Received: 12 February 2020 | Revised: 3 August 2022 | Accepted: 18 August 2022

DOI: 10.1002/joom.1219

RESEARCH ARTICLE

WILEY

Technology management in multi-tier chains: A case study of agency in logistics service outsourcing

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Handling Editor: Gregory Heim

Abstract

Shippers and logistics service providers implement information communication technology (ICT) in outsourced logistics to increase efficiency and remedy information asymmetry. However, the nature of outsourced logistics operations can create technology management challenges due to the organizational distances between the technology initiator and the technology users. Here, we apply the lens of positivist agency theory to study four cases of technology management and agency in multi-tier outsourced logistics services. Our findings suggest that while ICT remedies some information asymmetry, it also creates new information asymmetry—and gives rise to user privacy concerns. Furthermore, the setting of multi-tier subcontracted logistics services appears to be a critical factor in designing governance mechanisms for effective technology management. In addition to our theoretical contributions to technology management in multi-tier outsourcing, we offer an empirical account of agency, proposals for future research, and practical suggestions to help managers tackle agency issues that arise from information asymmetry.

KEYWORDS

agency theory, case study research, information and communication technology, information asymmetry, logistics service providers, service subcontracting, service triads

1 | INTRODUCTION

For damaged goods, the LSP calls us and says: "We have a problem. There's something broken." So, we ask our subcontracted driver about it, and he says, "No, no—nothing [is broken]" and takes a photo of a good pallet, sends it, and says, "Well, everything is okay." So, yeah, [the truth] is a difficult thing to track. The COO of a medium-sized carrier

In logistics service supply chains (LSSCs), technology management is challenging for many reasons (Klein & Rai, 2009), not least because logistics often involves multi-tier chains of outsourcing and subcontracting, which complicates monitoring and control (Nilsson et al., 2017). When considering opportunistic behavior, or agency, in outsourcing, the complexity increases even further (Wilhelm et al., 2016). To coordinate and remedy the negative effects of agency in outsourcing, shippers and logistics service providers (LSPs) capture information—often through information and communication technology (ICT) (Giannopoulos, 2004)—to monitor their suppliers. They can thereby address the information asymmetry (Eisenhardt, 1989a; Williamson et al., 2004) that occurs when one actor has more information than another and agency issues arise (Akerlof, 1970; Eisenhardt, 1989a). However, when implementing ICT such as RFID, blockchain, and tracking apps (Giannopoulos, 2004) in outsourced logistics services, the benefits (including reduced information asymmetry) usually are reached only when ICT is routinized—that is, successfully used by a sufficient number of supply chain members (Sternberg et al., 2021).

Shippers typically outsource their transportation to an LSP, which often subcontracts the actual transportation services to carriers of various sizes (Stefansson, 2006). As a result, many firms in this multi-tier LSSC act as both principals and agents. Given this double agency (Wilhelm et al., 2016), some agents may cover for each other while shirking their duties (Tirole, 1986). According to Child and Rodrigues (2003), the "problem of double agency arises when the process of holding agents to account for the attainment of goals given to organizations involves two sets of control relationships, reflecting the presence of agents at two main levels (p. 239)."

Outsourcing shippers rarely have direct contractual relationships with the carrier that both executes their transport and faces the consignee (van der Valk & van Iwaarden, 2011). As a result, technology management is complicated in multi-tier chains because agency might occur at any point, and the risk of agency grows as the distance from the shipper increases. Although ICT can help prevent agency's negative effects, the act of simply implementing ICT can in itself create conflict in relationships over privacy and efficiency (Sternberg et al., 2021), which further increases the complexity of technology implementation and use.

The operations and supply chain management (OSCM) literature addresses outsourcing of logistics, while information systems (IS) literature addresses outsourcing of information technology. Although researchers (e.g., Sodero et al., 2013) have amply studied technology management inside the firm and in dyadic supply chain relationships—that is, in relationships between suppliers of goods and their customers—we know little about how agency impacts technology management in the complex context of multi-tier logistics services outsourcing and subcontracting. We know even less about what managers might do to mitigate those impacts.

Positivist agency theory (PAT) identifies settings in which a principal and an agent are likely to have conflicting goals; it then describes governance mechanisms that limit the agent's self-serving behavior (Eisenhardt, 1989a), improve the principal–agent goal alignment, and limit information asymmetry. To contribute to midrange theory on technology management and contextualize PAT in contemporary outsourced logistics services, we pose two research questions. First, because ICT's purpose is to capture information that is useful for increasing performance and potentially mitigating agency, we ask:

> **RQ1.** What are the information asymmetry challenges in technology management of multi-tier logistics service outsourcing?

Information asymmetry causes inefficiencies (Akerlof, 1970) and is also a root cause of agency issues (Eisenhardt, 1989a). Therefore, it poses a threat to the optimization and coordination gains that ICT implementations aim to achieve. To address RQ1, our multiple case study identifies and examines information-asymmetry-related agency issues in technology management from both the principal and the agent perspectives. We then turn our focus to the second research question:

> **RQ2.** How can positivist agency theory be applied to overcome information asymmetries in technology management of multi-tier logistics service outsourcing?

To explore this, we use agency theory (Eisenhardt, 1989a; Fayezi et al., 2012) as the theoretical framework to structure our study's data collection and analysis.

The line between outsourcing and subcontracting is usually blurred. Here, for clarity's sake, we define outsourcing as a cost-cutting measure in which a firm's non-core processes are contracted to other firms, typically on a long-term basis; and subcontracting as a subset of outsourcing in which an individual or a firm is hired to carry out core processes of the firm's business, on a temporary or long-term basis. Our work goes beyond the traditionally investigated logistics service triad (Li & Choi, 2009; van der Valk & van Iwaarden, 2011; Wynstra et al., 2015) of a shipper, a consignee, and an LSP to investigate multi-tier logistics service outsourcing. To position our research within existing knowledge streams on logistics service outsourcing, we refer to the LSP as the primary service provider (i.e., the classic service triad) and to LSP subcontractors (i.e., any involved firms not contracted with the shipper, including subcontracted LSPs, brokers, carriers, and drivers) as secondary service providers. Although drivers might be carrier employees or owner-operators (common in the United States), or drivers for hourly hire (common in Europe), we consider them as a separate tier for two reasons. First, the nature of their tasks is independent and decentralized. Second, even if they are employees, they execute their services away from the eyes of their organization.

Our research offers two contributions to theory. First, we explain how agency affects technology management in logistics service outsourcing. We conjecture that (a) while ICT implementations are meant to remedy agency issues, they also create new agency issues and increase mistrust in certain relationships; (b) agency issues in technology management of subcontracts increase as the number of contracts with different technology principals increase; and (c) contracts must consider principal–agent relationships not only in terms of the service, but also in terms of the technology management (i.e., the roles required to implement and use the technology).

Second, we contribute to OSCM by providing an application of PAT to multi-tier logistics service outsourcing. Our conjecture here is that as the number of agent tiers increases, so too do opportunities for hidden action, as lower-tier agents will collude in shirking. As our study results highlight, in multi-tier chains, the governance and control typically applied to shorter chains must reach deeper, going beyond the LSP into the lower tiers of subcontracts.

Literature on technology management and supply chain technologies has examined interorganizational systems such as e-business adoption (Zhu et al., 2006), electronic data interchange (Iacovou et al., 1995; Subramani, 2004), and blockchain technology (Sternberg et al., 2021). However, ICT has received sparse attention beyond the conceptual or single-firm perspective (Marchet et al., 2009). Here, we provide an empirical contribution by elucidating ICT usage in multi-tier chains. First, however, we outline the practical background on technology management in this domain and discuss related literature in technology management and OSCM.

2 | OUTSOURCED LOGISTICS AND TECHNOLOGY MANAGEMENT

Because our case studies focus on European LSSCs, we first describe how this setting differs from the North American LSSC context. Second, we present a framework of key actors in outsourced logistics. Third, we describe the role of ICT in outsourced logistics.

2.1 | Logistics service markets in North America and Europe

North America and Europe differ in terms of how actors operate in outsourced logistics service markets. In the United States, a few larger LSPs with national networks dominate and owner–operators carry out the bulk of long hauling (Sternberg et al., 2013). Schneider National, for example, has 11,650 employed drivers, 10,120 trucks, and 33,830 trailers, and a large portion of those trailers are hauled by owner–operators. Although the U.S. market has numerous owner–operators, many lack the time or ability to acquire assignments outside of long-term contracts, creating a larger space for brokers. Further, many U.S. LSPs are mega carriers—that is, carriers operating tens of terminals and thousands of trucks across North America.

