



## Data Article

# Data exploration on the factors associated with cost overrun on social housing projects in Trinidad and Tobago



Aaron Anil Chadee<sup>a,\*</sup>, Chamari Allis<sup>b</sup>, Upaka Rathnayake<sup>c</sup>,  
Hector Martin<sup>d</sup>, Hazi M Azamathulla<sup>a</sup>

<sup>a</sup> Department of Civil and Environmental Engineering, The Faculty of Engineering, The University of West Indies, St. Augustine 32080, Trinidad and Tobago

<sup>b</sup> Department of Quantity Surveying, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe 10115, Sri Lanka

<sup>c</sup> Department of Civil Engineering and Construction, Faculty of Engineering and Design, Atlantic Technological University, Ash Lane, F91 YW50 Sligo, Ireland

<sup>d</sup> Department of Civil Engineering, Queen's University Belfast, University Belfast, United Kingdom

## ARTICLE INFO

## Article history:

Received 10 October 2023

Revised 5 December 2023

Accepted 11 December 2023

Available online 15 December 2023

Dataset link: [Data exploration on the factors associated with cost overrun on social housing projects in Trinidad and Tobago \(Original data\)](#)

## Keywords:

Project management

Construction industry

Root causes

Political

Technical

Cost overruns

Small Island developing states

## ABSTRACT

This data article explores the factors that contribute to cost overrun on public sector projects within Trinidad and Tobago. The data was obtained through literature research, and structured questionnaires, designed using open-ended questions and the Likert scale. The responses were gathered from project actors and decision-makers within the public and private construction industry, mainly, project managers, contractors, engineers, architects, and consultants. The dataset was analysed using frequency, simple percentage, mean, risk impact, and fuzzy logic via the fuzzy synthetic evaluation method (FSE). The significance of the analysed data is to determine the critical root causes of cost overrun which affect public sector infrastructure development projects (PSIDPs), from being completed on time and within budget. The dataset is most useful to project and construction management professionals and academia, to provide additional insight into the understanding of the leading factors associated with cost overrun and the critical group in which they occur (political factors). Such understanding can encour-

\* Corresponding author.

E-mail address: [Aaron.Chadee@sta.uwi.edu](mailto:Aaron.Chadee@sta.uwi.edu) (A.A. Chadee).

age greater decisions under uncertainty and complexity, thus accounting for and reducing cost overrun on public sector projects.

Crown Copyright © 2023 Published by Elsevier Inc.  
This is an open access article under the CC BY license  
(<http://creativecommons.org/licenses/by/4.0/>)

Specifications Table

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Subject                  | Engineering                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Specific subject area    | Construction Cost Management under the Project Management                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Data format              | Raw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Type of data             | Analysed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Data collection          | Table                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                          | Literature research and structured survey questionnaire both hard and soft copy (SurveyMonkey)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                          | Forty-one (41) factors related to cost overrun on construction projects were extracted from 37 journals, through literature research. Structured questionnaires designed with both open-ended questions and the 7-point Likert scale captured the demographic data and the views of the respondents. Survey questionnaires were distributed to construction professionals such as Project Managers, Contractors, Engineers, Architects, and Consultants. A total of 84 responses were obtained through the online SurveyMonkey application and 66 via hard copy. A total of 150 responses were obtained and were used in data generation. The data was analysed with the aid of software such as Statistical Package for Social Sciences (SPSS) IBM 25 and Microsoft Excel 2018. |
| Data source location     | Primary data sources: University of the West Indies, Trinidad and Tobago. Secondary data sources: Obtained through literature (Error! Not a valid result for table.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Data accessibility       | Direct URL to data: Chadee, Aron; Allis, Chamari; Rathnayake, Upaka (2023), "Data exploration on the factors associated with cost overrun on social housing projects in Trinidad and Tobago", Mendeley Data, V3, doi: <a href="https://doi.org/10.17632/46c7hr9r7v.3">10.17632/46c7hr9r7v.3</a><br>Repository name: Mendeley Data<br>Direct URL to data: <a href="https://data.mendeley.com/datasets/46c7hr9r7v/3">https://data.mendeley.com/datasets/46c7hr9r7v/3</a>                                                                                                                                                                                                                                                                                                           |
| Related research article | Chadee, A. A., Martin, H., Chadee, X.T., Bahadoorsingh, S., & Olutoge, F. (2023). Root Cause of Cost Overrun Risks in Public Sector Social Housing Programs in SIDS: Fuzzy Synthetic Evaluation. Journal of Construction Engineering and Management, 149(11), 04023106. <a href="https://doi.org/10.1061/JCEMD4.COENG-13402">https://doi.org/10.1061/JCEMD4.COENG-13402</a>                                                                                                                                                                                                                                                                                                                                                                                                      |

1. Value of the Data

- The data set is the first to provide a methodological classification of the leading root causes of cost overruns in public sector social development housing projects. This is useful in acquiring a deeper understanding of these leading root causes and validated against their theoretical ontologies.
- The data can be used in decision making research to show the uncertainty, imprecision and complexity of perceptions and heuristics used in the construction industry and their major influences on the economic viability of social developmental projects. The data set shifts the current research agenda in cost overrun studies, exposing the lack of attention to the true leading root causes of cost overruns and adds to contemporary academic debate by encouraging project and construction practitioners to reflect, refocus, reframe, and reset the research agenda to uncover key tacit knowledge areas.
- The data can be applied to develop forecasting models to demonstrate the misalignment in the construction housing industry and highlight the gaps in contemporary project practices leading to unsustainable delivery and practices of social housing. The data can be

used as a basis of comparison with that of other Small Island Developing States and/or on a worldwide scale, in the field of construction project management. It further updates project management practices by uncovering and prioritising theoretical constructs critical to public sector projects.

- The provided data can be utilized by academia and construction project practitioners to develop a multitude of risk assessment processes, models and pragmatic tools based on these critical risk factors for further testing to optimize cost performances and sustainability on this value driven socially dependent infrastructure projects.
- The data can be used by policy makers and governmental bodies to analyse the latent effects of critical risk factors grouped under various root causes can have on overall developmental policies, and their emulation on the overall social housing value. These latent effects can be studied to develop strategies to mitigate wicked problems associated with social housing such as crime, unemployment, and income inequalities.

