

1 **Construction Contingency Determination: A Review**
2 **of Processes and Techniques**

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13 **Abstract.** Contingency provision on a construction project is one of the risk
14 management techniques embraced by project owners to deal with project
15 unanticipated expense (spending) and time overruns. However, contingencies
16 could be overestimated or underestimated. The current study therefore
17 investigated how contingency is determined on construction projects and the
18 benefits of contingency planning. A literature review of literature was undertaken
19 from various databases including Academic Search Complete, Google, Goole
20 Scholar, Ebscohost and others. The materials used were selected based on their
21 possession of the key words related to the study. Thematic content analysis was
22 used to identify themes on cost and time contingency planning process and
23 techniques. The findings revealed that the process of cost contingency
24 determination entails identifying different scenarios of events and risks, and
25 developing the plans based on the potential responses to the identified risks.
26 Further findings revealed that various techniques may be used in the process and
27 practice of estimating cost and time contingencies. The findings are envisaged to
28 be beneficial to construction stakeholders assess and improve on contingency
29 planning process on projects.

30 **Keywords:** Construction, Contingency, Planning, Project management

31 **1 Introduction**

32 The construction industry contributes to the gross domestic product (GDP),
33 employment and capital formation in an economy [1]. The sector is the biggest
34 industrial employer recording to around 7% in many nations and making up around 9%
35 of the world's GDP [2]. However, most often, construction projects overall make a
36 nationwide headline for being a financial disaster as opposed to the accomplishment of
37 the critical engineering contribution that it adds to the improvement of our built

38 environment [3]. Construction projects are faced with various risk and uncertainties,
39 including conceptual cost estimation [4]. The construction industry had thus gained a
40 poor reputation for delivering project over the estimated budget and time plans. Due to
41 the numerous risks associated with project deliveries, project owners tend to make
42 provision for contingencies, as part of the costs at the planning stage, which are able to
43 absorb monetary impact risk/uncertainty and variability. These contingencies can be
44 in the form of (money, time, quality specification, man-hours, machine-hours, and raw
45 materials), which are put in place to ensure that the project objectives of time, quality
46 and scope are not jeopardized due to any unforeseen risk that might arise during project
47 execution. Contingencies are planned in order to hedge and absorb these risks [5].
48 However, construction projects hardly live up to the plans because of the risks related
49 and the general vulnerable and stochastic nature of construction projects [6]. These
50 risks should be recognized and overseen in the planning stage. This is even more
51 important given the complex nature of construction projects with hidden and apparent
52 costs. Therefore, research on how contingency amounts are determined and the benefits
53 of contingency planning in construction projects warrant attention.

54 Previous similar studies on contingency planning have dwelt on schedule delays and
55 plan contingency [6] or on the techniques and did not include the process of
56 contingency planning [7]. Further, [5] investigated management of contingencies
57 among Spanish contractors and found that about half of the site managers do not
58 typically include time and cost buffers in their budgets and schedules and when
59 contingencies are established, it is usually done in a subjective manner. However, the
60 study did not reveal the processes undergone or the factors considered in contingency
61 planning. Other studies which considered factors affecting contingency determination
62 employed risk analysis and fuzzy logic system (incorporating subjective notions of
63 contractors) [8], [9]. The objectives of the study were therefore to investigate the
64 processes and strategies for contingency determination and the pros and cons of
65 inadequate contingency planning. The findings of the study are significant because if
66 projects are delivered without adequate determination and management of
67 contingencies, they may not perform as planned. The succeeding sections of this paper
68 present the findings from a literature review on the factors that should be considered in
69 the contingency planning process, irrespective of the various stakeholder views.

70 **2. Methods**

71 The present paper presents a review of literature based on international context with
72 the aim of identifying how contingencies are determined and the benefits of adequate
73 contingency planning. To achieve this objective, a distillation of related literature from
74 online databases including Google, Google Scholar, Ebscohost and Science Direct, was
75 undertaken. Various sources including accredited journals, conference proceedings and
76 organisation websites were consulted. The materials used were selected based on their
77 possession of the key words related to the study, including contingency planning, risk
78 management, construction contingencies, and project management. Thematic content
79 analysis was used to identify themes on contingency planning influencers and

80 considerations. The succeeding sections present the review of related literature on the
81 themes, summary of findings, conclusion and recommendations.