In contrast, in Europe, smaller carriers (less than 50 trucks) often operate on behalf of larger LSPs. In Sweden, for example, DB Schenker is the largest LSP operating in the domestic market; it has 130 contracted carriers, most of which have fewer than 100 trucks each. Hence, studying carrier operations in Europe is more complicated than studying U.S. carrier operations, as control in Europe is typically distributed over a larger number of smaller firms (Sternberg et al., 2013). This also thickens the opaqueness in logistics service outsourcing in Europe (Nilsson et al., 2017), enabling ample opportunity for agency.

2.2 | Actors in outsourced logistics

In most global markets, firms selling goods typically outsource their logistics services—such as goods delivery—to one or more LSPs (van der Valk & van Iwaarden, 2011). Although the LSPs typically have resources such as terminals and a truck fleet, they often subcontract much of the physical distribution to other actors, including other LSPs, brokers, and carriers. Figure 1 illustrates a typical setup of actors in European outsourced logistics services.

In this model, subcontractors typically bypass the LSP, which thus loses control over service delivery (Van der Valk and van Iwaarden, 2011). This direct link between the consignee (the end customer) and the secondary service provider's drivers (Tiers 3 and 4) may gradually shift power from the LSP to the secondary service provider (Li & Choi, 2009). Further, subcontractors may not be included in customer feedback to the LSP. This inhibited flow of information hinders the secondary service providers' efforts to improve and innovate. So, while the LSP remains the primary service provider, it nonetheless sits in a sandwich-like position (Wilhelm et al., 2016), being both the contractor (vis-à-vis the shippers) and the customer (vis-à-vis the secondary service providers).

2.3 | ICT in outsourced logistics

Most literature on ICT in logistics services studies technologies that are initiated and used by the LSP, without including the shippers, the consignees, or the secondary service providers. Still, this literature offers telling findings. For example, Marchet et al. (2009) found that the Italian logistics industry struggles with technology management, including technology integration problems.

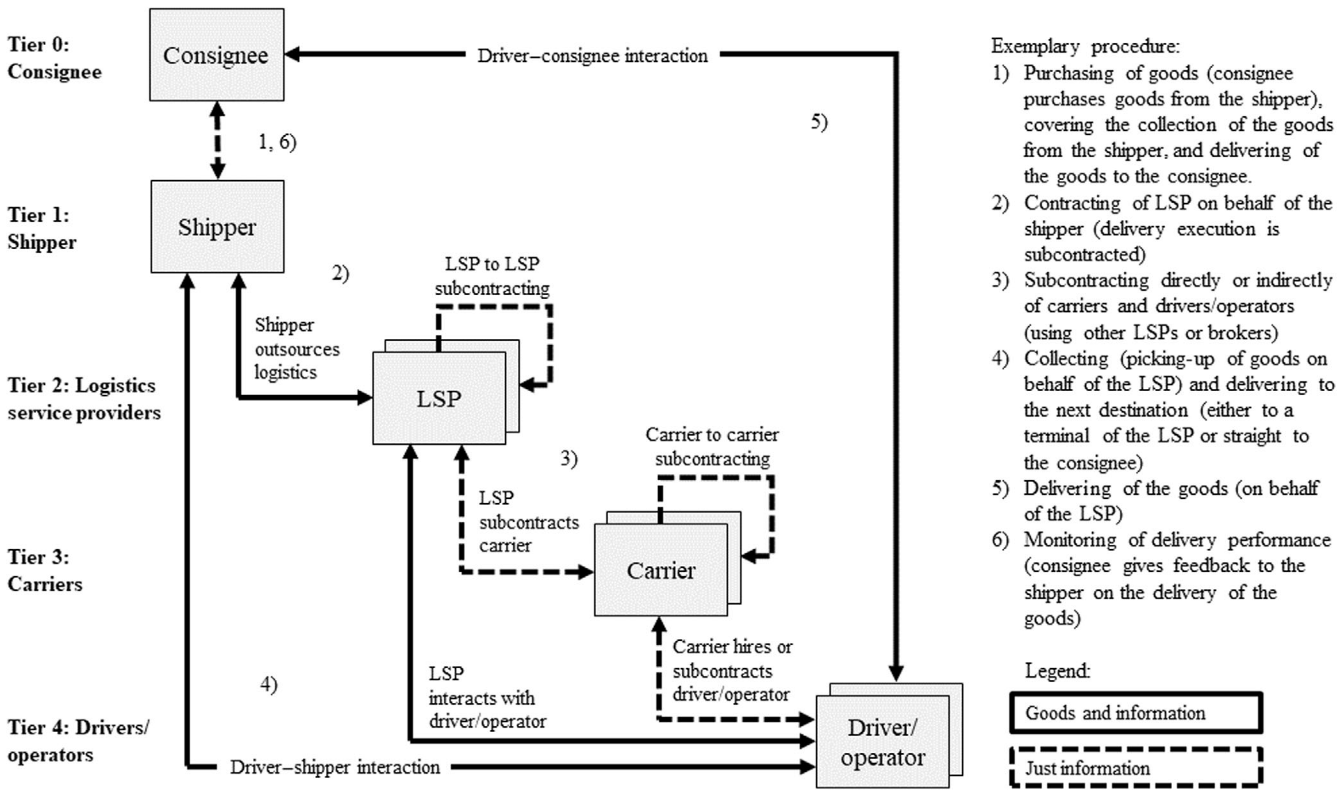

FIGURE 1 Multi-tier logistics service supply chains with LSPs and secondary service providers. LSP, logistics service provider

Further, a recent study by Cichosz et al. (2020) identified five barriers to LSP technology implementations: complexity of the logistics processes; lack of resources (in particular, a lack of skilled personnel); difficulty in selecting technology; resistance to change; and challenges in data protection.

Intuitively, the firm seeking to reap the largest benefits of an ICT implementation is the one initiating the ICT rollout. As Figure 1 shows, in the outsourced logistics context, this initiator (which we refer to here as the technology principal)— is usually either the shipper or (more commonly in the literature) the LSP. Previous technology management literature has documented the benefits of ICT that is driven by a technology principal. Subramani (2004) found that IS implementations in supply chains lead to closer buyer–supplier relationships. Similarly, Klein and Rai (2009) found that when buyers and suppliers go beyond transactional "arm's length" relationships and share strategic information, performance increases for both.

Given the actual landscape of logistics outsourcing, however, these studies have two primary limitations. First, they study only the LSP or the primary service providers, without examining the secondary service providers or agency issues at either tier. Second, the studies focus only on LSP-initiated technologies. We suggest that technology management in outsourced logistics merits further studies—specifically, studies that consider the secondary service providers and agency issues in technology management, including opportunism among subcontractors (Li & Choi, 2009). As we outline in the next section, we do this using the most commonly applied theory to investigate such opportunistic behavior: agency theory (Jensen & Meckling, 1976).

3 | THEORETICAL FRAME: AGENCY THEORY

A principal–agent relationship is contractual: the agent performs a service on behalf of the principal or principals (Jensen & Meckling, 1976). In this relationship, issues often arise for two reasons. The first is goal conflicts, in which each party's goals clash, either fully or partially. The second is information asymmetry, in which the agent possesses superior information stemming either from expertise or performance of the delegated task.

3.1 | Information asymmetries and their solutions

Conflicting goals might arise in this context, for example, when damage occurs. In such a case, the driver (agent) might skip documentation requirements to avoid exceeding the legal working-hour regulations. At the same time, a shipper (principal) has paid for this time-consuming documentation process and expects it to be executed. Such conflicts magnify the agency challenges associated with information asymmetry, which typically takes the form of adverse selection (misrepresentation of ability) and moral hazard (lack of effort) (Fayezi et al., 2012). These challenges are further complicated if the principal has difficulties verifying the agent's behavior due to the distribution of asymmetric information (i.e., the inability to capture adverse selection and moral hazard). Generally, as the number of outsourcing tiers increases, the physical distance between the principal, and the agents acting on the principal's behalf increases as well. Given this distance and limited physical monitoring, agents are more likely to attempt to evade control and, over time, their service performance is likely to degrade (Akerlof, 1970; Halldorsson & Skjøett-Larsen, 2006). Increasing the interaction between principal and agent can help address this issue by allowing the principal more opportunities to observe the agent's work.

PAT (Eisenhardt, 1989a) offers a way to not only diagnose agency issues, but also to overcome them using governance mechanisms. These mechanisms typically take the form of outcome-based contracts and monitoring systems. Performance-based contracts seek to align incentives and prescribe and promote desired behavior (Whipple & Roh, 2010). When effectively designed, these contracts can be a relevant lever in addressing or avoiding agency problems through agreements that are behavior-oriented (e.g., salary) or outcome-oriented (e.g., bonus-penalty models) (Fayezi et al., 2012).