## 2. Data Description

The data was obtained through literature research, and structured questionnaires. A total of 150 questionnaires were distributed to Project Managers, Contractors, Engineers, Architects, and Consultants within the construction industry who have been involved in social housing projects [1]. The data received from the participants were presented as follows: The data on the highest level of education attained by the respondents is presented in Table 1 which illustrates that more than 70% of respondents have a minimum qualification of a Bachelor of Science degree, data on the professional role (Table 2) which highlighted that respondents represent mainly five professional roles, sector of employment in which they are employed (Table 3) either in the

**Table 1**

Data highest level of education attained in the field of Civil engineering/ project management of the respondents.

| Education              | Frequency | Percent |
|------------------------|-----------|---------|
| Other (please specify) | 6         | 4.0     |
| BSc                    | 89        | 59.3    |
| MSc                    | 29        | 19.3    |
| MPhil                  | 7         | 4.7     |
| PhD                    | 2         | 1.3     |
| Diploma                | 17        | 11.3    |
| Total                  | 150       | 100.0   |

**Table 2**

Data on professional role in the company/organisation of the respondents.

| Professional role | Frequency | Percentage |
|-------------------|-----------|------------|
| Project Manager   | 57        | 38         |
| Contractor        | 13        | 8.7        |
| Engineer          | 57        | 38         |
| Architect         | 5         | 3.3        |
| Consultant        | 20        | 13.3       |
| Other             | 17        | 11.3       |

**Table 3**

Data of sector of employment of the respondents.

| Employment sector | Frequency | Percent |
|-------------------|-----------|---------|
| Public            | 85        | 56.7    |
| Private           | 65        | 43.3    |
| Total             | 150       | 100.0   |

**Table 4**  
Data on the nature of the organization's projects to which the respondents belong.

| Nature of organisation             | Frequency | Percentage |
|------------------------------------|-----------|------------|
| Transportation projects            | 22        | 14.7       |
| Civil Engineering projects         | 92        | 61.3       |
| Stadium/Exhibition/shopping center | 33        | 22         |
| Infrastructure Projects            | 81        | 54         |
| Commercial projects                | 44        | 29.3       |
| Water/Wastewater treatment project | 16        | 10.7       |
| Health service projects            | 20        | 13.3       |
| Housing                            | 75        | 50         |
| Other                              | 13        | 8.7        |

**Table 5**  
Data of the number of employees in the organisation of the respondents.

| Number of employees | Frequency | Percent |
|---------------------|-----------|---------|
| less than 20        | 23        | 15.3    |
| 21–50               | 28        | 18.7    |
| 51–100              | 22        | 14.7    |
| 101–150             | 14        | 9.3     |
| 151–200             | 4         | 2.7     |
| more than 200       | 59        | 39.3    |
| Total               | 150       | 100.0   |

**Table 6**  
Data of the number of projects the respondents were involved in /participated in.

| Number of projects | Frequency | Percent |
|--------------------|-----------|---------|
| 0–5                | 55        | 36.7    |
| 6–10               | 33        | 22.0    |
| 11–15              | 16        | 10.7    |
| 16–20              | 9         | 6.0     |
| more than 20       | 37        | 24.7    |
| Total              | 150       | 100.0   |

**Table 7**  
Data on the annual estimated turnover of the company in which the respondent is employed.

| Turnover                | Frequency | Percent |
|-------------------------|-----------|---------|
| Less than 5 million USD | 59        | 39.3    |
| Over 5 million USD      | 91        | 60.7    |
| Total                   | 150       | 100.0   |

public sector or the private sector, types of projects mainly carried out by the organisations to which the participants belong (Table 4) under main eight categories, the number of employees (Table 5) where that most of the respondents are belonging to the organisations which are having more than 200 employees, number of projects participated in (Table 6), annual estimated turn over (Table 7), expected duration of projects (Table 8), and the actual time spent (Table 9). Table 10 presents data on the number of years of experience of each respondent in the field of project management, consultancy, contracting, engineering, and architecture. Data

**Table 8**

Data of the expected duration estimated for the last executed project by the respondents.

| Expected duration of the last project | Frequency | Percent |
|---------------------------------------|-----------|---------|
| less than 12 months                   | 48        | 32.0    |
| 12–18 months                          | 39        | 26.0    |
| 18 months - 24 months                 | 26        | 17.3    |
| 24–30 months                          | 23        | 15.3    |
| 30–36 months                          | 10        | 6.7     |
| N/A                                   | 4         | 2.7     |
| Total                                 | 150       | 100.0   |

**Table 9**

Data of the actual time spent to execute the last project by the respondents.

| The actual duration of the last project | Frequency | Percent |
|-----------------------------------------|-----------|---------|
| less than 12 months                     | 36        | 24.0    |
| 12–18 months                            | 31        | 20.7    |
| 18–24 months                            | 25        | 16.7    |
| 24–30 months                            | 18        | 12.0    |
| 30–36 months                            | 22        | 14.7    |
| greater than 36 months                  | 18        | 12.0    |
| Total                                   | 150       | 100.0   |

**Table 10**

Data on the number of years of experience of the respondents.

| Field              | 0–5 years | 6–10 years | 11–15 years | 16–20 years | > 20 years | N/A years |
|--------------------|-----------|------------|-------------|-------------|------------|-----------|
| Project Management | 40%       | 20%        | 6%          | 10%         | 8%         | 16%       |
| Consultancy        | 23.3%     | 10%        | 4.7%        | 1.3%        | 2%         | 58.7%     |
| Contracting        | 20%       | 7.3%       | 6.7%        | 0.7%        | 6.7%       | 58.7%     |
| Engineer           | 34.7%     | 12%        | 7.3%        | 10.7%       | 12.7%      | 22.7%     |
| Architect          | 16%       | 1.3%       | 4%          | ---         | 2%         | 76.7%     |

on the Risk Impact associated with cost overrun on construction projects compared between the private sector and public is presented in [Table 11](#). The data clearly show that the impact of the factors that contribute to the cost overruns is different between the public and private sectors.

Furthermore, [Table 12](#) presented factors contributing to cost overrun on public sector projects which were extracted through the existing literature. The analysis of the raw data (factors presented in [Table 12](#)), provides the 22 critical factors associated with a cost overrun on public sector projects ([Table 13](#)) based on the severity and the probability of each risk whistle analysing the risk impact factor. The data in [Table 14](#) (Data on the classification and ranking of critical risk factors), [Table 15](#) (Data on the weightings for the 22 CRFs and 4 PRFs for Social Housing Program), [Table 16](#) (Data on the membership function of all CRFs and PRFs for Risk Probability and Severity), [Table 17](#) (Data on the membership function of the overall risk level), [Table 18](#) (Data on the overall risk level) presents the levels to the fuzzy logic analysis approach implemented to rank the principal risk groups (Political, Socio-economical, technical and psychological) according to the risk index.