82 **3. Construction Contingency Planning**

83 **3.1 An overview**

84 Construction projects are typically a once-off endeavour with numerous unique features,
85 for example, different project members, long maturation periods (between origination-
86 design construction), composite acquisition procedure, huge fiscal requests and
87 dynamic organization configurations. All these have made the risk and vulnerabilities
88 identified with construction projects more peculiar as compared to other sectors.
89 Though literature revealed that construction risk can't be disposed of, it can be relieved
90 and overseen successfully. Thus if project risk and unprecedented attributes are
91 recognized and measured at the beginning times of the project, this will ensure that all
92 relevant project stakeholders (customers, experts and contractors) will strive to
93 accomplish project goals of cost, time, quality and safety.

94
95 The success of construction projects, generally viewed as being completed on time,
96 within the budget plan and the quality fulfilled by all, is characterised as much preferred
97 outcomes over the normal or ordinarily acquired. Nonetheless, the term project success
98 is a foundation to manage and control the current project, in order to plan and orient the
99 future project [10]. It assumes that things that cannot be estimated cannot be improved.
100 This is the basis of adequate planning in construction project development. The
101 planning and control of costs cannot be successful if the extenuations are not evaluated
102 and planned for at the initial stage of the projects.

103 The term contingency, used in this document in a generic manner, is mainly employed
104 by a number of authors to describe the amounts of money that budgets often include in
105 order to prevent cost overruns related to unforeseen, unexpected or underestimated
106 events [5]. However, there are various other forms of contingencies including time
107 (buffers) to accommodate project delays, material stock piles buffers, work in process
108 buffers, capacity (manpower, tools and equipment), plan buffers as well as scope and
109 quality buffers [5]. According to [4], contingency is viewed differently but the various
110 stakeholders in a project. To engineers, contingency is a savings account that can be
111 drawn on to take care of the extra expenses of miscalculated or excluded project costs;
112 to the construction division, it is an amount used to take care of extra expenses caused
113 by longer schedules, construction issues, and lower profitability; to the cost engineer,
114 it is an amount that can be utilized to take care of higher expenses because of the
115 absence of definition at the evaluating stage, including miscalculation of material, gear,
116 labour and indirect expenses. The two main types of contingencies are further discussed
117 hereunder.

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121 3.1.1 Cost contingency

122 Contingency cost is a reserve fund added to the total assessed project cost and often it
123 is communicated in percentage terms [11]. “Cost” is alluded to as the level of fulfilment
124 of construction work within the assessed spending plan. A project’s total cost is often
125 broken down into two parts, namely: base cost and contingency cost. Base cost is the
126 expense of the project which omits contingency. The total cost is not just bound to the
127 tender sum, but incorporates any expenses that emerge from varieties, changes amid
128 the construction time period, including impact of changes in the price of labour,
129 material, plant, preliminary items and specialist subcontractors as well as costs brought
130 about by lawful cases, for instance, litigation and arbitration [12]. This underlines the
131 relevance of more accurate cost determination or estimation techniques at the planning
132 stage of projects, to cater for project exigencies or unexpected occurrences from a
133 reserve of funding termed “contingency”.

134 3.1.2 Time contingency

135 The term 'time contingency' is characterized as the measure of time added to the base
136 assessed project time to accomplish a particular certainty level or to take into account
137 changes where experience indicates commitment [13]. It can likewise be characterized
138 as the measure of time put aside to manage construction vulnerabilities, risk of overruns
139 of project goals to a satisfactory level [14]. Time contingency is viewed as a standout
140 amongst the most basic instrument used in a construction project to foresee or to give
141 a sensible time frame. Because of this reason, satisfactory estimation of time
142 contingency will help towards to minimization of overspending plan and help to prevent
143 completion delays in projects [13].

144
145 Contingency is utilized to guarantee the fruition of time of a project and all things
146 considered gives a level of certainty that the planned duration be accomplished. Most
147 managers and engineers depend on their experience of deciding on schedule and cost
148 contingency [13]. On their part, [15] evaluated time contingency as 20% of the project
149 period, while [16] presented an approach that joins network analysis incorporating
150 flexible scheduling in risk strategy and plan analysis due to changes as a result of the
151 complexity of construction projects. The study [16] examined the impact of different
152 factors on time contingency utilizing a linear equation. Further, [17] expressed that in
153 the industrial division, there are numerous project scheduling programming, for
154 example, Primavera and Microsoft Project; in any case, the most prominent is Risk
155 Expert. This is on the grounds that it gives quantitative and qualitative examinations of
156 project data, which is utilized to give a clearer image of the genuine expense and time
157 size of any project considering risk, punishments, and complex scheduling factors.