As Jensen and Meckling (1976) and Eisenhardt (1989a) propose, monitoring and information systems offer mechanisms to mitigate information asymmetry and verify agent behavior. As Eisenhardt stated, "Researchers should focus on information systems, outcome uncertainty, and risk (p. 70)." To more thoroughly analyze the relationship between ICT and information asymmetry in outsourced logistics, we dive into both adverse selection and moral hazard problems using Saam (2007, p. 827) four information asymmetry types:

Hidden characteristics (Hid_Character). Before contracting with agents, the principal has incomplete information about their qualifications, including their skills and abilities. Further, agents might claim to have specific skills that the principal cannot wholly verify, either at the time of hiring or while agents are working (Eisenhardt, 1989a, p. 61). To remedy this Hid_Character asymmetry, the literature typically suggests achieving various types of alignment through subcontractor auditing and contracts (Whipple & Frankel, 2000).

Hidden intentions (Hid_Intent). Every contract has some degree of freedom, which gives contracted agents the opportunity to realize any hidden intentions (Saam, 2007). Some agents might intend to act unfairly toward the principal—a problem known as hold-up (the agent resists performing an action that would shift power to the principal). Further, in such cases, the principal cannot simply void the contract, as doing so would result in lost investment in the contracted agent (sunk costs). The common solution to Hid_Intent is vertical integration, which gives the principal actual authority over the agent in place of the hypothetical equality implied between principal and agent at the contract stage.

Hidden knowledge or hidden information (Hid_Info). Agents have private knowledge of exogenous facts, such as environmental states and processes, that are relevant to evaluate the outcome of their contracted work. Such information is usually either professional or process knowledge that agents can use opportunistically. To address Hid_Info, agency theory suggests that the principal use incentive compensation systems, self-selection, and screening.

Hidden action (Hid_Action). Once contracted, agents can choose among different actions in the course of their work. They might shirk, for example, or choose to work less as they pretend to work hard—none of which can be easily evaluated by the principal. Monitoring, with or without a system, is the standard remedy for Hid_Action (Eisenhardt, 1989a). Hid_Action can also involve hidden transfer, which occurs when two or more agents unite to ignore, distort, or manipulate information given to the principal. These actions can result in monetary or (more often) non-monetary transfers. To prevent hidden transfer, Tirole (1986) suggests using the governance mechanism of shortening business relationships (here, for clarity's sake, we follow the Saam (2007) categories and denote hidden transfer as Hid_Action).

3.2 | Multi-tier chains, agency, and technology management

As we highlighted earlier, outsourced logistics services can be multi-tiered. Previous research models this complexity beyond one-to-one relationships through double agency (Wilhelm et al., 2016) or multiple agency (Child & Rodrigues, 2003) scenarios. Multi-tier service chains complicate the process of auditing and monitoring to prevent information asymmetries with new and existing agents. Further, in the fragmented logistics market, most actors (in particular LSPs and carriers) have multiple principals and agents to serve multiple customers through multiple carriers, which in turn contract with multiple LSPs. Bernheim and Whinston (1986) described this as a common agency, in which one agent fulfills several principals' tasks, with or without formal cooperation among those principals. Such fragmentation renders inefficient the numerous governance mechanisms suggested by researchers such as Anderson and Jap (2005). When a shipper outsources logistics to an LSP that in turn subcontracts a carrier, the role of the LSP becomes that of a supervisor (Tirole, 1986), that is, from the perspective of the shipper, the LSP is an agent whose role is to ensure the compliance of a second agent.

In the previous section, we introduced the technology principal, which initiates technology use in the LSSC; for example, the technology principal might be a shipper that mandates the use of a tracking system by the LSP and its subcontractors, the secondary service providers. In such cases, while the primary service provider (LSP) is the principal of the carriers, the shipper initiates and pushes the technology. Hence, the shipper—which has a strong economic interest in seeing its ICT used appropriately in logistics service execution—can be characterized as the technology principal for that ICT and plays that role for all subsequent LSSC tiers. Depending on the number of technology principals and technologies in an LSSC, various setups are possible: one technology–multiple technology principals, multiple technologies–multiple technology principals, or multiple technologies–one technology principal. Our research here will explore all three of these setups.

Whenever actors use ICT to track information related to individuals, privacy concerns arise, as Bhave et al. (2020) describe. Indeed, as we collected data for our study, numerous people that we interviewed expressed concerns about privacy and a lack of transparency. Here, we include such concerns in the definition of hidden information, even though it reverses the asymmetry (i.e., the principal has information that could be used against the agent).

4 | METHODOLOGY

In this section, we describe the study design, including case selection and sampling. We follow this with an outline of the data collection and a description of our data analysis.

4.1 | Study design, case selection, and sampling

To generate midrange theory (Stank et al., 2017) in technology management, we explore four in-depth case studies of multi-tier logistics service outsourcing. Our central unit of analysis is ICT use and individual actor perceptions through the PAT lens. We use an abductive approach to theory elaboration (Ketokivi & Choi, 2014; Mantere & Ketokivi, 2013). Although we ground our categories and concepts in the data, our process is guided by a priori theoretical considerations (i.e., PAT).

According to Eisenhardt (1989b), theoretical case sampling should replicate or extend theory by filling conceptual categories. We focused our sampling on sampling typical cases of ICT in outsourced logistics (Patton, 2015, p. 268) to answer our research questions; doing so also aligned with using PAT to frame our study of technology management. In the literature, we found no indication that the type of technology principal has an impact on agency in technology management, but to represent both standard types, we sampled cases that had either a shipper or an LSP as the technology principal.

All four cases are similar in terms of the application field, the type of state-of-the-art logistics ICT used, and the early-stage project success (from the technology principal's viewpoint). However, the cases differ in how the actors applied the ICT and governance mechanisms, how they configured the service chain, and (as noted) in the identity of the technology principal (LSP or shipper). Table 1 provides an overview of the measures we took to ensure validity and reliability (Barratt et al., 2011).

4.2 | Data collection

To begin our data collection, for each case, we identified a key company that facilitated access to the other firms in the LSSC. For this first contact, we outlined the sampling criteria and the need to include several actors in multi-tier chains. Next, a person from the key company identified potential firms and approached them to ask about their willingness to participate in the study. We then approached the firms that had initially agreed to participate, explained the study, and verified that the firms met our selection criteria (Bastl et al., 2019). Before the interviews, we asked companies to provide informational materials on the ICT they used. We then studied this material to inform our interviews with an understanding of the ICT and its use and management in each firm.

Next, we conducted semi-structured interviews in 13 organizations, with a total of 38 interviewees (see Table 2). Finally, we systematically sampled two types of interviewees: those with a management perspective at the LSSC's upper tiers and those with operational expertise at the technology-user level. This approach let us adjust our interview questions to each person's professional background and role in the firm. The 19 interviews that we conducted with driver employees were shorter (up to 30 min) and application-oriented. All other

TABLE 1 Overview of measures used for enhancing case data trustworthiness.

Dimension	Measures	Implementation in the study
Construct validity	Data collection based on triangulation including additional data sources on the technologies	Consider product descriptions and interviews with technology suppliers
	Transparent explanation of data collection procedure	Disclose identification of gatekeeper firms in the multi-tier LSSC
	Transparent explanation of data analysis procedure	Explain and elucidate the coding approach (Glaser, 1978)
Internal validity	Matching predicted and observed patterns of the unit of analysis, as the exploratory research did not allow comparisons with previous research	Create ex-ante visualizations of expected technology–principal–agent chains and compare them ex-post with the observed chains
	Clear, explicit statements of the unit of analysis, unit of observation, and research scope to ensure a causal relationship between what has been studied and what has been concluded	Explicitly address early-stage ICT use in multi-tier LSSCs as the unit of analysis and LSSC actors as the units of observation
	Triangulation and discussion among researchers during data analysis	Integrate insights from qualitative interviews, archival material on the firms, and supplemental data on technologies from different perspectives; ensure intercoder agreement
External validity	A detailed description of each case's context to limit the scope of interpretation	Describe technology–principal–agent setups and applied governance mechanisms
	Transparent explanation of sampling logic and procedure	Apply sampling guided by the research question (Patton, 2015)
	Completion of the within-case analysis by a cross-case analysis for enhanced generalizability	Contrast the observed cases' technology–principal–agent setups, information asymmetries, and governance mechanisms
Reliability	Careful documentation of the data collection	Review recordings, transcriptions, and presentation of data extracts
	Comparable interview settings	Use interview guidelines for all interviews
	Multi-perspective coding procedure	Involve three researchers

Abbreviations: ICT, information communication technology; LSSC, logistics service supply chains.

interviews followed a semi-structured interview guide (see Appendix A) and lasted approximately 45–150 min. We conducted most interviews in person; for interviewees who were further away, we used video and phone calls. We achieved data triangulation by combining the insights from the interviews with publicly available information on the firms, additional data on the offered service spectrum and technologies, and observations from our company visits.

