

RESEARCH ON THE COLLABORATIVE EFFECT OF GRASSROOTS IRRIGATION COOPERATION



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Abstract

Abstract: Collaborative governance is a new governance model that emphasizes the synergistic effect between stakeholders on the basis of multi center governance. Its effectiveness depends on effective interaction and coordinated operation among stakeholders. The article is based on the practice of "high standard farmland construction" in Hubei Province, exploring the various entities of cooperative supply of farmland irrigation, constructing a collaborative model, and analyzing its synergy and the synergistic effect of grassroots farmland irrigation cooperation.

Keywords: Collaborative supply and synergistic effect of agricultural irrigation cooperation

Introduction

As the seven stations and eight institutions related to agriculture gradually mature in the baptism of the market storm, the reform of farmland irrigation is facing difficulties. Due to the typical characteristics of public pond resources such as "competitiveness" and "weak exclusivity" in grassroots irrigation, market solutions for government control and property privatization cannot effectively solve the problems of grassroots irrigation management (Olson M, 1971). And more resilient self-organizing management, as the third path, has begun to receive widespread attention (Qin, G.Q. 2021), namely the path of "collaborative learning". From the perspective of supply, the collaboration of grassroots irrigation service systems can effectively save costs, share resources, and coordinate management. The synergistic effect can effectively improve the quality and quantity of grassroots irrigation service supply, while indirectly promoting the efficiency of collaborative innovation systems (Ai, X.Y. 2016). Therefore, based on the definition of relevant concepts and the judgment of the synergistic effect of grassroots irrigation cooperation, this article takes the "Shayang Model" of agricultural water conservancy construction in Hubei Province as the research object, uses the Delphi method to construct a model of grassroots irrigation cooperation, and analyzes its complex characteristics, collaborative mechanism, and operating mechanism.

Literature Review

1. Analysis of the Main Body of Grassroots Irrigation Cooperation System

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After constructing the basic framework of the grassroots irrigation cooperation system, we will analyze the various entities in the system to have a more comprehensive understanding of the grassroots irrigation cooperation system.

1.1 The government

The government is the organ of the state that expresses its will, issues orders, and handles affairs. It is the most important participant in China's grassroots irrigation cooperation system. Its functions determine the direction, tasks, methods, scope of action, and effectiveness of agricultural irrigation projects (Luo, X. Z. 2005).

The local government in China is a regional government, established under the central government, with the function of exercising some state power, executing state will and orders, and managing local public affairs. In the diversified management of the government, grassroots organizations, farmers, and the market, on the one hand, China's political and administrative system is not one piece, and the private sector, social organizations, and farmers have indeed become important forces in grassroots irrigation cooperation. Under the process of marketization, the space for farmers to participate has also been expanded. At the same time, local governments bear the responsibility of meeting the public needs of village communities and farmers, so they have more initiative in cooperating with other management entities. On the other hand, the government is the absolute leader. Although grassroots organizations, farmers, and markets should participate in management as independent management entities on an equal footing with the government, it has been a theoretical recognition. However, considering China's unique political context and land system, the mainstream view still tends to believe that China is still in a strong government stage. Although the government is no longer the only subject of grassroots irrigation cooperation management, it will still be the core subject and leader of collaborative management. Its functions have duality - it is not only an equal collaborator of multiple management subjects in social public affairs, but also provides a stable political and legal environment for market operation and social development. Therefore, it remains the leading force in promoting and achieving collaborative management.

1.2 Grassroots organizations

An organization is a social entity composed of several individuals or groups, with common goals and certain boundaries. As a specific form of production and social relations, the development and soundness of organizations are based on economic development. With the changes in rural productivity and production relations in our country, the form of rural grassroots organizations is also changing, from cooperative societies to people's communes, and then to rural autonomy. However, "rural grassroots organizations are the basic constituent cells of China's politics, economy, and society. The condition of rural grassroots organizations is directly related to the overall situation of China's reform, development, and stability, and directly related to the solution of the "three rural issues". The essence has not changed.

