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Citation: Kim, J., Lee, H., Son, B. G. & Choi, Y. (2024). A Social Network Analysis of Opportunistic Behaviors in Government R&D programs. CEUR Workshop Proceedings, 3737, ISSN 1613-0073

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A Social Network Analysis of Opportunistic Behaviors in Government R&D programs

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Abstract

Drawing on transaction costs analysis, this study investigates the effect of two partner-selection strategies in government R&D programs: selection based on dyadic relation and network reputation of candidate partners. While governments play a vital role in mitigating opportunistic behavior, direct intervention of governments can increase administrative burdens and decrease efficiency, leading to higher costs for the government. Building upon existing literature on relational and network theories, the research aims to provide insights on the role of partner-selection strategies as effective self-enforcing mechanisms on opportunism control. A simulation model is proposed to track long-term changes in network configuration and transaction costs under project uncertainties. The base model demonstrated that selection based on relations forms a more cost-effective partner network. The next step is to analyze how the transaction costs of these two strategies change on the project uncertainty.

Keywords

Partner-selection strategy, reputation, relation, opportunism, government R&D program [1]

Proceedings EGOV-CeDEM-ePart conference, September 1-5, 2024, Ghent University and KU Leuven, Ghent/Leuven, Belgium
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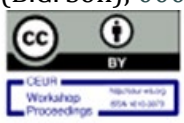

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CEUR-WS.org/Vol-3737/paper6.pdf

CEUR Workshop Proceedings ceur-ws.org ISSN 1613-0073

1. Introduction

Digital transformation of government is world-wide trend with a recent acceleration, aims to enhance public sector efficiency, transparency, stakeholder engagement, and service delivery. EU, for example, assigned significant amount of resources to support the digital transformation of government (eGovernment) of EU member states through R&D funding programs including European Structural Investment Fund(ERIF), Horizon Europe and Connecting Europe Facility(CEF) [1]. The magnitude of the budget, combined with the high uncertainty associated with research utilizing rapidly evolving ICT technologies can lead to increased opportunistic behavior among participating organizations and signifies the efficiency of government's governance upon the R&D collaborations [2]. In government R&D programs like EU Horizon Europe, the coordinator, who plays a pivotal role in leading the formation of the consortium and liaising with the funder for the overall execution of the project, search partners that have the skills and knowledge necessary to meet the funding call objectives. Coordinators often leverage their existing professional relationships or seek new partners outside their current network. R&D program providers often offer an online database, such as Partner Hub in EU project. This online database promotes the sharing of historical project data and profiles of the participants.

The existing literature on governance in government R&D programs primarily focuses on policy design, governmental agency roles, and evaluation [2]. The government's overarching framework reduces negotiation scope, lowering alternative considerations. This curtails initial transaction costs for both coordinators and partners and promotes collaborations. The government's monitoring role on the progress also lowers coordination costs and fosters long-term relationships. However, the direct involvements can increase administrative burdens of government, reducing efficiency of government R&D programs [2]. In addition, over-monitoring can erode autonomy and trust, harming collaboration and innovation. Prior research on government R&D programs still heavily lean on direct governmental roles, overlooking the potential for participants' self-enforcing mechanism[3].

Our research systematically analyses the effectiveness of reputation and relation as partner-selection mechanism and the moderation effect of two different uncertainties: Technological unpredictability and Measurement difficulty. Thus, the research questions are as follows. (1) How does a partner-selection strategy as self-enforcing mechanism play a role in reducing opportunism in government R&D networks? (2) In which situation is one form of self-enforcing mechanisms more beneficial than the other? Addressing these research questions is challenging due to complex factors like interactions among participants over time, uncertainties, and opportunistic behaviors. Directly measuring each mechanism's isolated impacts and discerning performance amidst diverse influences over a prolonged timeframe is nearly impossible. Hence, our study leverages a simulation model focused on relation and reputation as partner-selection mechanism, which is our main research question. This paper presents that preliminary results are in line with the relevant theories and empirical findings.

