



A model for investigating the stability factors in formal science and technology collaborative networks: A case study of Iran



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ABSTRACT

In spite of vast studies performed on Science and Technology Collaborative Networks (STCNs) in recent decades, factors affecting the stability of these networks have rarely been investigated. In this study, 6 collaborative networks established between 1995 and 2005 in Iran, in the fields of nanotechnology, biotechnology, molecular medicine and herbal medicine, were evaluated. Conducting a qualitative research, and using multiple-case study method, we collected related data adequately from in-depth interviews with key informants, survey, and archived documents, and identified the stability factors of STCNs. In this paper, a tentative conceptual model is proposed for classification of stability factors in formal STCNs. Employing this model, 27 identified and screened stability factors were classified into 2 main categories; including internal factors (network management, network formation processes, collaboration mechanisms in the network and characteristics of network members) and external factors (collaboration infrastructures and network environment). Designed model was evaluated by conducting an extensive survey which provides feedbacks from the representatives of network members and other informed people on the primary model. In total, 112 individuals from 83 affiliated organizations of 6 selected networks participated in this survey. Confirmatory factor analysis (CFA) method was used to evaluate the goodness of fit of the proposed model which indicated that each structural component of the model has suitable fit, separately. In addition, the whole model offers a good fitting and it can be reliably used to achieve the research goal only by omitting two of considered factors.

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1. Introduction

Collaborative networks have been acknowledged as an efficient tool for optimized management of resources (Musiolik and Markard, 2011), knowledge transfer between entities, sharing of assets and reduction of development risks in the industrial, business and economic sectors (Kapucu and Garayev, 2012; Cowan et al., 2004). In the public sector, the implementation and management of public programs through networks have now become more of the rule than the exception (Turrini et al., 2010). It is also useful in science, technology and innovation management domains (Ozcan and Islam, 2014; Musiolik et al., 2012; Musiolik and Markard, 2011). Evidences indicate that since the 1980s, rapid increase in networking at organizational level has been occurred, particularly in high-tech sectors including communications, computations and biotechnology (Hagedoorn and Schakenraad, 1992). In countries such as the United States, Australia and UK, innovation policies have a marked shift from the provision of financial incentives for R&D to the encouragement of multi-sector innovation networks (Corley et al., 2006).

In the available literature on networks, there are major weaknesses in the theories related to network formation and evolution processes (Hoang and Antoncic, 2003), as well as considerations necessary in these processes to obtain adequate network stability. This is because the researchers often presumed that networks have been pre-existed before their investigations (Powell and Gordal, 2004; Jack, 2010). In addition, they rarely discussed about the changes and adjustments took place in a network during its lifetime (Knoben et al., 2006), and most of the studies have been focused on structural aspects of the networks (Turrini et al., 2010). Network studies have been mostly dedicated to more stable networks, and, fewer studies have been conducted regarding failed networks (DeBreeson and Amesse, 1991). For this reason, significant theoretical imperfections can be observed in the context of stability risks and failure factors in the existing network literature.

Literature implies that most papers and books available on networks correspond to “informal” networks. They discuss the different types of collaboration in science and technology domain, including collaboration in research and development projects (for instance see; Rowley, 1997; Schilling and Phelps, 2007). As a fact, a great number of scholars have dealt with networks as virtual structures. Therefore, formal inter-organization (inter-firm) collaborative networks have seldom been investigated (Freeman, 1991; Wixted and Holbrook, 2012). In addition,

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a great deal of papers on collaborative networks correspond to the industry and business domains which have been evolved in the exchange market; hence, collaborative schemes in science and technology sector have been scarcely investigated (Chompalov et al., 2002). Collaboration driving forces and stability factors in STCNs - frequently supported by public funding - are probably different from business networks.

Social context is recognized as an important aspect in studying the collaborative networks (Turrini et al., 2010; Zacocs and Edwards, 2006; Jack and Anderson, 2002), so, it seems that the different social contexts lead to differences in network characteristics and functions across various countries. The literature on collaborative networks is mostly restricted to the networking experiences in developed countries (Bignami-Van, 2005; Bangens, 1993), whereas, to our knowledge, the properties and context of these networks in developing economies are generally remained uncovered. This might be related to the fact that, there are few numbers of successful collaborative networks reported from developing countries (Bianchi and Bellini, 1991) and examples of successful networks frequently correspond to the developed countries (Salazar and Holbrook, 2007). The social context of developed countries is more in favor of collaborative networks than developing economies. There are no strong infrastructures (e.g. ICT technologies), enough financial supports, proper organizational culture, and supporting S&T policies (like what exists in EU region) to stimulate collaborative networks in developing countries (Van Dijk and Sverrisson, 2003). Therefore, differences regarding the social context and economic structure of developing countries (such as Iran), must be taken into account more in future network studies. This issue is of vital importance because, as White and Watkins (2000, p. 338) correctly point out, "it is hazardous to generalize from populations with considerable social and economic differentiation [in developed countries] to the less stratified contexts of developing countries". Hence, the present study may contribute to the network literature to add some insights about the real collaborative networks in developing countries.

