

Opportunism still remained alive: conditional limits of trust and contract in software projects

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Abstract

Purpose – Based on a survey study of 138 software buyers in Turkey, this study examines conditional indirect effects of requirements uncertainty on supplier opportunism where buyer dependence, a proxy for relation-specific investments, undertakes a mediator role. The authors consider a two-level moderation effect of trust and contract in buyer–supplier relationships throughout the software project lifecycle.

Design/methodology/approach – A survey-based empirical study was conducted, and conditional process analyses were run using PROCESS macro in SPSS. The present study tests a two-stage moderated mediation model in which competence-based trust with a detailed contract setting moderates the mediational path from requirements uncertainty to buyer dependence.

Findings – The data obtained from the buyer side in the Turkish software industry showed that a relationship in which the buyer is structurally dependent begins at a high level of trust. On the other hand, the authors found that contractual rigidity fosters supplier opportunism ex-post in evolving process of the relationship.

Originality/value – This study contributes to project management literature by testing a two-level moderation effect of governance and the mediator role of buyer dependence in the relationship between requirements uncertainty and supplier opportunism. Moving differently from the previous studies, this study integrates contributions of both economic perspectives, such as resource dependence theory and transaction cost analysis, and relational perspectives into the information processing view.

Keywords Ex-post opportunism, Requirements instability, Buyer dependence, Trust, Contract, Software industry

Paper type Research paper

1. Introduction

Project-based software engineering brings remarkable benefits to dynamic efficiency (Gonzalez *et al.*, 2010), but the development of customized software solutions, in turn, generates serious transactional hazards between exchange partners (Ali *et al.*, 2020; Bahli and Rivard, 2003; Barros-Justo *et al.*, 2021; Khan and Khan, 2013). The reasons behind software project failure are often referred to as supplier opportunism (Haq *et al.*, 2019; Lioliou and Zimmerman, 2015), requirements instability (Fu *et al.*, 2012; Menezes *et al.*, 2019), the lack of mutual trust (Cheng *et al.*, 2021), misappropriation of information assets (Mathew and Chen, 2013), hidden costs (Larsen *et al.*, 2013), poor coordination, relational risk and insufficient quality of technical capability (Ali *et al.*, 2020). Buying companies usually experience permanent dissatisfaction with custom software projects (Laan *et al.*, 2011; Qi and Chau, 2015). According to the findings of Lamsweerde's large-scale study in software engineering (2000), one-third of the projects can never be completed while one-half can only be partially accomplished due to problems including dysfunctions, cost overruns and schedule delays. Software requirements changes produce an overall prevalence of project failure (Fu *et al.*, 2012; Haq *et al.*, 2019; Javed *et al.*, 2004). Accordingly, disappointment with software projects is largely dependent on intrinsic volatility surrounding system requirements (Wallace *et al.*, 2004). From an information processing viewpoint, requirements uncertainty signifies an expectation gap that appears between requirements information available and requirements



information required to perform the desired tasks (Nidumolu, 1996). In line with that, software buyers with limited information processing capacity in response to more complex and dynamic task environments will become incapable of evaluating and monitoring supplier performance. Difficulty in measuring performance incentivizes software suppliers to act selfishly. While requirements volatility leads to inconsistent task performance, supplier opportunism realized ex post is one of the key factors affecting the failure of software projects.

Requirements uncertainty reveals a signal of information asymmetry and leads to severe problems of moral hazard (i.e. misappropriation of knowledge assets in adjusting interlinked tasks). Supply-side has a knowledge advantage of software development resources and capabilities (Bahli and Rivard, 2003; Nuwangi *et al.*, 2014). The holders of knowledge could opportunistically exploit information asymmetries to make product and process adjustments. Where asymmetric information exists, it is extremely difficult to evaluate and verify how much effort suppliers endeavor to the desired procurement of software services or how much they volunteer for the necessary product modifications including additions, removals and updates that serve for eliminating errors and deviations in performance (Elitzur *et al.*, 2012). Changing requirements information provokes supplier manipulation that distorts the task responsibilities and financial constraints of a project. Supplier opportunism might arise even if a strong use of formal and informal incentives and controls prevailed in relationships. In case software failures are attributed to the inaccurate and incomplete information of project requirements, little remains left to be legally enforced previously agreed commitments against alleged non-compliances. Therefore, in task environments where user needs and project requirements are constantly changing, a more prominent and neglected question contains how and under which conditional governance limits supplier opportunism emerges in practice.

A relatively large number of previous studies have been focusing on investigating the impact of risk management on project performance (Gonzalez *et al.*, 2010; Haleem *et al.*, 2021; Nidumolu, 1996). The requirement risk is widely accepted as the main reason behind poor project performance (Haq *et al.*, 2019; Menezes *et al.*, 2019). Previous studies (e.g. Chen and Paulraj, 2004; Jiang *et al.*, 2009; Liu *et al.*, 2011) have disclosed a performance-diminishing effect of uncertainty and risks associated with information systems requirements. Specifically, Liu *et al.* (2011) distinguished different domains of requirements uncertainty and exhibited a negative relationship between software project performance and requirements instability. Furthermore, the effectiveness of governance mechanisms as an entangled phenomenon has been extensively studied but with some controversial results. Lu *et al.* (2015) pointed out that contractual and relational governance improves project performance in the construction industry. Haq *et al.* (2019) found further support for a strong relationship between governance mechanisms and project performance in software development. Contrarily, Qi and Chau (2015) found a nonsignificant effect between formal contracts and IT outsourcing success. Contractual governance provides a strong basis for building informal ties, and then relational governance enhances outsourcing success. Likewise, Benítez-Ávila *et al.* (2018) displayed that relational governance plays a mediating role between formal governance and project performance in public-private partnership projects. Their findings confirmed that the main effect of contractual governance is nonsignificant in enhancing project performance. In a supportive way, Müller and Martinsuo (2015) concluded that relational norms lead to better outcomes for IT project performance. Chi *et al.* (2017) focused on the interplay between formal and relational governance and exemplified the complementary nature of contractual and relational governance to boost relational IT performance.

It is worth noting that till now most studies have been interested in identifying the effectiveness of governance mechanisms to project success. Despite all these efforts, project

management literature has neglected to examine partner opportunism which lies beyond intentions but as surrogates for actual behavior patterns. Indeed, very few studies have yet fully explored the endogenous effect of opportunism in project management. Most of them were even not carried out in the software/information technology industry but were involved deeply in the governance of construction projects. Among them, according to the study by [Lu et al. \(2015\)](#) opportunism is not related to project performance. Unlike that, [Um and Kim \(2018\)](#) elucidated the indirect effect of opportunism in dropping performance at higher levels of project uncertainty. Contrary to relational mechanisms, in the opportunism-governance link, contract was found to be ineffective in alleviating opportunism ([Lu et al., 2015](#)). To disentangle different and somewhat contradictory results relating to the effectiveness of governance mechanisms on opportunism, [Wang et al. \(2019\)](#) distinguished the roles of governance mechanisms at different stages of the project lifecycle. Relational and contractual governance was found to have negative incentives for the prevention of exposure to opportunism in the early stages of the project lifecycle. However, relational governance exerts a stronger control in the middle and late stages.

Noteworthy, among them, [Haq et al. \(2019\)](#) dealt with software systems governance. In their pioneering work, a negative moderator effect of requirements analyzability risk was found to be in the relationship between governance mechanisms and project performance. In addition, they conveyed the opportunism-diminishing effect of governance mechanisms. Despite the opportunism-governance link disentangled in software development, this study does not answer the key question; to what extent the effectiveness of governance mechanisms does mitigate opportunism at higher levels of requirements uncertainty.

On the other hand, there are some remarkable studies focusing on the effects of asset-specific investments on opportunism in project management. It is important to note here that asset-specific investments have unilateral and bilateral effects. From a transaction cost perspective, the study by [Shi et al. \(2018\)](#) manifested a hold-up effect of buyers' specific investments resulting in reinforcing supplier opportunism in the construction industry. Contractual governance was found to negatively moderate the effects of unilateral investments on both strong and weak opportunism. However, trust undertakes a moderator role in alleviating a weak form of opportunism. In respect of software projects, the study by [Wang \(2002\)](#) is worthwhile and valuable to have some understanding of the transactional attributes of ex-post opportunism. According to his findings, bilateral investments curtail supplier opportunism and requirements uncertainty increases supplier opportunism. Contrary to expectations, asset specificity further strengthens the positive effect of requirements uncertainty on supplier opportunism. It appears here that the results of [Wang \(2002\)](#) include considerable biased effects. Biased estimates may account for asymmetric dependence on procedural assets that promote supplier opportunism rather than the bonding effect of bilateral investments. Reinforcing our inference that power-dependence relations, [Guo et al. \(2022\)](#) took notice of the combined effect of transaction hazards and demonstrated that formal control systems are unable to prevent supplier opportunism in case requirements uncertainty and asset specificity coexist in construction projects.

As [Chaudhry \(2020\)](#) suggested, the emergence of opportunism can be determined by several factors such as power balance and asymmetric dependencies in relationships, contractual mechanisms, trust development, uncertainties, prior relationship history and nature of contractual obligation. Pursuing this gap, the present study here aims to build a bridge for the ex-post nature of opportunism mediated by buyer dependence on task-oriented intrinsic uncertainties associated with software systems requirements uncertainty, a neglected field of research. This study scrutinizes the effects of requirements instability and buyer's resource dependence on supplier's opportunism. More importantly, first- and second-order conditional effects of governance mechanisms together employ to enlighten residual opportunism in that study. Buyer dependence mediates the uncertainty-

opportunism relationship for a high enough level of trust. Then, opportunism is still alive in the situation where buyer dependence mediates the uncertainty-opportunism relationship for more detailed contracts at high levels of competence-based trust. All in all, we provide an understanding of opportunism realized in practice, beyond considering opportunism to know *ex ante* as behavioral intentions. Given that the previous studies on project governance have abandoned the “left behind” examination of residual opportunism, this study is the first attempt to explain supplier opportunism for higher levels of contract in software projects wherein internal uncertainty nurtures buyer dependence on trusted suppliers.