158 These varying views therefore make it difficult to determine the amount to be set aside
159 for contingency on a particular project. However, certain factors affect the
160 determination or planning for contingency in order to deal with unanticipated expenses

161 and spending overruns, which are not considered or satisfactorily took into account at
 162 the planning phase [18]. This is the premise of the current study.

163 **3.1.3 Material and labour contingencies**

164 Related to the costs of construction are project resources such as material and labour
 165 required to successfully complete a given project [19]. Considerations made at the time
 166 of concept and planning of projects should include these which may constitute risks in
 167 building projects [20]. Hence, in preparation of bids, estimates should include thorough
 168 assessment and planning for project resources.

169 **3.2 Benefits of contingency planning**

170 Contingency planning helps to ensure that response is composed in light of the fact that
 171 objectives, procedures, roles and duties are cleared up ahead of time [21]. In addition,
 172 [22] added that the benefits of contingency reserve in a projects are as follows:

- 173 ❖ This reserve fund is important to guarantee smooth fulfilment of design and
 174 construction, with no risk to the project caused by an absence of accessible
 175 funds.
- 176 ❖ The contingency amount put aside as a cost contingency in the project is a
 177 component of the cost risks related to the project at that time.
- 178 ❖ The incorporation of contingency amount on a project spending plan mirrors
 179 the by and large budgetary plan that will be utilized to cover known and
 180 unknown components of the projects.
- 181 ❖ The value and assessed risk of a project change over its lifecycle. For
 182 example, the best pre-construction planning will greatly reduce contingency
 183 reserve.
- 184 ❖ Contingency reserve for design will reduce from the concept design stage to
 185 contract document stage.

186 Undoubtedly, contingency planning guarantees accessibility of standby resource and
 187 provides an effective mechanism that can help reduce project disaster response [23].
 188

189 **3.3 Contingency planning process**

190 According to [24] and [25], the contingency determination process, as depicted in
 191 Figure 1, entails an identification of scenarios of events, determination of imminent
 192 risks, developing responses to the identified risks and thereafter, developing a budget
 193 to cater for the risks identified.

194
 195 The first step in the planning process is identifying scenarios of events and having
 196 records or rundown of conceivable courses of events that could happen, which forms
 197 the reasons behind planning presumption. Notably, scenarios are important scope of
 198 conceivable issues and its probabilities, for instance, what planners think could happen,
 199 how to work around such issues, what conditions individuals will confront, what effect
 200 will the risk will have and what limit individuals should adapt to in such an event, how
 201 well to be prepared ahead of time. Developing scenarios is a good way of thinking
 202 through the possible impacts, on which basis one can develop a plan that sets out the

203 scale of the response and the resources needed [21]. Therefore, scenarios being the
 204 foundation of the contingency plan, it likewise contains the principle planning
 205 assumptions used for the development of such a plan [24].

206

207 The second step is detecting the imminence of risk. This alludes to the probability of
 208 the recognized risk happening and assessing the level of potential harm (Bridges, 2014).
 209 Once the risk has been recognized they ought to be recorded within contingency plan
 210 and monitored [25]. The risk is categorised by the probability of their occurrence [25].
 211 In addition, the impact or severity and distribution of those risks are quantified [8].

212 The third step is developing effective responses to the events are the activities required
 213 by the risk manager to relieve misfortune should the distinguished risk happen [25]. It
 214 is suggested that event managers conduct an experimental run of responses created to
 215 oversee recognized risk situations, therefore it will guarantee that they can deal with
 216 the management of contingency plan [25].

