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Type of Paper: Case Study ❒
"Best Tested and Proven Practice" ❒
New or Academic Theory ☒
Process or Procedure (New or Improved) ❒
Other _____ ❒

November - 2018
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STRATEGIES TO INCLUDE CONTINGENCY IN PUBLIC PROJECT ESTIMATES

ABSTRACT-

In some countries, Public Projects do not allow Contingency. As Private Projects, they also finish with cost overruns, because they are not exempt from the same problems during the execution of activities.

Can we determine a good strategy to include a contingency in their budgets and meet point estimates to avoid cost overruns?

The author has analysed different tools and techniques to respond strategically or tactically to an event and especially that can adapt to Public Projects Policies if we want a high confidence level of probability to meet project point estimates.

In addition, there is an analysis of what tools and techniques can help projects to monitor if these alternatives are helping to meet criteria like tendency charts or accuracy and precision of final estimates in order to accomplish projects' objectives.

A preliminary assessment can be conducted when preparing Estimates during Sensitivity Analysis, therefore, we can evaluate what strategy can be implemented for specific cost drivers and their potential impacts.

We can conclude that Buffer and Contingency strategy from the Guild of Project Controls is a good technique that meets all the criteria to prevent exceed Public Projects' Estimates.

KEY WORDS- Management of Contingency, Allocation of Contingency, Budget Transfer, Budget Shift, Trends and Contingency, Public Projects Point Estimates, Buffer Contingency, Buried Contingency, Risk or Opportunities Responses, Monitoring Risk, Sensitivity Analysis Factors.

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INTRODUCTION-

It is well known that indistinctly, private or public projects finish with cost overruns. Causes for cost overruns have been listed by many authors who have done research in different sectors and different project sizes, founding justification on bad estimates, poor tracking and analysis, bad forecast, bad contracts, poor project definition, final costs incurred were not based on the initial BOE, true cost was not revealed because cost-benefit analysis hurdles, bad control of project changes, unsettle requirements during quotation phase, project complexity, regulatory issues, type of ownership, etc.

Focusing on bad estimates, reasons to get results that do not match with what really happens in real life can also be listed as the bad definition of scope, early estimates are biased over-optimism, inaccurate initial estimates of overall cost and schedule reflecting technology development to accomplish the original work scope; ratios or unit prices are not updated, estimates are a function of the stage of the development of the subject article, escalation indexes that not reflect reality, lack of experience of estimator, bad estimation of contingency, contingency was not estimated, etc.

What is really surprising on the previous list is that Contingency is not estimated in some cases. A couple of reasons that it cannot be estimated are, poor knowledge of estimation methods or policies of public entities does not allow Contingency.

The author has noticed that most public projects in Peru do not allow contingency because "the government does not make mistakes"[1] (sic). This phrase is so far away from reality. Any Public Project executed is not exempt from the same problems as the private sector.

Why is important to have a contingency in public projects? To help Public Entities to have a more realistic estimate, avoid cost overrun and to meet best practices in preparing point estimates.

The risk management process integrates the analysis of the contingency, which can be estimated in time or cost, to finance the response plans during the occurrence of known events that were identified previously.