In this pioneering endeavor, we employ a conditional process model using the PROCESS macro for SPSS to understand the development of residual opportunism in building and sustaining buyer–supplier relationships in the Turkish software industry. Turkey provides an example of a rapidly growing market in software products, attracting a great amount of export-oriented foreign investment. Various information technologies and applications like hardware, software and services spur the development of a sizeable domestic market in Turkey (TC Investment Office, 2021). By the year 2021, the share of IT reached 12,9 billion USD or 29% of the whole industry while the overall market size of the ICT industry accounted for 29.9 billion USD. In addition, the export share of the IT sector grew by an average of 14% annually on average between 2017 and 2021. The most prominent category within Turkish inside sales of IT products is the software industry, which also holds the largest growth in IT exports (Deloitte and TUSIAD, 2021a). Because of producing high-added value and easily exported products at low input costs and encouraging more productive modes of competition across all other sectors, the software industry has become increasingly important in the Turkish economy (Deloitte and TUSIAD, 2021b). In parallel with the increasing importance of IT in business processes, both domestic and foreign companies within national boundaries have invested more heavily in the IT industry (TC Investment Office, 2021). As software is very widely outsourced, external technology integration raises governance problems like incentive misalignments between buyers and suppliers in a rapidly expanding sectoral field (Erdogan and Gurcaylilar-Yenidogan, 2021; Erdogan and Tokgoz, 2020; Wang, 2002).

2. An information systems approach to handle uncertainty in software project development: building a bridge to risk-based and capability-based paradigms of governance

Information technology systems have a broad research focus that applies organizational economics and management theory in practice. Particularly, Galbraith's organizational information processing theory provides justification for IS usage in mitigating organizational design problems (Dwivedi *et al.*, 2009). The theory argues that managerial authority and personal capacity are limited in processing information. To compensate for this problem, the use of IT plays a variety of vertical and horizontal coordination roles, both internally and externally. Information technology enables the integration of differentiated but largely interdependent operations, the decision-making for autonomous entities, the control conformance with performance standards and the adaptation to change (Daft, 2020). While strengthening both vertical and horizontal coordination ties, IS complements the hierarchy and even accommodates the ineffectiveness of hierarchies for producing desired outcomes. Galbraith (1974) appeals to the link between task uncertainty and organizational information processing capacity to rationalize the need for IT applications. The greater the task uncertainty, the greater will be the uncertainty associated with information. On the one hand, a *higher amount* of information needs to be processed under the conditions of (1) if tasks are highly interdependent within and across business processes and (2) if the number of problems and exceptions increases in executing the software engineering tasks (called “task variability”). On the other hand, *richer information* needs to be processed under the

conditions of (1) if organizational or inter-organizational activities are functionally differentiated and (2) if tasks are (un)analyzable (indicating the extent to which systematic procedures can be developed for completing a task). In a two-type combination of information requirements, less-analyzable tasks with a high level of task variety further increase uncertainty and arise the need for both *more quantity* and a *richer quality* of information processing capacity to achieve desired outcomes (Dwivedi *et al.*, 2009). As a result, (inter) organizational interdependence, professional differentiation, task variety and task analyzability work together to engender the uncertainty associated with degrees of difference between the amount of information that needs to be processed to fulfill a task and organizational information processing capacity.

Galbraith (1974) focuses on information processing problems between different departments at the organizational level. Beyond that, information processing problems would extend to include inter-organizational relationships if external technology integration causes conflicts and misalignments between IT buyers and vendors. The theory development on IT outsourcing considers the reciprocal relationship between external technology integration and uncertainty. At this point, IT can be both a solution for and a reason behind uncertainty. Uncertainty is associated with requirements information and is characterized by one of the most important driving factors behind information problems in software project management (Nidumolu, 1996). Software development needs a more sophisticated information systems architecture in pursuit of an integrated account of business processes and functions to meet highly variable user requirements. When user requirements are highly vague, it becomes difficult to specify clear and definite task descriptions. If exceptions were encountered during software development, ambiguous tasks arising from uncertain requirements would aggravate information system conflicts. Information systems development involves a highly dynamic process that requires reciprocal information exchange and mutual alignment of contracting partners to ever-rising and changing user requirements throughout pre- and post-release versions of software (Javed *et al.*, 2004). Even if the initial set of requirements is well documented and reduced to the standardized procedures that serve for a favorable task assignment, previously unknown requirements may occur during the software development lifecycle (Haleem *et al.*, 2021). Endogenous and instant changes to variables would inevitably induce product updates and modifications.

In IS governance literature, requirements uncertainty can be well adapted to task-related internal uncertainty but also closely interrelated with external uncertainties. Specifically, software buyers face two interacting types of uncertainty that encourage opportunist acts in project-based development: external- and internal-uncertainty (Lioliou and Zimmermann, 2015; Laan *et al.*, 2011). Two different views of governance explain the rise and fall of uncertainties. On the one hand, from a transaction-cost perspective (Williamson, 1985), external uncertainty regards rapid and significant changes in technology and market-related factors. External sources of uncertainty arise when future circumstances surrounding a relationship are highly unpredictable and hence consequential responsibilities and obligations cannot be specified *ex ante* in a contract. Due to substantial and unforeseen changes, contract conditions are likely to be renegotiated to prevent maladaptation. For instance, software services are frequently subject to technological changes. Challenges in technology forecasting induce subsequent revisions of requirements specifications and product updates (Khan *et al.*, 2019). As far as software suppliers send regular notifications about upcoming changes and developments within the business environment, technological uncertainty (as a subset of environmental uncertainty) is yet entirely innocent and emerges as the systemic risk factor for performance failure. In the absence of appropriate incentives for cooperative adaptation, new sets of information in performing tasks arise agency problems that leave software buyers in vulnerable situations (Gurcayilar-Yenidogan, 2017; Dekker, 2008). Software suppliers are closer to external information and hence undertake the

responsibility for submitting renewal applications to achieve adaptive project management (You *et al.*, 2018). If suppliers refused to integrate the entire system with application updates, they could generate new revenue streams and opportunistically exploit the surplus created from updated software installations. In this case, however, technological uncertainty would be so dangerous that poses strategic risks and hence problems of governance. As a relationship turns adversarial, misaligned incentives inhibit partner support for post-event recovery of and restoration investments in the software product. In a nutshell, external uncertainty becomes more speculative for addressing adaptation solutions when project partners refuse to make product adjustments to repair outdated system performance.

On the other hand, from a capability-based view of governance (Argyres *et al.*, 2007), building contingency planning in software contracts supports within-agreement adjustments to the new tech solutions. When strategic risks arising from external uncertainty are managed by drawing up an *ex ante* contingency recovery planning, an internal monitoring system serves to preserve the relational benefits of project partnerships and prevents ex-post opportunism while deploying new releases of a software project. Likewise, a proper task description clarifies the responsibilities of each party to address how to perform services and produce products in the software project. The parties might have different and conflicting interests where task information was ambiguous and led to multiple meanings of how to perform the task (Kanwal and Rajput, 2016). The effectiveness of task performance depends on the extent to which project requirements are precisely designated in specifications form that supplements the formal contract. The lack of clear requirements entails subsequent changes in the entire system of a software project, leaving a broader space for opportunism. Poor requirements analysis aggravates the estimation of performance outputs such as actual costs of a project, completion time, expected benefits and system compatibility (Nidumolu, 1996). Any renewal or correction of data on task performance induces additional costs. Regardless, here again, different behavioral attitudes of parties (cooperative vs adversarial postures for making corrections and adjustments in initial project constraints) attribute uncertainty to less systemic but more strategic sources of project risk management. Capabilities in contingency planning and task descriptions are internal elements of organizations that function together in building the contract design competence of a partner (Argyres *et al.*, 2007). Accordingly, internal uncertainty regards with partner's incapability of identifying expected performance standards in advance (Laan *et al.*, 2011). Internal uncertainty corresponds to Williamson's conceptualization of measurement uncertainty (Rindfleisch and Heide, 1997), referring to performance evaluation problems as well.

Requirements diversity, requirements instability and requirements (un)analyzability are all of which serve requirements uncertainty (Nidumolu, 1996). Information requirements regarding the users' needs (i.e. departments, employees and customers) are likely to highly vary in the tightly coupled software development system. A widely dispersed and functionally interdependent nature of requirements information across all functions of the buyer's organization entails task complexity in software project development. While diversity in user requirements makes the internal environment more and more complex, it will be so hard to draft a complete set of requirements specification and establish a proper task description. Second, buyer-specific limits in capabilities of precisely identifying user requirements within a proper recovery planning of future contingencies will induce requirements instability in software projects (Laan *et al.*, 2011). What is mentioned here is how complete and accurate the "requirement analyzing knowledge" of buyers that encompasses a wide variety of heterogeneous and interdependent user requirements along with possible future change conditions. A buyer's weaknesses in specifying user needs and expected responsibilities from the project partners provoke requirements instability. On the supplier side, requirements uncertainty refers to the difference in firm competencies to meet performance expectations by carrying out functional connectivity and technical

specifications conformance (Laan *et al.*, 2011; Nooteboom, 2002). It is therefore pertinent to state that internal uncertainties are of a two-sided nature in software development, and both can provoke requirements change. If a supplier is incapable of technically implementing user requirements to the software product, initial software requirements will once again go back to suffer changes throughout the engineering process. Third, a supplier's technical capability emerges in the technological transformation process even if it is a necessary precondition and a deliberate selection for contracting upon technical specifications. Suppliers' technological incapability induces performance risks, in spite of the nonexistence of relational risk (Zhang and Qian, 2017) and even though the requirements are well-defined.