**Table 11**  
Data on the level of risk associated with a cost overrun on construction projects.

| Assessment statements                                                                          | Private sector |              | Public sector |              |
|------------------------------------------------------------------------------------------------|----------------|--------------|---------------|--------------|
|                                                                                                | Risk impact    | Overall rank | Risk impact   | Overall rank |
| 1. For public sector projects, cost overruns have become the 'new normal' or accepted culture. | 5.64           | 4            | 5.36          | 8            |
| 2. Cost overruns undermine the viability of future projects.                                   | 5.42           | 7            | 5.60          | 5            |
| 3. Cost overruns can negatively impact taxpayers.                                              | 6.16           | 1            | 6.10          | 1            |
| 4. Psychological effects, such as optimism bias has a role in the cost overrun phenomena.      | 4.98           | 14           | 4.99          | 15           |
| 5. Project Actors are swayed by strategic misrepresentation, i.e. deception.                   | 5.03           | 13           | 5.15          | 12           |
| 6. Politicians broker deals on construction projects.                                          | 5.52           | 6            | 5.59          | 6            |
| 7. Politicians lobbying for projects based on personal interest.                               | 5.66           | 3            | 5.82          | 3            |
| 8. Project actors show a marked tendency to underestimate the duration of a project.           | 5.32           | 9            | 5.13          | 13           |
| 9. Project actors show a marked tendency to underestimate the cost of a project.               | 5.38           | 8            | 5.36          | 7            |
| 10. Project actors show a marked tendency to underestimate the risk associated with a project. | 6.08           | 2            | 5.95          | 2            |
| 11. Construction projects often overrun the budget sum.                                        | 5.56           | 5            | 5.62          | 4            |
| 12. There are robust empirical data on substantial cost overruns.                              | 4.49           | 17           | 4.55          | 17           |
| 13. Initial cost is underestimated.                                                            | 5.24           | 10           | 5.32          | 9            |
| 14. Initial cost is unrealistic.                                                               | 5.13           | 12           | 4.95          | 16           |
| 15. confidence in the government on project information is high.                               | 4.83           | 16           | 5.18          | 11           |
| 16. Benefits to society are overestimated.                                                     | 4.85           | 15           | 5.11          | 14           |
| 17. Value for money is less than anticipated.                                                  | 5.16           | 11           | 5.31          | 10           |

**Table 12**  
Data on the 41 factors linked to cost overrun on public sector projects, were extracted and grouped through literature research.

| Authors<br>References           | Cost<br>overruns<br>Factors | Technical Risk (CRG 3)     |                                   |                            |                                    |                      |               |                            |                        |                                                                                          |                 |          |              |                | Socio-Economical (CRG 2) |                     |                       |                |                    |                                |                          |                                |              |                         | Political Risk (CRG 1)                                |                       |                          |                          |                             |                                           |                                             |                                          |                                          |                                            |                                      |
|---------------------------------|-----------------------------|----------------------------|-----------------------------------|----------------------------|------------------------------------|----------------------|---------------|----------------------------|------------------------|------------------------------------------------------------------------------------------|-----------------|----------|--------------|----------------|--------------------------|---------------------|-----------------------|----------------|--------------------|--------------------------------|--------------------------|--------------------------------|--------------|-------------------------|-------------------------------------------------------|-----------------------|--------------------------|--------------------------|-----------------------------|-------------------------------------------|---------------------------------------------|------------------------------------------|------------------------------------------|--------------------------------------------|--------------------------------------|
|                                 |                             | Unknowns (e.g. earthquake) | Poorly defined project objectives | Innovation (novel) project | Schedule duration (Schedule error) | Legal implementation | Design change | Client initiated variation | Sub-surface conditions | Project procurement array of conditions variables & conditions propagating design errors | Underestimation | Omission | Scope Change | Reworks/Errors | Inexperience             | Financial Shortfall | Community involvement | Labour strikes | Shortage of labour | Lengthy bureaucratic processes | Economic business cycles | Acquiring regulatory approvals | Exploitation | Global financial crisis | Strategic Misrepresentation e.g. Underestimating cost | Escalating commitment | Pre-election commitments | Ministerial interference | Direct political influences | Selecting politically aligned contractors | Political business cycles (Election cycles) | Governance shortfall in the organisation | Contract Poorly designed (intentionally) | Selection of a politically aligned PM team | Project actors overestimate benefits |
| (Merewitz, 1973) [29]           |                             | X                          | -                                 | -                          | -                                  | -                    | -             | -                          | -                      | -                                                                                        | -               | -        | -            | -              | -                        | -                   | -                     | -              | -                  | -                              | -                        | -                              | -            | -                       | -                                                     | -                     | -                        | -                        | -                           | -                                         | -                                           | -                                        | -                                        | -                                          | -                                    |
| (Morris and Hough, 1987) [32]   |                             | -                          | X                                 | X                          | X                                  | X                    | -             | -                          | -                      | -                                                                                        | -               | -        | -            | -              | -                        | X                   | X                     | -              | -                  | -                              | -                        | -                              | -            | -                       | -                                                     | -                     | -                        | -                        | -                           | -                                         | X                                           | -                                        | -                                        | -                                          | -                                    |
| (Arditi et al., 1985) [7]       |                             | -                          | -                                 | -                          | -                                  | -                    | -             | -                          | -                      | -                                                                                        | X               | -        | -            | -              | -                        | -                   | -                     | -              | -                  | -                              | -                        | -                              | -            | -                       | -                                                     | -                     | -                        | -                        | -                           | -                                         | -                                           | -                                        | -                                        | -                                          | -                                    |
| (Kaming et al., 1997) [20]      |                             | -                          | -                                 | -                          | -                                  | -                    | -             | -                          | -                      | -                                                                                        | X               | -        | -            | -              | -                        | -                   | -                     | -              | -                  | -                              | -                        | -                              | -            | -                       | -                                                     | -                     | -                        | -                        | -                           | -                                         | -                                           | -                                        | -                                        | -                                          | -                                    |
| (Mezher and Tawil, 1998) [31]   |                             | -                          | -                                 | -                          | -                                  | -                    | -             | -                          | -                      | -                                                                                        | X               | -        | -            | -              | -                        | -                   | -                     | -              | -                  | -                              | -                        | -                              | -            | -                       | -                                                     | -                     | -                        | -                        | -                           | -                                         | -                                           | -                                        | -                                        | -                                          | -                                    |
| (Abd El-Razek et al., 2008) [2] |                             | -                          | -                                 | -                          | -                                  | -                    | -             | -                          | -                      | -                                                                                        | X               | -        | -            | -              | -                        | -                   | -                     | -              | -                  | -                              | -                        | -                              | -            | -                       | -                                                     | -                     | -                        | -                        | -                           | -                                         | -                                           | -                                        | -                                        | -                                          | -                                    |

(continued on next page)



**Table 13**

Data on the risk probability, severity, and risk impact along with the normalised values obtained for the risk factors associated with cost overrun.

