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Evaluation Critical Factors Affecting Success of Irrigation Projects

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Abstract

Irrigation assumes a vital role in socio-economic development, population stabilization, and environmental protection in developing countries, especially in agriculture-based countries like Vietnam. All these operations require many water resources. It is forecasted that by 2040, 260 billion m^3 of water will be needed for socio-economic use in Vietnam. However, water resources endure uneven spatial and temporal distribution, which makes exploitation and use of it a challenge. That is why construction and successful development of irrigation projects, efficient and economized use of water becomes the decisive factor in the development of agricultural production and, in turn, impacts people's living and the national economy. This paper ranks the critical success factors (CSFs) of irrigation projects in Vietnam by applying the fuzzy approach. The research results show that the three most critical success factors of irrigation projects are (i) the smoothness of ground clearance compensation; (ii) the capacity of project management unit and other project participants; and (iii) support of organizations inside and outside the project.

Keywords: *irrigation projects; critical success factor (CSF); project management; Vietnam;*

1. Introduction

Vietnam's economic growth has continuously improved over the years [1-6]. This is due to the development of transportation and infrastructure projects, especially irrigation projects [7, 8]. These projects play a vital role in people's lives and a supportive role in national economic development [9, 10]. It directly serves agriculture, forestry, fishery production, and the rural economy. Vietnam is one of the few countries in Southeast Asia, where the irrigation system has been completely developed. There are thousands of large, medium, and small irrigation works that provide irrigation and drainage to projects for domestic and industrial use as well as agricultural production and aquaculture [11]. If not for the irrigation system, Vietnam's food production would not have grown to become 2nd ranked in the world for rice exports, becoming a significant source of foreign currency that has strengthened the international payment balance.

Irrigation systems are also crucial to the prevention and mitigation of flood damages and for environmental protection. An irrigation system protects many residential areas, industrial parks, and other infrastructure facilities while ensuring the safety of the lives and material life of local people, as well as stabilizing production. Some irrigation projects go far beyond the main tasks of water reservation and mediation of water for agricultural purposes. They improve the ecological environment and beautiful landscaping that draws tourists (Suoi Hai Lake, Dong Mo - Ngai Son, Dai Lai, Nui Coc, Song Quao, Dau Tieng, to name but a few).

Nonetheless, the irrigation system is now faced with various challenges, many a result of climate change. These include water scarcity, sea-level rise, increasingly fierce natural disasters, floods, droughts, and saline intrusion, etc. the irrigation projects are not highly technical. However, the state management mechanism and policies are inadequate, are heavily subsidized, and rely heavily on the state budget. There is a lack of appropriate mechanisms and policies on motivating and promoting the potential of economic sectors, social organizations and participants

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in irrigation project investment and operation. Irrigation works cover just around 55-65% of the design capacity. For the Mekong Delta region alone, the State ensures water supplies to the levels of the backbone canals and grade-2 channels [11]. Water sources for grade 3 or lower channels are undertaken by cooperatives, collectives, and private companies. Therefore, the government needs to establish an irrigation investment strategy as a part of its national development plan. This paper ranks the critical success factors (CSFs) of irrigation projects in Vietnam using the fuzzy logic method because this approach considers risk factors and the importance of assessors [12, 13]. The research findings will help irrigation project management units with appropriate orientations for limited resources to be focused on specific objectives toward the successful improvement of the irrigation projects.

2. Research Background

Irrigation refers to the scientific and technological research, assessment, operation and use, protection of water resources and environment, prevention and mitigation of natural disasters, prevention of disturbed soils [14]. Irrigation is usually associated with the drainage systems for the run-off or groundwater in a specific area. According to the Law on Water Resources of Vietnam, irrigation works are economic – technical infrastructure dedicated to the exploitation of water resources and the prevention and fight against water's adverse effects. and the protection of ecology. They include reservoirs, dams, culverts, pumping stations, wells, water pipelines, canals and channels, and facilities, embankments of kinds thereon.

Pursuant to Clause 1, Article 2 of the 2017 Vietnam's Law on Irrigation, an irrigation project is a combination of solutions to store, regulate, transfer, distribute, supply, irrigate and drain water for agriculture, aquaculture, salt production; the combined water supply, irrigation, and drainage for domestic purposes and different economic sectors [15-17]. It contributes to environmental protection, adaptation to climate change, and water source security and combats against natural disasters. Irrigation's technical infrastructures include dams, water reservoirs, culverts, pumping stations, water transmission and transfer systems, revetments, embankments, and other works serving irrigation management and exploitation.

