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Investigation of Iranian General Contractors' Collaboration in Social Network of Construction

Samira Haghbin[a], Dr. Mojtaba Hoseinalipour[b], Amirhossein Mohebifar[c]

[a] M.S Student in Project Management and Construction, Shahid Beheshti University, Tehran 1981834171, Iran
[b] Ph.D.in Project Management and Construction , and Associate Professor in Shahid Beheshti University, Tehran 1983963113, Iran
[c] Ph.D. candidate for Project Management and Construction, Tarbiat Modares University, Tehran 1511815314, Iran

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ABSTRACT

The construction industry is a complicated network of relations between providers of knowledge and suppliers of materials and services. Meanwhile, creation of effective channels to identify existing capabilities in selection of best idea, material and implementation & integration methodology for central project' components sounds essential. Although, goals we have in small-sized projects will be successfully achieved through applying the traditional communication methods, but in big-scale ones, certainly creation of a large and more systemic context is at the center of attentions.

In this regard, the General Contractor (GC) companies, working as the focal point of communication and responsible for coordinating between main bodies in any project, are to take the primary responsibility of work. It is expected that these companies integrate the resources of contractors and consultants in order to achieve project goals and realize such objectives. At the same time, introducing the Collaboration Network or (CN), as a new initiative which is based on sharing companies' resources, knowledge and information while maintaining their independence and sovereignty of members presents us with a modern tool of inter-organizational relations. Similarities and capabilities created through Collaborative Network could be suitable for general contractors to establish their goals and do their due performance.

This paper analyzes cases of collaboration between Iranian's General Contractor firms involved in big projects by the approach of Social Network Analysis. The results show that as the size of inter-firm networks increases, the networks become denser and center around the densest large group. The results also indicate that the centrality of General Contractors are too powerful in these project and networks have a Structural hole which if be deleted, the network would be destroyed.

KEYWORDS: Collaborative Network, General Contractor, Social Network Analysis, Network centrality, Inter-firm Network.

1. INTRODUCTION

In recent years, complication and specialization of large projects of construction industry has led into wide recruitment of specialists contractors and therefore, dividing projects into small segments. Thus, there is more emphasis on maintaining coordination between various sections and contractors, which will in turn guarantee the overall performance of a project. Due to the high level of uncertainty in construction projects, which is resulted from the presence of various sub-contractors and suppliers, the general contractor should focus on coordination with subcontractors that is one of the most complex tasks in construction. To do this, general contractors need to use their resources, including: time, materials, and even labor. On the other hand, in addition to coordination of sub-contractors, general contractors have other important responsibilities such as: time, cost, and quality and resource management. This partner relationship significantly affects not only short-term projects, but also long-term success [1].Engineering and construction projects are dependent on two fundamental elements: 1) the ability to plan and manage the technical components of the project such as the tasks and resources; and 2) the ability of the project participants to effectively develop into a high performance team. Considering necessities in big projects, it will be useful if we can implement achievements in other knowledge areas in project management to improve success of projects and also, respond to their special needs. [2]

Given the growing importance of collaboration in promoting the success of large and international projects, by using the SNA approach this article examines the network of communications and knowledge in 3 big Iranian projects which are under construction by powerful Persian contractors through general contracts and aims at reviewing the growing rate of collaborations existing within the said projects.

* **Corresponding Author:** Samira Haghbin, M.S Student in Project Management and Construction, Shahid Beheshti University,Tehran 1981834171, Iran. Email: samirahaghbin@gmail.com, Tel: +9822147967

2. Background

2.1. Inter-firm network:

When a group of organizations, agencies, and/or institutions agree to work together for some period of time on a common problem or opportunity, they form an entity that is known by many names: consortium, collaborative, network, coalition, partnership, or alliance. As relationships are increasingly seen as strategic capabilities [3], it stands to reason that firms need to attend more carefully to their inter-linkages to other organizations, for example, through the development of network competence [4]. In an inter-firm network, member firms are viewed as interdependent rather than independent. Therefore, the relationship between member firms in inter-firm networks plays a facilitative role in inter-organizational contexts and is even described as a strategic resource. [5]