[1] Author Unknown

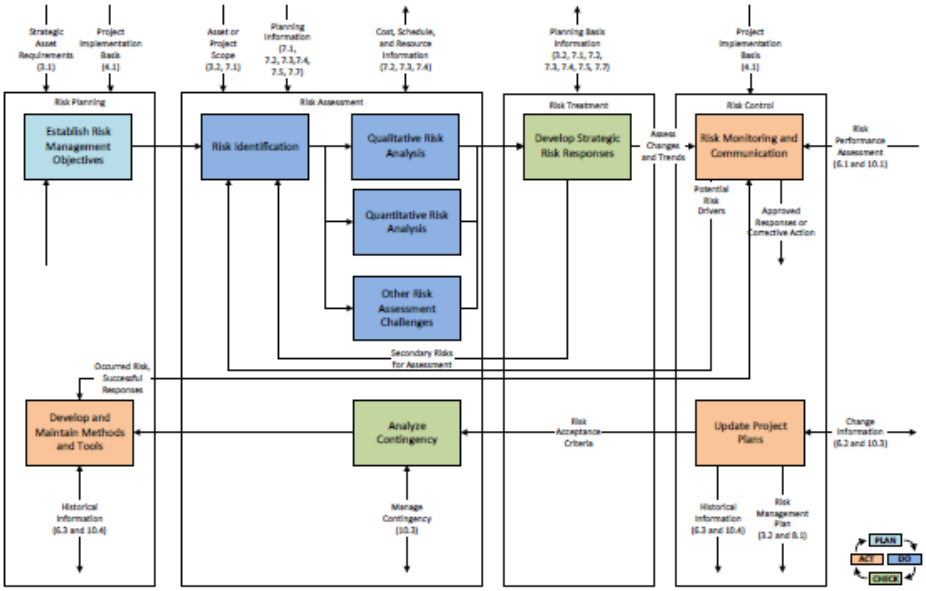

Figure 1 Risk Process Map[2]

In addition, during the forecasting process or change management process, contingency and risk are analysed again in order to determine if contingency can be drawdown or a new process to ask for funds should be triggered.

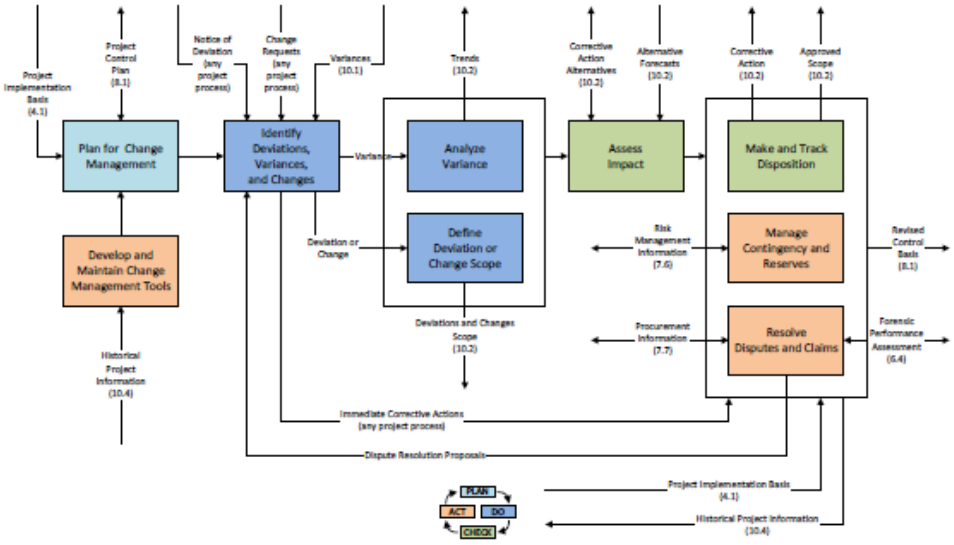

Figure 2 Change Management Process Map[3]

[2] H. Lance Stephenson. (2015). Total cost management framework: An Integrated Approach to Portfolio, Program, and Project Management (2nd Ed.). Morgantown, WV: AACE International. Page 201

[3] H. Lance Stephenson. (2015). Total cost management framework: An Integrated Approach to Portfolio, Program, and Project Management (2nd Ed.). Morgantown, WV: AACE International. Page 267.

Furthermore, when managing contingency, how project controllers have a more accurate forecast and determine a more realistic approach of use of Contingency in order to identify savings and draw down money to fund other projects in an investment company's portfolio? If money cannot be used and it is retained, there is a loss because of opportunity cost.

For example, as shown in next figure, contingency can be distributed at the beginning of each program and in a portfolio of projects as follows.

