Int. J. Nonlinear Anal. Appl. 14 (2023) 1, 2341–2349
ISSN: 2008-6822 (electronic)
http://dx.doi.org/10.22075/ijnaa.2022.7225

Identification of risks causing delays in design development and construction stages of state-owned irrigation projects in Turkey

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(Communicated by Mohammad Bagher Ghaemi)

Abstract

This work is carried out to determine various risk factors which cause delays in the design and development of state-owned irrigation projects in Turkey. Various factors such as management problems, design complexities, financial matters, labor attitude, equipment scarcities, and external risks were qualitatively studied. Data was collected through direct interviews with persons in state-owned irrigation projects and by a questionnaire survey (GAP project as a case study). The questionnaire was designed as on various questions and responses generated during direct interviews. It can be realized that major risk factors which arise through, management, design complexities, and financial matters, are mainly linked to the clients (i.e., Government and consulting firms) causing delayed completion of state-owned projects. During the execution cycle of the project, the contractors also produce a significant portion of risks related to common labor and equipment scarcity. This study can provide, and help in determining a suitable way forward for the completion of projects in time, by omitting delays caused by the government, and processing financial and other matters should be processed in due course for fruitful completion. Contractors should also be bound to follow the given time frame of each project and complete it within a stipulated time. Although external factors such as natural calamities put a strain on project completion time, management should be forecasting these factors and maintain a corrective course of action in case of any.

Keywords: Construction risk management, Delay factors, Irrigation construction projects in Turkey
2020 MSC: 91B05

1 Introduction

Keeping in view the continuous rise in global population and urban development, improving the irrigation system was imperative to meet with grown population's nutrition requirements. In 1990, it was 184 to 258 million hectares irrigation area increased to 324 million hectares just within two years by the end of the 1992 year. As per AQUASTAT (2014) report, it was indicated that Asia continent contains the majority irrigation sector in the world (i.e., 70%), operated through surface water resources (62%), utilizes surface irrigation (86%) systems with a crop density of 130%, having 61% grain growth. Projects dealing with the provision of sufficient irrigation directly benefit developing countries in terms of expanding the food supply chain, stabilizing clean drinking water requirements, and improving the

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Received: July 2022 *Accepted:* September 2022

life cycle of indigenous people. Water management projects mainly consist of integrated reservoir systems, channels, and hydraulic stations mainly to assist and organize the storage and supply of water for irrigation and other purposes [6].

Water projects generally consist of integrated systems of reservoirs, channels, and hydraulic installations, foremost and assistant to organizing storage and supply of water for agricultural lands and other purposes. The risk is continued linked with various stages of a project till its complete cycle. Cost management is a critical part of project management since it ensures that the project is completed on schedule and within budget. Further, risk management is mandatory to determine risks associated with the project, mitigation, and monitoring risks that could arise during the different phases of the project [33].

In each part of the world, water resources occupy greater importance for any country regarding its economic growth as well as for human life. Similarly, livestock and agriculture are the gifts by the nature to humankind to sustain life on this planet, which in turn require water to complete the natural cycle. Hence, it becomes imperative to maintain and manage properly the water resources, conserve and nurture this precious resource and not squander their utilization. It is therefore a necessity to perfectly utilize available resources to have sufficient food for all the living things in the present and future generations.

Keeping in view the importance of water management, this study is focused on analyzing various projects related to water management in Turkey. Turkey carries an abundance of natural water resources, thus being called a global food basket par excellence [17]. To preserve this great natural treasure, Turkey needs to exploit and reserve in a manner befitting to its importance, thus initiating the process of establishing irrigation projects of various kinds on the national level [9]. Accordingly, to develop a practical model for maintaining and mitigating various risk factors which directly affect the operation of different irrigation and water storage projects, it is mandatory to go through suitable well thought steps by acknowledging the work environment and the risks to which these are exposed. It is suitable to design an inventory and organize them according to its functional importance, thereby designing the model and determining its efficiency after various testing procedures. In this study, a comprehensive analysis is carried out for determining various risks associated with the design and development delayed and construction stages of State-Owned irrigation projects in Turkey. This study aims to evaluate various factors which provide major hindrances in the completion of various projects related to the irrigation sector.

2 Development of irrigation system in the south of Turkey and its risk assessment

One of the major regional development initiatives in the middle east ever is Turkey's Southeast Anatolia Project GAP (Güneydoğu Anadolu Projesi). The project's blueprints were officially launched in the early 1970s, with the main goal of inaugurating and constructing 22 dams and 19 hydroelectric power stations on the Tigris and Euphrates tributaries and rivers, as well as the establishment of large-scale irrigation networks for the production of hydroelectric power and irrigation of 1.8 million hectares of land in southeastern Anatolia [12].