Despite a variety of project risks and uncertainties, this study specifically deals with requirements instability in software project development. From an information processing perspective (Galbraith, 1974), requirements instability is a task-oriented, internal source of uncertainty. Requirements instability emanates from ongoing differences in the amount of information needed for a complete set of user needs and is estimated by constant changes in requirements specification (Nidumolu, 1996). The extent of changes in initial requirements depends on the buyer's information processing capabilities, which in turn, may lead to performance measurement problems that inhibit *ex ante* performance verification and *ex-post* traceability. We argue that, in addition to the influence of changes in the external environment, information processing capabilities contribute to the degree of requirements instability. However, the present study here does not intend to explain the interactions between the constructs of requirements uncertainty, neither does it investigate external or internal sources of requirements instability but simply focuses on the extent to which software project requirements are stable throughout the project lifecycle to appraise supplier opportunism.

3. Hypotheses

3.1 Requirements instability and *ex-post* opportunism

Potential hazards and risks threatening the project's success almost always occur in uncertain task environments where heterogeneous and dynamic system requirements cannot be prescribed in advance (Wallace *et al.*, 2004; Wang, 2002). Requirements information sets must be kept up to date throughout the project lifecycle and constantly processed to elicit the desired behavior of the software. Requirements instability necessitates engineering changes as well as adjusting project schedules, milestones and price conditions (Elitzur *et al.*, 2012). The failure to perform an explicit definition of users' needs entails subsequent changes in the entire system of a software project. Furthermore, a lack of processing renewal notices to perform dynamic tasks or solve problems can cause persistent failures *ex-post* (during the implementation phase of the project) even if the first set of requirements is fully defined. Especially in case of excessive dependence on suppliers, software buyers become dangerously vulnerable to partner opportunism while trying to maintain the relationship and receive assistance for serial response and recovery. For example, the data renewal for initial requirements may evoke excessive demands from the suppliers on additional services and subsequent corrections. Suppliers may withdraw unilaterally from the contractual commitments or compel buyers to accept a renegotiation of the agreed-upon performance targets (Chen and Paulraj, 2004). Hence, suppliers obtain unfair profits from a residual stream from ongoing payments for recovery works.

Opportunistic actions should not be reduced to a matter of detrimental effects of contract loopholes. Undesirable consequences of requirements instability extend beyond mere active opportunism resulting mainly from contract breakdowns. Opportunism can also manifest as passively, in the form of shirking responsibility to make appropriate phase adjustments (Hawkins *et al.*, 2008). A lack of delivering a clear-crystallized set of success criteria inhibits

effort and recovery verification while a supplier deliberately disregards existing software errors (Zhang and Qian, 2017). It is vague and blurred how much effort suppliers devote to eliminate errors and deviations in performance, fulfilling the dynamic needs of users (Elitzur *et al.*, 2012). Unverifiable hidden actions of a supplier are legally deemed unenforceable. Eventually, contractual breaches as an active form of opportunism and help avoidance as a passive form of opportunism work together into the rise of ex-post opportunism (Cho *et al.*, 2019; Laan *et al.*, 2011; Luo *et al.*, 2015; Zhang and Qian, 2017).

3.2 The mediating role of buyer dependence on the relationship between requirements instability and ex-post opportunism

Custom software development requires mutual investments in relation-specific assets such as setting up an information-processing system dedicated to the users of the system, personnel training and development, and building necessary infrastructure compatible with the entire system (Celly *et al.*, 1999). Initial system requirements are usually insufficient for capturing data provenance of software. An agile software development process starts with producing buyer-specific coding of conduct for a software product (Khan and Eilert, 2021). The software system is readjusted for the buyer's workflows and routines throughout the product development life cycle (de Vita *et al.*, 2011). A more desirable software product entails having more sophisticated knowledge of buyers' workflows following a truly deep learning experience. At last, suppliers create procedural assets to meet buyers' custom-determined expectations. In turn, buyers invest in the development of information-technology practices and create relation-specific human capital internally to exploit the value of custom software services. From the relational perspective of governance (Dyer and Singh, 1998), environmental uncertainty can be effectively managed by investing in co-specialized assets and interorganizational capabilities (Gurcaylilar-Yenidogan and Windsperger, 2015). Relation-specific investments function as a source of interorganizational competitive advantage and, in turn, yields the greatest returns inside a given project relationship. In this perspective, the parties rely on mutual commitment and trust to work together, and opportunism is regarded as the diminishing factor of social and economic benefits of relationships. Contrary to value-generating investments, relation-specific assets create a unique competence value for only one party, which makes him dependent on the other partner (Gelderman and Van Weele, 2004). From a transaction cost perspective (Williamson, 1985), relation-specific investments expose buyers to suffer harmful effects of sunk cost fallacy in case of excessive dependence. This implies that opportunism often strengthens while unbalanced and asymmetrical investments in a buyer-supplier relationship lead to power imbalances. Definitely, relation-specific investments cannot be attributed solely to the worst-case scenarios in which value-generating firm-specific assets transform into extravagant and risky investments. But the reverse, which ignores opportunism, is not true either (Steinle *et al.*, 2014). A more plausible research basis is to understand power-dependence contexts and envision that relation-specific investment may serve a residual level of opportunism (Lumineau and Oliveria, 2020). Thus, it becomes important to consider the power-dependence balance that arises from relation-specific investments.

Although project-based software development is a bilateral investment game, asymmetric dependence and power imbalance are paramount to understanding the link between uncertainty and residual risk of opportunism. Previous studies (Izquierdo and Cillan, 2004) have widely used asset specificity and switching costs as a proxy for dependence in buyer-supplier relationships. Based on the risk-oriented and transactional perspective of governance, relation-specific investments induce severe hold-up problems under the circumstances of unstable requirements, variable tasks and uncertain future performance (Hawkins *et al.*, 2008). Mostly, procedural asset investments result to gain suppliers'

bargaining power over process property in a workflow configuration and then cultivate the structural dependence of buyers. Increasing dependence and holdups over a given project set barriers to exit from the relationship. The hostage effect here depends on operational disruptions arising from workflow restructuring rather than the exit-deterrence of non-redeployable investments. As a supplier exercises structural power, buyer dependence prevents potential hold-up hazards for the value of relational commitment from the supplier's specialized investments. To put it differently, the buyer will be more structurally dependent on the supplier (RDT-based dependence) even if the supplier invests heavily in specific assets dedicated to the relationship (TCE-based dependence) (Teryokhin and Hannås, 2018). When a buyer locks in the supplier's services in the software development (Grandinetti, 2017; Handfield and Bechtel, 2004) this situation may lead to supplier opportunism ex-post due to excessive partner dependence on technical support or assistance over time (Teryokhin and Hannås, 2018). For instance, a supplier may opportunistically use asymmetric dependence to refrain from making its best effort to satisfy expectations while repairing or updating the impaired performance (Nooteboom, 2002). Herein, the underinvestment problem is the source of ex-post opportunism. Or else, he may opportunistically demand a greater share of the surplus or added value generated by the relation (e.g. better price). More precisely, buyers incur a negative aggregate of relationship value from specialized investments since continuous adjustment conduces additional risk or cost. A buyer's structural dependence in a bilateral investment treaty provides a persuasion motive for continuing a relationship even if a project's costs outweigh its benefits (Keil *et al.*, 2000). This situation typically regards the sunk-cost fallacy (Teryokhin and Hannås, 2018). Overall, supplier opportunism will be greater as RDT-based asymmetric dependence of buyers increases in dynamic internal environments (Laan *et al.*, 2011). Under the asymmetric-dependence conditions, the superior bargaining power of software suppliers opens up avenues of opportunism (Bahli and Rivard, 2003). As a result, a significant part of supplier opportunism tends to ensue from asset dependencies of software buyers under requirements instability and internal conflict. Consequently, we propose the following hypothesis by assuming that buyer dependence increases ex-post opportunism in unstable task environments.

H1. Buyer dependence mediates the relationship between requirements instability and ex-post opportunism.

3.3 Moderating role of trust: first-level conditional indirect effect of requirements instability on ex-post opportunism through buyer dependence

Suppliers are equipped with different technical skills and domain-specific expertise to meet commitments. More competent suppliers develop quality software, easily find solutions to performance deviations, implement innovations in a timely fashion, and eventually enable buyers to reach a dynamic reconfiguration of the workflows and business processes. Past interaction history helps buyers make better supplier selection decisions (Ashnai *et al.*, 2016; Jiang *et al.*, 2011). Task reliability in performing desired outcomes supports competence-based trust in suppliers (Connelly *et al.*, 2018). Competence-based trust reduces the potential for misappropriation of assets over less risky partners (Connelly *et al.*, 2018; Genefke, 2001). More competent suppliers can compensate as desired even in the case of faulty or incomplete determination of user requirements. At this point, competence-based trust functions as an incentive mechanism for specialized investments. A trust-based relational capital enables building a strong cooperative relationship in repairing misaligned reveals of the project and improving responsiveness to changing circumstances (Zhong *et al.*, 2018). Buyers are confident that software applications will be adjusted to future change requests by the partner's continued commitments.

Technological competence provides a safeguard for delivering what buyers need to meet users' needs. As the presence of proven competence on the supplier's side compensates for the buyer's incapacibilities and thus reduces internal uncertainty, opportunistic tendencies to reject product modification requests decrease by justifying them with deficiencies in the initial requirement definition during the adaptive and agile project lifecycle (Cho *et al.*, 2019). However, on the other hand, buyer confidence in a supplier's technology competence does not always complete with the goodwill dimension of trust (Connelly *et al.*, 2018; Jiang *et al.*, 2011), and residual opportunism continues to exist in the supplier's intentions. But nevertheless, investment incentives in accredited skills support the development of relation-specific assets and, hence prior experience in competence-based assessment helps ensure supplier selection and certification *ex ante* in project-based relationships. It is therefore argued that buyer reliance on a supplier's technical skills and experience generally fosters, although not always, goodwill trust over time (Jiang *et al.*, 2011). Beyond the extent to which competencies calm the occurrence of opportunistic actions, competence-based trust steadily performs a contingent effect on the relationship between requirements instability and relation-specific investments. Buyers can only undertake the structure-dependent risk for more competent suppliers. Suppliers' technology competence protects against adverse selection and moderates the relationship between requirements instability and buyer dependence. In a nutshell, relational investment (or buyer dependence) emerges out of providing convincing proof for competence-based trust. Hence, ones could assume that buyer dependence would mediate the uncertainty-opportunism relationship for high levels of trust. Considering adverse selection argument for investment decisions and competence-based remedies for trust-building, we establish the following hypothesis:

- H2. Competence-based trust moderates the indirect effect of requirements instability on ex-post opportunism through buyer dependence.