| ID | Risk Factors                                                                                         | Risk Probability |      | Risk Severity |      | RSI   | Risk impact | Overall rank | Normalized values |
|----|------------------------------------------------------------------------------------------------------|------------------|------|---------------|------|-------|-------------|--------------|-------------------|
|    |                                                                                                      | Mean             | Rank | Mean          | Rank |       |             |              |                   |
| 32 | Selection of politically aligned contractors                                                         | 5.95             | 1    | 5.83          | 4    | 34.65 | 5.89        | 1            | 1.00              |
| 36 | Contract Poorly designed (intentionally).                                                            | 5.77             | 9    | 5.93          | 1    | 34.18 | 5.85        | 2            | 0.98              |
| 30 | Project actors deliberately underestimate the cost to gain management approvals                      | 5.79             | 7    | 5.86          | 2    | 33.91 | 5.82        | 3            | 0.97              |
| 33 | Selection of political aligned project management team (i.e. consultant, team lead, directors etc.)  | 5.90             | 2    | 5.75          | 8    | 33.91 | 5.82        | 4            | 0.97              |
| 25 | Strategic Misrepresentation i.e. lying e.g. underestimating costs.                                   | 5.76             | 10   | 5.84          | 3    | 33.64 | 5.80        | 5            | 0.96              |
| 28 | Ministerial interference                                                                             | 5.86             | 3    | 5.74          | 9    | 33.64 | 5.80        | 6            | 0.96              |
| 31 | Project actors deliberately overestimating the benefits of projects to society to justify viability. | 5.83             | 5    | 5.75          | 7    | 33.56 | 5.79        | 7            | 0.95              |
| 19 | lengthy bureaucratic processes                                                                       | 5.77             | 8    | 5.79          | 6    | 33.41 | 5.78        | 8            | 0.95              |
| 27 | Pre-election commitments                                                                             | 5.85             | 4    | 5.67          | 10   | 33.13 | 5.76        | 9            | 0.93              |
| 29 | Direct political influences (i.e. ministerial influences, location & type of project)                | 5.63             | 11   | 5.81          | 5    | 32.75 | 5.72        | 10           | 0.92              |
| 34 | Political election cycles                                                                            | 5.80             | 6    | 5.31          | 15   | 30.82 | 5.55        | 11           | 0.83              |
| 26 | Escalating commitment                                                                                | 5.56             | 12   | 5.53          | 13   | 30.77 | 5.55        | 12           | 0.83              |
| 1  | Design change                                                                                        | 5.32             | 14   | 5.58          | 11   | 29.69 | 5.45        | 13           | 0.78              |
| 9  | Rework/Errors                                                                                        | 5.19             | 16   | 5.25          | 16   | 27.28 | 5.22        | 14           | 0.67              |
| 35 | Governance shortfall in the organization                                                             | 5.21             | 15   | 5.23          | 17   | 27.25 | 5.22        | 15           | 0.66              |
| 6  | Underestimation                                                                                      | 4.61             | 29   | 5.55          | 12   | 25.59 | 5.06        | 16           | 0.58              |

(continued on next page)

**Table 13** (continued)

| ID | Risk Factors                                                                                   | Risk Probability |      | Risk Severity |      | RSI   | Risk impact | Overall rank | Normalized values |
|----|------------------------------------------------------------------------------------------------|------------------|------|---------------|------|-------|-------------|--------------|-------------------|
|    |                                                                                                | Mean             | Rank | Mean          | Rank |       |             |              |                   |
| 20 | Economic business cycles                                                                       | 5.03             | 17   | 4.97          | 21   | 25.00 | 5.00        | 17           | 0.55              |
| 21 | Acquiring regulatory approvals                                                                 | 5.42             | 13   | 4.57          | 32   | 24.75 | 4.98        | 18           | 0.54              |
| 37 | Optimism bias, i.e. judging future Project events in a positive light than the actual reality. | 4.80             | 20   | 5.11          | 19   | 24.54 | 4.95        | 19           | 0.53              |
| 10 | Technical uncertainty, i.e. poorly defined project objectives.                                 | 4.67             | 23   | 5.23          | 18   | 24.43 | 4.94        | 20           | 0.52              |
| 17 | Labour strikes                                                                                 | 4.57             | 32   | 5.34          | 14   | 24.39 | 4.94        | 21           | 0.52              |
| 24 | Financial shortfalls                                                                           | 4.84             | 18   | 5.02          | 20   | 24.30 | 4.93        | 22           | 0.52              |
| 13 | Schedule errors                                                                                | 4.81             | 19   | 4.87          | 25   | 23.39 | 4.84        | 23           | 0.47              |
| 38 | Overcommitment/lock-in to a course of action                                                   | 4.66             | 25   | 4.97          | 21   | 23.18 | 4.81        | 24           | 0.46              |
| 14 | Legal implications                                                                             | 4.61             | 30   | 4.91          | 23   | 22.60 | 4.75        | 25           | 0.43              |
| 2  | Client initiated variation                                                                     | 4.78             | 21   | 4.73          | 30   | 22.59 | 4.75        | 26           | 0.43              |
| 8  | Scope change                                                                                   | 4.67             | 23   | 4.83          | 26   | 22.59 | 4.75        | 27           | 0.43              |
| 16 | Community involvement                                                                          | 4.63             | 27   | 4.77          | 28   | 22.09 | 4.70        | 28           | 0.40              |
| 23 | Global financial crisis                                                                        | 4.59             | 31   | 4.78          | 27   | 21.92 | 4.68        | 29           | 0.39              |
| 18 | Shortage of labour                                                                             | 4.63             | 28   | 4.53          | 33   | 20.97 | 4.58        | 30           | 0.34              |
| 15 | Unknowns (e.g. earthquake)                                                                     | 4.35             | 35   | 4.76          | 29   | 20.69 | 4.55        | 31           | 0.33              |
| 40 | Cognitive bias                                                                                 | 4.72             | 22   | 4.38          | 35   | 20.67 | 4.55        | 32           | 0.33              |
| 11 | Inexperience                                                                                   | 4.65             | 26   | 4.23          | 37   | 19.70 | 4.44        | 33           | 0.27              |
| 39 | Cautious attitude towards risks                                                                | 4.37             | 34   | 4.47          | 34   | 19.53 | 4.42        | 34           | 0.26              |
| 5  | The complexity of variables and conditions propagating design errors                           | 4.05             | 39   | 4.66          | 31   | 18.89 | 4.35        | 35           | 0.22              |
| 22 | Exploitation                                                                                   | 3.84             | 40   | 4.91          | 23   | 18.84 | 4.34        | 36           | 0.22              |
| 4  | Project procurement array of conditions                                                        | 4.57             | 32   | 4.06          | 38   | 18.54 | 4.31        | 37           | 0.20              |
| 41 | Prejudices                                                                                     | 4.33             | 36   | 3.97          | 39   | 17.19 | 4.15        | 38           | 0.12              |
| 12 | Innovation (novel) project                                                                     | 4.22             | 37   | 3.97          | 40   | 16.74 | 4.09        | 39           | 0.10              |
| 3  | Sub-surface conditions                                                                         | 3.49             | 41   | 4.37          | 36   | 15.28 | 3.91        | 40           | 0.00              |
| 7  | Omissions                                                                                      | 4.11             | 38   | 3.71          | 41   | 15.22 | 3.90        | 41           | 0.00              |

\*\*RSI means Risk Significant Index= Probability x Severity; .Risk Impact =  $\sqrt{RSI}$ .