In the mid-1980s, the project began to focus on the development of water and land resources, by including the most important industries such as those related to agriculture, transportation and communications of all kinds, health care, education, and infrastructure for urban and rural development. It was during that the development goals initiated a series of improved agricultural and industrial production, thereby enhancing their efficiency in that region, resulting in enhanced socio-economic standards and mitigating disparities in the population of that region. This development of economic growth prevented the migration of inhabitants thus producing the concept of a developed city. With this idea of expansion, the GAP project evolved as a multi-sectarian and integrated regional development objective, as well as envisaging the concepts of sustainable human development.

Later on, in the initial span of the 21st century, the project direction was modified to transform the social, economic, socio-political, and the GAP region's social-cultural structure, which includes about 10% (as shown in Figures 1 and 2) of the total area and population of Turkey, as well as achieving integration at the national and regional levels and developing it from a state-led technical project to a social project in its primarily [11].

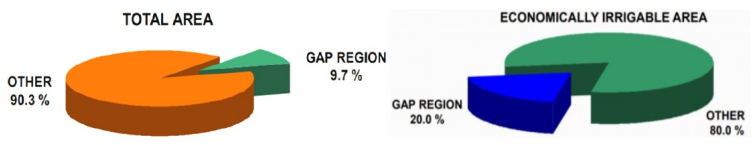

Figure 1: The percentage of GAP area from Turkey's area and the percentage of GAP area from economically irrigable Turkey's area

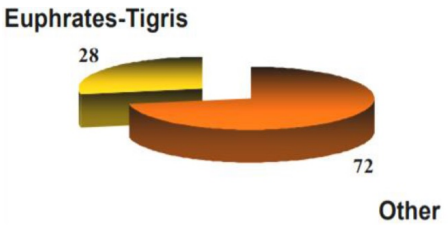

Figure 2: Turkey's water potential by basin 1

2.1 GAP's Developmental Stages [12]

The stages of development of the GAP project went through several stages from the beginning of its planning to the stages of implementation, and they were as shown in Table 1.

Table 1: GAP development stages

1936	Establishment of the "Electrical Power Resources Survey and Development Administration"
1960	Euphrates and Tigris rivers' studies begin
1977	Bringing all research of GAP together under the "GAP Water-Based Development Project Package"
1986	"State Planning Organization (SPO)" became the coordinating organization for GAP
1989	The master plan of GAP is been placed
1989	GAP Regional Development Administration's establishment
2002	Regional Development Plan for GAP (2002-2010)
2008	Implementation of GAP (2008-2012)
2014	Implementation of GAP (2014-2018)

2.2 Risk Management Overview

Risk management may be traced back to the start of civilization when people needed to protect their crops and constructed forts and walls to protect their cities and products. An example is when a merchant is managing his risk during transporting goods from one place to another requiring a security deposit from the buyer, which is returned when the buyer receives the goods in a safe condition, ensuring that the merchant is compensated for the loss of any catastrophes along the way. A more systematic technique arose as statisticians and theorists discovered quantified ways of gauging risks [14]. Risk management (RM) is an important decision-making process in construction project management [36], especially when it comes to project integration, schedule, also cost, quality, human resources, communications, procurement, and scope. By identifying uncertainties and probabilities, RM enhances the future elements of a project [13]. "A system that aims to identify and quantify all risks to which the project is exposed so that a conscious choice on how to manage the risk may be taken," according to the definition [40]. Operational risk management in construction demands an assessment of the potential risk in comparison to the expected return or future revenues on the project [24]. As indicated by Walker, "The planning, coordination, and control of a project from conception to completion (including commissioning) on behalf of a client, necessitating the identification of the clients," according to the definition of construction project management [37]. The utility of function, quality, time, and cost objectives as well as resource relationship establishment, project integration, monitoring, control contributors and their accomplishments, and selecting alternatives are to evaluate and achieve the client's goals that satisfy the project's goal. Risk and uncertainty can have either a positive or negative impact on any building project. Risk, on the other hand, does not entail insecurity [18], since the danger is the outcome of a negative risk, while the chance is the result of a positive risk. Barber 2005, defines risk as a threat to a project's success [8], while the possibility of an event occurring is defined as uncertainty with an unknown likelihood [2]. In its most basic form, uncertainty refers to a situation that decision-makers are evaluating but for which no previous information exists to evaluate the possibility of its occurrence [24].