4.3 | Data analysis

Based on Mantere and Ketokivi (2013), case study design allows for the following research procedure: observing the phenomena, explaining their occurrence, and deriving the rules. We executed this logic in our qualitative analysis using (a) open coding, (b) selective coding, and (c) theoretical coding. In the first step, we inductively grouped sentences and phrases into codes and categories to generate initial labels for the data.[1] In the second step—which began when no new open codes occurred—we limited coding to only those categories related to the core categories. Next, in the third step, we arranged the codes in relation to each other and connected them with established theoretical constructs (with a focus on agency). To increase reliability, two of us researchers were involved in the coding process (Lincoln & Guba, 1985), and we both coded two of the cases (Case_MH and Case_Temp) as follows. First, we jointly coded a long interview (90 min) page by page. For each page, we compared and elaborated on the codes. Once this initial interview had been coded, we worked independently of each other, openly and selectively coding the interview transcripts to prevent biased data interpretation. Our intercoder agreement reached 82.7%. Where our opinions differed, we resolved the codes in a longer meeting with all authors.

In our final step, we linked the codes to theoretical constructs, thereby reflecting coding on a meta-level

TABLE 2 Case overview, with Tier 4 (employed and subcontracted drivers) included on Tier 3 (carrier).

Cases	Employees	Tier	Firm	Description of firms in the dataset	Data sources (# of interviews)	Additional sources
Case_Smart	~100,000	1	Shipper_Smart	One of the largest pharma companies in the world, this company's drugs focus on asthma, HIV/AIDS, malaria, depression, migraine, diabetes, and cancer. Consignees (Tier 0) are specialized clinics.	Senior manager, cold-chain distribution (1)	Interview with technology supplier, physical testing on site, product descriptions (52 pages), product video, and podcast
	~500,000	2	LSP_Smart	International LSP providing full-spectrum logistics services, with an emphasis on the courier, parcel, and express-mail business segments.	Process and quality compliance specialist (1)	
	~120	2–3	Carrier_Smart	Local Carrier/LSP covering general cargo, temperature-controlled transports, and warehousing with certifications for dangerous goods, food, and pharmaceuticals.	Quality manager (1) and employed drivers (5)	
Case_MH	>500,000	1	Shipper_MH	Shippers are large food producers or food retail chains. Consignees are grocery stores.	Data from LSP_MH	Physical testing onsite, product descriptions (98 pages), product videos, and webpage of technology supplier
	~30,000	2	LSP_MH	Globally operating LSP active in European road transport, air, and sea logistics, food logistics, and contract logistics.	Business development manager (1), dispatcher (1), and technology lead (1)	
	~150	2–3	Carrier_MH_A	Local Carrier/LSP specializing in temperature-controlled goods, express delivery, and exhibition logistics.	CEO (1), COO (2), dispatcher (1), and employed drivers (8)	
	~60	3	Carrier_MH_B	Regional carrier with haulage and stock management as main business segments.	Co-CEO (1) and employed drivers (5)	

TABLE 2 (Continued)

Cases	Employees	Tier	Firm	Description of firms in the dataset	Data sources (# of interviews)	Additional sources
Case_FMS	~500	1	Shipper_FMS	Shippers are medium-sized regional manufacturers. Consignees are wholesalers for heating and sanitary products.	Data from LSP_FMS	Physical testing on site, product descriptions (68 pages), and product video
	~650	2	LSP_FMS	Medium-sized LSP with a focus on standard logistics services. Offerings cover general cargo solutions, warehousing, logistics consulting, and selected value-added services (e.g., transport insurance).	Member of the board (1), chief dispatcher (1), dispatcher (1), and business development manager (1)	
	~16	3	Carrier_FMS	Small LSP whose services include permanent local-transport tours on behalf of medium-sized LSPs and—rarely—also directly for shippers. In addition to general cargo (focal market sector), it serves the building industry using special trucks.	CEO (1) and driver (1)	
Case_Temp	~2650	1	Shipper_Temp	Pharma company focused on prescription medications, with an emphasis on iron deficiency conditions. This company is the global market leader in its field. Consignees are international providers of dialysis services.	Supply and demand specialist (1), group leader, and warehousing (1)	Interview with technology supplier, physical testing on site, product descriptions, product videos, and webpage of technology supplier
	~600	2	LSP_A_Temp	LSP for the pharma, medical, dental, and high-tech industry. Given its healthcare sector focus, its compliance with the highest regulatory demands differentiates it from competitors.	Member of divisional management, healthcare (1), and warehouse worker (1)	
	Unknown	2	LSP_B_Temp	Globally operating LSPs specializing in general cargo transport.	Data from LSP_A_Temp	

Abbreviations: FMS, fleet management system; LSP, logistics service provider; MH, multifunctional handheld.

again. Appendix B provides interview extracts and the assigned codes. We first analyzed all cases separately (within-case analysis) before we conducted the cross-case comparison.

5 | RESULTS

In this section, we outline our case study's empirical results. Our within-case analysis outlines the actors, information challenges, and technology management in each case. Then, in our cross-case comparison, we use PAT to highlight information asymmetry and governance mechanisms.

5.1 | Within-case analysis

5.1.1 | Case smart containers (Case_Smart)

An ICT smart container is used for the passively cooled transport of highly temperature-sensitive products. The smart container guarantees temperature deviations below 0.1%, tracks various status data for shippers, and stores that data in a blockchain-secured cloud. In our case, the technology principal was a large pharmaceutical production company that leased smart containers from the ICT provider. Both LSP_Smart and Carrier_Smart specialized in transporting temperature-controlled goods, and several shippers and LSPs, respectively, contracted with them. Carrier_Smart used various ICTs on behalf of LSP_Smart. These ICTs included different temperature-controlled containers. So, the Case_Smart case reflected the setup of multiple technologies–one technology principal. Carrier_Smart also handled the exact same type of ICT for other LSPs (so, those setups also reflected one technology–multiple technology principals).

Whenever the smart container passed a gateway (e.g., at an airport), data were transferred to the cloud, which only the shipper could access. This information asymmetry led to mistrust among the subcontractors. Although the subcontractors assumed that Shipper_Smart examined LSP_Smart and Carrier_Smart activities only to track temperatures, the feeling of being monitored spread at the user levels (Hid_Info). On the other hand, Shipper_Smart lacked information about how LSP_Smart and Carrier_Smart actually handled the smart containers (Hid_Info). Shipper_Smart insisted on jointly designing standard operating procedures (SOPs)—such as the time required for container handling—to reduce any potential hidden action (Hid_Action). Because the LSSC was multi-tiered, Hid_Action was especially pronounced. Smart containers were new to Shipper_Smart, which said it was never sure whether the damage to containers could be attributed to poor handling by Carrier_Smart (Hid_Action) or to a lack of container quality because when in doubt, LSP_Smart would cover for Carrier_Smart (Hid_Action). However, implementing controls by the consignees' warehouse staff reduced occurrences of Hid_Action by Carrier_Smart. Furthermore, Shipper_Smart paid the ICT provider for regular maintenance and inspection of the smart containers.

5.1.2 | Case multifunctional handhelds (Case_MH)

Case_MH involved the use of a multifunctional handheld device. The device included a handheld scanner that had several uses, including for optimizing information capture during loading and unloading in local distribution; tracking and tracing driver location through its GPS module; for communication (including some call functionality); and documentation (such as using its camera to photograph goods damage). The technology principal was LSP_MH, a global LSP (Tier 2) that subcontracts thousands of carriers, including Carrier_MH_A and Carrier_MH_B. Some of its shippers produce fresh and frozen food, while others are food retailers. The consignees are smaller grocery stores.

The subcontracted carriers (Tier 3) did not work exclusively with LSP_MH. For example, Carrier_MH_A had a similar contract with three other major LSPs and was in one technology–multiple technology principal setups with many different LSPs—as using a technology principal's handheld is a widespread practice for subcontracted carriers in the logistics industry. In our case, the handheld's roll-out from LSP_MH to Carrier_MH_A and Carrier_MH_B took approximately 2 weeks. Both subcontractors also used other ICT from LSP_MH (multiple technologies–one technology principal).

Data from the handheld were directly transmitted via mobile Internet from the local drivers to LSP_MH. In this LSSC, actors on Tier 3 and below knew neither which data got sent (Hid_Info) nor what LSP_MH (the technology principal) intended to do with it (Hid_Intent). This uncertainty led the carriers to make several assumptions, including that the technology principal was comparing the subcontractors' data. It also led drivers to make assumptions, such as that LSP_MH was surveilling them personally during the day. Simultaneously, the scanner granted new opportunities to shirk (Hid_Action), exemplified by the anecdote at the start of our paper.