2. Theoretical background

2.1. Governance for R&D collaboration for Digital transformation

Collaboration that requires a variety of rapidly changing technologies, such as research on digital transformation, inherently increases the uncertainty of success due to the coexistence of partners' opportunism with the uncertainties caused from the transaction itself [4]. Opportunistic behavior in partnerships can cause immediate economic harm and long-term relational damage. In R&D collaborations, it can delay projects, decrease deliverable quality, and even lead to project failure or early consortium dissolution [5]. The management of partner opportunism is, therefore, one of the important factors for the success of R&D collaborations. Therefore, the government play a role beyond just providing funding in government programs that require innovation, such as digital transformation R&D projects. Tripsas et al. (1995) suggest that government, through its institutional and administrative roles, can suppress opportunism during consortium formation and execution, thereby reducing costs associated with partner acquisition (ex-ante cost) and project management (ex-post costs). For example, by offering legal framework and conducting regular progress reviews during the project, the government makes direct efforts to mitigate partner opportunism, thereby reducing participants' transaction costs. Government R&D programs have a crucial role in advancing knowledge and innovation. However, prior studies mainly focused on the government's direct role in governing collaborative network and the absence of studies examining the impact of participant-level strategy on opportunistic behaviors is remarkable. Our paper aims to systematically address this gap while exploring the boundary conditions that affect the effectiveness of different types of non-contractual governance in mitigating such opportunism in the context of government R&D network.

2.2. Reputation and relation as partner-selection mechanism

Gilsing & Nooteboom (2006) argue that by employing strategic partner selection, one can effectively guard against opportunistic behavior within research networks that are dedicated to innovation amidst considerable technological uncertainty and high transaction costs [6]. When a coordinator requires a partner for an alliance, they often turn to known partners with whom they have had positive engagements in the past relationships. Firstly, selecting such partners can reduce the cost and time required for searching for a new partner [7]. Furthermore, selecting a known partner with a high level of relational embeddedness, such as trust, can function as a relational governance effectively reducing the likelihood of facing opportunistic behaviors in the future. However, selecting predominantly known partners could limit the firm's capability to innovate since it would restrict its access to non-redundant knowledge and information [8]. Furthermore, over-reliance on a number of known partners could also, in the long-term, increase the firm's vulnerability to opportunistic behaviors due to increased dependence [9]. Alternatively, coordinators may need to venture out for new partners, for example, when they require resources and knowledge not available through their current networks [10]. When forming a collaborative R&D consortium, the knowledge and capability requirements for projects

can change rapidly, so it may be difficult to form a consortium without seeking out new partners. Moreover, coordinators may seek new partners despite having existing partners with the necessary knowledge and capabilities due to various other reasons, such as dissatisfaction with previous. However, the decision to work with new partners increases the risk of opportunistic behavior. Therefore, when seeking new partners with no prior experience, coordinators should consider the reputation of potential partners as indicators for their trustworthiness, recognized within the collaboration network [6].

2.3. Uncertainties and partner opportunism

The link between different types of uncertainty and opportunism has been extensively investigated by researchers. Among them, technological uncertainty and measurement difficulty are particularly relevant for this study, since these are two of the most widely studied transactional attributes in technology R&D literature [11]. Firstly, technological uncertainty represents the difficulty of predicting future technology requirements, which is often beyond a firm's control and can lead to unforeseen challenges in project management. Firms may respond to this uncertainty with opportunistic behavior, such as reducing resource commitment to mitigate potential risks like project failure. High levels of technological unpredictability also complicate the creation, monitoring, and enforcement of contractual safeguards, thereby increasing the costs and reducing the effectiveness of these mechanisms to control opportunism, particularly in industries like information systems outsourcing where technology evolves rapidly. Secondly, measurement difficulty pertains to how hard it is to assess a partner's performance in a collaborative effort and is often linked to tasks that require joint effort and considerable time to execute. This challenge can lead to partner opportunism, as accurate performance measurement is critical for appropriate compensation, and perceived uncertainty in rewards may prompt a partner to withhold resources and effort. Additionally, measurement difficulty introduces an information asymmetry that can prevent coordinators from detecting partner defection, increasing opportunistic behavior by the partner. This study investigates the interactional role on the relation between the partner selection strategy and the project efficiency of R&D consortia.