3.4 Moderating role of contract: second-level conditional indirect effect of requirements instability on ex-post opportunism through buyer dependence

Supplier opportunism alleviates when there exist incentives for cooperation to realize continual improvement and overcome misaligned projects (Laan *et al.*, 2011). Under internal uncertainty, suppliers are able to satisfy expectations of technically proficient performance while responding flexibly to different needs with an edge-preserving recovery in costs and benefits of a project. Supply flexibility is a critical capability in software development, ensuring the formation of competence-based trust (Zhao *et al.*, 2010). Dissimilar to trust-based informal governance which plays a vital role in alleviating supplier opportunism (Ashnai *et al.*, 2016; Connelly *et al.*, 2018), contractual governance creates inflexibilities that inhibit adjustable responses to the change requests (Cho *et al.*, 2019).

From a transactional governance perspective, software contracting typically stipulates the total estimated cost and completion date of a project that meets system requirements and, in turn, provides formal safeguards against opportunism. Formal contracting may be beneficial to monitor potential damages and maintain the desired performance. On the contrary, the relational perspective asserts that contractual governance provides restricted performance incentives to implement flexible project arrangements in complex and dynamic environmental conditions. Contracts are inevitably incomplete in dynamic future conditions. As software system needs to be iterative reconfiguration throughout the project lifecycle, contractual control becomes somewhat controversial. Project partners cannot formally specify all possible statements of technical data to deal with dynamic user requirements (Connelly *et al.*, 2018). If conditions change in an unanticipated way, the use of contractual incentives may be insufficient in preventing opportunism. As change continues to remain a steady-state of project management and contracting over adjustable performance parameters

is so costly, domain-specific capabilities and knowledge applications of suppliers will be essential for adapting to ever-changing user requirements (Ashnai *et al.*, 2016). Moreover, contracts ensure effective deterrence for protecting the more powerful party (Chaudhry, 2020). Formal sanctions do not apply equally to both sides of the partnership. As a buyer is more structurally dependent on the supplier's ongoing modifications due to binding commitments for relation-specific investments, contracts should not be considered necessarily adequate remedies for buyers. Contractual rigidity makes project scope more and more specified *ex ante*, transforming it overadjudicatory upon formal rules (Love, 2010). When a strong contractual focus is only treated to control a strict set of rules, over-reliance on legalistic remedies limits strategic flexibilities and breeds distrust in the relationship process (Lumineau, 2017). Formal governance may exert a negative effect on partners' motivation to behave cooperatively. In this regard, contractual inelasticities and the "sticking to the rules" syndrome can trigger opportunism against the buyer. As a result, it is expected that relation-specific investment gives rise to supplier opportunism at higher levels of contractual governance. More specifically, ones could assume that buyer dependence would mediate the uncertainty-opportunism relationship for more detailed contracts at high levels of competence-based trust. Considering the "iron cage" of strict formalities and control systems that prevent flexible project arrangements implemented in complex and dynamic environmental conditions, we propose the following hypotheses:

H3. Contract moderates the conditional indirect effect of requirements instability on ex-post opportunism through buyer dependence.

In sum, we develop a multiple moderated mediation model, assuming that buyer dependence mediates the relationship between requirements instability and ex-post opportunism within conditional limits for trust and contract (Figure 1).

4. Methodology

This study follows a quantitative research approach to examine the hypotheses on the contingent effects of requirements instability on interorganizational behavior. Consistently, a cross-sectional survey is used to investigate the extent of ex-post opportunism in software development by considering the two-stage, multilevel moderating effects of informal and formal governance while buyer dependence mediates the relationship between requirements instability and supplier opportunism.

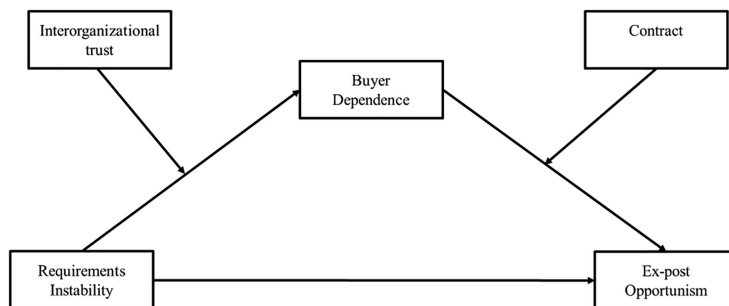


Figure 1.
Conceptual model

4.1 Data collection

The data of this research were collected using an internet-based survey. The critical informant methodology was used to ensure that IT managers with enough participation knowledge are included in the survey. Mid and senior IT executives, who are responsible for providing a complete project lifecycle, were chosen as critical informants. The surveys were sent to a selective sample of IT experts, IT managers, IT directors, CIOs, IT project and team leaders, and IT chiefs who work in different companies in Turkey through LinkedIn, a professional communication network. The participants were asked for answering all the questions by considering a particular software project they have been actively involved in. The survey tool was piloted with 10 IT professionals from customers and service providers. According to the feedback of participants, the questionnaire was carefully modified to obtain a valid and easily understandable version. Of the 600 questionnaires, 138 useable responses were obtained, and analyses were carried out on 138 questionnaire data. The participant profiles for software projects display 27 participants working in the position of Chief Information Officer (CIO), 34 participants in the IT director position, 64 participants in the IT manager position, 7 participants in the IT project leader and 6 participants in the IT chief position. The sector profiles of client organizations are mainly distributed across manufacturing (17.4%), wholesale and retail (16.7%), information and communication (14.5%), banking and insurance (10.9%), and tourism (5.1%). In addition, the customization degree of software projects was found at a very high average, giving a mean value of 5.40 on a 7-point scale.

4.2 Measurement

Survey scales of this research study were adopted from prior studies, and some items were adjusted to fit the context of software projects. All perceptual items were measured with seven-point Likert scales ranging from “strongly disagree” to “strongly agree”. Citing references for the constructs, all the measurement items are listed in [Table 1](#). Ex-post opportunism, the dependent variable of this study, covers the weak and strong forms of opportunism software vendors may exercise. The strong form of opportunism includes actions that violate the contractual norms explicitly specified in a formal agreement, or the amendment texts of the main contract ([Luo et al., 2015](#)). A weak form of opportunism involves the violation of relational norms that are not mentioned in a formal agreement but are embedded in a common understanding of parties associated with business scope and responsibilities. The items for ex-post opportunism were derived from the study of [Luo et al. \(2015\)](#). As a result of EFA, all items of weak and strong opportunism were largely attributed to a single factor, and therefore, we constrained them in a one-dimensional list and considered ex-post opportunism as a single construct (Cronbach’s alpha = 0.936).

As an independent variable of the analysis of supplier opportunism in practice, requirements instability refers to the continual changes in project requirements and the volatility experienced in the task environment. This construct was measured with four items adapted from [Nidumolu’s \(1996\)](#) study (Cronbach’s alpha = 0.820). Relation-specific investment refers to investments made by a buyer in specialized assets that are inappropriate for alternative uses or lose a substantial portion of their productive value if the exchange relationship ends prematurely ([Anderson and Weitz, 1992](#)). Relation-specific investments were measured with four items derived from the study by [Carson et al. \(2006\)](#) (Cronbach’s alpha = 0.683). This construct acts primarily as a proxy for buyer dependence and functions as mediating variable. Interorganizational trust (on the buyer side) is defined as the extent to which the buyer holds positive expectations that a supplier will meet user needs in developing a software project on account of its proven technology capability ([Jiang et al., 2011](#)). Since trust functions as an informal mechanism of governance and an effective remedy for relation-

Construct	Measurements	References
Requirements instability	RI1 – Requirements fluctuated quite a bit in earlier phases RI2 – Requirements fluctuated quite a bit in later phases RI3 – Requirements will fluctuate quite a bit in the future RI4 – Requirements identified at beginning of project were quite different from those existing at the end	Nidumolu (1996)
Interorganizational trust	IOT1 – Whenever the people we deal with at this supplier give us advice on our business operations, we know that they are sharing their best judgment IPT2 – We can count on the people we deal with at this supplier to be sincere IPT3 – Though circumstances change, we believe the people we deal with at this supplier will be ready and willing to offer assistance and support IPT4 – When making important decisions, the people we deal with at this supplier are concerned about our welfare IPT5 – When we share our problems with the people we deal with at this supplier, we know that they will respond with understanding IPT6 – When it comes to things that are important to us, we can depend on the support of the people that we deal with at this supplier	Ashnai <i>et al.</i> (2016)
Relation-specific investments (as proxy for buyer dependence)	RSI1 – If we had to switch to a different contractor during the project much of our investment would have to be made again RSI2 – If we had to switch to a different contractor during the project it would take some time for us to bring the new contractor up to speed on the technology RSI3 – We spent a lot of time and effort learning to work effectively with the contractor before our relationship was productive RSI4 – The project required close working relationships between the contractor's people and our people	Carson <i>et al.</i> (2006)
Contract	CTR1 – Our contract precisely defines the role of each party CTR2 – Our contract precisely defines the responsibilities of each party CTR3 – Our contract precisely states how each party is to perform CTR4 – Our contract precisely states what will happen in the case of events occurring that were not planned	Wuyts (2007)

Table 1.
Construct
measurements
(N = 138)

(continued)

Table 1.