These networks cross boundaries and often include multiple stakeholder groups from a number of sectors that have an interest in the goals and success of the inter-firm network. The degree of formality found in the structures that hold these entities together varies some are governed by formal agreements and contracts, while others are held together by the informal, verbal agreements of members. Some are formed with clear-cut objectives and dissolve when these are reached, and others come together and meander along indefinitely with vague goals that constantly shift. [6]

2.2. Collaboration in Big Construction Contractors:

Since construction projects cannot be completed by a single individual or organization, every project involves a close and complex collaboration of heterogeneous firms [7].As more construction firms expand into these rapidly changing overseas markets in order to capitalize on opportunities, intensified competition often leads to excessive burdens for bid participation. For example, in order to modernize their construction industries, overseas countries or clients in global construction markets particularly in developing countries require project financing, a high level of technology, and a foreign firm's advanced experience, knowledge and management skill [8]Collaborative network could enhance capability and meet requirements of General Contractor in construction projects. [2]Some research attempts to identify the specific effects of the properties of network structure on the performance of firms (specifically, the number of patents) in various industry sectors, such as the chemical [9]and high technology manufacturing markets [10]In construction field also two researchers; Chinowsky and Park have been done some research in this area.

Considering the importance of big construction projects and their strong communication needs, current research effort aims at investigating the possibility of creation of such communication networks for GC or big construction companies by applying the communication management approach which is one of the nine project management methods used in project management standard literature.

3. Research Procedure

3.1. Social Network Analysis

The research approach used in this paper is a social network analysis which analyzes the current state of Persian general contractors. Social Network Analysis provides a method to understand informal networks within and between organizations and manage the informal networks systematically [11].SNA has been an instrumental tool for researchers focusing on the interactions of groups since the concept was introduced by Moreno in 1934 [12] [13]. In the original concept formulation, sociograms were considered a formal representation of the patterns of interpersonal relationships upon which larger social aggregates are created. [14].

The key difference that distinguishes Social Network Analysis from other analysis and management methods is that Social Network Analysis draw attention to informal network in working place. Basically, Social Network Analysis is used to measure and visualize relationships and flows between peoples, groups, organizations, computers or other information/knowledge processing entities. [11]

The overall Social Network Model is illustrated in Figure 1, as illustrated, the model contains two basic components, the dynamics and the mechanics. The latter of these components, the mechanics, can be viewed as the "what" in a network, or the items that are exchanged to execute a project or address organization issues. The mechanics contains both the classic emphasis on information sharing and exchange as well as an emphasis on knowledge exchange. The goal of the model is to achieve knowledge sharing as the mechanics that drives collaboration. [14]

The first of the two primary components in the model, the dynamics, focuses on the motivators for individuals to increase performance on a project. The rationale behind this component is based on the research that high performance teams require trust and shared values to achieve the knowledge sharing which results in enhanced solutions [15].However, Chinowsky recognize that this level of social network is not automatically achieved on a project. The second component in the social network model, the mechanics, focuses on the information and knowledge that is exchanged during the completion of the project. This can be considered as the "what" of the project, or the measurable characteristics that affect project efficiency.

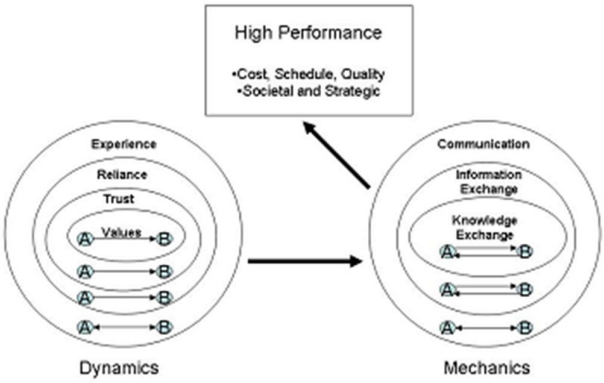


Figure 1: The Social Network Model [14]

3.2. Data Description

In order to develop inter-firm networks and investigate if they are the collaborated or not, we collected information about collaboration between 3 Iranian General Contractors in 3 big construction projects. This includes the basic information of projects such as project types, participated firms, Mechanics factors of SNA which has been introduced in last part of the papers, because the concentration of this research is on Collaborative relations in big projects, if we were looking for organizational relations in companies we should studied Dynamic factors too same as the work that Chinowsky has been done in different organization. As it's been stated before this level of social network is not achievable on a project. In

Table 1some of basic information of case studies of this research is been showed.

