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Analysis of Delay Factors in Post-Flood Reconstruction Projects: A Case Study of Gilan Province, Iran

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Abstract

Flood-induced damage to infrastructure poses significant economic and social challenges, particularly in disaster-prone regions. Reconstruction of damaged structures is often plagued by delays, leading to cost overruns, reduced quality, and loss of public trust. This study investigates the primary causes of delays in the reconstruction of flood-damaged structures in Gilan Province, Iran, a region frequently affected by severe flooding. Using a mixed-method approach, 19 qualified professionals (contractors, consultants, and employers) were surveyed with a 19-item questionnaire. Cronbach's alpha (0.886) confirmed high reliability. Descriptive statistics and frequency analysis revealed that untimely allocation of funds and international economic instability/inflation are the most critical delay factors. Conversely, adverse weather conditions had the least impact, a finding contrary to many international studies. Other moderate-impact factors included deficiencies in initial design, excessive material harvesting, and lack of laboratory equipment. The study provides practical recommendations for improving financial mechanisms, inter-organizational coordination, and project risk management in post-disaster reconstruction.

Keywords: Reconstruction delay, Flood damage, Construction management, Gilan province, Post-disaster recovery.

1 | Introduction

Infrastructure reconstruction is a cornerstone of economic recovery after natural disasters. However, reconstruction projects are often delayed, resulting in wasted capital, technical obsolescence, and social dissatisfaction. In Iran, a large portion of the national budget is allocated to civil projects, but many suffer from significant time overruns, sometimes exceeding 100% of the planned duration [1].

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Gilan Province, due to its geographical location along the Caspian Sea, is prone to seasonal floods that severely damage roads, bridges, and residential structures. Despite the urgency of reconstruction, projects in this region experience persistent delays. Understanding the root causes of these delays is essential for improving future disaster response and resource allocation.

This case study aims to:

I. Identify and rank the key factors causing delays in post-flood reconstruction projects in Gilan.

II. Determine the relationship between delays and the performance of employers, contractors, and consultants.

III. Propose actionable solutions to mitigate delays in similar contexts.

2 | Literature Review

2.1 | Project Management and Delays

Project management involves the application of knowledge, skills, tools, and techniques to meet project requirements [2]. Delays are almost inevitable in large-scale civil projects, with studies showing that over 50% of global construction projects experience time overruns [3]. In Iran, the average completion time for national civil projects has risen from 8.6 years in the Second Development Plan to over 11 years in the Fourth Plan.

2.2 | Classification of Delay Factors

Delays are generally divided into:

I. Uncontrollable (external): natural disasters, weather, political instability, economic sanctions

II. Controllable (internal): poor planning, financial mismanagement, contractor inexperience, design errors, lack of coordination

Table 1. Main causes of delay in civil projects (percentages).

Row	Cause of Delay	Percentage
1	Insufficient fund allocation	30.2%
2	Approved budget deficit	24.75%
3	Weakness of executive bodies	11.8%
4	Land procurement and preparation	5.5%
5	Contractor incapability	5.5%
6	Material shortage	9.4%
7	Design consultant	3.7%
8	Other	9.15%

2.3 | Global and National Studies

International research [4–6] highlights factors such as lack of commitment, poor site management, and inadequate planning. In Iran, studies by Rezaei [7], Khodadad [8], and Beheshti et al. [9] point to funding shortages, weak executive agencies, and bureaucratic obstacles as primary delay causes.

Table 2. Overall ranking of delay factors in Iran.

Rank	Delay Factor
1	Payment of progress reports, adjustments, etc.
2	Weakness in site management
3	Delay in approval of executive drawings
4	Lack of proper knowledge about the project area
5	Insufficient experience of the contractor
6	Expertise and skill of human resources
7	Insufficient cost estimation of the project execution

2.4 | Research Gap

Most existing studies focus on new construction, not post-disaster reconstruction. Moreover, few have specifically examined flood-damaged structures in northern Iran. This study addresses that gap.

Table 3. Ranking of delay factors from the perspective of the employer, consultant, and contractor in Iran.

Rank	Contractor's Perspective	Consultant's Perspective	Employer's Perspective
1	Payment of progress reports, adjustments, etc.	Weakness in site management	Weakness in site management
2	Lack of proper knowledge about the project area	Insufficient experience of the contractor	Payment of progress reports, adjustments, etc.
3	Insufficient cost estimation of the project execution	Payment of progress reports, adjustments, etc.	Design deficiencies
4	Delay in approval of executive drawings	Expertise and skill of human resources	Expertise and skill of human resources
5	Inappropriate planning	Insufficient cost estimation of the project execution	Delay in approval of executive drawings
6	Traditional tendering method and contractor selection	Delay in approval of executive drawings	Insufficient experience of the contractor
7	Financial capability of the contractor	Inappropriate planning	Applied execution methods

3 | Methodology

3.1 | Research Approach

This is an applied, quantitative, cross-sectional survey.