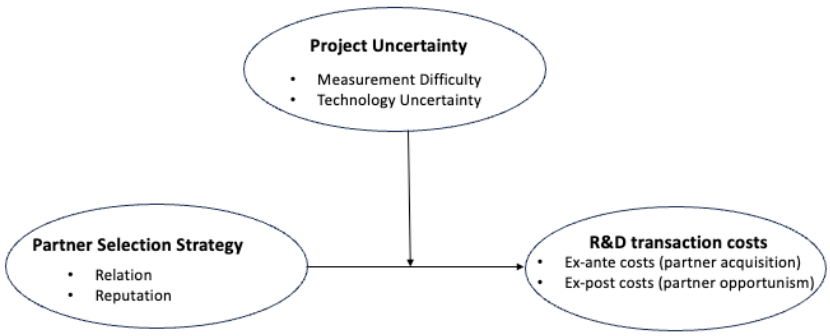

Figure 1. Research model.

3. Simulation model

3.1. Government R&D network and partner-selection procedure

In this research, we propose a simulation model of complex social processes of relationship and reputation development in government R&D networks for the digital transformation of government. Our model reflects the life cycle of such interactions from the selection of partners for the formation of the consortium to its termination, including the distribution of rewards among participants, with a particular focus on the role of partner-selection strategy of coordinator on governing partner opportunism and its project efficiency in terms of transaction costs (Figure 2).

3.2. Relation, Reputation and other key assumptions

Coordinators form consortia by using different partner selection strategies: relational selection and reputational selection. In our study, the concepts of relation and reputation were computationally modeled based on literature about trust and reputation [12]. Coordinators using a relational selection strategy choose partners based on positive past relationships, while those using a reputational selection strategy consider the partners' reputations, indicated by the number of positive feedback from previous collaborations.

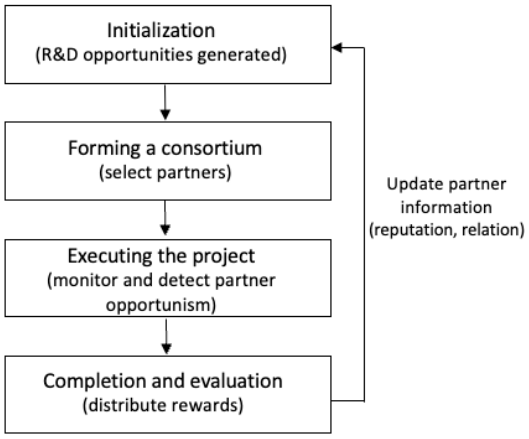

Figure 2. Simulation procedure of R&D partner-selection.

In our model, the level of relational trust for *k*-th coordinator to *i*-th partner at *T*-th round is calculated using Equation (1).

$$Relational\ Trust\ {}_{i}^{k}(T) = \sum_{t=1}^{T-1} Positive\ relation\ (t)_{i}^{k} \quad (1)$$

Where *Positive relation* is the reward earned from *i*-th partner to *k*-th coordinator at *t*-th round (in the past).

Similarly, the level of reputation for i-th partner at T-th round can be modeled as Equation (2).

$$Reputation_i(T) = \sum_{t=1}^{T-1} \sum_{j=1}^{All} Feedback_i^j \quad (2)$$

Where *Feedback* on i-th partner from j-th coordinator is defined as

$$Feedback_i^j = \begin{cases} 1, & \text{for a positive feedbackk on the behavior} \\ 0, & \text{for a negative feedback } when\ the\ opportunism\ detected. \end{cases}$$

Each partner possesses a specific technology that are essential for the successful completion of an R&D project: 'opportunistic' and 'cooperative', based on their propensity to behavior opportunistically during the execution phase of the project. At the implementation phase, coordinators monitor the contributions from partners and detect opportunistic partners which tend to withhold of previously committed resources [13]. The probability of successful detection is modeled inverse to the level of measurement difficulty inherent to the technology provided by the partner. In the final stage, the project fund is distributed among participating partners. If opportunistic partners are detected by the coordinator, they will receive a penalty that reduces their rewards, and their participation in the consortium will be restricted for the following number of rounds. In the event that the coordinator fails to detect opportunism, our model holds the coordinator responsible for quality control, resulting in a reduction of the coordinator's reward instead of the partner's. As the project is disbanded, in our model, all partners' reputation information is updated through the management system with the coordinators' feedback on each partner's participation in the project before new grant round begins.