**Table 14**  
Data on the classification and ranking of critical risk factors.

| Critical risk factor (CRF) and category                                                                                          | Risk Impact | Overall ranking | Category ranking |
|----------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------|------------------|
| <b>Political(CRG1):<i>u</i><sub>1</sub></b>                                                                                      |             |                 |                  |
| Selection of politically aligned contractors, <i>u</i> <sub>11</sub>                                                             | 5.89        | 1               | 1                |
| Contract Poorly designed (intentionally), <i>u</i> <sub>12</sub>                                                                 | 5.85        | 2               | 2                |
| Project actors deliberately underestimate the cost of gaining management approvals, <i>u</i> <sub>13</sub>                       | 5.82        | 3               | 3                |
| Selection of a politically aligned project management team (i.e. consultant, team lead, directors, etc.), <i>u</i> <sub>14</sub> | 5.82        | 4               | 4                |
| Strategic Misrepresentation i.e. lying e.g. underestimating costs., <i>u</i> <sub>15</sub>                                       | 5.80        | 5               | 5                |
| Ministerial interference, <i>u</i> <sub>16</sub>                                                                                 | 5.80        | 6               | 6                |
| Project actors deliberately overestimating the benefits of projects to society to justify viability., <i>u</i> <sub>17</sub>     | 5.79        | 7               | 7                |
| Pre-election commitments, <i>u</i> <sub>18</sub>                                                                                 | 5.76        | 9               | 8                |
| Direct political influences (i.e. ministerial influences, location & type of project), <i>u</i> <sub>19</sub>                    | 5.72        | 10              | 9                |
| Political election cycles, <i>u</i> <sub>110</sub>                                                                               | 5.55        | 11              | 10               |
| Escalating commitment, <i>u</i> <sub>111</sub>                                                                                   | 5.55        | 12              | 11               |
| Governance shortfall in the organisation, <i>u</i> <sub>112</sub>                                                                | 5.22        | 15              | 12               |
| <b>Socio-Economical(CRG2):<i>u</i><sub>2</sub></b>                                                                               |             |                 |                  |
| lengthy bureaucratic processes, <i>u</i> <sub>21</sub>                                                                           | 5.78        | 8               | 1                |
| Economic business cycles, <i>u</i> <sub>22</sub>                                                                                 | 5.00        | 17              | 2                |
| Acquiring regulatory approvals, <i>u</i> <sub>22</sub>                                                                           | 4.98        | 18              | 3                |
| Labour strikes, <i>u</i> <sub>24</sub>                                                                                           | 4.94        | 21              | 4                |
| Financial shortfalls, <i>u</i> <sub>25</sub>                                                                                     | 4.93        | 22              | 5                |
| <b>Technical(PRF3):<i>u</i><sub>3</sub></b>                                                                                      |             |                 |                  |
| Design change, <i>u</i> <sub>31</sub>                                                                                            | 5.45        | 13              | 1                |
| Rework/Errors, <i>u</i> <sub>32</sub>                                                                                            | 5.22        | 14              | 2                |
| Underestimation, <i>u</i> <sub>33</sub>                                                                                          | 5.06        | 16              | 3                |
| Technical uncertainty, i.e. poorly defined project objectives., <i>u</i> <sub>34</sub>                                           | 4.94        | 20              | 4                |
| <b>Psychological(CRG4): <i>u</i><sub>4</sub></b>                                                                                 |             |                 |                  |
| Optimism bias, i.e. judging future project events in a positive light than the actual reality., <i>u</i> <sub>41</sub>           | 4.95        | 19              | 1                |

**Table 15**  
Data on the weightings for the 22 CRFs and 4 CRGs for social housing program.

| Critical Risk Factors (CRFs)                                                                         | Risk probability ( <i>p</i> ) |                           |                   |                            | Risk severity ( <i>s</i> ) |                           |                   |                            |
|------------------------------------------------------------------------------------------------------|-------------------------------|---------------------------|-------------------|----------------------------|----------------------------|---------------------------|-------------------|----------------------------|
|                                                                                                      | Mean probability              | Weighing ( $w_m$ ) of CRF | Total mean of CRG | Weighting ( $w_i$ ) of CRG | Mean severity              | Weighing ( $w_m$ ) of CRF | Total mean of CRG | Weighting ( $w_i$ ) of CRG |
| Selection of politically aligned contractors                                                         | 5.95                          | 0.086                     |                   |                            | 5.83                       | 0.085                     |                   |                            |
| Contract Poorly designed (intentionally).                                                            | 5.77                          | 0.084                     |                   |                            | 5.93                       | 0.087                     |                   |                            |
| Project actors deliberately underestimate the cost to gain management approvals                      | 5.79                          | 0.084                     |                   |                            | 5.86                       | 0.086                     |                   |                            |
| Selection of political aligned project management team (i.e. consultant, team lead, directors etc.)  | 5.90                          | 0.086                     |                   |                            | 5.75                       | 0.084                     |                   |                            |
| Strategic Misrepresentation i.e. lying e.g. underestimating costs.                                   | 5.76                          | 0.084                     |                   |                            | 5.84                       | 0.086                     |                   |                            |
| Ministerial interference                                                                             | 5.86                          | 0.085                     |                   |                            | 5.74                       | 0.084                     |                   |                            |
| Project actors deliberately overestimating the benefits of projects to society to justify viability. | 5.83                          | 0.085                     |                   |                            | 5.75                       | 0.084                     |                   |                            |
| Pre-election commitments                                                                             | 5.85                          | 0.085                     |                   |                            | 5.67                       | 0.083                     |                   |                            |
| Direct political influences (i.e. ministerial influences, location & type of project)                | 5.63                          | 0.082                     |                   |                            | 5.81                       | 0.085                     |                   |                            |

(continued on next page)

