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Parallel teams for knowledge creation: Role of collaboration and incentives

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ABSTRACT

Parallel team strategy, in which multiple teams simultaneously pursue project goals, has been widely adopted by high-tech industries for knowledge creation. In this study, we investigate the design of organizational incentives, including a fixed wage payment and an additional reward structure, for effective management of the parallel team strategy. We consider two main variants of parallel teams—*collaborative* and *non-collaborative* teams. Proposing and investigating three types of organizational reward policies, individual, aggregate, and contingent, we analyze the viability and characteristics of these policies. We show that individual reward policy performs better than aggregate policy, and that collaboration in parallel teams is vital. When parallel teams work non-collaboratively or when aggregate reward policy is used for collaborative teams, the firm achieves optimal profits by only offering a share of the knowledge creation benefit as the reward. Under some conditions for collaborative teams, we demonstrate that individual and contingent reward policies can achieve maximal benefits (first-best) for the organization. This research provides valuable insights for firms in employing parallel team strategy for knowledge creation.

1. Introduction

Teams serve as effective organizational structures for pursuing innovation in firms. In a ground-breaking study of the practices of General Motors in 1943, Peter Drucker pointed out the effectiveness of team-based structures in organizations. As evidenced by numerous successful cases, team structures have been employed in many new projects. For example, Microsoft launched its gaming platform Xbox within a short period of time by employing the team strategy. At Google, various teams are assembled to work on different projects, such as Google Documents, Google Health, and Google Checkout.

Past research provides insightful perspectives on team composition. For instance, Drucker [9] identifies three kinds of teams as baseball, football, and tennis doubles teams. Cohen and Bailey [6] categorize teams in organizations into four types: work, parallel, project, and management teams. Katzenback and Smith [20] suggest three types of teams: teams that—recommend, do, or run things. These papers share some similar notions on teams, for instance, the parallel team categorization of Cohen and Bailey [6] is the same as the football team identified by Drucker [9].

Taking into account the increasingly complex nature of technologies, recent IS research on teams has considered virtual teams, for instance, the application of group support systems in supporting them [18] and the social factors for their creation and effectiveness [23]. Not only do firms have to adopt appropriate team structures, but also assemble multiple teams to collectively engage in a single project. For example, Microsoft organized more than 200 programmers into several teams in developing the Windows95 operating system which contains more than 11 million lines of code [8]. Firms are continuously seeking cost-effective strategies to manage and coordinate teams on innovative projects.

Different team strategies have been employed by industries for innovation and research. Concurrent team strategy is widely adopted to shorten the development time of new products. For instance, project managers at Microsoft usually divide a project into modules and different teams then work simultaneously on their modules but they synchronize with each other and debug daily [7]. In contrast, in the *parallel team strategy*, many teams work on the same research project simultaneously so as to maximize the overall success rate of the project. We cite a broad range of applications where parallel team strategy has been successful. It is frequently applied in research where single-team strategy results in high failure rates. For example, Nelson [29] documents the adoption of parallel strategy in R&D by the U.S. Air force. A similar parallel team approach was also used at National Institute of Health (NIH) to develop a malaria vaccine, instead of the traditional process of malaria vaccine development, where if one approach fails, the entire effort dies with it as well [32]. Arditti and Levy [2] report the use of parallel path strategy in the development of aircraft engines and MIG fighters, and also in the electronics industry for color TV development. Siegal and Chang [34] describe Samsung's use

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of parallel product development teams—teams in California and Korea working simultaneously pursuing different approaches in DRAM chip development, but cooperating as well. Wiklund [38] advocates the use of parallel drug development in which several candidate compounds are evaluated simultaneously to bring in productivity gains and shorter development times. In this paper, we model how to combine the parallel team strategy with incentives for effective knowledge creation.

We highlight this paper's contribution by considering two related important dimensions of team functioning: (i) whether the teams work in parallel or not, and (ii) whether the teams collaborate or not. Most prior research has addressed primarily non-parallel teams focusing on issues such as team structure, team motivation, and social and organizational factors impacting team performance [19]. Some papers incorporating collaboration within and between non-parallel teams investigate how collaboration improves team performance [1]. Among the very few papers that have analyzed the parallel team strategy, Arditti and Levy [2] study how to choose the best number of parallel teams in new product development; but their context is limited to non-collaborative teams. In contrast, our paper primarily focuses on the so-far-unaddressed *parallel* and *collaborative* teams and highlights the role of collaboration by comparing it to the case when it is absent. Considering the parallel teams strategy, we study how the design of incentives and collaboration affect the success rate of innovation. Specifically, we address the following research questions in this paper.