3.2 | Variables

I. Dependent variable: delay in reconstruction.

II. Independent variables: financial, human, natural, and employer-related factors.

3.3 | Data Collection and Instrument

A 19-item questionnaire was developed based on literature and field observations. Each item was rated on a 4-point Likert scale (1=very high impact, 4=low impact). The questionnaire was distributed to 19 professionals involved in flood reconstruction projects in Gilan Province, including:

I. Employers (government representatives)

II. Consultants (supervising engineers)

III. Contractors (executing firms)

3.4 | Validity and Reliability

Cronbach's alpha for the questionnaire was 0.886, indicating excellent internal consistency.

4 | Results

4.1 | Descriptive Statistics

All 19 participants completed the survey (100% response rate). *Table 4* shows the raw response frequencies.

Table 4. Questionnaire and response matrix (19 items × 4 options).

Question No.	Question Text	Very High	High	Medium	Low
Q1	The role of initial design and its deficiencies in reconstruction project delays	4	6	5	4
Q2	The role of local authorities' negligence toward initial damage (before complete failure)	4	7	5	3
Q3	The role of excessive material harvesting and deforestation on damage severity and subsequent reconstruction delays	5	5	6	3
Q4	The role of redoing preliminary studies in reconstruction delays	3	7	6	3
Q5	The role of regional economic factors in reconstruction delays	2	5	8	4
Q6	The role of regional political factors in reconstruction delays	2	6	7	4
Q7	The role of the shortage of specialized human resources in reconstruction delays	5	6	4	4
Q8	The role of modern machinery in reconstruction delays	3	6	7	3
Q9	The role of coordination between regional institutions and government sectors	4	6	5	4
Q10	The role of subcontractors in reconstruction delays	2	5	8	4
Q11	The role of weather and climatic conditions in reconstruction delays	0	3	7	9
Q12	The role of regional access conditions to nearby cities	3	6	6	4
Q13	The role of material supply in reconstruction delays	3	6	7	3
Q14	The role of project location and distance from the provincial center	2	7	7	3
Q15	The role of laboratory equipment in reconstruction delays	5	4	6	4
Q16	The role of fuel supply in reconstruction delays	4	5	6	4
Q17	The role of the tendering process and land allocation methods	4	6	5	4
Q18	The role of timely fund allocation in reconstruction delays	8	5	3	3
Q19	The role of the international economy and inflation in reconstruction delays	7	6	3	3

4.2 | Most Significant Delay Factors

The two factors with the highest “very high” and “high” combined frequencies were:

I. Timeliness of fund allocation (Q18) – Most respondents rated this as “very high” impact.

II. International economics and inflation (Q19) – Also rated very high.

These findings align with national reports indicating that 30–50% of delays are due to budget shortages and allocation mismatches.

4.3 | Moderately Significant Factors

The following factors received a “medium” impact rating:

I. Initial design flaws and errors (Q1)

II. Excessive harvesting of materials and deforestation (Q3)

III. Availability of laboratory equipment (Q15)

4.4 | Least Significant Factor

Contrary to expectations, weather and climatic conditions (Q11) were rated as having the lowest impact. This suggests that in Gilan, while floods are the triggering event, post-flood reconstruction delays are primarily managerial and financial, not meteorological.

4.5 | Reliability Analysis

Cronbach's alpha = 0.886 (>0.7), confirming the questionnaire's reliability.

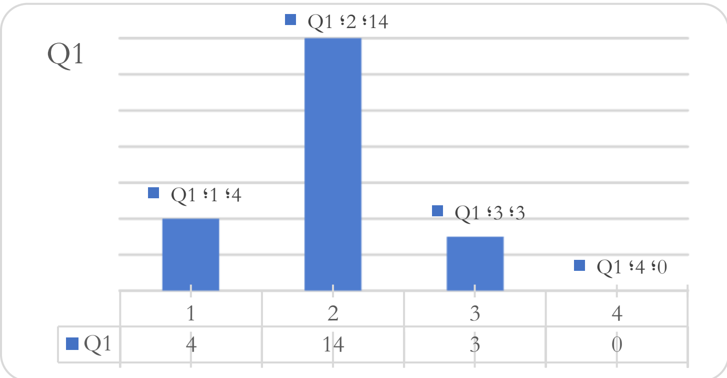
Table 5. Cronbach's alpha table.