5.1.3 | Case advanced fleet management system (Case_FMS)

Our third case, Case_FMS, involved an advanced fleet management system, or the platform, as some interviewees call it. The FMS platform integrates three systems: a mobile scanner system for local distribution (System 1); a cloud-based tablet and vehicle-connected box for long-haul transport (System 2); and the existing transportation management system (TMS) of LSP_FMS (System 3). System 2 can access vehicle information (including real-time tracking) and transmit data and messages to and from the driver.

Carrier_FMS was a long-term subcontractor for LSP_FMS. For general cargo subcontractors, ICT use is typically limited to what is installed on the trucks and the technological equipment (e.g., the handhelds) that the LSP provides. In this case, the ICT's integration took 2 months. The FMS platform integrated messaging and real-time tracking of driver- and vehicle-related information. This messaging and tracking reduced the cost of interacting with drivers and freed them from the time-consuming task of reporting data after they finished their workday.

Only System 1 (for local transport) allowed the use of subcontractors and drivers, as it was connected to mobile scanners. System 2 (for long-haul transport) was available only to the employed drivers. Information-related problems had already arisen in this case before the first ICT pilot was launched. Specifically, LSP_FMS had trouble assessing subcontractors' characteristics to select suitable pilot users (Hid_Action) as it could not draw on past experiences with similar systems. LSP_FMS therefore had to select pilot users based on nontechnological characteristics, such as the length of their business relationship or their reliability in daily business. This process unveiled the hidden intention (Hid_Intent). The lower tiers did not know what LSP_FMS intended (Hid_Intent) to do with the data (hidden information, Hid_Info), and they feared that the data would be passed on to some other party unknown to them (Hid_Action). Coalitions within Carrier_FMS that were opposed to the monitoring therefore delayed the FMS platform roll-out process (Hid_Action).

Carrier_FMS often complained about drivers missing their technology training, and the drivers did not sufficiently study the provided material. Drivers were also too time-constrained to scan all the shipments. LSP_FMS therefore introduced outcome-oriented contracts with financial sanctions for inappropriate technology use (e.g., for items not scanned; see Appendix C).

5.1.4 | Case temperature-tracking devices (Case_Temp)

The Case_Temp ICT ensures high-accuracy temperature monitoring and tracking across the pharmaceutical supply chain. During transport, the ICT logs temperature data points. The shipper must retrieve those data points after the consignment has arrived. All data are stored in a cloud solution accessible to the shipper. In this case, Temp_Shipper was the technology principal.

Temp_LSP_A was Temp_Shipper's long-term warehousing partner for Europe. The produced goods were brought directly to one of Temp_LSP_A's warehouses, where they were prepared for shipment worldwide. Temp_LSP_A used various technologies for the same customer, including packaging technologies and trackers (multiple technologies–one technology principal). The roll-out process for the temperature tracking devices was 3 months.

Temp_LSP_A was responsible for starting the tracking devices, attaching the correct number of trackers to the pallets, and documenting the process. Temp_LSP_A also handled the data-transmission process for loggers attached to incoming shipments. Because the temperature trackers eliminated the need for temperature controls by each actor in the LSSC, they also increased process efficiency.

Temp_LSP_A dealt with similar technologies for many customers (multiple principals), which gave it an information advantage over Temp_Shipper. Temp_LSP_A knew the time needed to provide the tracker-related services, potential process pain points, and the technical competence required (Hid_Info). Temp_Shipper was aware of its adverse position; in response, it requested the joint design of SOPs. While introducing new devices, Temp_LSP_A had to write and review binding SOPs, which were then approved by Temp_Shipper. The SOPs were equivalent to a technology-specific contract, which helped Temp_Shipper reduce Hid_Info as the SOPs made technology handling more transparent. Case_Temp was also vulnerable to other information asymmetries (Hid_Action), such as users saving time by cutting corners on starting and positioning the trackers.

5.2 | Cross-case comparison

5.2.1 | Information challenges in technology management

The most common theme we found across the four cases was subcontractor fear of ICT—specifically, individual subcontractors feared that the technology principal would monitor and potentially use ICT data in ways other than the stated purposes, such as by passing the data to third parties. These concerns grew along with the obviousness among users that data was being collected about them (Case_FMS and Case_MH).[2]

Hidden action occurred across all cases; it typically manifested as Tiers 3 and 4 workers cutting corners by not using the technology as instructed by the technology principal. Among the examples from our data were workers not documenting damage, starting the ICT later than intended to save time, and skipping shipment scans. The technology principals highlighted their general challenges in controlling the technologies' intended use. In Case_FMS, the data management platform optimized the workflow based on facilitated messaging and tracking. While this new workflow sped up communication between the dispatcher (Tier 3) and the drivers (Tier 4), it also made it easier for individual drivers to collude in shirking. In this LSSC, the technology principal complained about the lack of distance between dispatchers (Tier 3) and drivers (Tier 4), who sometimes colluded (Hid_Action), with dispatchers covering up for driver negligence or laziness. Our data also showed reports of individual consignments being listed as delivered on time, when in reality dispatchers and drivers had taken a break together and actually delivered the consignment late. As the LSP_Smart case outlined, deviations from the standard handling procedure were most common in longer LSSCs, such as Case_MH and Case_FMS.

Table 3 offers an overview of information asymmetry in all four cases.

We will now examine how various technology and technology principal setups impacted agency from the subcontractor's perspective.

One technology–multiple technologies principals setups. All four cases had one technology–multiple principal setups. In Case_Temp and Case_Smart, the challenges related to this setup were clear. Both shippers had long-term outsourcing arrangements with a few LSPs, each of which was responsible for logistical activities of a select part of the shippers' supply chains. For example, Shipper_Smart used an LSP whose employees loaded and transported the smart containers. Because the LSP provided the technology-handling service for many other customers, the shipper did not have the same expertise level as the LSP, which had to assess whether the ICT was handled appropriately (Hid_Info). As we outlined earlier, subcontractors often dealt with the technology inappropriately, which we observed in both Case_MH and Case_FMS.

Multiple technologies–multiple principals technology setups. This setup occurred in three of the four cases (Case_FMS involved only one technology across the organizations, even though that ICT integrated several systems between the LSP and the carriers). Having several principals and technologies is similar to having one technology–multiple principals, but it gives more power to the subcontractors. For example, in using handhelds, Tiers 3 and 4 subcontractors typically pay the technology principal a monthly rent; in this setup, they were able to negotiate rents based on prices for similar technology use with other principals. Furthermore, when the handhelds were damaged, and the technology principals tried to invoice the subcontractors, the latter could use their experiences of quality issues with similar technologies to refute the invoices. Further, while some principals were in an early-stage or pilot use of an ICT, their subcontractors were at times already experts in its use.

Multiple technologies–one technology principal setup. In all but one of the cases (Case_FMS), the subcontractors were already using ICT technologies other than only the targeted one for their technology principal. Larger shippers and LSPs regularly pilot new technologies. LSP_MH selected subcontractors for its technology pilots based on their performance in previous early-stage rollouts, where it frequently chose Carrier_MH_A. As this example shows—and our interviewees reflected—in addition to the targeted agent (subcontractor) characteristics, having a multiple technologies–one technology principal setup helped reveal agent intentions. In both Case_Temp and Case_Smart, for example, Tier 3 (carriers) interviewees said that their previous handling of new technologies may have influenced the primary principal's decision to test other technologies with them.

5.3 | Governance mechanisms

Here, we examine ways to improve principal–agent goal alignment and limit information asymmetry using governance mechanisms. Table 4 offers an overview of the mechanisms we observed across our cases.

Contract design and incentives reflecting technology–principal–agent chains. Case_MH and Case_FMS required a high degree of technology interaction as part of their daily business. The opposite was true for Case_Smart and Case_Tracker, where the freight forwarder simply loaded and moved the containers without technology interaction. All four cases, however, had governance mechanisms to tackle information asymmetries—especially Hid_Action.

The primary technology principals of Case_MH and Case_FMS had installed a remuneration system with an outcome-oriented component. The carrier (Tier 3) received full payment only if certain key performance indicators (e.g., scanning rate) were met. However, to align the technology principals' goals with Tier 4 (drivers), some of the technology principals offered additional incentives for individual drivers who were using the technology (regardless of their employer). LSP_MH even revealed the performance indicators and a comparison of

TABLE 3 Comparison of information asymmetry between cases.