Statistical population of this study consists of big Iranian companies working as general contractors in construction field which considering their homogeneity and consistency, a random sampling method for studying the date collected from inside and outside country projects is applied.

Table 1 :General information of case studies

Project number	Project Type	Number of Sub-contractors and Suppliers
Project 1	Building Construction	10
Project 2	Plant Construction	6
Project 3	Plant Construction	20

3.3. Overall model and Data analysis

The information has been collected by filling questionnaire in General contractors and Sub contractors which are involved in these 3 projects. The survey contains questions that map to the levels in the Social Network Model.

The survey results were analyzed using the UCINET Social Network Analysis software. The UCINET software provides the mathematical measurements as well as the graphical representations required for the organization analysis. A separate analysis is completed on each of the variables to acquire the relationships outlined in the Social Network Model. The analysis in this report utilizes three key measurements for evaluating the organization network as follows.

3.3.1. Degree, Density, and Centrality :

Centrality is a structural attribute of nodes in a network, in Social Network Analysis practice; centrality is one of the most important and widely used conceptual tools for analyzing social networks. Nearly all empirical studies try to identify the most important actor in a social network model. The centrality measurement is to identify who is the most important actor in a social network model [11]Centrality denotes the grade of structural efficiency. There are three types of centrality whether the focus is placed on inward directive, outward directive, and total connection: in degree centrality, out degree centrality, and total centrality. [16] Equation of that is like following:

- Centrality = (variation in the degree of vertices)/ (maximum degree variation)

Degree indicates the number of actors collaborating with a specific actor, and it is a good index to measure regional centrality. [16]Equation of that is like following:

- Degree = number of connected vertices to a vertex

Density represents the connectedness between all actors in a network. It explains a network cohesive attribute as a whole. The density of a network may give us insights into such phenomena as the speed at which information diffuses among the nodes, and the extent to which actors have high levels of social capital and/or social constraint. [17]Density represents a level of crowd; thus, is calculated by dividing the number of existing

lines with the number of all possible lines, therefore, density varies from 0 (no connection in the network) to 1 (every vertex are interrelated) [16]. Equation of that is like following:

- Density = l/ (n*(n-1)) (l = number of existent lines, n = number of existent vertices)

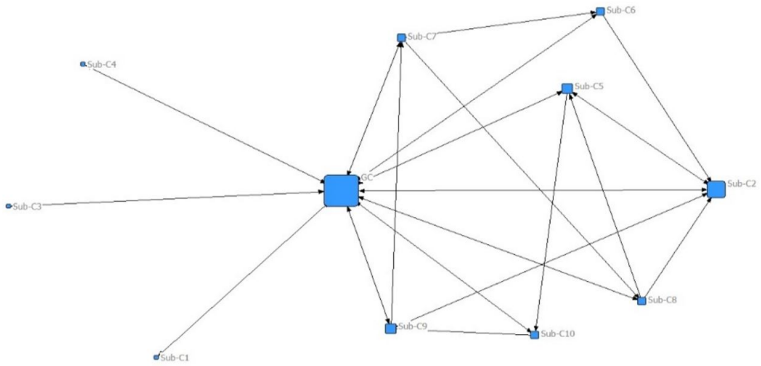
4. RESEARCH RESULTS

The study focused on three specific types of networks: communication exchange networks (quarterly; a communication network is graphed in Figure 2), information exchange networks (quarterly; a communication network is graphed in Figure 3), and knowledge exchange networks (quarterly; a knowledge network is graphed in Figure 4), the communication exchange network reflects the current communication that exists between project General contractors and subcontractors and the frequency in which those communications occur. Similarly, the information exchange network reflects the current knowledge exchange that exists between project General contractors and subcontractors and the frequency in which that information exchange such as reports and projects plan exchange occur. Also the knowledge exchange network reflects the current knowledge exchange that exists between project General contractors and subcontractors and the frequency in which that knowledge exchange occurs. These exchanges are reflected in the graphs as lines between the individual nodes. The size of the node indicates the relative number of individuals who indicated that they communicate or exchange information or knowledge with that individual.