3.3. Measurements

In the process of forming a consortium and carrying out a project, two transaction costs determine project efficiency [2]. First, ex-ante costs efficiency encompasses activities such as partner identification, negotiation, and contract establishment during the project formation phase. Second, post-contract costs efficiency relates to quality management, including monitoring partner performance and ensuring adherence to contractual obligations during project execution. In this study, by quantifying the proportion of new partners (PNP) and opportunistic partners (POP) within the collaboration, we gain insights into their influence on overall project outcomes. These variables collectively contribute to assessing efficiency based on different partner-selection strategies.

Table 1.
Specification of simulation model and variables.

Variables	Model	Reference
Relational strategy	Select a partner based on the prior relation. Repetition is cost effective, but overdependence hinders new opportunities.	[4], [14]
Reputational strategy	Prefer reputational partners. Search wide for innovation at the search costs.	[15], [16]
Measurement Difficulty	The higher MD, the greater chance partner opportunism goes undetected. {low, mid, high}	[11]
Technological Unpredictability	The Higher TU, the greater number of new partners are required to form a consortium. {low, mid, high}	
Proportion of New Partners	Determines 'ex-ante costs' of a collaboration - acquisition and negotiation costs.	[2]
Proportion of Opportunistic Partners	Determines 'ex-post costs' of a collaboration - monitoring and penalty costs.	
Project efficiency	Overall performance related to transaction costs of new- and opportunistic-partners.	Author defined

All the result values are normalized to the maximum level of the variables, employing min-max normalization to scale the value. Each simulation result represented in this study represent the average value, obtained by conducting 100 experiments.

4. Results and findings

4.1. Base model

In the base model as a starting point, both MD and TU are set at low levels to minimize the impact of these project uncertainties on the outcomes of two different partner selection strategies. Figure 3 shows the changes in the proportion of new partners (PNP), proportion of opportunistic partners (POP) and their project efficiency for coordinators taking the two different partner selection strategies throughout the simulation rounds of 200. According to the simulation results of the base model test, the relation-based selection strategy of maintaining relationships with old partners appears to be more efficient in terms of transaction costs.

The base model indicates a scenario when the demand for technology is stable, not rapidly changing with each round, and when low measurement difficulty, coordinators can continue to work with their existing partners, for example, the coordinator has a good understanding of the technology provided by the partner, is low. In this setting, coordinators with the relational strategy minimize the necessity to search, evaluate and negotiate with new partners, that is lower level of PNP, thus they can be more cost efficient

than coordinators constantly looking reputational partners regardless their prior relationship. The trending decrease in PNP within a reputation-based strategy indicates that a certain number of reputational partners form a partner pool within the network, monopolizing collaboration opportunities that arise, which leads to a situation that partners who join later face difficulty to find these opportunities. Table 2 illustrates the final values reached after 200 rounds for three measured variables, demonstrating that a relation strategy maintains lower PNP and POP within the consortium and achieves higher project efficiency compared to the reputation-based strategy. The results supports the argument that the costs incurred from searching for and switching to unfamiliar partners can be saved through maintaining long-term relationships [14], by demonstrating the connection between the configuration of the consortium by partner-selection strategy and project performance.

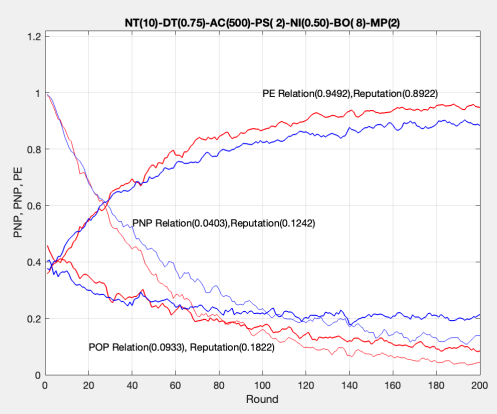

Fig. 3. Simulation results on the base model: Low MD and Low TU.