Case	Case_Smart	Case_MH	Case_FMS	Case_Temp
Applicable information asymmetry types (affected actors in italic letters)	• Hid_Info: *Technology principal (Shipper)* does not disclose to other LSSC actors the extent to which it analyzes the data from the smart containers (e.g., to conclude how single actors in the LSSC performed). In turn, the *LSP* does not disclose whether information on technology use is applied to other technology projects for different primary principals. • Hid_Info: *LSP* also operates as a service center for the smart container producer and, therefore, already knows the relatively new technology better than the shipper does. Additionally, this know-how is used to initiate new business relationships with other principals. • Hid_Action: *Technology-user level* accepts the damaged containers to provide a service as quickly and cheaply as possible. Subsequent LSSC tiers (e.g., the carrier and the employed drivers) try to cover up any transport damage.	• Hid_Info: *Technology principal (LSP)* does not disclose to the others what it intends to do with the acquired data from the handhelds. In turn, the secondary service provider does not inform whether it transfers information on technology use to customer relationships with other primary principals. • Hid_Info: *Secondary service providers* benefit from using different technologies for different primary principals to discover weak points by comparing the technologies against each other. • Hid_Action: *The technology-user level* profits from the handhelds' increasing complexity and finds new ways to shirk (e.g., by deliberately taking false photos). Subsequent LSSC tiers (e.g., the drivers and the dispatcher) form coalitions to cover up incorrectly entered information about consignments.	• Hid_Info: *Technology principal (LSP)* does not disclose to others what it intends to do with the platform data. • Hid_Action: *Technology principal* gathers driver-related data to improve future choices of subcontractors (without them knowing it). Principal does not disclose when data are transferred to third parties (e.g., data-analysis specialists). *Technology-user level* of the LSSC is too lazy to scan all items and consciously leaves out single consignments. Subsequent LSSC tiers (e.g., the carrier and its employed drivers) collaborate in covering up missing technology training to hide their inability to scan.	• Hid_Info: *Technology principal (Shipper)* does not disclose whether it applies insights on technology use (e.g., from the SOP, which it designed with the LSP) to other technology projects for different technology principals. • Hid_Info: *LSP* deals with similar tracking devices for different customers and can appraise the whole roll-out process, including pain points. Furthermore, it can use know-how from other technologies (e.g., temperature-controlled containers) for business relationships with other principals. • Hid_Action: *Technology-user level*, to finish faster, does not start the trackers carefully. Subsequent LSSC tiers (e.g., warehouse employees and drivers) form coalitions to prevent detection of incorrectly attached trackers.

Abbreviations: LSP, logistics service provider; LSSC, logistics service supply chains; SOP, standard operating procedure.

all carriers and all drivers (see Appendix C). According to one of the interviewees, the money itself was not the main incentive, but rather the professional respect it implied.

Case_Temp and Case_Smart had recently established behavior-oriented contracts between the technology principal and the LSPs. Given that the technology principals in both cases were satisfied with their subcontractors' performance, the contracts did not include a financial incentive or sanction.

Non-contractual governance mechanisms. After incentive alignment, the first governance mechanism we observed in the cases was staff rotations to break up the observed coalitions. However, formal governance mechanisms were rare and could be examined only in Case_Temp and Case_MH. LSP_A_Temp provided

TABLE 4 Comparison of governance mechanisms between cases

Case	Technology–principal–agent chain	Governance mechanisms
Case_Smart	• One technology–multiple technology principals chain: Yes—both LSP and carrier provide comparable service to different firms. • Multiple technologies–one technology principal chain: Yes—both LSP and carrier use various technologies for the same customer. • Multiple technologies–multiple technology principals chain: Yes—both LSP and carrier use various technologies for different customers.	• Collaborative governance mechanism design (all subsequent tiers). • Monitoring through the consignee acting as proxy-principal (technology-user level).
Case_MH	• One technology–multiple technology principals chain: Yes—Carrier provides comparable service to different LSPs. • Multiple technologies–one technology principal chain: Yes—Carriers use different technologies for the same LSP. • Multiple technologies–multiple technology principals chain: Yes—Carriers use different technologies for different LSPs.	• Outcome-oriented contract with penalties for inappropriate technology use (technology-user level). • Rotation of people controlling agents (all subsequent levels).
Case_FMS	• One technology–multiple technology principals chain: Yes—Carrier provides comparable service to different LSPs. • Multiple technologies–one technology principal chain: No—carrier handles only the observed technology for the same LSP. • Multiple technologies–multiple technology principals chain: No—carrier handles just the observed technology for the same LSP.	• Outcome-oriented contract with penalties for inappropriate technology use (technology-user level).
Case_Temp	• One technology–multiple technology principals chain: Yes—LSP provides comparable service to different shippers. • Multiple technologies–one technology principal chain: Yes—Carriers use different technologies for same shipper. • Multiple technologies–multiple technology principals chain: Yes—carriers use different technologies for different shippers.	• Collaborative governance mechanism design (all subsequent levels). • Monitoring through the proxy-principal role of the shipment consignee (technology-user level). • Monitoring through rotation of the principal's people (all subsequent tiers).

Abbreviations: LSP, logistics service provider.

warehousing services to various pharma companies, and each warehouse employee was assigned to at least one pharma company. The staffing plan stipulated regular rotation of team heads among the teams. In the process, the team heads identified any inappropriate technology handling by individuals, which might have remained undiscovered if the team heads had monitored only one team. As we noted earlier, dispatcher–driver coalitions emerged in Case_MH, where dispatchers covered for their drivers who had entered incorrect status information into handhelds. Such behavior was discovered by chance during dispatcher rotations due to a vacation replacement; this discovery resulted in a formalization of the staff rotation.

The second observed governance mechanism was making the consignee a proxy of the principal. The nature of the consignee's two proxy-principal roles that we observed were (1) a major technology interaction with a monitoring component (Case_Temp and Case_Smart), and (2) a minor technology interaction without a monitoring component (Case_FMS and Case_MH). The interviewees testified to the consignee's interaction level affecting the technology's appropriate use. In some cases, the consignee extensively interacted with the technology and simultaneously performed a monitoring function. In Case_Smart, for example, the shipment consignee's warehouse unloaded the containers and checked the integrity of both the containers and the goods inside them. The employed drivers were aware that any improper handling would be noticed, which prevented them from Hid_Action. Because Case_MH and Case_FMS did not involve high levels of interaction between the consignee and the technological innovation, we did not observe comparable positive effects in their data.

In Case_MH, the technology principal ensured that the technical specifications prevented the handheld devices from being used in assignments for other principals. Because this was not possible in Case_Temp and Case_Smart, the primary principals intensified exchanges with their subcontractors and worked on building trustful business partnerships to systematically reduce asymmetry.

6 | DISCUSSION

In this section, using the lens of agency, we first elaborate on RQ1 and the information asymmetry challenges in LSSC technology management. We then turn to RQ2, discussing how applying PAT addresses agency issues, focusing on contracts and control systems as governance mechanisms in outsourced logistics services.

6.1 | Information-asymmetry challenges

6.1.1 | Early-stage ICT usage

Regardless of whether the shipper or its contracted LSP is the technology principal, the LSP typically provides training for the subcontractors' technology users (agents). In Case_Temp, for example, the shipper and the LSP collaborated on SOPs, which defined the technology for the entire LSSC. Consequently, technology-related training and education reduced information asymmetries, especially hidden action (Hid_Action). Thus, based on the case data and the impact of close interaction on agency (Zu & Kaynak, 2012), we conjecture the following:

> **Conjecture 1a.** In multi-tier LSSCs, the early stages of ICT use require interactions between the technology principal and the agents; this early interaction reduces hidden action at lower tiers.

However, as our case results highlight, the opportunistic behavior (Hid_Info and Hid_Action) of subcontractors (agents) increases again after these initial stages, when trainings are completed and interaction frequency declines. This outcome was true for all four cases, and is exemplified by Case_Smart, where, in the long run, only regular maintenance by a technology principal contractor was able to prevent damages to the temperature-controlled containers. Therefore, we conjecture the following:

> **Conjecture 1b.** In multi-tier LSSCs, declining interaction between the primary and secondary service providers in the routinization stage is positively associated with hidden information and hidden action at the lower tiers.

As Conjecture Conjecture 1b implies, subcontractor (referring to the secondary service providers) behavior changes over time as moral hazards increase. Direct monitoring during technology training allows the technology principal to reduce the information asymmetry related to the actions of secondary service providers (subcontractors). This effect disappears once the principal's direct monitoring of subcontractors decreases.

6.1.2 | Dual perspective on hidden information

In the literature, information asymmetry is typically viewed from the principal's perspective, that is, the principal lacks information that the agent has (and potentially takes advantage of). However, in LSSC technology management, information asymmetry is two-sided: Not only is there hidden information/action on the agent side, but the agents cannot determine how or if the principals are using the ICT-generated data. Our case study highlights this result among German-speaking technology users in Europe; these users (agents) were very concerned about the principals using and sharing their data with third parties. Recent studies echo these concerns about information privacy in ICT implementation (e.g., Sternberg et al., 2021). Such concerns negatively affect the relationship between the technology principal and the agents, and they could compromise loyalty, leading to more agency issues (such as Hid_Action). Further, assuming opportunistic behavior (Eisenhardt, 1989a), the agent (especially secondary service providers) will exploit new possibilities to shirk. This leads to the following conjecture:

> **Conjecture 2.** In multi-tier LSSCs, ICTs that acquire multi-tier usage data that are accessible to only one actor are (a) positively associated with agent mistrust, and (b) those agent concerns are associated with hidden action of secondary service providers.