Table 15 (continued)

| Critical Risk Factors (CRFs)                                                                   | Risk probability ( <i>p</i> ) |                           |                   |                            | Risk severity ( <i>s</i> ) |                           |                   |                            |
|------------------------------------------------------------------------------------------------|-------------------------------|---------------------------|-------------------|----------------------------|----------------------------|---------------------------|-------------------|----------------------------|
|                                                                                                | Mean probability              | Weighing ( $w_m$ ) of CRF | Total mean of CRG | Weighting ( $w_i$ ) of CRG | Mean severity              | Weighing ( $w_m$ ) of CRF | Total mean of CRG | Weighting ( $w_i$ ) of CRG |
| Political election cycles                                                                      | 5.80                          | 0.084                     |                   |                            | 5.31                       | 0.078                     |                   |                            |
| Escalating commitment                                                                          | 5.56                          | 0.081                     |                   |                            | 5.53                       | 0.081                     |                   |                            |
| Governance shortfall in the organisation                                                       | 5.21                          | 0.076                     |                   |                            | 5.2333                     | 0.077                     |                   |                            |
| <b>Political(PRF1):<math>u_1</math></b>                                                        |                               |                           | 68.90             | 0.578                      |                            |                           | 68.25             | 0.566                      |
| lengthy bureaucratic processes                                                                 | 5.77                          | 0.225                     |                   |                            | 5.79                       | 0.225                     |                   |                            |
| Economic business cycles                                                                       | 5.03                          | 0.196                     |                   |                            | 4.97                       | 0.194                     |                   |                            |
| Acquiring regulatory approvals                                                                 | 5.42                          | 0.211                     |                   |                            | 4.57                       | 0.178                     |                   |                            |
| Labour strikes                                                                                 | 4.57                          | 0.178                     |                   |                            | 5.34                       | 0.208                     |                   |                            |
| Financial shortfalls                                                                           | 4.84                          | 0.189                     |                   |                            | 5.02                       | 0.195                     |                   |                            |
| <b>Socio-Economical(PRF2):<math>u_2</math></b>                                                 |                               |                           | 25.63             | 0.215                      |                            |                           | 25.69             | 0.213                      |
| Design change                                                                                  | 5.32                          | 0.269                     |                   |                            | 5.58                       | 0.258                     |                   |                            |
| Rework/Errors                                                                                  | 5.19                          | 0.262                     |                   |                            | 5.25                       | 0.243                     |                   |                            |
| Underestimation                                                                                | 4.61                          | 0.233                     |                   |                            | 5.55                       | 0.257                     |                   |                            |
| Technical uncertainty, i.e. poorly defined project objectives.                                 | 4.67                          | 0.236                     |                   |                            | 5.23                       | 0.242                     |                   |                            |
| <b>Technical(PRF3):<math>u_3</math></b>                                                        |                               |                           | 19.80             | 0.166                      |                            |                           | 21.61             | 0.179                      |
| Optimism bias, i.e. judging future project events in a positive light than the actual reality. | 4.80                          | 1.000                     |                   |                            | 5.1133                     | 1.000                     |                   |                            |
| <b>Psychological(PRF4):</b>                                                                    |                               |                           | 4.80              | 0.040                      |                            |                           | 5.11              | 0.042                      |
| Total of mean values of PRFs                                                                   |                               |                           | 119.13            |                            |                            |                           | 120.66            |                            |

CRF = Critical Risk Factor, CRG= Critical Risk Group.

**Table 16**

Data on the membership function of all CRFs and CRGs for risk probability and severity.

| Membership functions for all CRFs and PRFs for cost overrun on Social Housing Programs (Risk Probability) |                   |                                            |                                                   | Membership functions for all CRFs and PRFs for cost overrun on Social Housing Programs (Risk Severity) |                   |                                            |                                                   |
|-----------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------------|---------------------------------------------------|
| CRFs&CRGs                                                                                                 | Weighing for CRFs | Membership function for level 3 (CRFs)     | Membership function for level 2 (CRGs)            | CRFs&CRGs                                                                                              | Weighing for CRFs | Membership function for level 3 (CRFs)     | Membership function for level 2 (CRGs)            |
| <b>Political(CRG1):</b>                                                                                   |                   |                                            |                                                   | <b>Political(CRG1):</b>                                                                                |                   |                                            |                                                   |
| Selection of politically aligned contractors                                                              | 0.086             | (0.01, 0.02, 0.01, 0.05, 0.15, 0.39, 0.36) | (0.012, 0.009, 0.035, 0.077, 0.194, 0.384, 0.290) | Selection of politically aligned contractors                                                           | 0.085             | (0.03, 0.01, 0.01, 0.09, 0.12, 0.39, 0.35) | (0.013, 0.011, 0.035, 0.093, 0.194, 0.374, 0.281) |
| Contract Poorly designed (intentionally).                                                                 | 0.084             | (0.01, 0.02, 0.07, 0.06, 0.14, 0.33, 0.37) |                                                   | Contract Poorly designed (intentionally).                                                              | 0.087             | (0.02, 0.01, 0.03, 0.05, 0.13, 0.36, 0.39) |                                                   |
| Project actors deliberately underestimating the cost to gain management approvals                         | 0.084             | (0.02, 0.00, 0.04, 0.08, 0.12, 0.45, 0.29) |                                                   | Project actors deliberately underestimating the cost to gain management approvals                      | 0.086             | (0.01, 0.01, 0.02, 0.11, 0.12, 0.39, 0.35) |                                                   |
| Selection of political aligned project management team (i.e. consultant, team lead, directors etc.)       | 0.086             | (0.01, 0.01, 0.02, 0.10, 0.12, 0.37, 0.37) |                                                   | Selection of political aligned project management team (i.e. consultant, team lead, directors etc.)    | 0.084             | (0.01, 0.02, 0.05, 0.07, 0.15, 0.37, 0.33) |                                                   |
| Strategic Misrepresentation i.e. lying e.g. underestimating costs.                                        | 0.084             | (0.01, 0.01, 0.04, 0.08, 0.15, 0.43, 0.28) |                                                   | Strategic Misrepresentation i.e. lying e.g. underestimating costs.                                     | 0.086             | (0.01, 0.01, 0.03, 0.08, 0.18, 0.38, 0.32) |                                                   |
| Ministerial interference                                                                                  | 0.085             | (0.01, 0.01, 0.03, 0.06, 0.17, 0.37, 0.35) |                                                   | Ministerial interference                                                                               | 0.084             | (0.01, 0.02, 0.03, 0.08, 0.21, 0.35, 0.31) |                                                   |

(continued on next page)