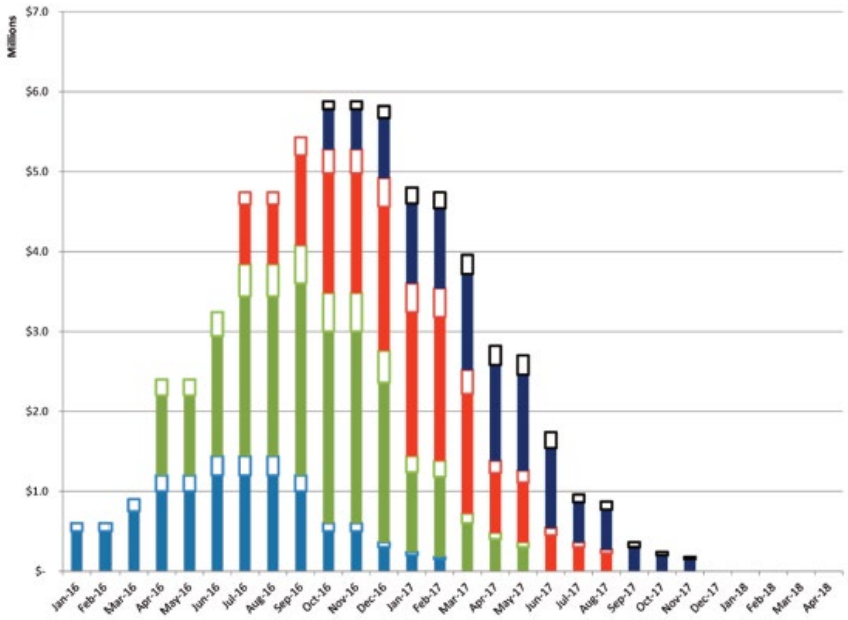

Figure 3 Four project portfolio with contingency distributed[4]

But, what happens in reality? Most of the contingency is spent at the end of a project, once budget cost has been spent and funding is required. See the figure below.

[4] White, R. (2015). CSC.1937- Project Risk Drawdown – Contingency Drawdown Forecasting, Tracking, and Actual Contingency Spend Forecasting. AACE International, Morgantown, WV. Page 10

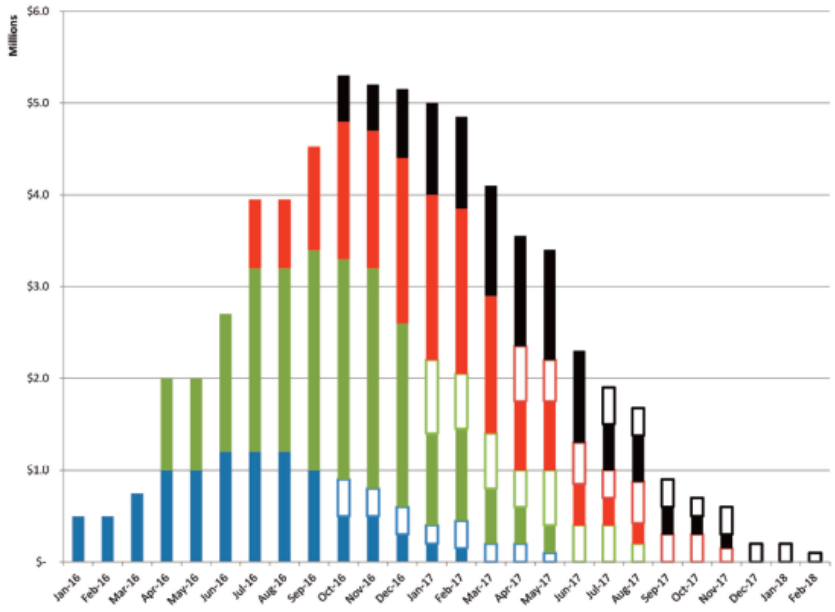

Figure 4 Realistic Spend of Contingency Forecast[5]

These processes are aligned to best practices in estimating that recommend adding a contingency to the estimate and document the cost or time contingency estimate required for each event identified. Contingency estimates should respond to complete a task within the range of probability of estimate expected by the estimator. For that reason, when documenting the basis of estimate, the allocation of this contingency in the project costs differs from projects or industrial sectors according to policies of companies related to accepting or not a contingency in their budgets.

The Guild of Project Controls mentions two types of approaches to building a time or cost contingency in order to allocate them within the budget, through buffer activities or buffer accounts, or buried time or cost in project accounts in order to respond to known events when they occur.