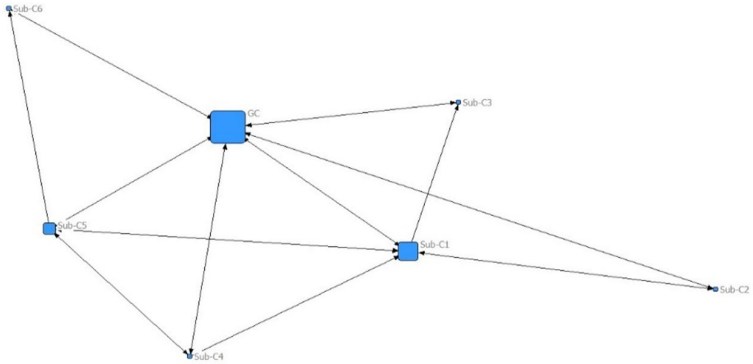
4.1. Communication Exchange:

For finding the communication Exchange between the companies, we asked some questions about if they know each other and the time of their communication (such as telephone dialog or casual meeting between two companies). In amount of key measurement of case studies which has been achieved as a SNA result, has been showed, Although it is just showing the total measurements of each project network, but in Figure 2 each node has a different size depend on its Centrality In degree, As it is obvious General Contractors are the biggest node of all networks.

Project 1



Project 2



Project 3

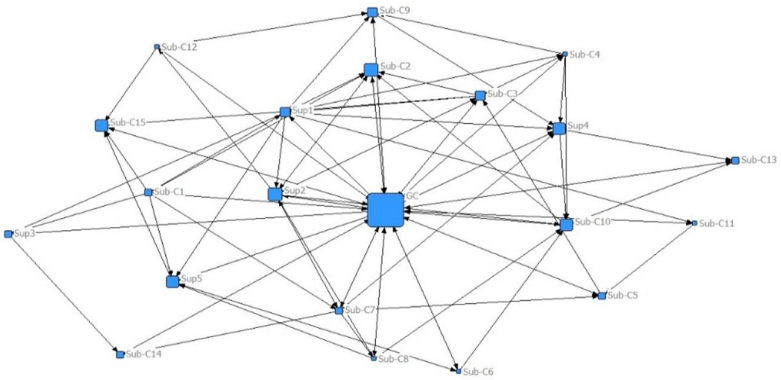


Figure 2: Communication Network in Case studies

4.2. Information Exchange:

For finding the Information Exchange between the companies, we asked some questions about if they know each other and the time of their Information exchange (such as sending reports of projects and projects specific meeting). In

Table 2 amount of key measurement of case studies which has been achieved as a SNA result, has been showed, Although it is just showing the total measurements of each project network, but in Figure 3each node has a different size depend on its Centrality In degree, As it is obvious General Contractors are the biggest node of all networks same as the Communication network.

Table 2 :Information Exchange Network Results

Case study number	Size	Average degree	Density	Centrality	
				Out Degree	In Degree
Project 1	26	2.364	0.236	93.333	93.333
Project 2	15	2.143	0.357	90	90
Project 3	66	3.143	0.157	93.158	65.526

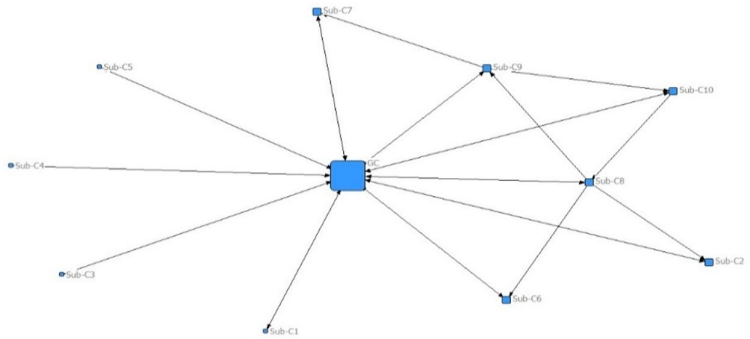
4.3. Knowledge Exchange:

For finding the Knowledge Exchange between the companies, we asked some questions about if they know each other and the time of their Knowledge exchange (such as asking questions about execution of specific activity of project or using experience of other companies) In **Error! Reference source not found.** amount of key measurement of case studies which has been achieved as a SNA result, has been showed, Although it is just showing the total measurements of each project network, but in Figure 4 each node has a different size depend on its Centrality In degree, As it is obvious General Contractors are the one of the biggest node of the network but not only one. In the knowledge network of projects some other companies has a great amount of Centrality In degree based on their size in the network diagrams.