Table 16 (continued)

| Membership functions for all CRFs and PRFs for cost overrun on Social Housing Programs (Risk Probability) |                   |                                            |                                                   | Membership functions for all CRFs and PRFs for cost overrun on Social Housing Programs (Risk Severity) |                   |                                            |                                                   |
|-----------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------------|---------------------------------------------------|
| CRFs&CRGs                                                                                                 | Weighing for CRFs | Membership function for level 3 (CRFs)     | Membership function for level 2 (CRGs)            | CRFs&CRGs                                                                                              | Weighing for CRFs | Membership function for level 3 (CRFs)     | Membership function for level 2 (CRGs)            |
| Project actors deliberately overestimate the benefits of projects to society to justify viability.        | 0.085             | (0.01, 0.00, 0.03, 0.07, 0.17, 0.41, 0.30) |                                                   | Project actors deliberately overestimating the benefits of projects to society to justify viability.   | 0.084             | (0.01, 0.01, 0.03, 0.09, 0.12, 0.45, 0.28) |                                                   |
| Pre-election commitments                                                                                  | 0.085             | (0.01, 0.01, 0.03, 0.09, 0.17, 0.37, 0.33) |                                                   | Pre-election commitments                                                                               | 0.083             | (0.01, 0.01, 0.03, 0.13, 0.18, 0.35, 0.29) |                                                   |
| Direct political influences (i.e. ministerial influences, location & type of project)                     | 0.082             | (0.01, 0.01, 0.01, 0.03, 0.37, 0.32, 0.23) |                                                   | Direct political influences (i.e. ministerial influences, location & type of project)                  | 0.085             | (0.01, 0.01, 0.03, 0.06, 0.17, 0.43, 0.29) |                                                   |
| Political election cycles                                                                                 | 0.084             | (0.01, 0.01, 0.02, 0.05, 0.19, 0.46, 0.25) |                                                   | Political election cycles                                                                              | 0.078             | (0.01, 0.01, 0.02, 0.09, 0.43, 0.35, 0.09) |                                                   |
| Escalating commitment                                                                                     | 0.081             | (0.01, 0.00, 0.08, 0.15, 0.14, 0.30, 0.31) |                                                   | Escalating commitment                                                                                  | 0.081             | (0.01, 0.00, 0.09, 0.15, 0.17, 0.27, 0.32) |                                                   |
| Governance shortfall in the organization                                                                  | 0.076             | (0.01, 0.01, 0.04, 0.09, 0.43, 0.39, 0.03) |                                                   | Governance shortfall in the organisation                                                               | 0.077             | (0.01, 0.01, 0.04, 0.11, 0.37, 0.41, 0.04) |                                                   |
| <b>Socio-Economical(CRG2):</b>                                                                            |                   |                                            |                                                   | <b>Socio-Economical(CRG2):</b>                                                                         |                   |                                            |                                                   |
| lengthy bureaucratic processes                                                                            | 0.225             | (0.01, 0.01, 0.03, 0.13, 0.11, 0.40, 0.31) | (0.015, 0.023, 0.053, 0.180, 0.314, 0.313, 0.103) | lengthy bureaucratic processes                                                                         | 0.225             | (0.01, 0.03, 0.05, 0.07, 0.15, 0.36, 0.35) | (0.009, 0.024, 0.068, 0.187, 0.291, 0.273, 0.148) |

(continued on next page)

Table 16 (continued)

| Membership functions for all CRFs and PRFs for cost overrun on Social Housing Programs (Risk Probability) |                   |                                            |                                                  | Membership functions for all CRFs and PRFs for cost overrun on Social Housing Programs (Risk Severity) |                   |                                            |                                                   |
|-----------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------------|---------------------------------------------------|
| CRFs&CRGs                                                                                                 | Weighing for CRFs | Membership function for level 3 (CRFs)     | Membership function for level 2 (CRGs)           | CRFs&CRGs                                                                                              | Weighing for CRFs | Membership function for level 3 (CRFs)     | Membership function for level 2 (CRGs)            |
| Economic business cycles                                                                                  | 0.196             | (0.01, 0.01, 0.04, 0.17, 0.45, 0.31, 0.02) |                                                  | Economic business cycles                                                                               | 0.194             | (0.01, 0.01, 0.10, 0.14, 0.38, 0.34, 0.02) |                                                   |
| Acquiring regulatory approvals                                                                            | 0.211             | (0.01, 0.01, 0.05, 0.11, 0.29, 0.34, 0.19) |                                                  | Acquiring regulatory approvals                                                                         | 0.178             | (0.01, 0.03, 0.07, 0.36, 0.41, 0.09, 0.04) |                                                   |
| Labour strikes                                                                                            | 0.178             | (0.03, 0.06, 0.13, 0.13, 0.38, 0.27, 0.00) |                                                  | Labour strikes                                                                                         | 0.208             | (0.01, 0.05, 0.09, 0.14, 0.15, 0.31, 0.25) |                                                   |
| Financial shortfalls                                                                                      | 0.189             | (0.01, 0.02, 0.01, 0.36, 0.33, 0.26, 0.02) |                                                  | Financial shortfalls                                                                                   | 0.195             | (0.02, 0.00, 0.04, 0.22, 0.38, 0.28, 0.06) |                                                   |
| <b>Technical(CRG3):</b>                                                                                   |                   |                                            |                                                  | <b>Technical(CRG3):</b>                                                                                |                   |                                            |                                                   |
| Design change                                                                                             | 0.269             | (0.03, 0.00, 0.01, 0.07, 0.44, 0.39, 0.06) | (0.020, 0.00, 0.023, 0.236, 0.457, 0.211, 0.052) | Design change                                                                                          | 0.258             | (0.01, 0.02, 0.01, 0.06, 0.39, 0.30, 0.22) | (0.007, 0.015, 0.015, 0.081, 0.437, 0.305, 0.140) |
| Rework/Errors                                                                                             | 0.262             | (0.02, 0.00, 0.01, 0.10, 0.53, 0.28, 0.06) |                                                  | Rework/Errors                                                                                          | 0.243             | (0.01, 0.01, 0.02, 0.07, 0.52, 0.33, 0.04) |                                                   |
| Underestimation                                                                                           | 0.233             | (0.01, 0.00, 0.04, 0.41, 0.44, 0.05, 0.05) |                                                  | Underestimation                                                                                        | 0.257             | (0.01, 0.02, 0.01, 0.09, 0.39, 0.23, 0.25) |                                                   |
| Technical uncertainty, i.e. poorly defined project objectives.                                            | 0.236             | (0.02, 0.00, 0.03, 0.37, 0.43, 0.12, 0.03) |                                                  | Technical uncertainty, i.e. poorly defined project objectives.                                         | 0.242             | (0.01, 0.01, 0.03, 0.10, 0.45, 0.35, 0.05) |                                                   |
| <b>Psychological(CRG4):</b>                                                                               |                   |                                            |                                                  | <b>Psychological(CRG4):</b>                                                                            |                   |                                            |                                                   |
| Optimism bias, i.e. judging future project events in a positive light than the actual reality.            | 1.000             | (0.01, 0.01, 0.04, 0.28, 0.49, 0.12, 0.05) | (0.01, 0.01, 0.04, 0.28, 0.49, 0.12, 0.05)       | Optimism bias, i.e. judging future project events in a positive light than the actual reality.         | 1.000             | (0.02, 0.01, 0.05, 0.10, 0.44, 0.33, 0.05) | (0.02, 0.01, 0.05, 0.10, 0.44, 0.33, 0.05)        |

CRF = Critical Risk Factor, CRG= Critical Risk Group.