Construct	Measurements	References
Ex-post opportunism	SO1 – Our partner is deceptive when sharing critical information required by our contract SO2 – Our partner fails to invest in sales and human resources as required by our contract SO3 – Our partner tries to increase their own gain by evading contractual obligations SO4 – Our partner sometimes violates contractual terms and conditions WO1 – Our partner withholds from expending full effort in our cooperative relationship WO2 – Our partner may hide critical information in order to benefit at our expense WO3 – Our partner refuses to make adjustments in response to our requirements	Luo <i>et al.</i> (2015)

specific investments, this construct was integrated as the first stage moderator variable into the research model. Interorganizational trust was measured with four items adapted from Ashnai *et al.* (2016) (Cronbach's alpha = 0.933). Contract as a formal governance mechanism is the second stage moderator variable of this study. Contractual complexity refers to the extent to which a contract designates detailed provisions to mitigate holdups, solve conflicts and support contingency planning. This construct was measured with four items adapted from Wuyts (2007) (Cronbach's alpha = 0.915).

Cronbach's alpha values of all constructs were found to exceed the threshold level of 0.65 (Taber, 2018) and none of the correlation coefficients for all variables is large enough (>0.80) to cause concern about severe multicollinearity (Hair *et al.*, 1998). After computing Cronbach's alpha values for the reliability of each construct, we performed exploratory (EFA) and confirmatory factor analysis (CFA) to assess the validity of questionnaire measures. EFA yields a five-factor solution accounting for 73% of the cumulative variance. According to the Kaiser rule (Kaiser, 1960), the factors were retained with eigenvalues greater than 1. Factor loadings of the 23 items were above 0.40 (Hair *et al.*, 1998), ranging from 0.41 to 0.90. The Kaiser–Meyer–Olkin test, which resulted in KMO = 0.837, verifies the sampling adequacy for the analysis. Bartlett's test of sphericity (Chi-square = 2,285,584, $p < 0.001$) indicates that the correlations between items were sufficiently large for principal component analysis. CFA was conducted through SPSS assessment in SEM. The results verified the factor structure of observed variables and revealed a good fit with the data. The goodness of fit index has a CMIN/df of 1.51 (<2.0-satisfactory), RMSEA of 0.06 (<0.08-acceptable), CFI and IFI of 0.95 (>0.95-satisfactory) and GFI of 0.844 (>0.8-acceptable).

In addition, prior ties and experience were included as control variables that might influence supplier opportunism. Prior ties refer to the number of years since software partners have begun the business relationship while experience represents the buyer's year of operation in the industry. Prior ties from relationship history may form a basis for trust and then reduce supplier opportunism. Also, higher experience in the industry can mitigate opportunism with an increase in capabilities for drafting a contract and preparing a requirements specification. Control variables were found to have a negative but non-significant effect on supplier opportunism.

5. Results

5.1 Testing simple mediation effect

The present study employs a three-stage testing of moderated moderated mediation. First, we examined the simple mediation hypothesis suggesting that buyer dependence mediates the relationship between requirements instability and supplier opportunism as hypothesized in hypothesis H1. We conducted three widely used analytical approaches to estimate simple mediation. From a classical perspective, we first followed Baron and Kenny's (1986) recommended procedure. Second, we employed the Sobel test which contains similarities with Baron and Kenny's (1986) method. Sobel's test (1982) for indirect effects serves as complementary statistics for simple mediation.

Regression analysis revealed that requirements instability was positively related to supplier opportunism (Model 2: $\beta = +0.262, p < 0.01$). The main effect of requirements instability was significantly and positively correlated to buyer dependence (Model 1: $\beta = +0.314, p < 0.01$). Besides, buyer dependence was found to be significantly and positively associated with supplier opportunism (Model 3: $\beta = +0.295, p < 0.01$). Taken together, the prerequisite conditions for Baron and Kenny's (1986) method were satisfied for simple mediation. After having controlled for buyer dependence addition, the effect of requirements instability on increasing supplier opportunism was relatively weakened, albeit still significant. This result demonstrated a partial mediation effect of buyer dependence on the relationship between requirements instability and supplier opportunism. Furthermore, the Sobel test resulted in a Z-score of 2.250 ($p = 0.025$), indicating that buyer dependence functions as a mediator (in support of H1). Finally, the mediation effect may differ notably at different levels of the buyer's industry experience and relationship history. Therefore, the variables of experience and prior ties were included as covariates in the analysis to strengthen the validity of the mediation model. However, it was observed that control variables did not have a significant effect on the mediating effect of buyer dependence.

Despite its widespread application in mediating testing, the methods suggested by the classical approach have many weaknesses that appear in different aspects. One of the most important concerns is that the direct effect between X and Y before and after controlling for a mediator is overemphasized, albeit this can be misleading where there exists a stronger indirect effect compared to the total effect (Zhao *et al.*, 2010). Another reason for concern is that classical methods only work well with large sample sizes under the assumption of normal distribution. Contrarily, the bootstrapping confidence interval method performs better, even in small samples, to control for type-I error leading to an incorrect rejection of the null hypothesis. As a result, SPSS Process Macro was run to compute bias-corrected confidence intervals for the mediator effect in the third step of this study. Adopting the contemporary approach to mediation, we employed regression analysis to further proceed in moderated moderated mediation. In this approach, the total and direct effect is considered to have no influence on an indirect effect (Hayes, 2009). The statistical significance of the total indirect effect is explicated as mediation in any case.

Table 2 demonstrates the results of simple mediation analysis (Model 4; Hayes, 2021) following the bootstrapping approach with PROCESS. There was a statistically significant effect of requirements instability on buyer dependence ($a_1 = +0.302, p < 0.01, CI = +0.146, +0.458$). On the other hand, buyer dependence was positively related to supplier opportunism ($b_1 = +0.281, p < 0.01, CI = +0.081, +0.480$).

The indirect effect of requirements instability on ex-post opportunism through buyer dependence ($a_1 b_1 = +0.085, CI = +0.018, +0.173$) was statistically significant and the 95% bias-corrected confidence interval did not include zero, providing further support for H2. Overall, the results confirmed the mediating role of buyer dependence in the relationship between requirements instability and ex-post opportunism.

Table 2.
Results of simple
mediation analysis
with PROCESS
(Model 4)

		Buyer dependence (M)		Supplier opportunism (Y)		
		Coeff	95% CI	Coeff	95% CI	
Requirements Instability (X)	$a_1 \rightarrow$	+0.302** (0.079)	+0.146, +0.458	$c' \rightarrow$	+0.213* (0.079)	+0.021, +0.405
Buyer Dependence (M)				$b_1 \rightarrow$	+0.281** (0.101)	+0.081, +0.480
Prior Ties (U_1)	$a_2 \rightarrow$	-0.001 (0.026)	-0.053, +0.051	$b_2 \rightarrow$	-0.039 (0.031)	-0.100, +0.022
Experience (U_2)	$a_3 \rightarrow$	+0.060 (0.120)	-0.177, +0.297	$b_3 \rightarrow$	-0.119 (0.140)	-0.396, +0.159
Constant	$i_M \rightarrow$	+3.211** (0.553)	+0.146, +0.458	$i_Y \rightarrow$	+0.901 (0.721)	-0.526, +2.328
		$R^2 = 0.099$ $F = 4.930, p = 0.003$		$R^2 = 0.132$ $F = 5.059, p = 0.01$		

Note(s): *, $p < 0.05$; **, $p < 0.01$

5.2 Testing moderated mediation effect

Second, a first-level moderated mediation for hypothesis H2 was tested using the PROCESS macro in SPSS (Model 7; Hayes, 2021). The analysis was run for the conditional indirect effect of requirements instability on ex-post opportunism through buyer dependence as moderated by trust. For such a contingent effect to exist, four conditions are expected to be satisfied; (1) there should be a significant effect of requirements instability (X) on buyer dependence (M); 2) there should be a significant interaction between requirements instability (X) and trust as the first level moderator (W) in predicting buyer dependence (M); 3) buyer dependence (M) should have a significant effect on ex-post opportunism (Y); and 4) there should be a different conditional indirect effect, as evidenced in case of when the strength of conditional indirect effect for ex-post opportunism differs at levels of trust.

Our results for hypothesis H2 indicated that requirements instability increased buyer dependence ($a_1 = +0.287, p < 0.01, CI = +0.137, +0.437$), supported Condition 1 (see Table 3).

Table 3.
Results of moderated
mediation analysis
with PROCESS
(Model 7)

		Buyer dependence (M)		Supplier opportunism (Y)		
		Coeff	95% CI	Coeff	95% CI	
Requirements Instability (X)	$a_1 \rightarrow$	+0.287** (0.076)	+0.137, +0.437	$c' \rightarrow$	+0.213* (0.079)	+0.021, +0.405
Trust (W)	$a_2 \rightarrow$	-0.299** (0.089)	-0.437, -0.124			
X*W	$a_3 \rightarrow$	+0.145* (0.059)	+0.029, +0.261			
Buyer Dependence (M)				$b_1 \rightarrow$	+0.281** (0.101)	+0.081, +0.480
Prior Ties (U_1)	$a_4 \rightarrow$	+0.005 (0.025)	-0.045, +0.055	$b_2 \rightarrow$	-0.039 (0.031)	-0.100, +0.022
Experience (U_2)	$a_5 \rightarrow$	+0.025 (0.116)	-0.205, +0.254	$b_3 \rightarrow$	-0.119 (0.140)	-0.396, +0.159
Constant	$i_M \rightarrow$	+4.623** (0.408)	+3.815, +5.431	$i_Y \rightarrow$	+1.828** (0.673)	+0.498, +3.159
		$R^2 = 0.185$ $F = 5.992, p = 0.000$		$R^2 = 0.132$ $F = 5.059, p = 0.01$		