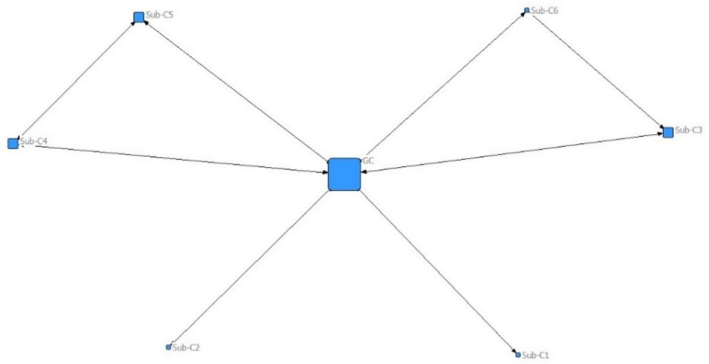
Table 3: Knowledge Exchange Network Results

Case study number	Size	Average degree	Density	Centrality	
				Out Degree	In Degree
Project 1	22	2	0.2	24.444	24.444
Project 2	11	1.571	0.262	33.333	33.333
Project 3	74	3.524	0.176	24.737	19.211

Project 1



Project 2



Project 3

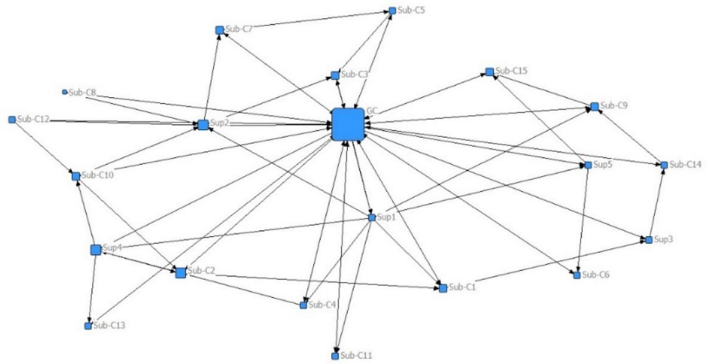
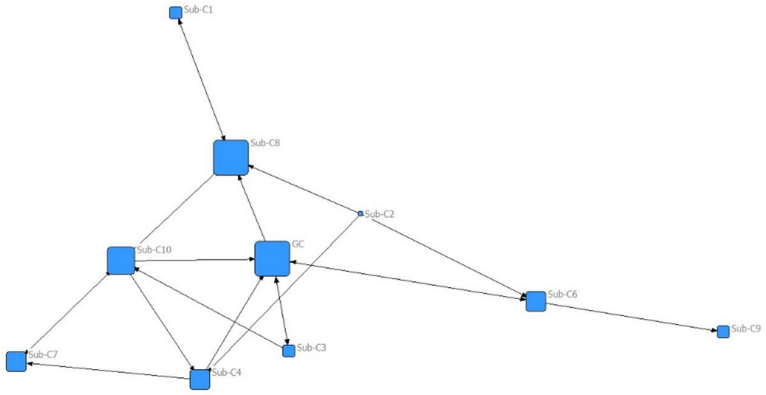
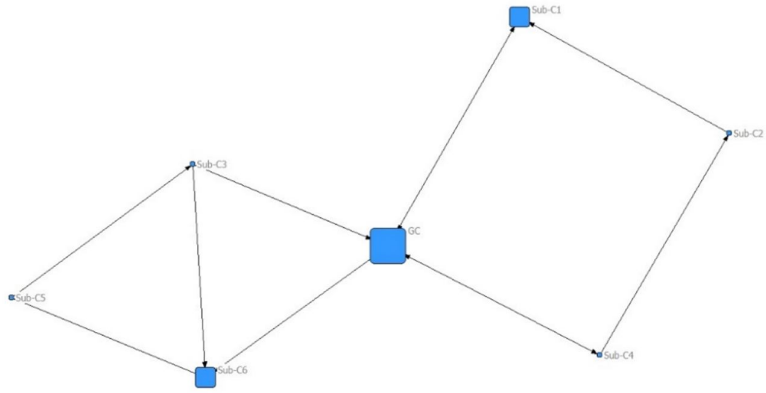