**Table 17**  
Data on the membership function of the overall risk level (level 1).

| Critical risk groups (CRGs)    | Weighing for CRGs | Membership function of level 2 (CRGs)             | Membership functions of level 1 (ORL)             |
|--------------------------------|-------------------|---------------------------------------------------|---------------------------------------------------|
| Risk Probability:              |                   |                                                   |                                                   |
| <b>Political(CRG1):</b>        | 0.578             | (0.012, 0.009, 0.035, 0.077, 0.194, 0.384, 0.290) | (0.014, 0.010, 0.037, 0.134, 0.275,0.330, 0.200)  |
| <b>Socio-Economical(CRG2):</b> | 0.215             | (0.015, 0.023, 0.053, 0.180, 0.314, 0.313, 0.103) |                                                   |
| <b>Technical(CRG3):</b>        | 0.166             | (0.020, 0, 0.023, 0.236, 0.457, 0.211, 0.052)     |                                                   |
| <b>Psychological(CRG4):</b>    | 0.040             | (0.01, 0.01, 0.04, 0.28, 0.49, 0.12, 0.05)        |                                                   |
| Risk Severity:                 |                   |                                                   |                                                   |
| <b>Political(CRG1):</b>        | 0.566             | (0.013, 0.011, 0.035, 0.093, 0.194, 0.374, 0.281) | (0.011, 0.015, 0.039, 0.111, 0.269, 0.339, 0.217) |
| <b>Socio-Economical(CRG2):</b> | 0.213             | (0.009, 0.024, 0.068, 0.187, 0.291, 0.273, 0.148) |                                                   |
| <b>Technical(CRG3):</b>        | 0.179             | (0.007, 0.015, 0.015, 0.081, 0.437, 0.305, 0.140) |                                                   |
| <b>Psychological(CRG4):</b>    | 0.042             | (0.02, 0.01, 0.05, 0.10, 0.44, 0.33, 0.05)        |                                                   |

CRG= Critical Risk Group.

**Table 18**  
Data on the Overall Risk Level (ORL).

| Critical risk group (PRFs)     | Probability of Occurrence |            | Severity |            | Overall Risk level |            | Ranking |
|--------------------------------|---------------------------|------------|----------|------------|--------------------|------------|---------|
|                                | Index                     | Linguistic | Index    | Linguistic | Index              | Linguistic |         |
| <b>Political(PRF1):</b>        | 5.743                     | Very High  | 5.690    | Very High  | 5.716              | Very High  | 1       |
| <b>Socio-Economical(PRF2):</b> | 5.104                     | High       | 5.138    | High       | 5.121              | High       | 2       |
| <b>Technical(PRF3):</b>        | 4.953                     | High       | 5.403    | High       | 5.173              | High       | 3       |
| <b>Psychological(PRF4):</b>    | 4.800                     | High       | 5.113    | High       | 4.954              | High       | 4       |
| <b>OverallRiskLevel(ORL)</b>   | 5.437                     | High       | 5.496    | High       | 5.466              | High       | -       |

3. Experimental Design, Materials and Methods

The population of the data consists of professionals within the construction industry namely Project Managers, Contractors, Engineers, Architects, and Consultants. A total of 150 questionnaires were distributed, 84 via the online SurveyMonkey tool. These included 15 email invitations with 5 responses (33.33%) and 79 web links. Additionally, 66 hard-copy questionnaires were administered and returned. Evidence from the literature provided 41 risk factors associated with cost overruns on public sector projects within the construction industry. The responses were rated on a 7-point Likert scale (1 = extremely low, 2 = very low, 3 = low, 4 = moderate, 5 = high, 6 = very high, 7 = extremely high), to determine the probability and severity of each risk factor. The data collected was analysed in the Statistical Package for Social Sciences (SPSS) IBM 25. Descriptive statistical tools such as frequency, percentage, and mean were used to present the data. Calculations of the risk impact (RI) values, normalisation values, and ranking were carried out in Microsoft Excel 2018.

The respondents' perceptions of the problematic issues related to cost overrun on public sector infrastructure development projects (PSIDPs) were ranked distinctly according to the sector of employment of the respondents (Table 11).

The 22 critical factors contributing to cost overrun within Trinidad and Tobago public sector projects were obtained through normalisation of the risk impact (RI) values of the 41 factors and

ranked according to the normalised values obtained so that factors having values greater than 0.5 were deemed critical (Table 13).

Through the application of fuzzy logic, namely fuzzy synthetic evaluation, the 22 critical risk factors (CRFs) were classified under four critical risk groups (CRGs), namely, political, socio-economical, technical, and psychological, and ranked overall according to their category, based on the risk impact (Table 14) [1]. The weighing function, of the CRFs, (second-level) and CRGs (first level) are calculated from the mean values, obtained through SPSS for both its probability and severity (Table 15). Next, the membership functions of the CRFs & CRGs (level 1) along with the risk level of each CRG (MF level 2) were determined and presented in Table 16. The obtained fuzzy evaluation matrixes,  $D_i (i = u_1, u_2, u_3, u_4)$  of the CRGs (level 2) were further normalized by considering their weighing functions to generate the final fuzzy evaluation matrix of overall risk level (ORL) of cost overrun of social housing development (i.e. level 1). The probability and severity matrixes of the PRFs are represented in column 3 of Table 17. The overall risk level of cost overrun on public sector projects in developing countries is presented in Table 18 which illustrates that the political category has more risk compared to the others.

The outcome of this study indicates that further studies could be conducted to evaluate the cost controlling and monitoring strategies for the identified risk factors of cost overrun on social housing projects and a study on cost planning and estimating mechanisms to mitigate the factors of cost overrun on social housing projects could also be carried out. Furthermore, similar types of studies can be conducted for the other types of building and infrastructure construction projects which will contribute greatly to the existing knowledge and the betterment of the industry.

## Limitations

None.

## Ethics Statement

The proposed data does not involve any human subjects, animal experiments, or data collected from social media platforms.

## Data Availability

Data exploration on the factors associated with cost overrun on social housing projects in Trinidad and Tobago (Original data) (Mendeley Data)

## CRedit Author Statement

**Aaron Anil Chadee:** Conceptualization, Methodology, Software, Writing – original draft, Investigation; **Chamari Allis:** Validation, Writing – review & editing; **Upaka Rathnayake:** Validation, Writing – review & editing; **Hector Martin:** Validation, Writing – review & editing; **Hazi M Azamathulla:** Validation, Writing – review & editing.

## Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Reference

- [1] A.A. chadee, H. Martin, X.T. Chadee, S. Bahadoorsingh, F. Olutoge, Root cause of cost overrun risks in public sector social housing programs in SIDS: fuzzy synthetic evaluation, *J. Constr. Eng. Manag.* 149 (11) (2023) 04023106, doi:[10.1061/JCEMD4.COENG-13402](https://doi.org/10.1061/JCEMD4.COENG-13402).