The grassroots organizations referred to in this article refer to the village committee organizations that play an important role in the collaborative management of grassroots irrigation and the farmer water use associations led by the village committee. Village level organizations are the dual agents of the government and agricultural production and operation entities, connecting the government at the upper level and organizing villagers at the lower level. Village level organizations play an important role in the supply of agricultural infrastructure (Wang, X. 2014). In previous agricultural irrigation management, village committees, as the most grassroots administrative organization, were the operators of government administrative tasks, facing both administrative pressure and receiving support from administrative power. When facing the water management department, the village committee represents farmers to buy and release water, and a trading relationship is formed between the village collective and the water management department. The village committee is responsible for formulating plans, determining water release times, mobilizing labor, organizing collection of funds, and unifying water transfer internally, organizing farmers into collective water units. At the same time, the village committee has a certain degree of coercive power to prevent free riding behavior in irrigation and drainage. As a link in the system, there is also the problem of agency corruption, which obtains "oil and water" through disguised

charges. Now, the power of village committees is gradually weakening, and in the entire process of grassroots irrigation collaborative management, more emphasis is placed on coordination and support. The support of grassroots organizations can make farmers feel the importance that village organizations attach to the governance of agricultural irrigation systems. On the other hand, collective actions can also reduce individual input costs for farmers and improve their enthusiasm for participating in management and management (Yang, Y. et al., 2015). In the context of rural village autonomy in China, rural grassroots organizations have multiple identities such as "agents" of grassroots political power, village representatives, and village leaders. Their dynamic capabilities will affect the development of rural industries, and are related to the competitiveness and sustainability of rural industries in the constantly changing environment (Zou, B.L. 2023).

1.3 Farmers

Farmers are participants and direct beneficiaries of grassroots irrigation cooperation supply, as well as vulnerable entities in the grassroots irrigation cooperation system. Their willingness and behavior to cooperate directly and positively affect the performance of grassroots irrigation management (Mao, S.L. 2010; Wang, G.L. 2013). Today, with the continuous adjustment of rural industrial structure, the irrigation demand characteristics of different types of farmers are showing a trend of alienation. During the previous period of homogenization, the foundation of agricultural water conservancy cooperation established based on geographical and industrial relationships among farmers gradually disintegrates, making it increasingly difficult to achieve long-term governance of grassroots agricultural irrigation systems (Qin, G.Q. 2021).

With the transformation and changes of the socio-economic structure, the heterogeneity of farmers in various aspects such as occupational class and wealth income is constantly increasing. The economic dependence among farmers is decreasing, the allocation of factors is becoming more diverse, the value of benefits is gradually differentiated, farmers are becoming atomized, and agricultural water conservancy organizations are becoming deserted. These are unavoidable practical problems that we cannot avoid. The active participation of farmers is an essential part of the effective governance process of agricultural irrigation systems (Lam & Ostrom 2010). However, due to the conflict between the public product attributes of agricultural irrigation systems and the private product attributes of household production and operation, as well as problems such as incomplete management mechanisms and unclear maintenance responsibilities, the enthusiasm of farmers to participate in management and management is greatly weakened (Liu, M. 2015).

In the process of farmers participating in grassroots irrigation cooperation, they need to experience the perception of cooperative supply and make adaptive countermeasures for whether to cooperate, that is, cooperation willingness and cooperation behavior. In the studies of Wang, G.L. (2010), Yang, L. (2018), Wang, L. (2020), and others, empirical methods have been used multiple times to verify that the personal characteristics of farmers, their family characteristics, their understanding of agricultural water conservancy, the village environment, and the government's investment in grassroots irrigation construction all have a significant impact on their willingness and behavior to cooperate.

1.4 Market

The "market" in the supply of rural public goods, also known as the private sector, refers to the main body of private sector activities, mainly consisting of various organizations and people participating in market activities. The private sector referred to in this article refers to various enterprises participating in grassroots irrigation cooperation. Enterprises are essentially profit driven, but the possibility of providing rural public services cannot be ruled out. Irrigation in farmland is different from other public goods in rural areas, as it has the characteristics of "non exclusivity" and "competitiveness", making its supply somewhat unique. Generally speaking, the government is more suitable for the supply of public goods than enterprises because it can compensate for the cost of producing public goods through mandatory taxation as a representative of social interests. At the same time, due to constraints

such as information asymmetry, it is difficult to establish an organic interconnection between producers and consumers. The non exclusivity and non competitiveness of public goods, as well as the coexistence of free rides and transaction costs, determine the low efficiency and even infeasibility of enterprises providing public goods. However, farmland irrigation is a typical quasi public good, and its competitive nature can be encouraged by the government to encourage private voluntary provision (Zheng, S.Y. 2007), which means that enterprises can participate in grassroots irrigation cooperation.

