Agile and Stage-Gate: how they relate to innovation performance

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Introduction

While innovation ranks higher than ever on the strategic agenda of top managers and R&D spend continues to grow, the failure to meet time, cost, and quality targets remains high (Markham and Lee, 2013).
Innovation studies indicate inappropriate approaches to the management of the New Product Development (NPD) process as a key reason for failure.
A new class of process models has emerged that operates differently from the conventional and linear methods. The latter, including Stage-Gate and Waterfall, prescribe detailed product specifications and front-end plans, sequential phases, development activities adhering to agreed specifications and strictly defined criteria (Cooper et al., 2002).
In contrast, flexible models, such as Agile and lean start-up, advocate minimal up-front planning, adapting product design to changing requirements until late in the NPD process, involving users early through prototyping and frequent testing, organizing development work in iterations of time-boxed design-build-test cycles (Chan and Thong, 2012).

Agile: a paradigm shift

Shortly after the creation of Agile, Boehm and Turner (2003) introduced the concept of home ground, referring to the conditions in the NPD environment that are most favorable for each process model: large projects with stable and predictable requirements for plan-driven Stage-Gate, and small-to-medium projects with highly dynamic and unpredictable requirements for Agile.

While there is evidence of the success of both approaches in their respective home grounds, recent studies report a growing trend of migrating from linear plan-driven models to Agile.

Mangalaraj et al. (2009) suggest that developers increasingly perceive Agile as a viable approach across all NPD projects. Several authors provide evidence of successful applications of Agile methods even in traditional Stage-Gate management environments. Boehm and Turner (2005) argue that Agile generally works as well as or better than conventional approaches. Interestingly, Chow and Cao's (2008) study on the critical success factors of Agile implementation find that project characteristics, such as variability and criticality, play no role, which lends support to the broad applicability of Agile methods, not only for software development, but also industrial products.

The Agile adoption

A key driver of the adoption of Agile is the uncertainty and volatility of business environments (Boehm and Turner, 2003).
For NPD, this means that most innovation projects start with incomplete knowledge of customer needs and the technologies used to fulfil needs that may change over the course of projects. Such conditions strain traditional plan-driven models based on prediction, stability, and compliance (Boehm and Turner, 2003). Organizations need to accept uncertainty and adapt NPD to meet unanticipated and evolving requirements, regardless of when they occur in a project's lifetime. With today's intensified competition, rapid technological advances, and fluid market demands, agility is an imperative, not an option.

Purpose of the research (1/2)

The present study investigates the influence of plan-driven Stage-Gate models, flexible Agile models, and their interaction on NPD speed, cost, and quality performance.
First, we focus on the principles that underlie the two process models, instead of their practices and tools. Most empirical research conceptualizes Agile adoption in terms of the extent to which specific practices are used and their effectiveness (Eisenhardt and Tabrizi, 1995

Purpose of the research (2/2)

A second point of departure is that to investigate the performance of Stage-Gate and Agile models, and their interaction, we do not assess all their underlying principles, but only those related to managing uncertainty and resulting changes (Mangalaraj et al. (2009). Uncertainty, defined as the absence of complete information on the phenomenon under study, is inherent in innovation initiatives with the goal of developing something new (Cooper et al., 2002).). Uncertainty concerns, for example, customer needs and preferences, technological possibilities, and competitors' moves. Effectively managing uncertainty and resulting changes is a core capability in NPD management (Eisenhardt and Tabrizi, 1995) for which Stage-Gate and Agile prescribe two fundamentally different approaches. Stage-Gate attempts to *control uncertainty* up-front to *avoid* later *changes*.

Hypothesis

H1a. In software development, managing the NPD process according to Stage-Gate principles is associated with lower speed performance.

H1b. In software development, managing the NPD process according to Stage-Gate principles is associated with lower cost performance.

H1c. In software development, managing the NPD process according to Stage-Gate principles is associated with lower quality performance.

H2a. In software development, managing the NPD process according to Agile principles is associated with higher speed performance.

H2b. In software development, managing the NPD process according to Agile principles is associated with higher cost performance.