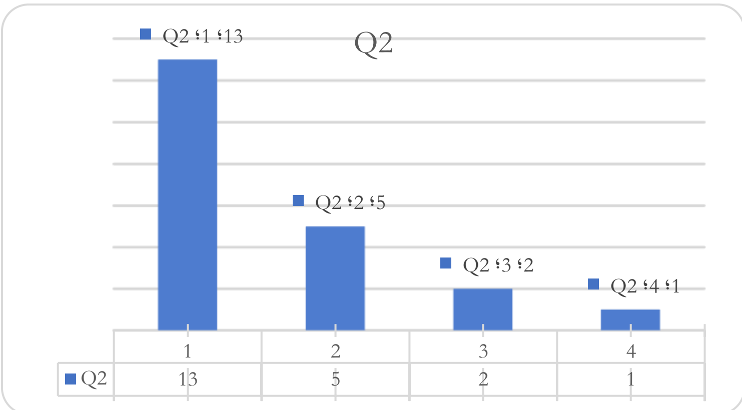
Value	Threshold	Interpretation
0.886	> 0.70	Excellent internal consistency.
19 items	—	All questionnaire items contribute reliably to the construct.

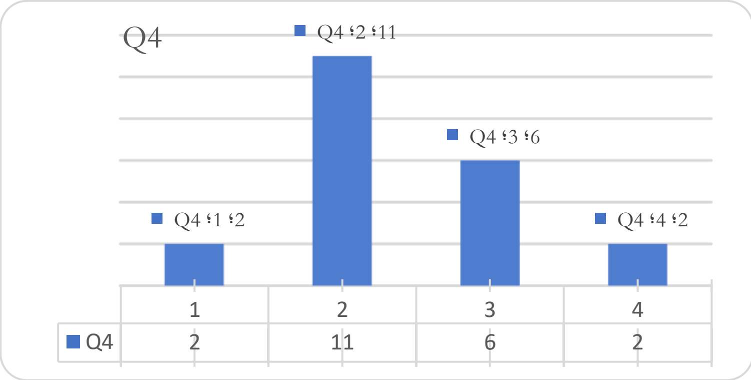
A Cronbach's alpha of 0.886 indicates that the 19-item questionnaire has high reliability and is suitable for measuring delay factors in reconstruction projects. This value exceeds the generally accepted threshold of 0.70, confirming that the survey instrument is valid and consistent.

4.6 | Figures (Bar Charts)

The following figures (original thesis) should be inserted here to visualize responses for each of the 19 questions:







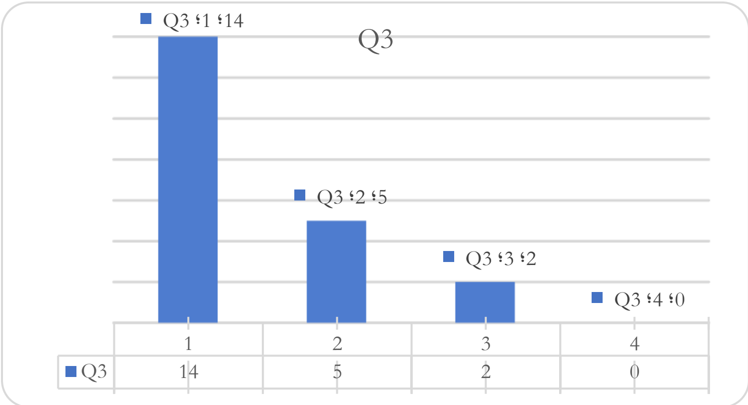


Fig. 1. Bar charts showing response distributions for Q1 to Q4.

These figures clearly show that for Q18 (fund allocation) and Q19 (inflation), the bars for "very high" and "high" are dominant, while for Q11 (weather), "low" is the most common response.

4.7 | Descriptive Statistics Table

Table 6. Descriptive statistics (mean, std. deviation, variance, skewness, kurtosis for each Q).