[5] White, R. (2015). CSC.1937- Project Risk Drawdown – Contingency Drawdown Forecasting, Tracking, and Actual Contingency Spend Forecasting. AACE International, Morgantown, WV. Page 11

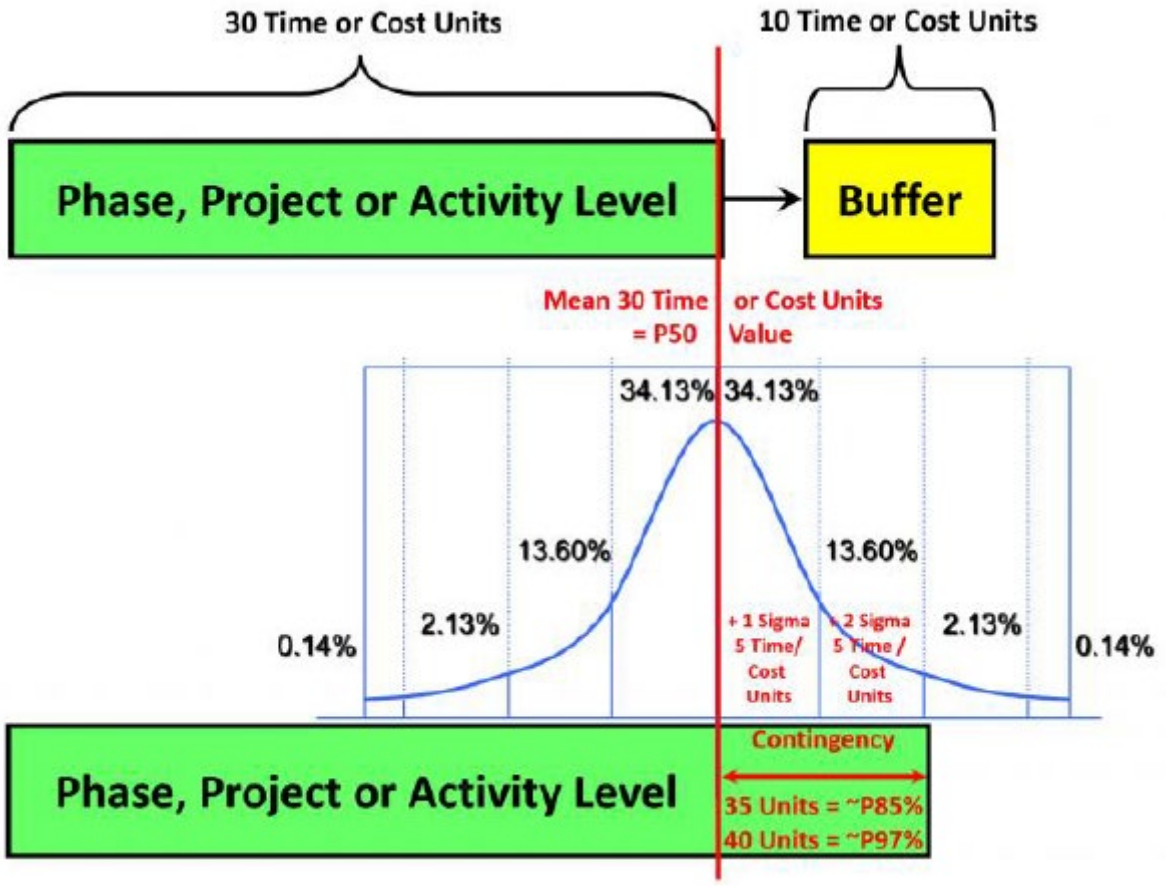

Figure 5 Two Approaches to establish Buffer or Contingency[6]

What approach is better to rely on meeting program cost objectives or program time objectives? What approach would help us to meet other estimate's attribute as accuracy and precision?

Contingency is often represented by a single line item. Are buffer or buried contingencies good strategies to implement in public project estimates?

[6]Module 04-5 – Risk Opportunity Response strategies and tactics - Guild of project controls compendium and reference (CaR) | Project Controls - planning, scheduling, cost management and forensic analysis (Planning Planet). (2016, January 08). Retrieved September, 2018, from http://www.planningplanet.com/guild/gpccar/risk-opportunity-response-strategies-and-tactics

METHODOLOGY-

Step 1

Most of Public Projects do not allow to add contingency in their budgets. Public Projects' processes and plans to design and execute future assets are not so different from private enterprises. Therefore, Public Projects are not exempt from risk and opportunities when executing project activities. When a risk or opportunity occurs sometimes an impact needs the best as you could predict, a tactical or strategical response.

What are best practices to a Risk Management Process that can help to implement the best strategical or tactical response to an event and especially that can adapt to Public Projects if we want a high confidence level of probability to meet project point estimates?