Therefore, there is a significant gap in theories related to the stability of formal S&T collaborative networks, especially in the context of developing countries.

Since the Islamic Revolution of 1979, the higher educational system of Iran has gone through quantum leaps, both qualitatively and quantitatively. The system enrolls 3 million students every year, 65% of whom are female. In the last two decades, Iran has shown one of the world's highest scientific growth rates, particularly in advanced technologies including nano- and bio-technologies. The number of researchers in the country, which was around 82 per one million in the 1980s, has reached to 1500 per million now. Also, the number of articles written by authors who reside in Iran that are published in ISI journals has increased considerably in recent years, from 682 in 1997 up to 13,568 in 2008, a 20-fold increase in 11 years (Soofi and Ghazinoory, 2011). In order to maintain this growth rate and translation of scientific achievements into implementable technological innovations and also due to the country's limitations in resources, the country is in need of using networking approach for science and technology infrastructures. However, despite great interests in networks and relatively good financial and legal supports, experiences of the past two decades indicate that networks have not been successful enough. Most of the networks in the S&T field in Iran have failed in the early years of their formation. So this question has arisen in the mind of authorities in the field of science and technology that is why these collaborative networks lack desired stability? Therefore, a deep understanding of the factors affecting the stability of the networks seems necessary for policy makers and administrators of science and technology.

In this study, we have evaluated six major collaborative networks established in science and technology domain in I. Rep. of Iran between 1995 and 2005 in the fields of nanotechnology, biotechnology, molecular medicine and herbal medicine. All of these networks had been established formally with government support to address a national mission; so, their stability in the long run was a main concern of

founding organizations. In this work, we have tried to develop a well-defined model for evaluation of the factors affecting the stability of collaborative networks in S&T domain. In this regard, a combination of qualitative and quantitative research methods was used in order to create and evaluate the desired model. We focused on the study of inter-organizational networks at the network level rather than at the organizational level of analysis. Some researchers have considered it as "whole network" studies (Kilduff and Tsai, 2003; Provan et al., 2007). In this research, we also focused on formal inter-organizational collaborations, while most of social network studies have addressed inter-individual relationships. This limited us to borrow much from social network theories and literature, whereas we employed existing literature on inter-organizational networks in a large extent.

2. Theoretical background

2.1. What is meant by the term "network" in this research?

"Network" is a general concept that is widely used nowadays in sociology, politics, economics and management. The broad extent of this concept sometimes results in wrong impressions; hence, it seems necessary to determine the exact definition of the word "network" preferred in this investigation before further discussion.

Barringer and Harrison (2000) define networks as constellations of organizations that come together through the establishment of social contracts or agreements rather than legally binding contracts. Legally binding contracts may exist within a network, but the organization of the relationship is primarily based on the social contracts. In the field of public administration, networks are defined either as inter-organizational collaboration arrangements or as new governance structures designed to achieve a common goal that cannot be achieved (effectively) by one single organization (Koliba et al., 2010). Provan et al. (2007) believe that despite differences, nearly all definitions of "network" refer to certain common themes, including social interaction (of individuals acting on behalf of their organizations), relationships, connectedness, collaboration, collective action, trust, and cooperation.

The definition of the "network" considered in this work is very similar to that proposed by Ceglie and Dini (1999). According to these researchers, "a group of firms can be recognized as a "network" if they; cooperate on a joint development project, complement each other, specialize in order to overcome common problems, achieve collective efficiency and conquer markets beyond their individual reach". We believe that in an inter-organizational collaborative network, some of the main features are; "having a common goal", "supplementary membership", "collaboration in joint projects", "voluntarily participation", and "retaining members' autonomy".

2.2. Formal collaborative networks

Generally, one can classify networks into two main types including; formal (or mandated) and informal networks. These two groups of networks have been differentiated in several studies such as the investigations performed by Kapucu and Garayev (2012), Wixted and Holbrook (2012), Tidd and Bessant (2009), Powell and Gordal (2004), and Buchel and Raub (2002).

Based on the definition given by Tidd and Bessant (2009), formal or "engineered" networks are specifically created to facilitate the innovation. Musiolik et al. (2012), define a formal network as an organizational structure with clearly identifiable members where firms and other organizations come together to achieve common aims or to solve specific tasks.

The closest definition of formal networks in the sense used in this study is the description proposed by Wixted and Holbrook (2012) to classify two types of formal and informal networks. According to their definition, informal networks consist of research collaborators working on any research project or co-authors in any article or book. Most

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