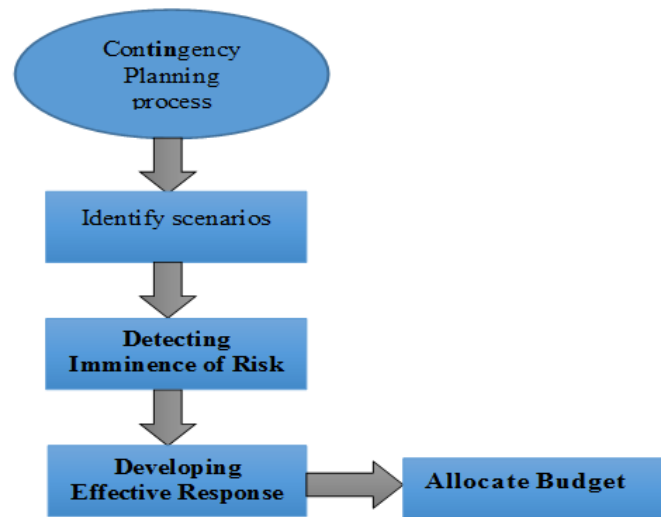
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218 Lastly, a contingency budget and schedule plan is created and all required will be reliant
 219 on the size and unpredictability of the project. For example, most organisations usually
 220 add 10 % - 15 % to the base cost for all contingency related expenditure. In addition, it
 221 ought to be noticed that while some contingency planning are broadly detailed, others
 222 are short and unreal [26]. Nonetheless, planning for contingencies should incorporate
 223 all the factors that potentially affect estimated costs, time and related uncertainties in
 224 order to ensure that a project is completed successfully.

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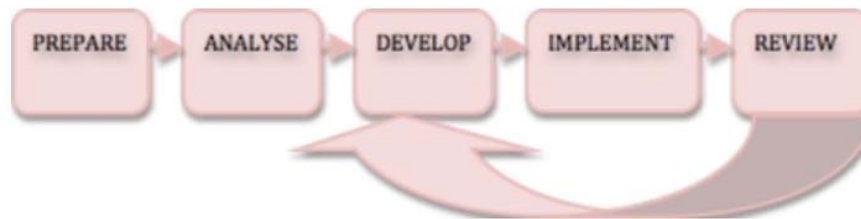


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Figure 1. Contingency Planning Process (Source: Bridges, 2014)

230 In the view of the IFRC (2019), the contingency planning process is an iterative process
 231 that involves developing plans, reviewing and refining plans (Figure 2). In addition, it
 232 should be a collaborative effort on the part of all stakeholders involved in the project.



233

234 **Figure 2.** Steps in Contingency Planning (Source: IFRC, 2019)

235 **3.4 Contingency determination techniques**

236 According to [27], the methods used to estimate cost contingency in most construction
 237 industries are traditional, qualitative, semi-quantitative, probabilistic, deterministic,
 238 and simulation-based techniques. The majority of contingency estimation methods
 239 available focuses on the initial estimate of time and cost contingency and the most
 240 methods used are the deterministic and probabilistic method.

241 Deterministic approaches are the most basic since they focus on estimating a general
 242 percentage of the base cost estimate to include in the budget or the schedule, while
 243 probabilistic methods focus on identifying risk and allocating them in an itemised way
 244 of time and money to cover the risk [28]. Further findings evinced the advantages and
 245 disadvantages of these cost contingency determination techniques [7], [13], [18] and
 246 [29]. These are summarised in Table 1. According to [7], a variety of techniques are
 247 necessary, given the major shortcomings of the traditional judgemental and arbitrary
 248 approach to cost contingency estimation, which includes the following:

- 249 • Being calculated as an across-the-board percentage addition on the base
 250 estimate, typically derived from intuition, past experience and historical data;
- 251 • It is usually illogically arrived at and thus may not be appropriate for the
 252 proposed project;
- 253 • Calculation is difficult for the estimator to justify or defend and the risk is
 254 either disregarded or handled in a discretionary way, and so percentage used
 255 is sometimes not justifiable; and
- 256 • It does not encourage creativity in estimating practice, promoting a routine
 257 and mundane administrative approach requiring little investigation and
 258 decision making.

259 Therefore, other methods including Monte Carlo simulation, range estimating,
 260 regression, artificial neural networks and others may be more suitably applied in certain
 261 types of projects than others. In summary, if project risks and unprecedented attributes,
 262 which cause (envisaged) vulnerabilities in the project, are recognized and measured at

263 the planning stage of projects, success in terms of cost and time control, will be
264 achievable.

265 **4. Conclusion**

266

267 The study sought to investigate the process and techniques for planning and
268 determining contingencies on construction projects. It was found that the process of
269 contingency determination involves identifying different scenarios of events and risks,
270 and developing the budget and schedule plans based on the potential responses to the
271 identified risks. Further findings revealed that various techniques may be used in the
272 process and practice of estimating contingencies. The current study provides
273 information, which is envisaged to be beneficial to construction stakeholders in
274 adequately planning and allowing for contingencies on their projects.