Step 2

Alternative Solutions

We are going to select the following guidelines for project management:

1. Project Management Body of Knowledge (PMBOK) from Project Management Institute
2. Total Cost Management Framework (TCM) from AACE International

We are going to add:

3. Compendium and Reference (CaR) from Guild of Project Controls

The three of them offer Risk Management Process Maps. See maps below:

1. Project Management Body of Knowledge – Project Management Institute

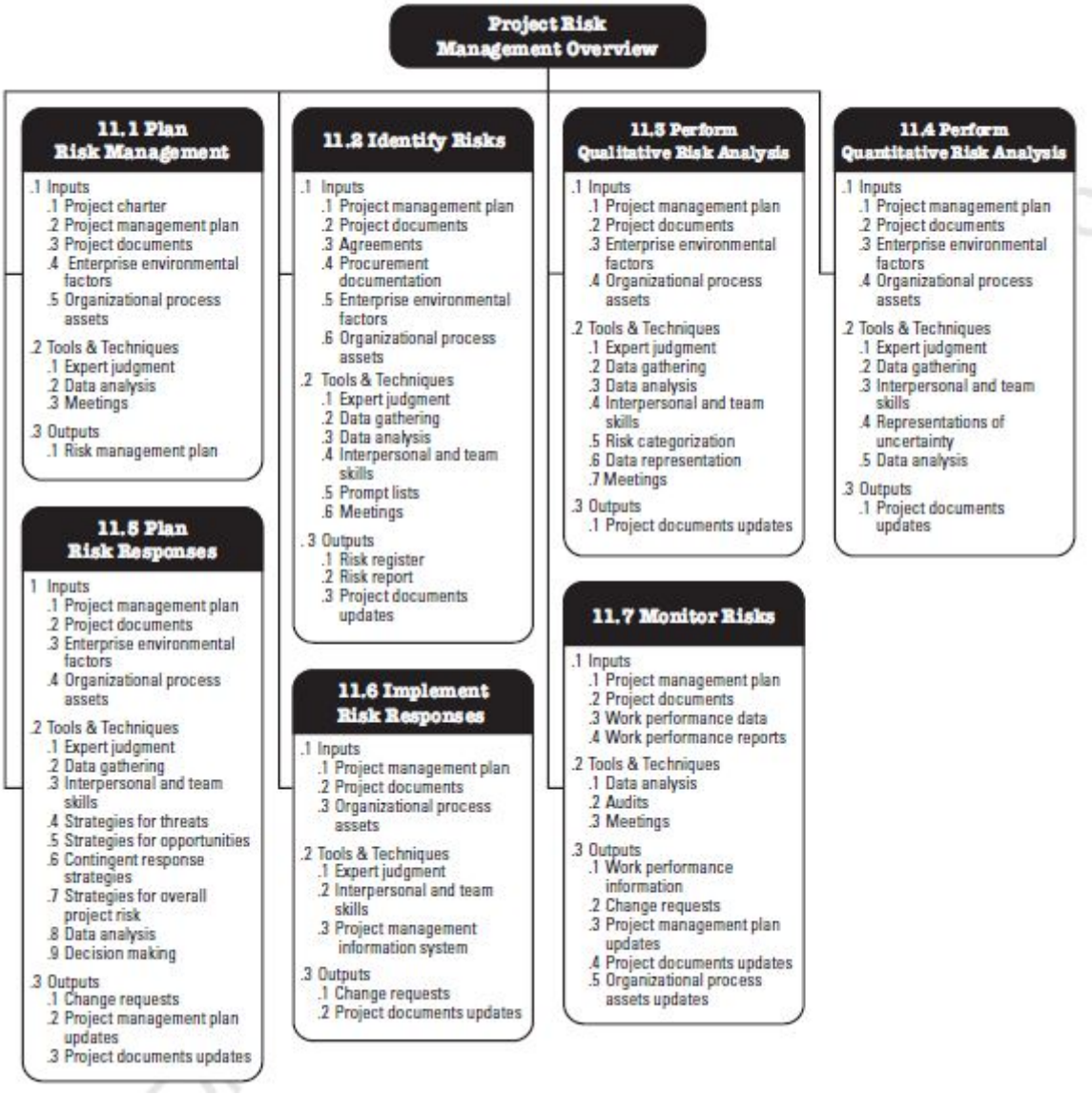

Figure 6 – Project Risk Management Overview[7]

2. Total Cost Management Framework – AACE International

[7] A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 6th ed. Newton Square, Pa: Project Management Institute, Inc. 2017. Page 396.