Besides, in Vietnam, there are two kinds of organizations involved in the management, exploitation, and protection of the irrigation system: (i) State-owned organizations including waterworks operating enterprises, agricultural irrigation centers, and management units; (ii) water users [18, 19]. Water works-operating enterprises undertake the exploitation of focal works and backbone canals of medium and large-scale irrigation systems of high complexity. The remaining works are under the management of grassroots irrigation organizations (also called as water users), which include small-scale construction systems or infield irrigation systems affiliated to larger systems under the management of operating enterprises.

By 1945, Vietnam as a whole had only 13 medium and large-scale irrigation systems concentrated in the Midlands, Northern Delta, and Central Coast in addition to a number of upstream canals in the Mekong Delta [15]. The total irrigation capacity was 324,900 ha, and drainage capacity of 77,000 hectares. As of 2013, Vietnam had built 75 large irrigation systems, 1967 reservoirs with a total capacity or over 0.2 million m^3 more than 5,000 large irrigation and drain culverts, and over 10,000 medium and large pumping stations with a total pumping capacity of 24.8x106 m^3/hour, and thousands of small and medium waterworks.

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Vietnam had also built more than 5,700 km of river dikes, 3,000 km of sea dikes, 23,000 km of embankments and thousands of culverts under dikes, hundreds of kilometers of revetments, and many large reservoirs to strengthen the force against floods in downstream areas [18, 20]. In particular, the large reservoirs of the Red River system are capable of taking in 7 billion m^3 of water. They help raise the flood control capacity of the dike system by standing one in 500-year flood events. The total capacity of the systems assures the direct irrigation of 3.45 million hectares, water sources for 1.13 million hectares, drainage for 1.4 million hectares, salinity prevention for 0.87 million hectares, and soil acidity treatment for 1.6. million ha, provisions and generation of the water supply of 5-6 billion m^3 per year for domestic, industrial, tourism, service use; rural water supply coverage of 70-75% of the total population.

Vietnam is ranked 15th irrigation systems in the world, after China, the US, India, Japan, Spain, Canada, South Korea, Turkey, Brazil, France, South Africa, Mexico, Italy, and the UK. Reservoirs are a vigorous driver of microclimate improvement, air humidity, soil moisture, the formation of vegetation to prevent erosion and de-sedimentation.

As of April 1, 2014, the total volume of reservoirs in Vietnam was 12,477 million m^3 with 6,080 reservoirs of all kinds, among which:

(i) The Red River Delta: 448 reservoirs with a total capacity of 619 million m^3;

(ii) Northern midlands and mountainous: 2,169 reservoirs with a total capacity of 1,259 million m^3.

(iii) North Central Coast and Central Coast: 2,296 reservoirs with a total capacity of 7,066 million m^3;

(iv) Mekong Delta: 12 reservoirs with a total capacity of 8 million m^3;

(v) Central Highlands: 1,069 reservoirs with a total capacity of 1,389 million m^3; and

(vi) Southeast and Ho Chi Minh City: 86 reservoirs with a total capacity of 2,137 million m^3.

The irrigation development strategy aims to facilitate the restructuring of agricultural and forestry production, the diversification of crops, and the assurance of food security in response to population growth, and adverse changes in weather and world's movements [21]. At the same time, the strategy is designed to provide water sources for the domestic, industrial, fishery, and tourism uses, to maintain and improve the ecological environment, and exploit hydropower. The national irrigation development strategy to 2020 addresses the overall target of releasing Vietnam from the under-development trap; significantly improving the material and spiritual life of the people; laying a foundation for becoming a modernized industrial country by 2020 [22]. Human resources, scientific and technological capacities, infrastructure structure, economic, national defense, and security potential are reinforced, as the socialist-oriented market economy is basically formed, and our national position in the world is enhanced [23-26].

Development viewpoints include sustainable development, water use in parallelism with water resources protection; multi-purpose, natural disasters mitigation and hunger elimination and poverty reduction [27]. In addition, it is necessary to focus on supplementing, completing and improving the quality of irrigation development planning for river basins and localities in close coordination with the Ministry of Natural Resources and Environment, as well as other ministries and branches. The overall development orientation is to develop irrigation and water supply to

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serve economic restructuring, industrialization, and modernization of agriculture—rural areas and develop the socio-economic sector. Also, we must strengthen and develop our solutions in order to prevent and mitigate natural disasters, floods, and storms, and to strengthen water resource and irrigation works management.