Whenever the outcome of a decision is negative, risk and uncertainty both influence - actual goals, which differ from expected results. Both scenarios have two conceivable outcomes: a positive or negative divergence in the timeframe or budget of the construction project. It is impossible to avoid risk and uncertainty in the construction industry. This is true for both the construction industry and the parties involved in the construction industry. It is not the same as saying that there are risks and uncertainties. The term risk came from France and was first used in insurance

transactions in England in 1830 when the phrase was introduced into the English language. Recognized dangers are divided into three categories; well-known to possible risks, risks varying from well-known to unknown, as well as unknown to unknown risks. Possible risks include minor modifications to the project's scope; risks varying from well-known to unknown include anticipated events based on their likelihood or potential impact; unknown to unknown risks events with an unknown probability and an unknown likely impact on the project's scope [2]. Some academics believe it is important to distinguish between risk and uncertainty, whereas others believe that the two phrases should be used interchangeably [24]. Risk and uncertainty are unavoidable in all endeavors and may have beneficial or detrimental outcomes on their performance. Throughout a project, risk factors may occur internally or outside and it is critical to succeed and meet the project's objectives, identify potential risks and have a strategy in place to manage them and goals [19]. This means that risk management (RM) is a tool used to make decisions in project management, and it's a critical component of the project management strategy. It explains how promising parts of the project work, and the tools and techniques used to find and assess risk. Besides that, Lester 2006, says that risk is "the mix of an event's likelihood and its effects" [30]. RM, according to the Institute of Risk Management (IRM), is a fast-evolving field that lacks clarity on what constitutes risk. According to the International Risk Management Association (IRM), there are two types of risk: positive and negative. A project's success may be positively affected by positive risks, while its failure might be negatively affected by negative risks [35].

2.3 Risk Management Process

Cost and/or time overruns are common in building projects. According to Cretu, in Europe and North America, there was cost analysis research on public works projects conducted [18]. Cost overruns were discovered to be common and severe, according to the study, "Cost overruns occurred in 86% of the 258 projects", and that was resulting 28% increase in actual cost to budget cost.

One of the primary causes of cost overruns is insufficient risk analysis. This happens when the scope of work was not properly stated and recognized during the early stages of the project while developing the project budget, or when the project was purposefully delayed to accommodate political goals. Risk management and risk assessment are not synonymous; some people may use the term risk management to refer to a risk assessment procedure [27]. Risk management is defined by Westland as "the process through which project hazards are explicitly recognized, assessed, and managed" [38]. Various risk categories can be recognized, appraised, and analyzed during the planning and construction stages, evaluating risks and controlling their impact on the construction project using probability theory or the relative significance index theory [22]. Risk management aids in the reduction of delays, which decreases contractual conflicts. According to Braimah, In delay analysis and the use of simple methodologies rather than complex methodologies One of the main findings of existing methodologies for analyzing construction project delays from the clients' and consultants' perspectives was even though simple methodologies are notorious for their lack of dependability [16]. Internal and external risks are the two broad categories of risk in building projects. Other classifications are more precise and include political, financial, commercial, intellectual property, social, and safety hazards [21, 34]. By documenting risk data in a risk register, risks can be detected at any stage of a project, however, risks in construction projects can be defined by the likelihood of an event occurring or the actual occurrence of an event taking place throughout the construction process [23]. Risks can also occur when In a decision-making or planning environment, structured outcomes or consequences are unpredictable [26]. An estimate based on the uncertainty associated with possible outcomes may yield results that are either better or worse than expected [31]. This study employs the more general and comprehensive risk management definitions recommended by Larson (2011) and Westland (2007), where risk management is defined as the official identification, quantification, and management of project hazards (assessing and responses) [29, 38]. Cost risk is a major concern for companies that invest and work in large construction projects, It is also regarded as the primary source of legal disputes between parties in the region, as financial delays cause project completion deadlines to slip [25]. Risk management has become more important as an integrated project management tool approach in every project in the area.

3 Research plan and methodology

The main objective of this work is: to recognize and evaluate various risks occurring during the construction and implementation phase of state-owned irrigation projects in Turkey and take a case study of the Anatolian irrigation project, then suggest a suitable model for analyzing those risks to mitigate the delay in these projects. To achieve the aim of the research, the study was divided into successive stages:

First: Perform a thorough literature survey related to the aforementioned concepts and identify and assess various risks related to the construction and implementation of projects.

Second: Identifying influential risks exposed to the involved parties in the construction projects under consideration.

Third: After the aforementioned theoretical approach, the interviews were conducted with experts of various departments of the Anatolian Irrigation Project, for determining the risk factors to be measured and their significance.