Figure 3: Information Exchange Network in Case studies

Project 1



Project 2



Project 3

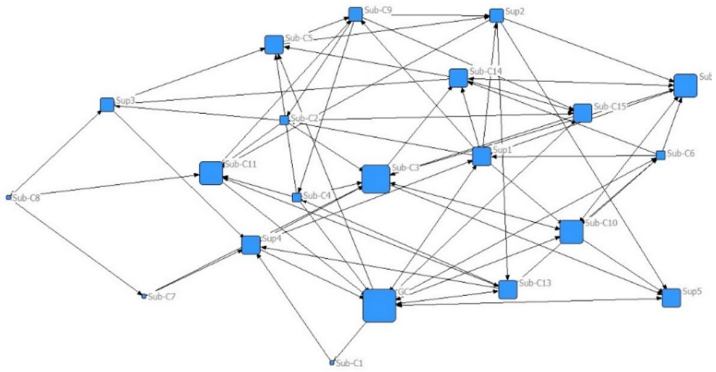


Figure 4: Knowledge Exchange Network in Case studies

5. Researcher analysis :

5.1. The Outcome of Communication and Information Exchange Networks:

In Iran, these two networks are roughly complying with one another and GC is their strongest and central element. This informs us of the fact that communications in Iranian construction field are only limited to information exchange and that no attention is paid to formation of a suitable platform for collaboration in next cooperation opportunities& help the communication-interaction network to expand. In both networks, GC is the most powerful and essential element that is hugely different from other components, too. Centralization and concentration of a network element signals lack of interaction and maintenance of hierarchy order throughout that network. It shows that component contractors have been more interested in preserving their hierarchical powers and consequently careless about interacting with one another. Therefore, if GC is eliminated, the network will collapse and there remains only some scattered small clusters here and there. Meanwhile, it is necessary to note that in comparison with other two ones, in third project a higher level of interaction was present which caused the project network to be maintained. While GC still counts as the vital element amongst other ones, but its' concentration in third project is lower. Finally, since the third project has a larger network, it is logical for more interaction to be obvious within it.

5.2. The Outcome of Knowledge Exchange Networks:

Knowledge Exchange Network has a slightly different shape than the other two networks which is due to competitive conditions of taking part in construction projects. Contrary to factors discussed before, nowadays GCs do not possess their ex-position and a great bulk of relations is what communicated between component contractors. Of course, it should be noticed that the exchange of experiences and information in these kinds of networks is limited to implementation of current or past projects and the costs of it and it is further interesting to know that the underlying knowledge exchange refers to price of the project, execution method, location and problems of it and even difficulties faced by general contractors. Although centralization and concentration of GCs seems inevitable in such networks, but splitting it into clusters is also possible on the other hand in order to eliminate such undesirable characteristics.

6. CONCLUSION

This paper measured the communication and information and knowledge exchange, 3 factors of SNA model which could examined the collaboration status of companies. To determine these factors in three companies, a network representation was created. In the research results is obvious that density and centrality of GC in each network are the most which shows that GC in Iran is one powerful company in the network that try to control all of the activity and communications instead of integration, although in Knowledge exchange network this is a little lighter than 2 other factors. In Knowledge exchange networks it is clear if one powerful node like GC eliminate from the network, network would divide to various clusters and it wouldn't collapsed to the individuals. As in the measured factors of communication and information exchange has been shown that centrality and density amount of one or two companies in the network is bigger, and other do not have the specific role in creating the network, the level of collaboration in these case studies are in the primary level (just Networking level) but in the knowledge exchange network are more collaborated(Coordination Level), that is because of competitive situation of these projects that forced subcontractors to increase their collaboration in knowledge exchange network so that they could remain in the market. What is received from the analysis indicates a significant gap in existing conditions to create interactive networks. Yet, given the fact that competitive market needs help in making these two fields closer and easier to comply, some recommendations have been provided here to identify and suggest the initial context of creating necessary platform.

Suggested topics for future research include measurement of Dynamics factors of SNA in construction companies and examination of their effect on the Mechanics factor.

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