Question	N	Minimum	Maximum	Mean	Std. Deviation	Variance	Skewness	Kurtosis
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
Q1	4	0	14	5.25	6.076	36.917	2.764	2.619
Q2	4	1	13	5.25	5.439	29.583	1.908	2.619
Q3	4	0	14	5.25	6.185	38.250	1.840	2.619
Q4	4	2	11	5.25	4.272	18.250	-0.324	2.619
Q5	4	1	9	5.25	3.500	12.250	-1.598	2.619
Q6	4	0	9	5.25	3.862	14.917	0.984	2.619
Q7	4	1	14	5.25	5.965	35.583	3.091	2.619
Q8	4	1	12	5.25	4.787	22.917	1.910	2.619
Q9	4	0	13	5.25	5.560	30.917	1.819	2.619
Q10	4	1	9	5.25	3.862	14.917	-4.409	2.619
Q11	4	3	8	5.25	2.217	4.917	-1.700	2.619
Q12	4	1	10	5.25	4.425	19.583	-4.773	2.619
Q13	4	1	10	5.25	3.775	14.250	0.257	2.619
Q14	4	2	10	5.25	3.948	15.583	-3.321	2.619
Q15	4	1	14	5.25	5.965	35.583	3.091	2.619
Q16	4	1	13	5.25	5.679	32.250	0.154	2.619
Q17	4	1	14	5.50	5.916	35.000	2.229	2.619
Q18	4	0	17	5.25	7.932	62.917	3.487	2.619
Q19	4	0	16	5.25	7.274	52.917	3.465	2.619
Valid N (listwise)	4							

Table 7. Original – frequency statistics (percentiles, min, max).

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19
N Valid	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
N Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Std. Deviation	6.07	5.43	6.18	4.27	3.50	3.86	5.96	4.78	5.56	3.86	2.21	4.43	3.78	3.95	5.97	5.68	5.92	7.93	7.27
Variance	36.91	29.58	38.25	18.25	12.25	14.91	35.58	22.91	30.91	14.91	4.91	19.58	14.25	15.58	35.58	32.25	35.00	62.91	52.91
Skewness	1.52	1.46	1.38	1.04	-0.32	-1.00	1.74	1.33	1.20	-0.17	0.48	0.13	0.36	0.48	1.75	1.13	1.54	1.85	1.82
Std. Error of Skewness	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Minimum	0	1	0	2	1	0	1	1	0	1	3	1	1	2	1	1	1	0	0
Maximum	14	13	14	11	9	9	14	12	13	9	8	10	10	10	14	13	14	17	16
Percentiles																			
25th	0.75	1.25	0.50	2.00	1.75	1.25	1.25	1.50	0.75	1.50	3.25	1.25	1.75	2.00	1.25	1.00	1.25	0.25	0.50
50th (Median)	3.50	3.50	3.50	4.00	5.50	6.00	3.00	4.00	4.00	5.50	5.00	5.00	5.00	4.50	3.00	3.50	3.50	2.00	2.50
75th	11.50	11.00	11.75	9.75	8.50	8.50	11.50	10.25	11.00	8.75	7.50	9.50	9.00	9.25	11.50	11.25	11.75	13.50	12.75

5 | Discussion

5.1 | Interpretation of Findings

The results clearly demonstrate that financial and economic factors outweigh physical or environmental factors in causing delays in post-flood reconstruction. This is a critical finding because many disaster recovery plans focus on logistics and weather, but in Gilan, the real bottleneck is the timely release of funds and inflation control.

The moderate impact of design errors suggests that while initial planning is important, it is not as critical as cash flow. The low impact of weather indicates that reconstruction activities can be scheduled around seasonal rains if funding is available.

5.2 | Comparison with Previous Studies

Unlike studies in Jordan [4] and Pakistan [5], where weather and site conditions were the top causes, this study found finance to be primary. This reflects the specific economic context of Iran, including international sanctions and domestic budget cycles.

5.3 | Practical Recommendations

Based on the findings, the following solutions are proposed (adapted from the thesis and updated with recent insights):

I. Establish Rial Letter of Credit (LC) mechanisms for reconstruction projects to ensure timely payments to contractors, as originally suggested in the thesis (Section 2-16). This can decouple payments from annual budget fluctuations.

II. Decentralize fund allocation to provincial levels for emergency reconstruction, reducing bureaucratic delays.

III. Incorporate inflation adjustment clauses in reconstruction contracts to protect contractors from cost volatility.

IV. Improve design quality control before tender to reduce mid-project changes.

V. Pre-position laboratory and testing equipment in high-risk provinces to avoid procurement delays.

5.4 | Limitations

I. Small sample size (n=19), limiting generalizability.

II. Focus only on Gilan Province; other regions may differ.

III. Self-reported questionnaire data may be biased.

IV. Only flood damage was studied, not earthquakes or other disasters.

6 | Conclusion

This case study of post-flood reconstruction projects in Gilan Province, Iran, identified that delays are primarily driven by financial factors, specifically, untimely allocation of funds and international economic instability/inflation, rather than by weather or site conditions. The findings challenge the common assumption that natural hazards themselves are the main cause of reconstruction delays. Instead, managerial and economic weaknesses prolong recovery.

Policymakers should prioritize financial innovation (e.g., project-specific LC accounts), strengthen local governance, and improve design quality. Future research should expand the sample size, compare multiple provinces, and include other disaster types (e.g., earthquakes).

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