6.1.3 | Depth of technology–principal–agent chains

We observed hidden action (Hid_Action) several times across our cases. In Case_FMS, for example, carriers and drivers covered for each other regarding missing technology training to hide their inability to use a handheld. These findings align with the literature suggesting that Hid_Action might occur whenever principal–agent chains have more than two tiers, allowing agents to form coalitions (Tirole, 1986). We therefore conjecture the following:

> **Conjecture 3.** In multi-tier LSSCs, an increasing number of tiers is positively associated with hidden action through collusion between secondary service providers.

Conjecture 3 suggests that Tirole's (1986) logic on principal–supervisor–agent dynamics transfers to secondary service providers in outsourced logistics. Tirole's rationale holds for both inter-organizational and intra-firm LSSCs: Whenever hierarchical relationships have three or more tiers, two actors can form a coalition and work toward a common cause to the third actor's detriment (Tirole, 1986).

6.1.4 | Breadth of technology–principal–agent setups

As Case_MH shows, applying the same technology (a multi-purpose handheld) to different principals can give secondary service providers an information advantage over primary service providers. Thus, we conjecture the following:

> **Conjecture 4a.** In multi-tier LSSCs, setups of one technology–multiple technology principals are positively associated with hidden information among secondary service providers.

Conjecture 4a demonstrates that LSPs' particularities impact information asymmetries. Because LSPs and carriers usually serve multiple customers using different technologies, they are forced to gather technology management know-how and display a willingness to use new ICT, which in turn generates the potential for more business (in particular, for the carrier). The result (a display of eagerness to use new ICT, regardless of actual ambition) is an information advantage over the technology principal—particularly when that principal is a shipper (and further away from the actual executing tier) rather than an LSP.

However, our data also suggest that having multiple technologies and one (or more) technology principals can go in a different direction. At times, subcontractors will try to make the best possible use of a technology—and show it—based on existing experience with the same technology principal or with comparable technology applications from other principals. As our data indicate, subcontractors see multiple technologies–one principal chains as an opportunity to build a closer partnership with the principal based on good performance with technology. Hence, we conjecture:

> **Conjecture 4b.** In multi-tier LSSCs, setups of multiple technologies–one technology principal are negatively associated with hidden characteristics and hidden intentions of secondary service providers.

Multiple technologies–multiple principal chains are common in LSSCs. When the shipper is the technology principal, it must rely on the LSP to ensure that subsequent agent tiers comply with the technology use. In Case_MH, the LSPs (MH_LSP and others) handed over their various scanners and other devices to the drivers. To avoid surveillance, the drivers sometimes feigned scanner failure—something they were skilled at doing, as they had experience using multiple technologies for multiple technology principals. The LSP in this case had no way of proving that the scanners were deliberately misused. As this example shows, as LSPs' need for monitoring and control expands and they supply more technologies accordingly, their subcontractors' ability to behave opportunistically while using those technologies also expands. Thus, we conjecture:

> **Conjecture 4c.** In multi-tier LSSCs, setups of multiple technologies–multiple principals are positively associated with hidden information and hidden action of secondary service providers.

6.2 | Positivist agency theory application

In our case study, effective technology management was linked to contracts that had incentive schemes reflecting the setup. In Case_MH and Case_FMS, for example, the technology principals were aware of emerging information asymmetries in lower tiers. They therefore linked incentives not only to the subcontractor on the next tier, but also to the final subcontractor executing the service. We therefore conjecture the following:

> **Conjecture 5.** In multi-tier LSSCs, contracts are an effective governance mechanism to overcome moral hazard between providers when contract design reflects the technology–principal–agent setup.

Typically, principals use information gained from monitoring agents to impose sanctions on the agents as soon as they detect misconduct. We also observed randomness in the monitoring of subcontractors. Specifically, rotating supervisors seems to impact the effectiveness of such monitoring. Case_Temp and Case_MH exhibited the importance of supervisor rotation, which breaks up familiar ties between supervisors and drivers. We therefore suggest the following:

> **Conjecture 6.** In multi-tier LSSCs, rotating staff is an effective governance mechanism to

> overcome information asymmetries, especially at the lower tiers.

To the best of our knowledge, Conjecture 6 is the first empirically grounded conjecture on how to effectively overcoming hidden transfer (Hid_Action) in a multi-tier setting (Tirole, 1986). The observed collusion between agents who felt close to each other (e.g., between dispatchers and drivers) could be explained by ingroup favoritism (Dasgupta, 2004). To cut through such "too close" boundaries and prevent their adverse effects (Anderson & Jap, 2005), job rotation seems to be an effective governance mechanism in the logistics context.

As our study outlines, technology management in multi-tier LSSCs is challenging and gets more challenging with each additional tier. Compared to LSPs, the shippers in LSSCs are further away from the executing tier and closer to the end-customer—that is, to the consignee. Our cases suggest that the consignee can collaborate by acting as a proxy to the technology principal and monitor the technology usage. Hence, our final conjecture is as follows:

> **Conjecture 7.** In multi-tier LSSCs, the primary service provider's collaboration with end-customers is negatively associated with hidden information and hidden action at the lower tiers.

7 | CONCLUSIONS AND FUTURE RESEARCH

Our multiple case study addresses the impact of technology—specifically, how it functions and how subcontractors use it—on technology management in multi-tier logistics service outsourcing. Applying PAT as a framework, we find that the systems intended to remedy agency actually create new venues for agency issues and trigger mistrust. While ICT may create more transparency in the supply chain, that transparency is mostly accessible only to the technology principal, not to downstream service subcontractors. Our study found that hidden action and hidden information were common types of agency issues in multi-tier outsourced logistics services.

We conjecture that governance mechanisms drawn from the cases can benefit technology management in outsourced logistics services and potentially beyond them. Our findings stress the feasibility of governance mechanisms, as well as the importance of taking a holistic approach to their design that considers subcontractors' subcontractors (and beyond).

7.1 | Contribution

This research offers two contributions to theory. First, we outline information asymmetries and the agency issues they enable, both of which must be considered for effective technology management in logistics service outsourcing. We conjecture that (a) while ICT is meant to increase efficiency and reduce information asymmetry, its use creates new agency issues and increases mistrust in certain relationships; (b) agency issues in technology management of subcontractors increase as the number of contracts with different technology principals increase; and (c) contracts must consider principal–agent relationships not only in terms of the service, but also in terms of the technology management (i.e., the roles required to monitor and use the technology).

Second, we contribute to the OSCM literature by providing an application of PAT to multi-tier logistics service outsourcing. We conjecture that, as the agent tiers increase, so too do opportunities for hidden action and for lower-tier agents to collude while shirking. In line with existing theory, our results show that in LSSCs, contracts are an important governance mechanism. However, as our work shows, these contracts must take into account the prevailing landscape and the distances between the technology principal and the agents. Rotating staff members to different positions can help to tackle some of the information asymmetries in LSSCs by preventing overly familiar links between the supervising and the executing agents. This in turn, could make technology management more successful by decreasing the likelihood of collusion and hidden actions.

Scholars have been hesitating to address technology management in the black box of multi-tier service chains, particularly in logistics. This study makes a first empirical contribution to a complex and understudied area that offers plentiful opportunities for future research. Such research can go far beyond the outsourced logistics field to other sectors with multi-tier service chains, including maintenance, tourism, and construction.

7.2 | Future research

Our paper provides venues for future research through both the conjectures and the empirical account of LSSCs. We derived our conjectures from case data, and they have the merits and limitations that come with an in-depth, small-scale study. Additional studies are needed to further develop and test the generalizability of our conjectures, for example, whether these conjectures hold in multi-tier service outsourcing outside the logistics realm. The range of LSSCs we examined was broad, but not exhaustive, and all focused on central Europe. Studying entire networks of service providers—rather than a subset of multi-tier relations—could lead to even more complex chains than we found in the multi-tier landscape, as well as more intertwined information asymmetries.

We framed our results using agency theory, and we did not account for contingency effects. Applying stakeholder theory and power asymmetry in service subcontracting could yield interesting insight into the technology management of LSSCs. Another possible venue of research would be to study the relation between technology fit and user acceptance.

Our study touches only the surface of differences between shippers and LSPs as technology principals in service chains, as well as of governance mechanism possibilities. Among the outstanding and highly relevant questions for both OSCM and technology management are: What are the possible setups of these multi-chains in terms of information asymmetry and governance mechanisms? How does each setup impact technology management success?