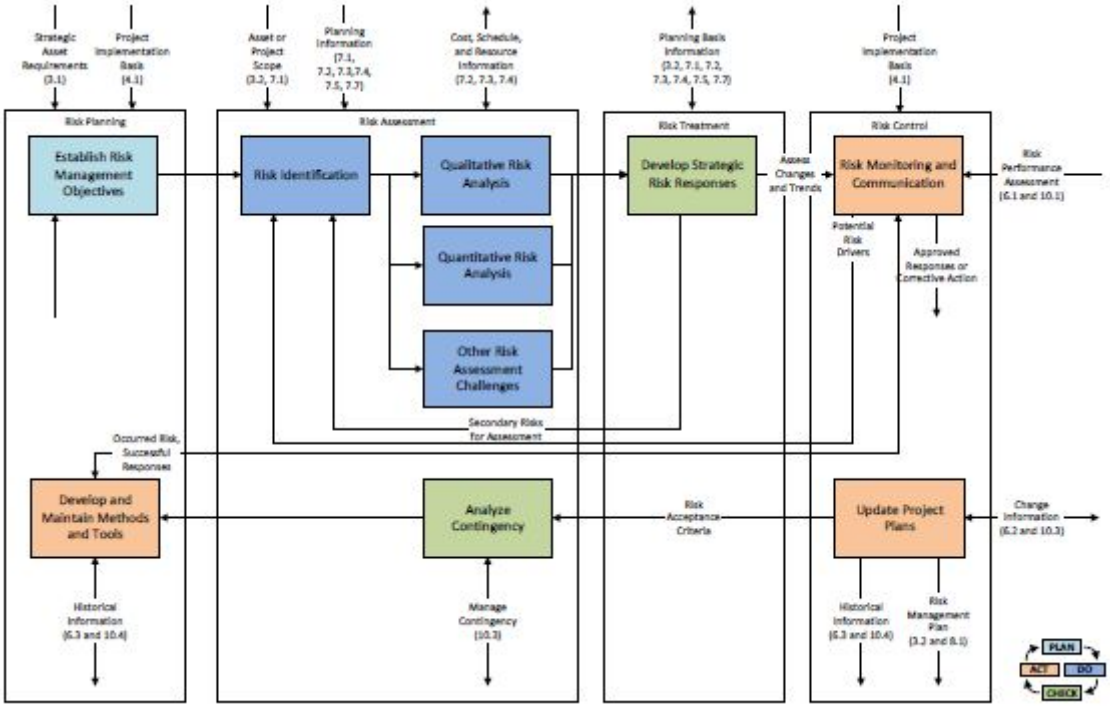

Figure 7 Process Map for Risk Management[8]

3. Guild of Project Controls

[8] H. Lance Stephenson. (2015). *Total cost management framework: An Integrated Approach to Portfolio, Program, and Project Management* (2nd ed.). Morgantown, WV: AACE International. Page 269.