H2c. In software development, managing the NPD process according to Agile principles is associated with higher quality performance.

H3a. In software development, the interaction between Stage-Gate and Agile principles is negative and associated with lower speed performance.

H3b. In software development, the interaction between Stage-Gate and Agile principles is negative and associated with lower cost performance.

H3c. In software development, the interaction between Stage-Gate and Agile principles is negative and associated with lower quality performance.

Sample

The unit of enquiry is software developers who are members of four Italian virtual communities (Italia JavaScript, Google Development Group Slack Milan, Google Development Group Florence, ASP.NET Italia) focusing on the development of internet software products.
A raw sample of 276 software developers yielded a raw response rate of 16% . After excluding responses with missing values, the final sample consisted of 181 software developers .

Methods & Results

This study uses seemingly unrelated regression models (Zelner, 1962). To test H1a, H1b, H1c and H2a, H2b, H2c, the main independent variables are the Stage-Gate and the three Agile factor variables. To test H3a, H3b and H3c on the complementarity between Stage-Gate and Agile, we introduce the Stage-Gate and three Agile factor variables together with their interaction terms.

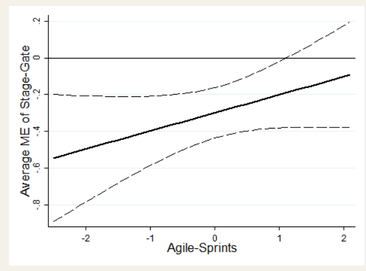

Figure 1. Average marginal effect of Stage-Gate as Agile-Sprints varies – speed performance

To avoid multicollinearity concerns, we test interaction effects both separately for each Agile factor and by including all interactions between Stage-Gate and the three Agile factors in a full model.

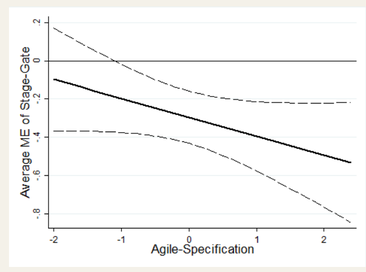

Figure 2. Average marginal effect of Stage-Gate as Agile-Specification varies – speed performance

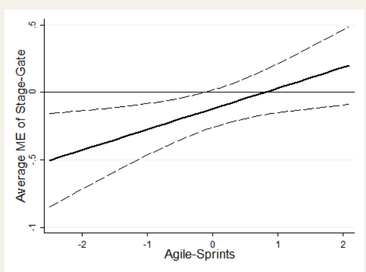

Figure 3. Average marginal effect of Stage-Gate as Agile-Sprints varies – quality performance

Discussion

H1a, H1b, and H1c posit that following Stage-Gate management principles is associated with lower speed, cost, and quality performance. As to speed and cost performance, the Stage-Gate coefficients are negative and significant consistently across all the different models. H1a and H1b are therefore supported. Conversely, we do not find support for H1c.
H2a, H2b, and H2c predict a positive relationship between Agile management and performance. The results are nuanced: the use of sprints is positively associated with higher speed, cost, and quality performance, as demonstrated by corresponding positive and strongly significant coefficients across all models.
H3a is positive and significant. With regard to cost performance (H3b), the results show that no interaction terms between the Stage-Gate and Agile factors are significant. As to H3c concerning quality performance, the coefficients of the interaction terms between Stage-Gate and Agile-Sprints are positive and significant at the 1% and 5% level respectively.

Conclusion

This study suggests that organizations with traditional Stage-Gate systems should start a stepwise transition towards Agile by adopting sprints for micro-planning and the execution of development tasks. Even if reluctant to fully abandon linear plan-driven models, due to the strong negative effect of Stage-Gate on performance, adhering to the traditional way of developing a new product may lead to the failure of innovation initiatives. For firms with no such process model, e.g., new ventures, the suggestion is to avoid following Stage-Gate principles that would seem less adequate to deal with the uncertainty inherent in fast-changing business contexts. While not a panacea for NPD, Agile principles would seem the better alternative.

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