Finally, professional truck drivers execute a considerable portion of logistics services. In our Europe-focused study, the drivers were very concerned about information privacy. A key question here is whether this finding is generalizable to drivers in other geographical regions and cultural contexts. Given the global shortage of truck drivers and the importance for carriers to keep their drivers in the profession, we suggest a broader look into driver culture and differences among different driver groups to address information privacy and other issues.

7.3 | Managerial implications

As previous literature notes, firms struggle with technology management in outsourced logistics. Our work provides managerial insights that can ease this struggle by offering information on information asymmetries and related challenges, highlighting the importance of transparency in how the data collected through ICT is used and who can access it. Following an informed approach to technology management will likely improve a firm's relationships with its subcontractors and the user acceptance of technology. Finally, our work offers firms insight into governance mechanisms—including consignee involvement, incentives for subcontractors' subcontractors, and supervisor rotation—that can help them better succeed in technology management.

As both outsourcing and digitalization increase in virtually every industry, effective technology management becomes more critical than ever before. As we emphasize here, it is therefore, essential for scholars and practitioners alike to focus on all tiers of the subcontracting chain in order to manage technology in a way that achieves the intended benefits and avoids information asymmetry.

ACKNOWLEDGMENT

Open access funding provided by the Iowa State University Library.

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ENDNOTES

[1] We describe the actual steps we took; while our study started out as an inductive case study, as agency theory became central to explain what was happening in the cases, we moved to an abductive approach.

[2] Contextually, it should be noted that users in German-speaking Europe generally expect significantly more damage and attribute higher probability to privacy-related violations than, e.g., U.S. users (Ilhan & Fietkiewicz, 2021).

[3] This could also be translated as state-of-the-art ICT, though "innovative ICT" is closer to the original German expression. The cases were on state-of-the-art ICT, selected before the interview began. The ICT studied would not necessarily be labeled *innovative*.

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How to cite this article: Sternberg, H., Mathauer, M., & Hofmann, E. (2022). Technology management in multi-tier chains: A case study of agency in logistics service outsourcing. *Journal of Operations Management*, 1–22. https://doi.org/10.1002/joom.1219

APPENDIX A: INTERVIEW GUIDELINE

This appendix shows an extract of the interview guideline (adapted for logistics service providers).

1. Logistics service chain
   - What do the logistics service chains that your company is embedded in look like?
   - Do you use subcontractors?
   - Are your subcontractors allowed to enter into subcontracting relationships as well (tiering)?
2. Innovative information communication technology (ICT)[3]
   - Please describe the innovative ICT in detail.
   - Please describe the concrete logistics service chain concerned with the roll-out and use of the innovative ICT.
   - What kind of data is acquired by the innovative ICT, and who is authorized to access it?
   - Do you enter into any technology-related contracts with your subcontractors?
   - How long did it take from the decision to adopt the innovative ICT to the appropriate technology handling on the user level?
   - What does the interaction between the innovative ICT and the drivers look like?
   - What does the interaction between the innovative ICT and the shipment consignee look like?
3. Information asymmetries
   - What kinds of problems emerged during the roll-out and use of the innovative ICT?
   - What problems might be attributed to information asymmetries?
   - How do you select users for pilot projects?
   - To what extent do you evaluate specific characteristics of subcontractors before they are integrated with technology projects?
   - Are you able to judge whether the innovative ICT is applied correctly at each level of the logistics service chain?
   - At which level(s) of the logistics service chain is the innovative ICT deliberately misused?
   - Are there any examples of coalitions of technology users that operate to your disadvantage in the logistics service chain?
4. Governance mechanisms
   - Do you have governance mechanisms in place that ensure the appropriate handling of the innovative ICT throughout the logistics service chain?
   - What do these governance mechanisms look like?
   - Does the shipment consignee have a controlling function concerning the technology used for service provision?
   - Are the governance mechanisms/documents for correct use of the innovative ICT designed jointly with your partners in the logistics service chain?
   - In your opinion, what should governance ideally look like to overcome the described problems during the roll-out and use of innovative ICT?
   - Please describe a less successful technology roll-out from the past. From a governance perspective, what should have happened differently?

APPENDIX B: SAMPLES OF CODING

This appendix contains selected quotes and extracts of the coding.

Quotes from the interviews	Selective codes	Theoretical codes
"[LSP_MH] has exclusive access to all data, although it is generated by our drivers, so to speak. Isn't that crazy? If we want to see how many shipments our driver has delivered and scanned, we have to ask [LSP_MH] for an extract from the system." (CEO of Carrier_MH_A)	Data acquisition	Characteristics of innovative ICT
"In my opinion, data protection is being trampled underfoot here [...]. Personal data is transmitted to the 3PL unfiltered. In our dependency relationship, we can do nothing other than watch. The data sovereignty lies solely with [LSP_MH]." (Co-CEO of Carrier_MH_B)	Data protection	Characteristics of innovative ICT
"The new solution has a lot of functions, for example, text messaging. These devices have more in common with a smartphone than with an actual scanner. The downside is that all these functions also have the potential to distract from the correct application." (Chief dispatcher of LSP_FMS)	Technological integration	Characteristics of innovative ICT
"... yes, this is nothing special in this industry. We attach trackers to the shipments of all our pharma customers. Therefore, our employees know how to handle them and exchange knowledge among the customer teams regularly. You would call it 'horizontal knowledge transfer' probably." (Member of divisional management health care of Temp_LSP_A)	One technology–multiple principal chain	Technology–principal–agent chain
"It used to be that we only had one technological solution for one customer. Today, things look completely different. Something new is constantly being added, which we also include in our services. From a single technology perspective, the handling is usually not that difficult. The challenge, however, is to master the whole set of technologies." (Group leader warehousing of Temp_LSP_A)	Multiple technologies–one principal chain	Technology–principal–agent chain
"There are those cases where people do not even think about using the technology correctly. They want to continue to do their own thing and obstruct new technology projects. It's ... difficult because you cannot get inside people's heads." (Dispatcher of LSP_FMS)	Hidden intention	Information asymmetry types
"Of course, there is something you call 'hidden action.' Drivers can be lazy guys. When they see 25 individual consignments that they would have to scan individually under time pressure, they get creative. We are responsible for designing a solution that makes it very difficult to cheat.... and expensive to cheat." (Dispatcher of LSP_MH)	Hidden action	Information asymmetry types
"The more levels there are in the service chain, the more difficult it is to keep the exact overview. I can tell you stories you will not believe .... Our products also have to be shipped to nations which are less well developed. At some pallets there, the trackers suddenly disappeared. People had made common cause and sold the stuff." (Supply & demand specialist of Temp_Shipper)	Hidden transfer	Information asymmetry types
"If you work together with a new partner, you do not know his technology skills before. SOPs are a good thing .... We work together for months on binding documents and talk almost daily on operative processes. At some point, you really know whether they fooled you in the tender or know their business well." (Senior manager cold chain distribution of Shipper_Smart)	Collaborative mechanisms	Governance mechanisms
"It must hurt financially. All other governance mechanisms are nice to have but less effective." (Business development manager of LSP_MH)	Financial penalties	Governance mechanisms

Abbreviations: FMS, fleet management system; ICT, information communication technology; LSP, logistics service provider; MH, multifunctional handheld; SOP, standard operating procedure.

APPENDIX C: SAMPLE OF A GOVERNANCE MECHANISM

This appendix shows an example of a governance mechanism. Following is a screenshot of an email sent by an LSP's head traffic controller to the contact people at all of its subcontracted carriers (including subcontracted subcontractors). As the screenshot shows, the email indicates a comparison of all the subcontractors' performances. The percentage refers to the consignments correctly scanned using the handheld device.

The text preceding the chart is in German; the translation is as follows:

Honored ladies and gentlemen,

Following is the October evaluation. The three best drivers are again receiving a bonus of 35€. Your drivers will also be receiving this information. All drivers marked with red must improve.

Von: Anonymized
Gesendet: Mittwoch, 10. November 2021 13:18
Cc: Anonymized
Betreff: Scanquote Oktober

Sehr geehrte Damen und Herren,

nachfolgend die Auswertung von Oktober. Für die besten 3 Fahrer vergüten wir wieder eine Prämie von 35 €.
Für die Fahrer wird die Auswertung gleichfalls veröffentlicht. Alle rot markierten Fahrer müssen sich verbessern.

Unternehmer 12to. Scanner-Bewertung				Januar
Relation	Unternehmer		Scan-Quote	
NZ	Anonymized		100%	Prämie
NZ			100%	Prämie
NZ			100%	Prämie
NZ			99%	
NZ			99%	
NZ			99%	
NZ			99%	
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NZ			94%	
NZ			94%	
NZ			94%	
NZ			94%	
NZ			93%	
NZ			93%	
NZ			90%	
NZ			89%	
NZ			87%	
NZ			73%	

Mit freundlichen Grüßen

Anonymized
Speditionsleiter