Fourth: After interviews, a questionnaire was designed containing the aforementioned points and was distributed among various stakeholders (i.e., owner, consultant, and contractors) responsible for irrigation projects in Southeast Anatolia for achieving the desired goal. It is mentioned that the sample questions were limited to the employer and contractor in the East Anatolia Project, since this is a government entity, and it is the body that designs and consults with various cadres and departments.

Fifth: After analyzing the survey questionnaires, the risk factors were identified, then evaluated and weighed according to their critical placement, to which the projects of constructing state-owned irrigation facilities in Turkey are exposed at various stages that a construction project goes through, such as design variations, implementation, and construction.

4 Survey outcomes and identification of risks

Survey questionnaires are utilized as a research tool to evaluate and analyze qualitative data such as risks related to construction works [21], since in qualitative terms no limit can be applied to the questions asked, but it depends on the attributes of the questionnaire as well as the responding entity's participation and time accomplishments [20].

Two types of survey questionnaires are there, first open and second the closed questionnaire. In this work, the closed questionnaire was adopted to organize the answers from multiple choices, to obtain unified information and opinions, within the order in advance, easy to compare, and also quantitatively. As for as the cons closed questionnaire is concerned, it is that the participants do not have the opportunity to clarify their responses as it just provides multiple options without justifying their answers. However, this type of survey is easy to convert a qualitative response into a quantitative outcome.

4.1 Data Collection Process

To determine information related to construction risk factors in the GAP Project, two steps were followed, the first one was to acquire exploration information by direct investigation, and the second was to distribute and collect the information by questionnaire.

4.2 Determining Various Risks Involved In Construction Projects

At the beginning of the research, literature related to the topic of risk factors affecting public construction projects was collected and reviewed, then those factors were classified according to the type of projects being affected, and the relevant factors were assessed, classified, and organized in a listed manner. In this way, the literature review assisted to decide the appropriate method to be implemented.

Secondly, to acquire the research goal through Exploratory Interviews (i.e., Qualitative approach) direct interviews were conducted as mentioned above. Direct interviews were conducted with personnel directly linked to the management of the Southeast Anatolia Project having prior knowledge of risks occurring in such type of construction sector to determine the risk factors related to these projects. Later, a questionnaire was prepared to contain risk factors that had been collected and classified previously in the literature stage, and related to this type of project, and also the questions put by the researcher in the field of project risks during construction were benefited likely [5].

An interview was conducted with eight specialists from the departments of DSI, two from each of the DSI departments (in Gaziantep, Urfa, Kahraman Mersh, and Idman), and the questionnaire was distributed later, including three from the contractors' side. The interviews were in English with a simple explanation in Turkish to clarify the topic.

In summary, 119 risk factors from the literature review, 64 of them were excluded, and 55 risk factors of them were agreed upon to be based on direct interviews. These risks are tabulated below for further understanding.

The risk factors were collected from the literature review and were included in the questionnaire.

4.3 Negative Impact Shares of Risk Factors

After determining various factors, a negative impact was discussed on the field of research. Consequently, the share of responsibility is allocated to each of the risk factors, based on their personal and practical experiences (Table 2), thus obtaining the shares of the negative impact of those risk factors. Later on, based on the results obtained through the literature survey, the final questionnaire was arranged, printed, and translated into Turkish to make it understandable for the participants.

Table 2: The relative weight and shares of responsibility for risk factor categories of case research projects

	a-Risk Factors Related To Management		**Responsibility %**	
	Category Relative weight	38%	DSI=Client+ consultant	Contractor
1	Delay in mobilization and handover of the site		85	15
2	The process of decision making		75	25
3	Coordination and communication between clients contractors, consultants		55	45
4	Unspecified responsibilities		50	50
5	Provide qualified representatives		65	35
6	Deferred work orders (Held Orders)		25	75
7	Instructions Issuance		80	20
8	Experience availability of project management members		80	20
9	Dissemination of information		80	20
10	Experiences of contractors		30	70
11	Qualified suppliers' and subcontractors' availability		10	90
12	Errors' rework during construction		10	90
13	The amount of disputes and claims and their settlement		90	10
14	Overlap and conflict in subcontractors' schedules during implementation		30	70
15	Subcontractors' delays in their work		30	70
16	Contractor's work is unsatisfactory		10	90
17	Delaying approvals for major changes in project		75	25
18	The long waiting for tests and inspections approvals		70	30
19	The quality assurance control		30	70
20	The excessive number of contractors and subcontractors		20	80
21	Unreasonable risk allocation		40	60
22	Frequent changes to subcontractors due to inefficiency		10	90
23	Delay in revising and approving: design documents, drawings, and sample materials		75	25
	b- Risk Factors Related To Design		**Responsibility %**	
	Category Relative weight	12%	DSI=Client+Consultant	Contractor
1	Experience of the design team		80	20
2	The project design's complexity		80	20
3	Confusing in a requirements		40	60
4	Modifications in designs		70	30
5	Pre-design data collection and survey		80	20
6	The completeness of project documents and drawings in time		80	20
7	Complete modified design documents in time		85	15
8	Details' clarity in drawings		80	20
9	Too many change orders		90	10
	c- Risk Factors Related To Finance		**Responsibility %**	
	Category Relative weight	20%	DSI=Client+Consultant	Contractor
1	Payments of completed works		90	10
2	The project's finance due to contractor or client		15	85
3	Analysis of the cash flow plan		25	75
4	The accuracy of cost estimation		70	30