275

276 Since the current study was a literature review only, further studies are recommended
277 to determine how contingencies are allowed for on construction projects and the level
278 of usage of the identified techniques in practice, using alternative research approaches.

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Table 1: Contingency methods/techniques

	Contingency Methods / Level or area of usage	Advantages	Disadvantages
1	Traditional Percentage Method / Used on all project types	<ul style="list-style-type: none"> •Convenience and consistency •Subjectivity is expelled from the procedure by the utilization of a consistent percentage. 	<ul style="list-style-type: none"> •Problematic for the estimator to legitimize the reason for the percentage utilized. •Does not support creativity in evaluating in practice. •The risk is either disregarded or managed in a discretionary way.
2	Method of Moment / Infrequently used	<ul style="list-style-type: none"> •The individual cost in the project has its normal values and variance. •The normal values and variance for all cost items are included in arriving for the overall project cost. 	<ul style="list-style-type: none"> •Because of its mathematical foundation, it is extremely hard to use •Not reasonable for complex and large infrastructure.
3	Individual risk- expected value / Used in all project types	<ul style="list-style-type: none"> •It can model vulnerability as contingencies with particular probabilities can be examined for a better outcome. 	<ul style="list-style-type: none"> •Recognizing the fixed and variable components of the project is in respect to the type and nature of the project. Regardless, it receives a conventional approach
4	Monte Carlo Simulation / Used in substantial capital projects	<ul style="list-style-type: none"> •The model identifies the result of risk identification and effect assessment which can be used to estimate Contingency. 	<ul style="list-style-type: none"> •Monte Carlo evaluating method is frequently harder than the traditional strategy. •It is once in a while used as a part of the business. It does not specifically give data about the change of the measurable dispersion of the acknowledged net benefits.

Contingency Methods / Level or area of usage	Advantages	Disadvantages
5 Factor Rating / Used in substantial capital projects	<ul style="list-style-type: none"> •This technique can be utilized to check the measure of contingency dictated by different strategies for assessing contingency sum. •Apart from the capacity to check the contingency sum created by different techniques, it is a strategy for foreseeing its own particular contingency. 	<ul style="list-style-type: none"> •Picking the four determinants of the accuracy of the estimate is Seriously deficient. It might prompt high contingency if the estimator is incorrect.
6 Range Estimating / Construction road projects	<p>It deals with hopeful and negative closures of estimation. It is more secure than the traditional strategy.</p>	<ul style="list-style-type: none"> •It additionally receives a deterministic approach which makes it less precise compared with regression models.
7 Regression / All construction projects, mostly building	<ul style="list-style-type: none"> •These models depend on historical information of projects, they bring expert information to contingency setting without the requirement for a skilled expert on each project. 	<ul style="list-style-type: none"> • It depends on historical cost information which once in a while may not be accessible. Tedious to assemble historical cost information.
8 Artificial Neural Networks / Roads projects, Oil and gas projects	<p>The forecast precision of this strategy for contingency estimation outperforms that of the traditional technique</p>	<p>Appropriate for non-linear modelling of information. It contradicts the direct approach of regression and different techniques like the Monte Carlo.</p>
9 Fuzzy Sets / Significantly on building projects; few highway projects	<ul style="list-style-type: none"> •It permits examination with small samples. •It uncovers relationship between result and illustrative factors 	<ul style="list-style-type: none"> •It is difficult to build up a model from a fuzzy system. For this strategy to be utilized for successful contingency estimation, it requires more fine tuning and simulation before it is operational.
10 Controlled Interval Memory / hardly used	<ul style="list-style-type: none"> •The model is accommodated with different perspectives of the project it speaks to. 	<ul style="list-style-type: none"> •The numerical structures make it hard to use since management and expert thinks that it's hard to understand.
11 Influence Diagrams / Multifaceted construction projects	<ul style="list-style-type: none"> •It helps to lessen extensive volumes of information that is fundamental to the decision making process. 	<ul style="list-style-type: none"> •Like other probability Models.
12 Theory of Constraints	<ul style="list-style-type: none"> •The utilization of this model yields an achievable and immunized plan centred on the Critical path of the work that rules the project through to its execution. 	<ul style="list-style-type: none"> •This strategy presumes cost Items are autonomous from each other. •This is not correct in a real life application.

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