the other hand, they need to more fully understand how groups and individuals experience challenges, obstacles, and errors in the implemented ES, and turn to technology workarounds to accomplish organizational, group, and individual goals.

5.4 | Limitations and future research

Our study of course has some limitations, and offers some foundations for future research. First, this study focuses on *technology* workarounds. While the successful implementation and application of ES is operational in nature and we also believe technology workarounds have significant implications to the OM and IS literature, there are other domains of workarounds such as work processes, people, rules/policies, and equipment (Halbesleben et al., 2013). Future research may examine how these different domains of workarounds differentially influence group and individual performance over time. A more interesting research direction can be further exploration of how technology workarounds interact with relevant non-technology-related workarounds to affect group and individual outcomes.

Second, in order to extend the current study, future research can also examine the effects of group technology workarounds on other group outcomes. The current study (in particular, Study 1) focuses on financial performance (i.e., accumulated loans, appropriate to the studied organizations). However, other outcomes such as financial risks, operational efficiency, and process innovation are also of interest. For example, one the one hand, group technology workarounds can help discover and accomplish a means of achieving higher levels of performance and might generate more process innovation and task process improvements. On the hand, group technology workarounds might also induce more overdue loans or inaccurate records and thus increase the financial risks. Technology workaround benefits can also extend to other individual outcomes such as employee innovation and job satisfaction.

Third, our multilevel model can be further extended by investigating additional relevant moderating factors, such as the group manager's experience (Salvador et al., 2021), perceived extent of ES-task misfit and ease of circumvention (Bendoly & Cotteleer, 2008), and organizational resource shortages (Morrison, 2015). Considering the importance of incorporating "individual differences into OM research advocated by the behavioral OM perspective" (Bendoly et al., 2006, p. 741), we also conducted a post hoc analysis to test how individual differences (e.g., identification with and tenure in the group) shape the group-individual technology workaround relationship and found that the cross-level group-individual technology workarounds relationship is stronger when the employees identify with or have a long tenure in the group (in both Studies 1 and 2; as reviewed in Section 3.3). Future research may explore some other individual characteristics, such as individuals' regulatory focus (Higgins, 2012) and construal level (Liberman et al., 2002, 2007), which may further help clarify the different ways in which group technology workarounds may account for differences in individual technology workarounds and performance.

Fourth, Study 1 tests the hypotheses with cross-sectional data, and thus is limited in causal claims, but did test for cross-level effects, and provided a sound basis for developing the more rigorous Study 2. Study 2 used a time-lagged cross-level field study to further confirm the relevant Study 1 results. Future research can integrate time-lagged cross-level data with archival data in one study.

Finally, we collected our data from one large financial institution in China with multiple business units that only involve one specific type of ES (i.e., CMS) in Study 1 and one large electronics company that involves another specific type of ES (i.e., ERP) in Study 2. Although such a research design can provide some advantages, such as controlling for the variances due to factors external to the company and the variances due to different types of ES, the use of only two systems in two distinct companies may also limit the generalizability of our findings. Further research may test our research model by using data from more organizations (e.g., different locations and different industries) and involving more types of ES.

6 | CONCLUSIONS

This study examines how group technology workarounds affect short- and long-term group performance and how system failure, task nonroutineness, and competition intensity moderate those relationships. Moreover, we also explore the cross-level relationship between group and individual technology workarounds and individual performance. We find that group technology workarounds have differential impacts on short- and long-term performance and these relationships are differentially influenced by system failure, task nonroutineness, and competition intensity. Furthermore, group technology workarounds have significant effects on individual technology workarounds and individual job performance. Our study contributes to the OM and IS literature by providing nuanced insights into both micro- and macro-level issues related to ES use in general and technology workarounds in particular. We hope our study sparks future research to further explore the links between group technology workarounds, individual technology workarounds, group performance, and individual performance.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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