Popular Innovations and Dynamic Communities: A Computational Network Analysis

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In any science and technology (S&T) field, there is always a list of popular innovations that dominate the agenda of research and practice. As the field progresses, the list is constantly changing, with new innovations replacing old ones. *Popularity* is a vital property of an innovation. A popular innovation means a vibrant area for research and education, a sizable, untouched market for entrepreneurs, a competitive advantage for users, a hot, new topic of interest to a considerable audience for the media, or a significant and possibly thorny issue for policymakers and regulators. Yet, very few innovations become popular in a field; most fade away quietly and quickly. *Why do some innovations come to be highly popular, while others do not?*

Research on S&T innovations has yet to provide a definitive answer to this question. Innovation studies have thus far focused primarily on the boom periods of a few ultimately popular innovations, but not those innovations that never take off, and those experience a short heyday but decline dramatically in popularity and legitimacy. This bias severely limits theory-building and testing, because popular innovations are rare instances and thus focusing on them risks overemphasizing the exceptions rather than the more abundant, less popular innovations. This bias is exacerbated by the problem that the research streams on innovation *production* and on innovation *use* rarely converge to show the whole supply-and-demand picture of innovations.

Seeking to address these limitations, we have conducted this study to examine multiple innovations with various degrees of popularity and the communities of organizations involved in the production and use of the innovations. Theoretically, we posit that innovations emerge, spread, and evolve in a competitive and symbiotic ecosystem. One important resource in the ecosystem that every innovation relies on is *attention* from people and organizations. As the popularity of an innovation evolves, the collection of organizations in the innovation's community evolves dynamically, and so does the collective attention paid to the innovation. From this theoretical perspective, this study explores *how the dynamic characteristics of innovation communities are related to the popularity of innovations*.

Specifically, we have selected Information and Communication Technologies (ICT) as an exemplar field and examined sixty ICT innovations with various degrees of popularity (e.g., RFID, groupware, and Web 2.0) in a twenty-year period (1988-2007). First, we built a collection of all articles published in three trade press magazines (e.g., *Computerworld*), three general news magazines (e.g., *Time*), and three ICT scholarly journals (e.g., *MIS Quarterly*). We then automatically extracted the paragraphs containing the labels for the ICT innovations. The extracted paragraphs were grouped by innovation and year. We also automatically detected the names of organizations mentioned in each of the extracted paragraphs. Based on the co-occurrences of organizations in the paragraphs, we constructed a network of organizations for each innovation in each year. The popularity of each innovation is measured by the yearly number of paragraphs that mention the innovation.

Comparing the network structures of the innovation communities, we have found that communities for highly popular innovations are characterized by the so-called "scale-free" networks, where most nodes have only a few links, held together by a few highly connected *hubs* or *gatekeepers*. This finding supports the explanation that a few gatekeepers spread an innovation, building up its popularity. Second, we have found that organizations often participate in multiple innovation communities. Interestingly, a gatekeeper in one community may not be a gatekeeper in another community. This result implies that the organizational knowledge of innovations is highly local and specific to specific innovations. Third, when two innovation communities share members, the two innovations are correlated in popularity. When the sharing is moderate, the correlation is negative. When the sharing is high, the correlation is positive. This non-linear relationship suggests that different innovations may compete or complement with each other through the convergence or divergence of organizational attention.

More broadly, this study illustrates that innovation research may benefit from examining a large number of innovations of all possible outcomes and differentiated trajectories and from analyzing the communities of all organizational stakeholders. Such broader consideration makes it possible to reveal the true conditions under which innovations progresses or fail to do so. Consequently, the large-scale dataset that stems from the broadened research design begs automated approaches, such as those demonstrated in this study. Scalable computational analysis of innovation communities holds great promise for advancing innovation research and practice to the next level.