	d- Risk Factors Related To Material		**Responsibility %**	
	Category Relative weight	15%	DSI=Client+Consultant	Contractor
1	Materials' quality is under the standards		30	70
2	Construction materials' availability in markets		20	80
3	Changes in material specifications during construct		70	30
4	Delivery of material		10	90
5	Time of manufacturing special construction materials		15	85
6	Problems due to materials supplier's		0	100
7	Waste materials due to handling		10	90
8	The conform of materials to specifications		10	90
	e- Risk Factors Related To Labors And Equipment		**Responsibility %**	
	Category Relative weight	7%	DSI=Client+Consultant	Contractor
1	Performance and productivity of labors		10	90
2	The availability of equipment		0	100
3	The efficiency and productivity of equipment		0	100
4	The relations between labors and management		0	100
5	The necessary skills		30	70
6	Dispute and strike for site workers		10	90
	f- Risk Factors Related To Externals		**Responsibility %**	
	Category Relative weight	8%	DSI=Client+Consultant	Contractor
1	The changing in site topography after design		90	10
2	Civil troubles		0	100
3	Problems with neighbors		30	70
4	Delay in governmental permits		40	60
5	Changes in government instructions		30	70

4.4 Comparative studies on various risk factors; Current Studies and Literature Review

Here, we try to organize in a tabular manner a comparative table regarding the investigations carried out on the aforementioned risk factors by the earlier researcher. Few studies were taken into consideration regarding their analysis of various risk factors assessed by these studies. Table 3 given below determines a comparative indication of various studies related to the risk factors studied during current work. As can be observed from the given table, almost each risk factor is widely analyzed by the researchers; however if seen through %age, risk related to management, labor, equipment, design, and finance put a heavier toll on project completion as evident through earlier studies carried out in this regard.

Table 3: The relative comparison of risk factors with earlier literature

Reference	Risk Factors Related to Management	Risk Factors Related to Design	Risk Factors Related to Finance	Risk Factors Related to Material	Risk Factors Related to Labor and Equipment	Externals Risk Factors
[3]	✓	✓	✓	✓	✓	✓
[4]	✓		✓	✓		
[5]	✓	✓	✓	✓	✓	✓
[7]	✓		✓		✓	
[1]	✓				✓	✓
[39]		✓	✓		✓	
[15]	✓	✓	✓	✓	✓	✓
[32]	✓				✓	✓
[10]		✓			✓	
[28]	✓		✓	✓	✓	

5 Conclusion

This study was carried out to determine the proportions of the risk impact on the construction stages of the state-owned irrigation construction projects in Turkey through the results of the direct survey. Various risk factors were

determined that directly affect various phases of projects thus causing a delayed completion time and unsatisfactory results. Furthermore, based on the outcomes of the survey, a mathematical model can be developed to reduce the impact of the risks deduced from the statistical analysis on the projects of state-owned irrigation facilities in Turkey. The study reveals that a variety of reasons for delays and disruptions still persist, and their impacts put building projects in jeopardy, affecting their performance. These causes are poor management and internal misunderstandings between management and labor. Furthermore, the topographical difference between foreign/non-local management provides an insecure and untrustworthy environment among laborers causing slow work response. In addition, complex design changes put constraints on an engineer's ability to complete work in the stipulated time. Furthermore, delays in contractor payment, information delays, financial challenges, poor contract management, compensation concerns, and disagreements over the value of completed work all add to the lengthening of the complete cycle. Time overruns, cost overruns, poor societal impact, idle resources, and disagreements are all outcomes of these delays. As a result, it is advised that the parties involved in the project procurement process prioritize a sufficient construction budget, timely information dissemination, design completion, and project management abilities. This study can help determine a suitable way forward for the completion of projects on time without producing any economic constraints on the national budget and the benefit of local habitants of Turkey.

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