First, *how does the design of teams differ between collaborative and non-collaborative parallel teams?* Multiple parallel teams can be formed as either non-collaborative team or collaborative team similar to the differentiation between working groups and teams by Katzenback and Smith [19]: non-collaborative teams are loosely bound together for some common goals, whereas collaborative teams coalesce because of the collaboration among them. In particular, non-collaborative teams work independently without learning from or sharing with other teams, whereas collaborative teams work closely together so as to effectively increase the success rate of the research project. We study whether and how the presence of collaboration in parallel teams helps a firm improve knowledge creation.

Second, *how should a firm design incentive structures for parallel research teams?* The incentive structure for a team in this research consists of a fixed wage payment and an additional reward policy. All the teams get the fixed payment irrespective of their individual success and they will be rewarded additionally if their research project succeeds. Three types of reward policies (individual, aggregate, and contingent) are proposed in this paper and we analyze how these rewards should be designed so that the firm may achieve maximal profit.

Finally, *how should the firm match the reward policy appropriately for different team structures?* We examine whether different reward policies can achieve the maximal profit (first-best) for the two team structures. We show the conditions under which these reward structures are effective.

Our paper makes several significant contributions. While it is true that collaboration can be expected to improve team performance, we demonstrate that the first-best solution can be achieved even when workers voluntarily choose their effort levels. Similarly, although rewards can generally improve performance, we characterize the structure of the reward itself. Moreover, we explore the characteristics of various reward policies—individual, aggregate, and contingent policies, including the appropriate number of teams. We show that individual reward policy performs better than aggregate policy, and that collaboration in parallel teams is vital. When parallel teams work non-collaboratively or when aggregate reward policy is used for collaborative teams, the firm achieves optimal profits by only offering a share of the knowledge creation benefit as the reward. In spite of the negative complementarity between the effort level and the total number of teams, we demonstrate that individual and contingent reward policies can achieve maximal benefits (first-best) for the organization. Therefore, managers can employ our results to design reward structures to improve knowledge creation outcome.

The paper proceeds as follows. Section 2 briefly reviews prior related research, Section 3 outlines our model, Section 4 presents the detailed analysis and discussion, and Section 5 provides managerial insights and concludes the paper.

2. Literature review

We briefly review prior research on the theory of knowledge creation, team incentives, tournaments, collaboration and team approach for knowledge creation, and contrast our work from these studies. The theory of knowledge creation pioneered by Nonaka [30] proposes four patterns of interactions between tacit and explicit knowledge in organizations. Against this backdrop, Fong [11] develops a conceptual model of knowledge creation in the context of multidisciplinary project teams by synthesizing various relevant knowledge creation processes. Li and Kettinger [22] outline an iterative process of knowledge creation in which new knowledge is generated through applying existing knowledge in solving problems. Malhotra and Majchrzak [25] describe different types of IT support to enable knowledge sharing across multiple far-flung teams so as to facilitate knowledge creation. Our research does not focus on what specific knowledge creation process is used, but rather on the complementary aspect of incentives and collaboration that facilitate knowledge creation in parallel teams.

A rich body of research exists on incentives, teams, and tournaments in the economics literature. Classical principal–agent models explore the optimal incentive structure under incomplete information and the relationship between first-best and second-best solutions. For example, Holmstrom [16] and Grossman and Hart [13] study the moral hazard problem within the context of a single principal and a single agent. Spence [35] introduces the important idea of signaling in a model where employees signal their productivity levels via educational levels in the job market. These early studies provide significant insights into how the principal can use incentives to induce agents to exert optimal effort. Building on the principal–agent models, the theory of teams literature [26] introduces important ideas for team-based incentive systems. Two common incentive systems – the paid worker and profit sharing incentive structures – may be used to align team members' interests with that of an organization [14]. However, in a team with multiple agents, group incentive cannot achieve efficiency without breaking the budget-balancing constraint [17]. Under certain conditions, a contract linear in output can be optimal for a team and monitoring does not improve the team output [27]. But none of these papers consider parallel team structures, whereas our research focuses on the design of incentives for parallel teams with or without collaboration.

We present a brief overview of the related stream of literature on tournaments and contrast our model. In tournaments, compensation is based on relative ranking rather than on output level. Tournament format is often used when the absolute value of the output is difficult to measure, whereas relative ranking is easy to establish. Examples abound in employee promotion policies and sports. Considering a firm with two players, and external shocks, Lazear and Rosen [21] show that tournament prize schemes can achieve the same optimal resource allocation induced by output based contracts when agents are risk neutral. Green and Stokey [12] further analyze tournaments with many risk averse agents, and demonstrate when tournaments perform better than independent contracts—without common shock, independent contracts fare better while tournaments dominate when the shock is diffused. In the context of idea generation, Morgan and Wang [28] explore the suitability of different types of tournament formats and features (such as winner-take-all, multi-