On the other hand, success means achieving the best results using the available resources [28-32]. A critical success factor is a basis for investors or organizations to obtain the success of a project [33]. Project success factors are the set of several things that cause or influence outcomes, which contribute to the project success or failure [34-37]. Parfitt and Sanvido [38] concluded that it is very difficult to identify certain significant factors that control the project success because there are various complex functions affecting the design, construction, and operation of engineering projects. Therefore, based on experts' opinion, the three most important critical success factors affecting the success of irrigation projects in Vietnam analyzed using fuzzy approach.

3. Research Methodology

By considering the decision-makers' role, their importance weights are taken into account in a fuzzy approach. It deals with uncertainty due to inaccuracy, unclearness, and ambiguity of decision making analysis [39, 40]. Experts regularly found that it is more convenient and more confident to use interval judgments than only a fixed value opinion [41-43]. In general, the fuzzy logic is used to support experts' judgment by interval comparison judgments because this method is very close to the natural language of humans.

4. Results and Discussion

It is found that the smoothness of ground clearance compensation is the most important factor in the success of irrigation projects in Vietnam. In Vietnam, currently, construction ground clearance has been met with various difficulties and shortcomings. In many cities, the determination of compensation and support for local people is not commensurate with the market price [44-46]. Occupation transformation and employment of people whose land is redeemed have also become headaches. Delayed site clearance leads to project delay, which affects the overall project goal. To overcome these problems, the state should further propagandize and ensure rational compensation for people in the project planning area.

Research results reveal that the capacity of a project management unit and other project participants is the second leading factor for the success of irrigation projects. An inadequate project management unit will result in a backlog and wasting of resources, progress delays, and increased costs [47]. Project planning is also of high importance [48, 49]. An over-long project plan will waste capital and delay the launch of work. In such cases, the project management unit must analyze the trade-offs among time, cost, and quality in order to meet the project's progress goals and outcomes [50].

For a decent capacity of the project management unit, the involvement of the right numbers and members with adequate capacity and appropriate skills of extreme importance throughout the life-cycle of the project [51]. Besides professional skills, staff members of a project need communication skills, troubleshooting skills, problem-solving skills, and the ability to work in a team [52, 53]. Irrigation projects usually take a long time and involve numerous construction items, project staffs need to be capable of implementing the objectives. If the staff has serious limitations, the result will be a bad quality of work, including slow progress, cost overruns, waste of resources and time, and a "psychology of reliance" with other members. This easily leads to

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internal conflicts and greatly harms the project outcomes. Many irrigation projects in Vietnam often have too many employees and have poor workmanship. Some project staffs are capable only of formality-based tasks and do not have professional skills.

Next, the support of organizations inside and outside the project is considered the third important factor for the success of irrigation projects. The organizations inside the project must have support from senior management, the organizational structure, the functional managers and the head of the project [54, 55]. Project success heavily depends on the project's organizational structure (Tkhorikov et al., 2018). For a function-based organizational structure, the project generally experiences no conflict of resources, but it is parochial, not clarified of specific responsibilities, and lack of inter-party coordination. For a pure or matrix organizational structure, the availability of resources is very important. This type of organization may simultaneously conduct multiple projects with varied schedules and workloads, so they require sufficient resources for construction. Frequently everyone claims to have priority, and resource conflicts are common. Resolving this requires managers to have negotiating skills, the ability to empower others, and to distribute resources so as to facilitate project success.

5. Conclusion

Success means achieving the best results using the available resources. The success of irrigation projects is critical to not only project stakeholders, but also to Vietnam and the course of its economic development. Project success is under the influence of factors such as project procedures, the external environment, project management strategies, the working environment and stakeholders. Every participant should consider these success determinants in their management performance to increase the chance of success. Based on fuzzy preference method, this paper points out the three most critical success factors (CSFs) of irrigation projects in Vietnam are (i) the smoothness of ground clearance compensation; (ii) the capacity of project management unit and other project participants; and (iii) support of organizations inside and outside the project. The research findings will help irrigation project management units with appropriate orientations for limited resources to be focused on specific objectives toward the successful improvement of the irrigation projects.

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