After breaking the people's commune of "eating big pot rice", we once handed over the entire farmland irrigation system to the market for operation, using the market to achieve effective resource allocation. However, this approach ignored the public welfare of farmland irrigation and the public ownership of land. Therefore, it is a historical reversal, and the construction of farmland irrigation is seriously lagging behind, especially the "last mile" grassroots farmland irrigation project is on the verge of collapse. The comparable economic benefits of farmland irrigation are low, while enterprises are profit driven. Therefore, without being affected by other factors, they will not invest in the long term, at most it is a short-term behavior, which will cause a vicious cycle of farmland irrigation governance.

2. Basic composition of grassroots irrigation cooperation system

The grassroots irrigation system is the nerve endings of the entire agricultural water conservancy system, and its quality is related to the success or failure of agricultural water conservancy. In terms of the construction of grassroots irrigation cooperation systems, many scholars have made good summaries based on the cooperative supply situation in different eras and regions, such as the research of Luo, X.Z. (2005) on national intervention in cooperative water management; Gui,H (2010) Discussion on Organization and Cooperation in Grassroots Irrigation Governance; Guo,Z.(2016) studied the multi center collaborative mechanism of agricultural infrastructure supply;Yue,T. (2016) proposed a multi center cooperation on small-scale agricultural water conservancy in Shandong province

Research on co governance; Ma,J.Y. (2020) Research on Collaborative Governance of Small Water Conservancy Projects in Zhejiang Province; Feng,X (2021) analyzed the composition of the agricultural water supply system from the perspective of stakeholders. On the basis of the above literature, this article also takes the "Regulations on Agricultural Water Conservancy" issued by the State Council in 2016 as the blueprint, and from the perspective of collaborative governance and supply side reform, divides the grassroots irrigation cooperation system into the following four subsystems:

Firstly, the government leads the subsystem, including government policy guidance and financial support.

Secondly, the grassroots organization subsystem includes uploading and issuing government instructions, organizing and mobilizing farmers, coordinating the relationship between the market and farmers, and so on.

Thirdly, participate in the farmer subsystem, including cooperation between farmers and grassroots organizations.

Based on the structure and interrelationships of grassroots irrigation cooperation supply, the basic framework of a grassroots irrigation cooperation model is constructed, as shown in Figure 1:

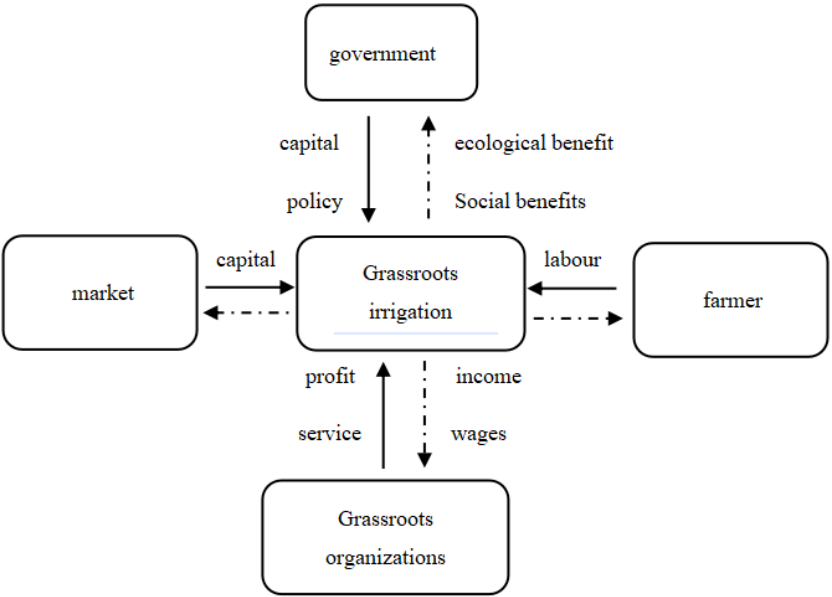


Figure 1 Basic framework of cooperative supply of grassroots irrigation

As an open, dynamic, and collaborative system, the complexity of grassroots irrigation cooperative supply lies not only in its composition of multiple subsystems, but also in the non-linear relationship between various subsystems within the system, which is not a simple linear relationship, but also mutual influence and constraint. This non-linear relationship forms a diverse collaborative network, with various subsystems interconnected and connecting government, grassroots organizations, farmers, and market participants in collaborative management.