These results are in line with the findings of relational theory and empirical findings in IS development. In the perspective of relational theory, the main outcome of positive interactions is an accumulation of goodwill and trust [4], and mutual trust and commitment would serve to uphold agreed norms of collaboration reducing partner opportunism. Empirical findings in the ITO studies suggest that the performance of ITO alliances is improved by repeated relations, the longer duration of ITO contracts and the expectation of future opportunity.

Table 2.
Simulation results of Base model.

Metric	Reputation	Relation
PNP	0.1241	0.0400
POP	0.2012	0.0937
Project efficiency	0.8919	0.9495

In our study, we consider the simulation results of the base model at the level of MD and TU are both low as the starting point. Now, we analyze the impact of MD and TU on the

network configurations of PNP, POP and project efficiency of coordinators with reputation- and relation-based selection strategies.

4.2. Preliminary results for the high TU level on project efficiency.

When the technological requirements become highly unpredictable and diverse, coordinators are faced with the need to expand their search for new partners possessing the requisite technology for forming consortia. This situation forces relational coordinators to search partners beyond their existing networks. As depicted in Figure 4, with TU increasing, both selection strategies lead to greater number of new partners (PNP) and opportunistic partners (POP), but the changes are differential. The simulation results highlight a marked change in network configuration, particularly for relational coordinators. The simulation shows that the network configuration has changed a lot, especially for relational coordinators with significant increase in PNP and POP, which in turn raises costs of acquisition and quality monitoring, thereby diminishing the advantage in the project efficiency found in the base-model. In contrast, the changes of PNP and POP for reputation-based strategy remains relatively moderate for the increasing TU. This suggests that coordinators are leveraging accumulated network information from other coordinators' experiences [7] to mitigate costs associated with opportunism[17]. Furthermore, the trend that PNP decreases over time for reputation coordinators suggests that as time progresses, recognized reputational partners form a pool within the network, implying reputational partners are more accessible and repeatedly chosen in a manner similar to the relational strategy.

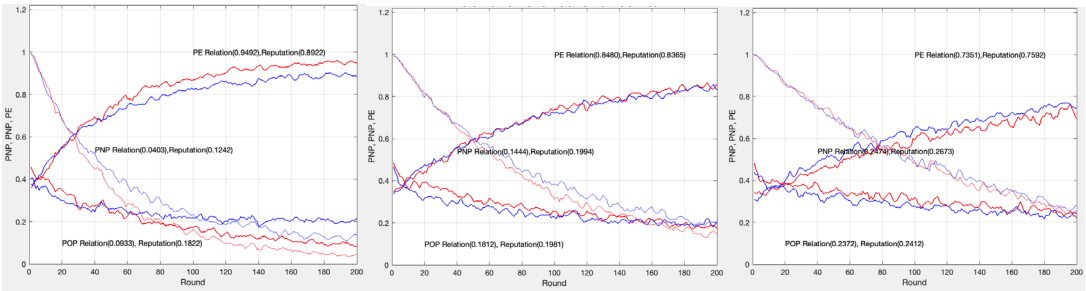

Fig. 4. Simulation results by the TU level: From the left (a) Low, (b) Mid and (c) High**.**

In the results, we observed that reputation-based selection more effectively can prevent opportunistic partners from participating consortia, thereby overperform the relational strategy in project cost efficiency. The results hints that selecting reputational partners as well can be effective in safeguarding opportunism in academic research networks, which pursue innovation and face high technological uncertainty.

5. Conclusions and future works

The paper proposed government R&D network model and the results illustrate that reputation and relation as partner-selection mechanism can effectively reduce partner

opportunism and transaction costs. The base model results in a low-uncertainty environment, our model complies to the prior studies that a relational strategy seeking stability in partner relationships is cost-effective. However, our results also hinted a boundary condition of the relation strategy and the reputation mechanism become more effective when technological unpredictability becomes high. This demonstrates the potential of the proposed model can be utilized to investigate various topics affecting t collaboration performance in government R&D network environment.

The next steps involve analyzing how another uncertainty model, measurement difficulty, differentially impacts the transaction costs of reputation and relation strategies. We will compare this with the varying TU results presented in this paper to determine the conditional superiority of the two strategies. Additionally, we will explore other factors that may influence the relative performance of reputation and relation, such as reciprocity and penalties.

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