Note(s): *, $p < 0.05$; **, $p < 0.01$

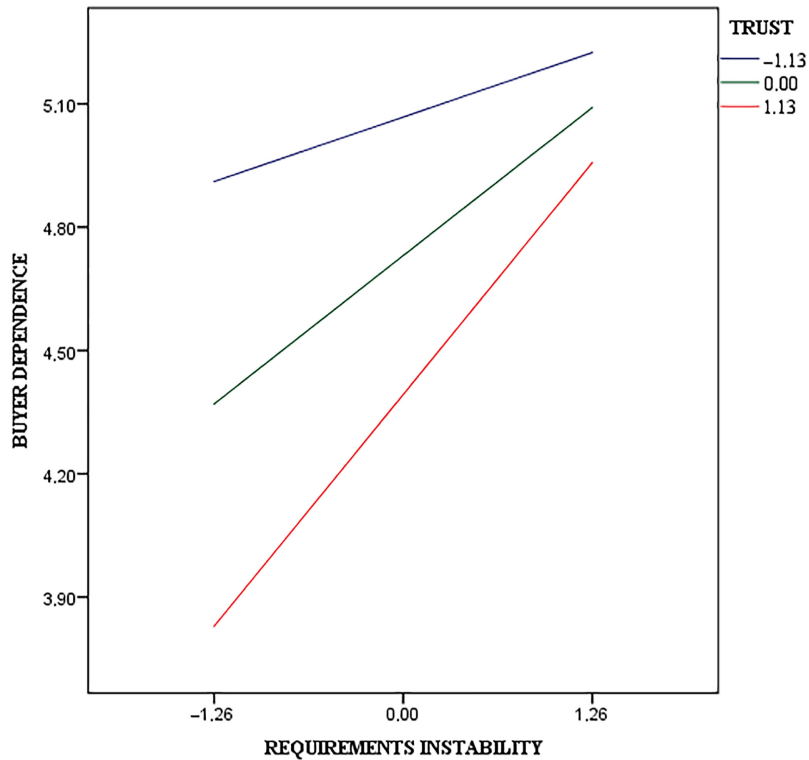


Figure 2.
First-level moderation
effect of trust

The interaction of requirements instability with trust was significant in predicting buyer dependence ($a_3 = +0.145, p < 0.05, CI = +0.029, +0.261$). The moderation effect was found to contribute an additional (approx.) 4% to the explanatory power of variance in buyer dependence. Figure 2 plots this interaction, in support of Condition 2. Condition 3 was supported in which buyer dependence was positively related to supplier opportunism ($b_1 = +0.281, p < 0.01, CI = +0.081, +0.480$). The index of moderated mediation was found to be $+0.041$ with a 95% confidence interval (CI) of $[+0.001, +0.108]$. Our results confirmed Condition 4, showing that for a lower degree of trust, the conditional indirect effect of requirements instability on supplier opportunism ex-post through buyer dependence was $+0.035$ with a 95% (CI) of $[-0.026, +0.104]$, $+0.081$ with a 95% CI of $[+0.015, +0.168]$ for a medium degree of trust and $+0.126$ with a 95% CI of $[+0.025, +0.271]$ for a higher degree of trust. Thus, H3 was supported, indicating that trust moderates the indirect effect of requirements instability on ex-post opportunism through buyer dependence. Specifically, buyer dependence mediates the requirements instability-supplier opportunism relationship when trust is high, but not when it is low.

5.3 Testing moderated moderated mediation effect

Third, PROCESS model 21 was run to estimate moderated moderated mediation (Hayes, 2021). So that we finally employed mediation together with a two-level moderation to estimate the conditional indirect effect of requirements instability on ex-post opportunism through buyer dependence as moderated by trust and contract. Moderated moderated mediation

occurs when a two-level moderation interacts with the mediator such that the value of the indirect effect changes depending on the value of moderators. This is a multilevel conditional indirect effect. The value of the indirect effect is conditional on first- and second-stage moderators. The conditional effect of requirements instability on supplier opportunism through buyer dependence that depends on level-1 (i.e. trust) and level-2 (i.e. contract) moderators was assessed by testing five conditions; (1) there should be a significant effect of requirements instability (X) on buyer dependence (M); (2) there should be a significant interaction between requirements instability (X) and trust (W) in predicting buyer dependence (M); (3) buyer dependence (M) should have a significant effect on supplier opportunism (Y); and (4) there should be a significant interaction between buyer dependence (M) and contract (Z) in predicting supplier opportunism (Y); (5) there should be different conditional indirect effects, as evidenced in cases of when the strength of the total conditional indirect effect for supplier opportunism differs at levels of trust and contract.

Our results for hypothesis H3 (see Table 4), which demonstrated that requirements instability was positively related to buyer dependence ($a_1 = +0.287, p < 0.01, CI = +0.137, +0.437$), supported Condition 1. Condition 2, showing that trust moderates the relationship between requirements instability and buyer dependence was $+0.145$ with a 95% (CI) of $[+0.029, +0.261]$. When comparing the conditional effects of requirements instability at values of trust, requirements instability was found to have no significant effect on buyer dependence in a relationship with a low level of trust ($a_1 = +0.125, p > 0.05, CI = -0.077, +0.327$). However, the results showed that as trust increased, buyers who were not able to identify project requirements *ex ante* became more dependent on suppliers (When trust = 0.00, a_1 takes the value of $+0.288$, with a 95% (CI) of $+0.139, +0.436$; when trust = 1.13, a_1 takes the value of $+0.450$, with a 95% (CI) of $+0.258, +0.641$). Specifically, the relationship between requirements instability and buyer dependence was statistically significant for higher levels of trust. So that a stronger trust positively moderates the relationship, in support of Condition 2. Buyer dependence was positively related to ex-post

		Buyer dependence (M)			Supplier opportunism (Y)	
		Coeff	95% CI		Coeff	95% CI
Requirements Instability (X)	a_1	+0.287** (0.076)	+0.137, +0.437	$c' \rightarrow$	+0.194* (0.095)	+0.006, +0.381
Trust (W)	a_2	-0.299** (0.089)	-0.437, -0.124			
X*W	a_3	+0.145* (0.059)	+0.029, +0.261			
Buyer Dependence (M)				b_1	+0.245* (0.100)	+0.047, +0.442
Contract (Z)				$b_2 \rightarrow$	-0.248* (0.096)	-0.439, -0.058
M*Z				$b_3 \rightarrow$	+0.191* (0.085)	+0.023, +0.360
Prior Ties (U_1)	a_4	+0.005 (0.025)	-0.045, +0.055	$b_4 \rightarrow$	-0.041 (0.030)	-0.100, +0.019
Experience (U_2)	a_5	+0.025 (0.116)	-0.205, +0.254	$b_5 \rightarrow$	-0.173 (0.137)	-0.444, +0.099
Constant	i_M	+4.623** (0.408)	+3.815, +5.431	$i_Y \rightarrow$	+3.345** (0.485)	+2.388, +4.306
		$R^2 = 0.185$ $F = 5.992, p = 0.000$			$R^2 = 0.192$ $F = 5.197, p = 0.000$	

Note(s): *, $p < 0.05$; **, $p < 0.01$

Table 4. Results of moderated moderated mediation analysis with PROCESS (Model 21)

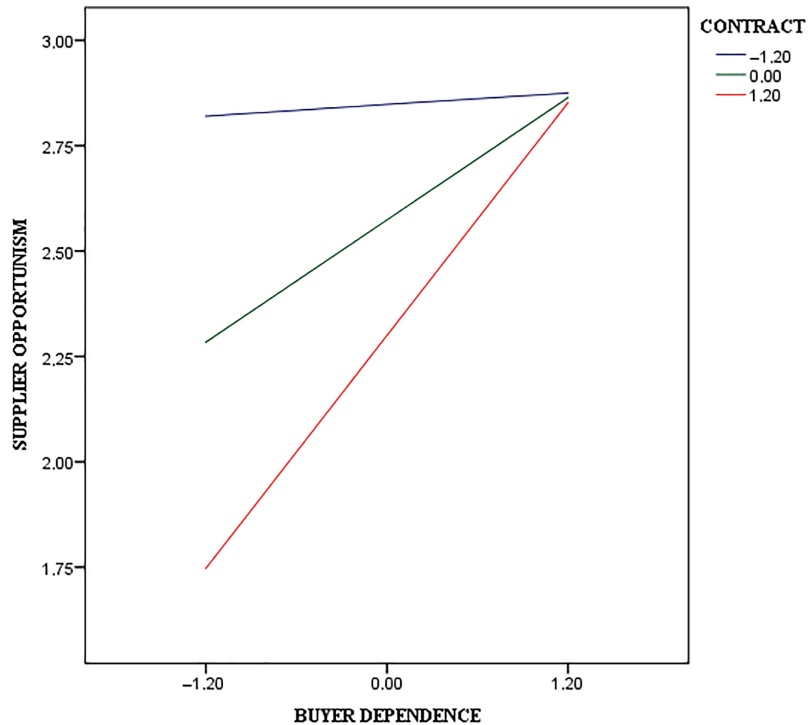


Figure 3.
Second-level
moderation effect of
contract

opportunism ($b_1 = +0.245, p < 0.05, CI = +0.047, +0.442$), in support of Condition 3. As suggested in Condition 4, contract significantly moderates the effect of buyer dependence on supplier opportunism ex post ($b_3 = +0.191, p < 0.05, CI = +0.023, +0.360$) (see Figure 3). Respectively, the relationship between buyer dependence and ex-post opportunism was stronger when contractual arrangements become more detailed (When contract = 0.00, b_3 – the conditional effect of buyer dependence on supplier opportunism is +0.288, with a 95% (CI) of +0.139, +0.436; when contract = 1.20, b_3 – the conditional effect of buyer dependence on supplier opportunism is +0.450, with a 95% (CI) of +0.258, +0.641), supporting positive moderation for contract. No significant effect was found to exist between buyer dependence and supplier opportunism for lower levels of contractual complexity ($b_3 = +0.023, p > 0.05, CI = -0.287, +0.333$ for the effect of contract at the value of -1.120).

