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Applying social network analysis to validate mass collaboration innovation drivers: An empirical study of NASA's International Space Apps Challenge

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ABSTRACT

The authors model the user innovation networks of NASA's International Space Apps Challenges and use social network analysis to empirically investigate the existence and impact of three drivers of innovation. These drivers are competition, social interaction, and network vitality. We empirically prove that competitive intensity exists as a driver of innovation in our networks, and is an indicator of innovation success, while the drivers of social interaction intensity and network vitality do not.

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1. Introduction

How innovation is generated is a topic of importance to industry, scholars, and practitioners (Poetz and Schreier, 2012). Users are excellent sources of innovation; they hold unique knowledge and expertise that enable them to produce effective and economic solutions completely tailored to their needs (Bogers et al., 2010; Berthon et al., 2007). There are numerous approaches to both open and user innovation (e.g. crowdsourcing, virtual customer environments), which can create a myriad of confusing strategic network formations if utilized without forethought. One can demystify these network formations and attack the question of their innovation potential through the identification of factors that drive innovation. Understanding how drivers of innovation manifest within real-world user innovation networks will increase our chances of creating environments that foster and promote innovation potential.

This research supports current scholarly inquiry identifying factors, catalysts and barriers to innovation (Gnyawali and Srivastava, 2013; Park et al., 2014; Sandberg and Aarikka-Stenroos, 2014; Hadjimanolis, 1999; Madrid-Guijarro et al., 2009). Research on innovation factors, catalysts, and barriers within innovation networks mostly focus on systems of inter-firm networks. The studies are primarily conceptual and theoretical and often lack complimentary empirical investigation. Research along these lines limits our ability to truly understand how drivers of innovation manifest and evolve in real-world user innovation networks. In this study we empirically investigate three drivers of innovation: (1) competition, (2) social interaction, and (3) network vitality within a user innovation network generated by a hackathon-style event.

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Hackathon-style events are exemplar user innovation networks for the examination of drivers of innovation. Despite widespread application across numerous industries and popularity around the globe (Calcoa and Veecka, 2015; Leckart, 2012) there has been little scholarly and empirical research of these nascent mass innovation user networks (Johnson and Robinson, 2014). In this article we investigate NASA's hackathon-style event, the International Space Apps Challenge. The users in our social networks represent the general public, the primary benefactors of government products and services, and the participants in our federal challenge events. The innovative solutions produced as a result of the examined mass collaboration events support research findings in the literature indicating users (citizens), just like producers (federal employees and or contractors), can be major sources of innovation (Bogers et al., 2010). In line with traditional empirical research methods of innovation network studies, we examine our modeled networks of the Space Apps community using social network analysis techniques. We break from the common trend of analysis of unipartite social networks and analyze bipartite social networks instead. The use of bipartite networks provides flexibility in our examination of propositions and retains information that is traditionally lost when bipartite networks are transformed into uni-mode graphs using projection (Latapy et al., 2008).

The first contribution of our research approach is the use of NASA's International Space Apps Challenge event networks to gain a better understanding of innovation drivers. To our knowledge there has not been scholarly investigation of this particular type of mass collaboration network. In the literature the primary mass collaboration events studied include Wikipedia, crowdsourcing, and open software networks, not nascent, trending hackathon-style event networks. The second contribution of our research is that it fulfills the need for additional empirical investigation substantiating conceptual models that identify drivers of innovation and their impact within innovation networks. To increase the understanding of, and potential for, innovation in user innovation networks, our approach builds propositions to examine three drivers of innovation. These drivers are derived from recent research literature regarding innovation catalysts and barriers. Our method of investigation continues with the study of the relationships between the identified innovation factors and the innovation output of the networks, using social network analysis.

This article is organized as follows: Section 2 presents a discussion of current and relevant literature and the formulation of our research propositions. Section 3 provides information concerning our studied mass collaboration event and our methodology of network modeling and statistical analysis and testing. Section 4 contains our results and discussions and Section 5 features conclusions and avenues for future research.

2. Literature review

The process of innovation (regardless of its origin e.g. user, firm) contains an element of chance, so it is often "impossible to predict the exact nature and timing of innovation outputs" (Dhanaraj and Parkhe, 2006). Given that we cannot precisely predict when innovation (Berthon et al., 2007) will occur, we need to settle for creating environments that are conducive to its occurrence (Madrid-Guijarro et al., 2009). User innovation research spans multiple subject areas (i.e. globalization, social networks, health care, product development, organizational theory, strategic management, etc.) across numerous industries (agriculture, health care, education, manufacturing, technology, etc.). Although the context of innovation-focused research is varied, the approach presented in the literature is very similar. Understanding the underlying factors of innovation is the key to innovation research. Those that "want to encourage and support innovation" ... "should address those factors that stimulate and constrain innovation" (Madrid-Guijarro, Garcia and Van Auken, 483). Thus the initial step of inquiry in innovation and user innovation research is typically geared toward the factors that drive innovation potential and the factors that place obstacles in the path of its development.

In our investigation of drivers of innovation we analyze what is presently being studied concerning innovation and user innovation research. In particular we examined the literature related to the user innovation generated by mass collaboration, specifically user innovation networks resulting from hackathon-style events. We reviewed the literature to see if these user networks have been studied before, and if so, to what extent. We paid special attention to how drivers of innovation were being studied and which drivers in particular were most appropriate to investigate. The literature clearly illustrates that drivers of innovation are the most effective means to understand the innovation potential of an innovation network. Our literature review provides a foundation for the investigation of hackathon-style user innovation networks. Additionally, it provides justification for the three drivers of innovation on which we build our propositions.

2.1. Drivers of Innovation

The literature clearly identifies users and user communities as major sources of innovation potential (Bogers et al., 2010; Gales and Mansour-Cole, 1995; Poetz and Schreier, 2012), making user innovation networks the ideal context for the study of drivers of innovation. The resurgence of interest in user innovation potential is also bolstered by the adoption and success of open innovation methods, such as mass collaboration, in both public and private industries. Mass collaboration is an open innovation technique in which a wide range of individuals are engaged in collective problem solving. A more formal definition of mass collaboration is "the engagement of a broad group of diverse participants in collective deliberation and action focused on generating creative, emergent solutions to pressing problems" (NASA Open Innovation Program and SecondMuse 1). Some of the most popular examples of mass collaboration in the literature include Wikipedia,

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