Research Methods

1. Construction of a collaborative model for grassroots irrigation cooperation

The selection of experts is crucial for the success or failure of the application of the Delphi method. The experts selected for this study are from agricultural water conservancy management institutions, experts from relevant majors in universities, grassroots organizations, elite farmers, and representatives of enterprises. These experts are active in the forefront of research and service, familiar with the development trends of grassroots irrigation services, and able to actively propose suggestions and participate in discussions from the strategic perspective of leapfrog development of grassroots irrigation services. This article constructs a framework for grassroots irrigation cooperation indicator system based on the Delphi method, as shown in Table 1:

Table 1 Framework of indicators for grassroots irrigation cooperation

Overall indicators	Overall indicators	Primary indicators	Code	Secondary indicators
Grassroots Irrigation Cooperative Supply System A	B1	Government led system	C11	Farmland water conservancy management personnel (name)
			C12	Policies supporting the development of grassroots irrigation
			C13	Government investment in grassroots irrigation

				supply services (in thousands of yuan)
			C14	Public financial budget expenditure for grassroots irrigation construction (in thousands of yuan)
			C15	Number of institutions related to agricultural water conservancy construction (number)
	B2	Grassroots support system	C21	Grassroots organization management personnel
			C22	Grassroots irrigation plumber
			C23	Investment of grassroots organizations in grassroots irrigation supply services (yuan)
			C24	Promotion of irrigation technology in grassroots organizations (item)
			C25	Contact experts (person times)
			C26	Irrigation work coordination (times)
			C27	Irrigation work report (times)
	B3	Farmer participation system	C31	Farmers participating in grassroots irrigation construction
			C32	Farmers participating in grassroots irrigation management and protection
			C33	Time investment for farmers to participate in grassroots irrigation (days)
			C34	Funds invested by farmers in participating in grassroots irrigation (in thousands of yuan)
			C35	Frequency of communication between farmers and grassroots management personnel in irrigation management (times)
			C36	Frequency of communication between farmers in irrigation activities (times)
	B4	Market replenishment system	C41	Number of enterprises participating in grassroots irrigation supply services
			C42	Provide management training
			C43	Provide technical training
			C44	Capital investment in grassroots irrigation supply (in thousands of yuan)
			C45	Profit from grassroots irrigation supply services (in thousands of yuan)

2. Analysis of the synergistic effect of grassroots irrigation cooperation

Collaboration is the self-organizing behavior generated by the interaction of various subsystems in the grassroots irrigation cooperation system, achieving the degree of subsystem consistency. The level of collaboration depends on the size of the order parameters of each subsystem. The higher the degree of collaboration, the greater the overall collaborative effect generated by the grassroots irrigation cooperation system; On the contrary, the smaller it is. According to the "servo principle" of synergetics, the synergistic effect between the order parameters of the system affects the characteristics and laws of the system phase transition. The measure of this synergy is the degree of synergy in this model. To objectively evaluate the synergy of irrigation cooperation service supply, this article adopts the correlation matrix weighting method.

3. Matrix weighting method

The basic idea of the correlation matrix weighting method is that the correlation coefficient between indicators reflects the degree of mutual influence between indicators. The larger the absolute value of the correlation coefficient, the higher the degree of mutual influence between indicators; On the contrary, the lower the degree of mutual influence between indicators. If a certain indicator has a high overall correlation with all other indicators in the indicator system, it indicates that the indicator has a significant impact on other indicators, and the indicator with a greater impact also plays a greater role in the indicator system, so it should be given a relatively large weight; On the contrary, the opposite is true.

Based on the above ideas, the basic steps of the correlation matrix weighting method can be expressed as follows: let the indicator system contain n indicators, and their correlation matrix is R .