As advanced in hypothesis H3, the index of moderated moderated mediation was found to be +0.028 with a 95% (CI) of [+0.000, +0.074]. The conditional moderated mediation effect of buyer dependence by trust was significant just for the value of 1.20 in contractual complexity but not when contractual complexity takes lower values. When the contract was 1.20, the index value increased to +0.069 with a 95% (CI) of [+0.004, +0.161]. In addition, the results showed that adding the first-level moderator (i.e. trust) made a significant change of 0.038 and adding the second-level moderator (i.e. contract) made a significant change of 0.031 in the R-squared value of the model. Consistently, supporting evidence for Condition 5 revealed different conditional indirect effects. The positive relationship between requirements instability and ex-post opportunism is stronger for higher levels of contract when trust positively moderates the indirect effect of requirements instability on supplier opportunism through buyer dependence.

In addition, the calculated R-squared value indicates that the proposed model explains nearly 19% of the variation in supplier opportunism. The R-squared value provides an estimate of the movement in the dependent variable as the function of movements in a set of other explanatory variables. However, a higher R-squared value does not always indicate a poorly or well-fitted model (Castaño *et al.*, 2015). A good model can have a low R-squared value like in social sciences. Falk and Miller (1992) suggest that R-squared values greater than 0.10 can be deemed adequate. Taken together, we confirmed the hypothesized moderated moderated mediation model linking requirements instability to ex-post opportunism. Our results suggest that buying firms with a lack of capability to identify user requirements of a project *ex ante* will be exposed to more ex-post opportunism due to increased structural dependence while building a trust-based relationship but yet heavily relying on contract coverage.

6. Discussion

6.1 Summary of findings

Our ex-post impact analysis of residual opportunism in software development revealed some important findings linking information processing problems to software project governance. This study estimated a two-stage conditional mediator effect of buyer dependence in the relationship between requirements instability and supplier opportunism. The conditions under which residual opportunism persists were exposed for software development projects. The first contingent effect of competence-based trust flourished buyer confidence that the supplier will fulfill project tasks effectively and ex ante incentives for initiating a relationship. Yet, this type of confidence does not have to breed the supplier's goodwill in its intentions. The second contingent effect of contract strictness notified how opportunism remains alive even if buyers would build structurally dependent relationships only with competent suppliers. Where trust positively moderates the indirect effect of requirements instability through buyer dependence, ex-post opportunism shows a significant increase in higher contractual complexity. If else, while suppliers could not gain sufficient confidence to invest more in procedural assets and then the contract contained more flexible rules rather than restrictive provisions, the reasons for both the relational bounding of resource interdependence and yet the opportunism-enhancing effect of internal dynamism (as regards task-related information requirements) would stay out of the research focus that investigates the governance of software projects. Looking beyond the overall contribution provided, this study not only sheds light on the governance limits that supplier opportunism remains alive in ex-post transaction nature of a relationship but also contributes separately and in combination for broader impacts of uncertainty, interdependence, trust and contract. Therefore, in this section, we discuss our findings on direct and indirect impact analyses one by one.

Requirement instability and supplier opportunism- Our results revealed that requirements instability increases incentive misalignments between software project partners. Ambiguous and dynamic requirements information impede accurate analysis of user needs to implement fully defined specifications. Internal uncertainty rises to question of how suppliers perform in dynamic tasks which, in turn, engenders opportunistic expropriation hazards stemming from post-contracting unfair bargaining practices and the threat of contract termination. There are few studies investigating the relationship between requirements uncertainty and supplier opportunism. Wang's work (2002) provides a first look at this link in software development. Consistently, this study further supports the opportunism-enhancing impact of task-oriented internal instability for uncertain requirements information.

Requirement instability and buyer dependence- Project-based development of new information system technology is typical of reciprocal interdependence. Tasks can never

be accomplished in a linear sequence or in a planned manner but instead coherence in actions and mutual adaptation breed project success. As seen here, the intensive technology nature of software development needs co-specialized investments of both sides of a relationship in achieving value creation for system users. This situation entails a bilateral dependence relationship. The relational governance perspective suggests bilateral-specific investments as a remedy for managing uncertainty. Consistent with this thesis, we provide, for the first time, evidence of buyers' investments as a proxy for asymmetric interdependence as the instability of information requirements increases in software project development.

Buyer dependence and supplier opportunism- Reciprocal partner dependence appears in different types. On the one hand, software suppliers make specific investments in physical assets such as design tools and engineering processes for developing a customized software product. On the other hand, software buyers make specific investments in human and procedural assets as regards organizational routines and workflows tailored to a particular information systems development project. On the supplier side, as physical specificity will not be able to redeploy to alternative use without sacrificing its productive value, increased relation-specific investments of software suppliers lead to "lock-in" dependence. However, exit barriers will be higher for software buyers due to the double hold-up effect of procedural specificity. On the buyer side, the overwhelming hostage effect of procedural specificity arises from operational disruptions and delays arising from workflow restructuring, rather not from the exit deterrence of non-redeployable investments. This clearly points to the asymmetrical vulnerability of interdependent relationships. Buyers' "structural" interdependence in software development projects creates power asymmetry in favor of suppliers. When a supplier withholds new information, denies continual task adjustments and withdraws the agreed-upon commitments during the execution of the task, the buyer's excessive dependence on procedure-specific property resources promotes supplier opportunism. We found that buyer dependence leads to supplier opportunism in interdependent relationships in which resource dependence prevails over transactional lock-in dependence. Our results unveil a neglected asymmetric facet of relational interdependence and strongly emphasize that, contrary to the bounding effect argument, opportunism continues to persist in bilateral asset specificity as resource dependencies engender the overwhelming lock-in consequences of power asymmetry. According to You *et al.*' work (2018), buyer's asset specificity provides a control for the opportunism-enhancing effect of uncertainty. We expand the control role of asset specificity (from the buyer side) implicating opportunism in construction projects to software projects where buyer specificity exerts an encouraging effect in supplier opportunism. This study strongly emphasizes that different types of interdependence arising from asset-specific investments will relieve the tension between the conflicting results of the previous literature on the relationship between asset specificity and opportunism. As an example of conflicting results, Wang (2002) confirmed the bonding effect of asset-specific investments on opportunism but then, in contrast, revealed an unexpected, positive moderator effect of asset specificity in the relationship between requirements uncertainty and supplier opportunism. The biased effect estimation of asset-specific investments can be corrected when considering the asymmetric nature of interdependence and estimating the mediator role of asset specificity in the relationship between requirements uncertainty and supplier opportunism.

The mediating role of buyer dependence in the relationship between requirements instability and supplier opportunism – A diverse and variable set of user needs with tightly coupled functional procedures and integrated information processing prevents an accurate and complete designation of information requirements. Developing custom software systems in which information requirements inevitably change pre, during and post-phases of project development entails subsequent changes in the task environment. However, information requirements instability displays a systemic character and is much more innocent in

incentivizing supplier opportunism. More strikingly, while requirements uncertainty can effectively be managed with bilateral specific investments while structurally dependent information system specialized in procedural knowledge assets overwhelms the lock-in dependence of parties, interdependence will make more risky requirements instability for supplier opportunism. Higher instability in information system requirements activates a resource-dependent partnership relationship, and therein lies more vendor opportunism. In project-based software development, suppliers' responsibility to meet the dynamic requirements of information systems increases the procedural dependence of the buyer. Consistently we found that suppliers' responsibility to meet the specialized and dynamic requirements of information systems increases buyers' procedural interdependence in project-based software development. Furthermore, our results confirm that buyer dependence mediates the requirements instability-supplier opportunism link. According to our best knowledge, no previous such evidence exists for software development projects. Even more, the interfirm governance literature still needs to fill gaps in explaining the potential interdependence effects of asset-specific investments. For instance, [Huo et al. \(2018\)](#) found a nonsignificant relationship between uncertainty and opportunism in the procurement of logistics services although buyers invest more in specific assets as uncertainty increases and then specific investments made by buyers increase supplier opportunism. Their results signal a mediating effect of asset specificity as a proxy for buyer dependence. At this point, we build on the previous literature and add a new account of buyer dependence that mediates between internal uncertainties of the task environment and supplier opportunism.

The first-order moderating effect of competence-based trust- Buyers will establish a structurally dependent relationship if suppliers have a higher level of technical competence due to the difficulty in designating accurate and more complete information requirements increases. In other words, software buyers tend to engage in a project-based relationship with suppliers perceived as trustworthy. Building competence-based trust provides reasonable risk ground ex ante for initiating relationships in the partner selection process. Accordingly, our results support the mediating role of buyer dependence for higher levels of the buyer's trust in the technical competence of the supplier. On the contrary, low competence-based trust undermines the buyer's incentives to enter into a structurally dependent relationship for software development projects where requirements are uncertain.

The second-order moderating effect of contractual complexity- In a trusting relationship, uncertainties can only be effectively managed with reciprocal and flexible responses to task-dependent changes. Otherwise, structurally dependent buyers will be more exposed to vulnerability in the later stages of a project-based relationship. The strictness of a contract demarcates self-enforcing cooperative transactions. With this in mind, we considered the second-order contingent effect of contract and revealed that the mediating role of buyer dependence is stronger in higher levels of contractual complexity. This study shows that supplier opportunism persists even in a trust-based relationship and structurally dependent buyers will be exposed to supplier opportunism for more detailed contract setups, but not in a low degree of contractual complexity. Our findings support previous studies by [Guo et al. \(2022\)](#) and [Lu et al. \(2015\)](#), suggesting that formal control systems are unable to prevent supplier opportunism. Beyond that, in a similar way as [Wang et al. \(2019\)](#), this study assumes that contract and trust have different impact strengths in the *ex ante* and *ex post* lifecycle assessment for controlling opportunism. But differently, we found that more detailed contracts display rather inversely strengthening effects in the later stages of software projects, instead of being restrained supplier opportunism. Contrary to what [Haq et al. \(2019\)](#) argue in software projects, governance mechanisms (i.e. competence-based trust and contract) do not always induce restraints for opportunism.