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ r_{31} & r_{32} & \cdots & r_{3n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nn} \end{bmatrix} \text{ among } r_{ii} = 1 (i = 1, 2, \dots, n)$$

Obviously, matrices have the following properties: (1) $r_{ij} > 0$; (2)

$$r_{ij} = \frac{1}{r_{ji}} (i \neq j); \quad (3) \quad r_{ij} = 1 (i, j = 1, 2, \dots, n)$$

To form the above judgment matrix, this article quantifies the judgment based on the 1-9 scale method, as shown in Table 2:

Scale	meaning
1	Indicates that two indicators have equal importance compared to each other
3	Compared to two indicators, the former is slightly more important than the latter
5	Compared to two indicators, the former is significantly more important than the latter
7	Compared to two indicators, the former is more important than the latter
9	Compared to two indicators, the former is extremely important compared to the latter
2、4、6、8	The intermediate value representing the adjacent judgments mentioned above
The reciprocal of numbers 1-9	If the comparison between the importance of indicator i and indicator j is a_{ij} , So the comparison of the importance of indicator j and indicator i is as follows: $a_{ji} = \frac{1}{a_{ij}}$

3.1 Evaluation process of collaborative degree of grassroots irrigation cooperation

According to the judgment matrix method, calculate the weights of various indicators in the government led subsystem of the "Small scale Farmland Water Conservancy Key County Construction" project in Hubei Province:

$$W_1 = \begin{bmatrix} 0.10 \\ 0.25 \\ 0.46 \\ 0.11 \\ 0.08 \end{bmatrix} \quad CI = 0.02, RI = 0.56, CR = 0.03 < 0.10$$

The weights of various indicators in the grassroots organization support subsystem of the "Key County Construction of Small Farmland Water Conservancy" project in Hubei Province:

$$W_2 = \begin{bmatrix} 0.05 \\ 0.13 \\ 0.08 \\ 0.11 \\ 0.07 \\ 0.36 \\ 0.28 \end{bmatrix} CI = 0.10, RI = 1.32, CR = 0.07 < 0.10$$

The weights of various indicators for the participation of farmers in the subsystem of the "Key County Construction of Small Farmland Water Conservancy" project in Hubei Province:

$$W_3 = \begin{bmatrix} 0.11 \\ 0.10 \\ 0.12 \\ 0.27 \\ 0.18 \\ 0.22 \end{bmatrix} CI = 0.03, RI = 0.9, CR = 0.06 < 0.10$$

The weight of each indicator in the market filling subsystem of the "Key County Construction of Small Farmland Water Conservancy" project in Hubei Province:

$$W_4 = \begin{bmatrix} 0.18 \\ 0.14 \\ 0.12 \\ 0.36 \\ 0.20 \end{bmatrix} CI = 0.001, RI = 0.57, CR = 0.05 < 0.10$$

Research result

After dimensionless analysis of the relevant data, the order degree of each subsystem of the "Small scale Farmland Water Conservancy Key County Construction" project in Hubei Province was calculated based on the above weights, as shown in Table 3. As can be seen from Table 3, the order of the irrigation cooperation supply system in 2009 was very low, all of which did not exceed 0.1. In 2011, the No. 1 central document focused on the construction of farmland and water conservancy, and the order of each subsystem began to increase year by year. From 2014, the order of each subsystem began to advance rapidly. By 2019, when the country included farmland and water conservancy construction in the construction of high standard ready farmland, the order of each system will remain at a high level. As of 2021, the order degree of each subsystem has exceeded 0.5, with the highest order degree of the national leading subsystem being 0.8; The market replenishment subsystem has the lowest value of 0.53.

Table 3 Order degree of each subsystem of the "Key County for Small scale Farmland Water Conservancy Construction" project in Hubei Province

	Government led subsystem	Grassroots support subsystem	Farmer participation subsystem	Market filling subsystem
2009	0.05	0.02	0.01	0.01
2010	0.07	0.03	0.01	0.01
2011	0.33	0.17	0.03	0.02
2012	0.36	0.16	0.10	0.05
2013	0.39	0.24	0.24	0.12
2014	0.41	0.27	0.36	0.23
2015	0.57	0.33	0.68	0.28
2016	0.59	0.58	0.43	0.31

2017	0.61	0.60	0.55	0.40
2018	0.64	0.61	0.62	0.38
2019	0.87	0.75	0.68	0.47
2020	0.82	0.80	0.73	0.50
2021	0.80	0.77	0.70	0.53

Discuss

From Figure 2, it can be seen that the growth trend of the order of various subsystems in the grassroots irrigation cooperation supply of the "Key Project of Small Farmland Water Conservancy Construction" in Hubei Province is maintaining an upward trend. In this process, the government led subsystem is particularly prominent. In 2019, 2020 and 2021, it has broken through the high point of 0.8 in succession, which reflects the national strategy, the No. 1 central document of 2011- strengthening the effective implementation of the national farmland water conservancy construction and sustainable development, and also reflects the strength of the national centralized system, which is now often referred to as "focusing on major issues". However, the degree of order of this subsystem has reached an inflection point in 2019, which makes us must consider whether this "mobilization order" governance model can be effectively combined with the long-term mechanism of farmland water conservancy;Among these four subsystems, compared to others, the degree of order in which farmers participate in the subsystems fluctuates greatly, which precisely confirms the current statement of atomization in rural areas and farmers - "Modern development, increased atomization and differentiation of farmers, while stimulating the vitality of rural social development, also accelerates the discretization of rural social and cultural communities to varying degrees" (Liang,H.Q. 2017), making the stability of farmers' participation in irrigation cooperation weak; Compared with the orderliness of other subsystems, the orderliness of the market replenishment subsystem is mostly at a lower level below 0.4. However, its development trend is always upward, which also indicates that the public welfare of agricultural water conservancy construction suppresses the marketization of agricultural water conservancy. At the same time, it also indicates that agricultural water conservancy development also needs to participate in market competition and provide better services for irrigation cooperation supply.

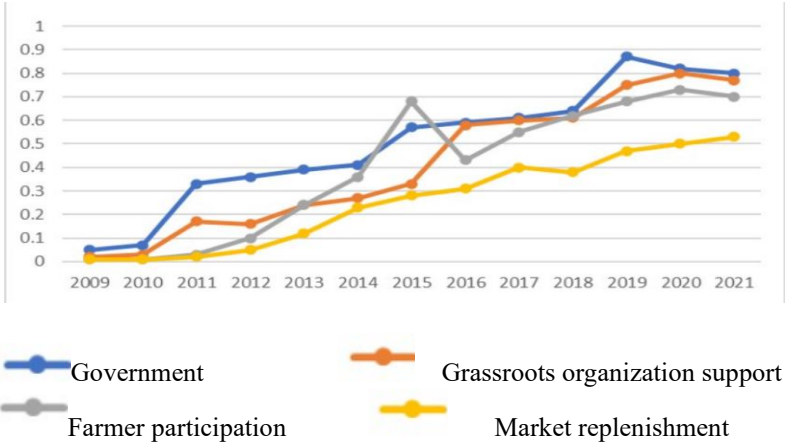


Figure 2 Changes in the orderliness of various subsystems in grassroots irrigation cooperation

Summary and suggestion

The collaboration of grassroots irrigation service systems can effectively save costs, share resources, and coordinate management. The synergistic effect can effectively improve the quality and quantity of grassroots irrigation service supply, while indirectly promoting the efficiency of collaborative innovation systems. Therefore, based on the definition of relevant concepts and the judgment of the synergistic effect of grassroots irrigation cooperation, this article takes the "Shayang Model" of agricultural water conservancy construction in Hubei Province as the research object, uses the Delphi method to construct a model of grassroots irrigation cooperation, and analyzes its complex characteristics, collaborative mechanism, and operating mechanism. Collaborative governance is a new governance model that emphasizes the synergistic effect between stakeholders on the basis of multi center governance. Its effectiveness depends on the effective interaction and coordinated operation among stakeholders. Based on the practice of "high standard farmland construction" in Hubei, I explore the various entities of cooperative supply of farmland irrigation, construct collaborative models, and analyze the synergistic effects of their collaboration and grassroots farmland irrigation cooperation, providing reference for solving current farmland irrigation problems.

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