6.2 Theoretical implications

This research makes distinctive contributions to the literature on information systems integration and continuous improvement, an area that should be examined by an integrated “frame of reference” across the relevant theories, including information processing theory (IPT) transaction cost theory (TCT), resource dependence theory (RDT), social exchange theory (SET). Unlike the discrete and polarized relationship postures over preexisting human behavior, this study argues that partner behavior may change in different stages of the project lifecycle. Taking a new look at interfirm relationships, opportunism is neither a yes nor a no decision but rather a dynamic and situational behavior matter. For instance, competence-based trust is the bright side of the dark in information system conflicts. This implies screening and selection of partners before initiating a project-based relationship. Still and all, opportunism remains permanent if the buyer’s competence beliefs are not enough for a new breed of goodwill in a later stage of the lifecycle. In contrast with the TCE tradition, opportunism can be only known *ex post* and diagnosed implicitly in the action patterns of participants.

The recent findings from existing literature on environmental knowledge–organizational behavior contingency point out internal layers of uncertainty associated with the task environment to understand the motives behind *ex-post* opportunism. Some previous studies (e.g. [Handley and Benton, 2012](#); [Huo *et al.*, 2018](#); [You *et al.*, 2018](#)) found either a nonsignificant relationship between uncertainty and *ex-post* opportunism or a different, unexpected opportunism-boiling effect of governance mechanisms. While external uncertainty leads to systemic risks across a particular sector and hence interpartner cooperation exerts not innocent but strategic influences in managing internal uncertainties, mediation investigation for dependence-power relations is of critical importance to disentangle the uncertainty-opportunism contingency.

Dependence can evolve in different forms. From the TCT perspective, asset-specific investments induce a lock-in type dependence in the relationship. Dissimilar to TCT, the SET perspective argues the role of relation-specific investments and adds to a form of balance in dependence. While TCT attributes opportunistic behavior to a holdup problem for unilateral investments, SET predicts that, in the absence of and a never born social acceptance of opportunism, reciprocally invested parties can create superior value and manage project uncertainty effectively. On the other side, the RDT perspective relies on the coexistence of power imbalance and mutual dependence in a relationship. Power resides in one party’s dependence on the other’s resource ownership and control. A more resource-dependent side of a relationship may be exposed to the other’s power exercises as a threat of one-sided action toward opportunism. RDT regards a form of structural dependence in which idiosyncratic firm resources engender incentives to shirk obligations. Software outsourcing projects require asset-specific investments made by both sides of a relationship that may emerge different forms of dependence simultaneously in the lifecycle. A project-based software developed to the specialized user needs breeds the supplier’s lock-in dependence, and in turn, becomes buyers structurally more dependent on procedural assets owned or controlled by the supplier. This situation increases relative buyer dependence on suppliers and weakens buyers’ power position. Asymmetric power outcomes of different types of interdependence (e.g. lock-in dependence from a TCT view and structurally resource dependence from an RDT view) should be differentiated from and kept out of balanced interdependence within a double holdup of offsetting investments; the former type helps us to understand why opportunism persists for alive as the latter lies behind its inhibition. Compared to previous studies which support a one-stand theory ground of partner dependence in enhancing opportunism, this study offers a new theoretical framework by integrating dependence-power explanation (RDT) to asset specificity condition (TCT) for the requirements uncertainty-opportunism link (IPT). The integrative model shows that buyer dependence (arising from specific

investments) functions as a mediator between requirements uncertainty and supplier opportunism.

Our study suggests alternative considerations for theory development with a two-stage methodology application in the governance of software projects. While previous studies often refer to the opportunism mitigating roles of governance mechanisms, this study develops a new understanding of how residual opportunism emerges in formal and informal governance during the project lifecycle. The supplier's technology competence serves as an *ex ante* risk-mitigation mechanism and positively moderates the role of requirements instability on the buyer's structurally dependent resource investments. Buyer dependence makes a more strongly and significant mediation for the uncertainty-opportunism contingency when considering conditional limits of trust and contract. This study is the first that buyer dependence positively mediates the relationship between requirements uncertainty and supplier opportunism when contract is designated more detailed in the project-based relationships initiated by a buyer trustee for the supplier's technology competency. Envisioning governance mechanisms that play different roles in different stages of the project lifecycle gives a dynamic and innovative perspective on understanding how to emerge opportunism. In this regard, applying multilevel conditional process analysis is a purposeful approach to reveal governance interaction in the project development process.

6.3 Managerial implications

The present study has several implications for the management of software projects. First, our findings revealed that contract increases partner opportunism in the later stages of the project lifecycle. Contracting upon more detailed task descriptions (or specifying service level agreements in precise, nonadjustable future terms) increases transaction costs. Drafting, negotiation and bargaining of contract provisions is not costless and entails bearing considerable costs of both *ex ante* design costs and ex-post monitoring and evaluation costs (Benaroch *et al.*, 2016). According to TCE, it is difficult to predict all future conditions due to the bounded rationality of human beings, and requirements are of inevitable instability throughout the software development process (Liu *et al.*, 2011). Undoubtedly, contract is important for establishing the rules of the game but not as a stand-alone punishment mechanism. Contracts do not function well for vertical control in corporate environments with weak regulatory enforcement. Moreover, there is a possibility of encountering situations where the powerful actor of a project-based relationship violates formal institutions that do not function effectively with informal institutions (Gurcaylilar-Yenidogan and Erkus, 2023). This leads to unfair exploitation of contractual provisions, resulting in opportunism by a powerful partner on which the other party is structurally dependent. Accordingly, flexible contract setups that strengthen horizontal coordination in software projects will also be more effective in preventing opportunism. Second, confidence in the partner's software development capabilities plays essential safeguard functions for entering a project-based development business where requirements are uncertain. Thus, building competence-based trust points to the pivotal importance of selecting the right partner for software projects. Besides, supplier development programs will be beneficial for improving partner capabilities which in turn breeds the buyer's trust in the relationship process. Third, information requirements in software development projects are inevitably subject to considerable changes throughout the process (Liu *et al.*, 2011). Our findings revealed that the opportunism-enhancing effect of requirements instability is still alive under conditional limits of governance mechanisms. This situation entails a need for recruiting effective IS project managers who are capable of harmonizing comments and state-behavior feedbacks made by IS experts on both the buyer side and the supplier side. Effective communication can safeguard software project partners from unfavorable outcomes of requirements instability

and diminish conflicts leading to opportunism. To achieve this purpose, on the buyer side, the facilitator roles of boundary spanners in building effective relationships are particularly valuable. Buyers must establish effective project management offices and work with professional project managers to achieve successful software projects.

6.4 Limitations and recommendations

This study still comes with some limitations that merit future discussion. First, it takes a one-point stand for the fact of opportunism. Future research is needed to employ a dyadic design. Surveying on both sides of the project-based relationships allows researchers to reciprocally diagnose the influence one partner's behavioral patterns have in uncertain task environments on the other partner. Hence, it can be better understood and identified overlaps and contrasts in ex-post opportunism across members of the two groups (i.e. buyers and suppliers). Second, our analysis contains a cross-sectional design to explore steady-state exposures in supplier opportunism. Designing a longitudinal study may yield more reliable results for partner-dependence mediation moderated by trust and contract, respectively. Third, this study was carried out on software projects as a neglected, specific area of interfirm governance research, and hence ex-post opportunism explanations in the present study should be extended and compared to future aggregating results across a broad scope of project management. Fourth, this study was conducted in the Turkish software sector, a fastly growing but still younger sector in Turkey as a developing country. Formal institutions, in less transparent and weaker enforceable regulative environments like in Turkey, are not working effectively and their interactions with informal institutions are able to produce convergent or divergent outcomes like opportunism (Gurcaylilar-Yenidogan and Erkus, 2023). Consistently, our findings demonstrate the dark side of contract that promotes supplier opportunism in the Turkish context. Furthermore, while user requirements are constantly changing during the project lifecycle, contract does not function as an effective legal system mechanism in information processing and strengthens supplier opportunism in asymmetric dependence power relationships (Lee and Zhong, 2020). This situation can be explained by a relational governance perspective arguing that contractual rigidity can undermine trust. More precisely, this study discloses that in an unfavorable institutional environment with the state's support of ineffective formal institutions, later stages of the project lifecycle need goodwill remedies, or even worse ineffective formal institutions can be violated with opportunistic actions. Compared to competence-based trust, goodwill trust may fill formal institutional voids and hence is stronger in collectivist countries with weak institutions (Connelly *et al.*, 2018). Furthermore, in the absence of goodwill intentions, contractual rigidity can legitimate formal institutional enforcement of project termination and resistance to ongoing support. To contribute further to IS literature, future studies should concentrate more on explaining a variety of conditional governance limits in different institutional contexts.

7. Conclusion

The research agenda revisited for inter-firm governance holds considerable promise for investigating the ex-post nature of opportunism. In the recent literature, Lumineau and Oliveira's study (2020) criticizes previous research which is polarized by hypothetical assumptions of human nature and remains heavily neglected in the empirical test of endogenous opportunism that realizes in interorganizational actions. Great controversy exists between transactional and relational perspectives that have rested on behavioral oppositions. However, this study adopts a reconciliation way of conflicting perspectives of governance in explaining supplier opportunism ex-post. While asset-specific investment can

serve not only transaction costs but also value creation, while formal and informal governance can play both substitutive and complementary roles, it would be a theoretically acceptable assumption that exchange parties can behave in both opportunistic and non-opportunistic (Noorderhaven, 1995). Moreover, the use of governance mechanisms is often oversimplified to context-specific differences, but more inclusively, it can be argued that organizational behavior may vary at different stages of a relationship.

At this point, in line with Lumineau and Oliveira's (2020) suggestion, explaining how and under which conditions opportunism manifests will contribute significantly to the goal of theory development. To bridge this gap, the present study here explains supplier opportunism in project management. Software development offers a very convenient research area to examine opportunism ex-post while user requirements are highly volatile during the relationship process. The analysis of the data from the buyer side in the Turkish software industry demonstrates some major findings that confirm supplier opportunism at higher levels of contractual rigidity, in case a structurally dependent relationship is built relying on the partner's technology competence under task-based internal uncertainty.

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