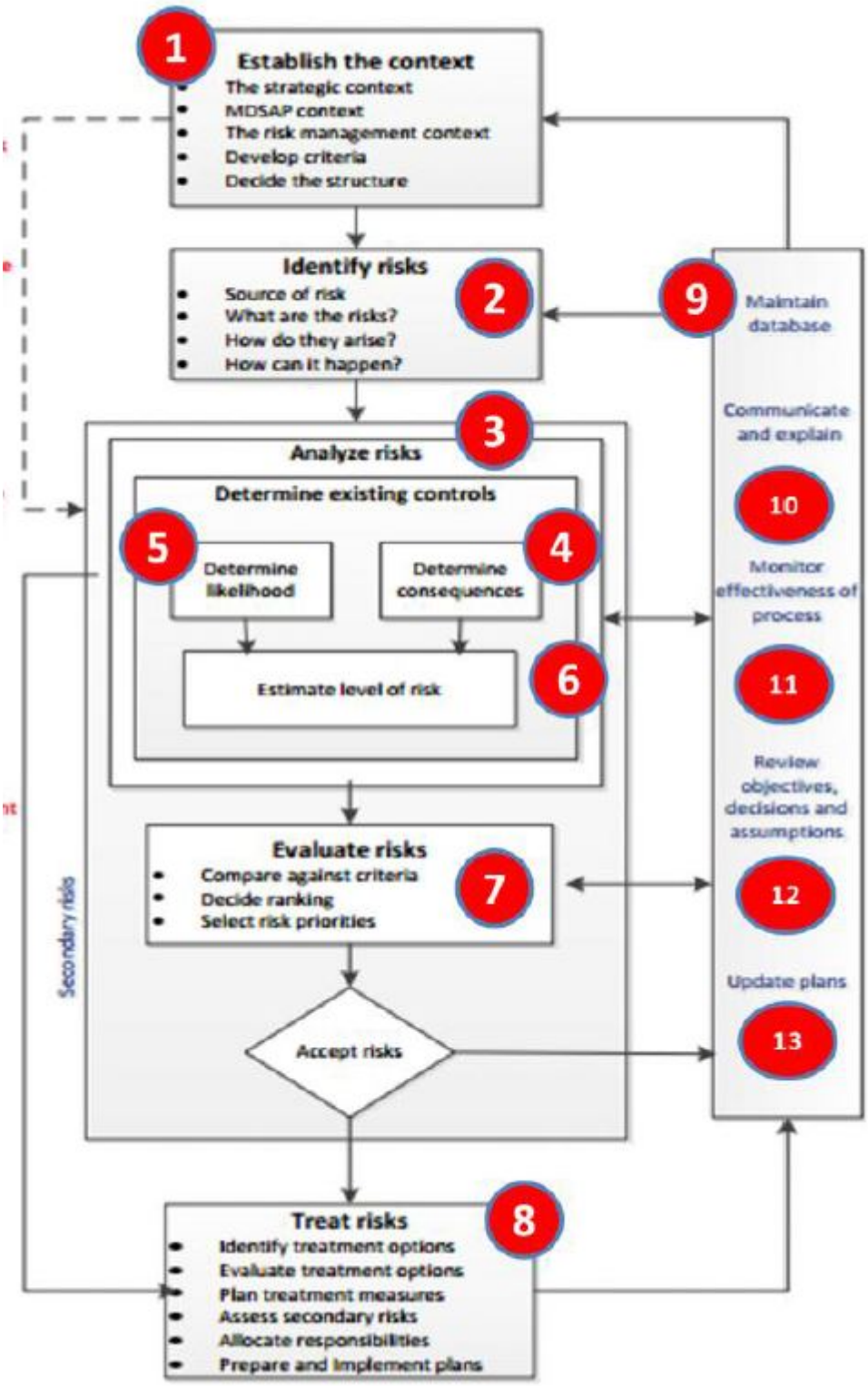

Figure 8 US FDA "Risk Process Map" Adapted for use in the GPCCAR[9]

[9] Module 04-5 – Risk Opportunity Response strategies and tactics - Guild of project controls compendium and reference

Step 3

As explained above, we need to determine which of the three offers better tools or techniques to respond to impacts when events occur.

We will analyse risk/opportunities response on strategies and tactics to treat risk/opportunities. What are the steps to implement a plan to treat risk/opportunities? Let's see the following lists:

PMBOK	TCM	GUILD OF PROJECT CONTROLS
1. Expert Judgement		
Threat Response Strategies		
Opportunity Response Strategies		
Contingent Response Strategies		
Overall project risk response strategies		
2. Data Gathering		
Interviews		
3. Interpersonal and Team Skills		
Facilitation		
4. Strategies for Threats	**1. Response Strategies for Threats**	**1. Risks**
Escalate		
Avoid	Avoid	Avoidance
Transfer	Transfer	Transfer
Mitigate	Reduce	Reduction/Mitigation
Accept	Accept	Acceptance
5. Strategies for Opportunities	**2. Response Strategies for Opportunities**	**2. Opportunities**
Escalate		
Exploit	Exploit	Exploit
Share	Share	Spreading/Sharing (Gain Sharing / Pain Sharing)
Enhance	Enhance	Enhance
Accept	Accept	Ignore
		Buffer vs. Contingency
		Decision Trees using Expected Monetary Value
6. Contingent Response Strategies		
7. Strategies for Overall Project Risk		
Avoid		
Exploit		
Transfer/Share		
Mitigate/Enhance		
Accept		
8. Data Analysis		
Alternative Analysis		
Cost-Benefit Analysis		
9. Decision Making		
Multicriteria Decision Analysis		

Table 1 Tools and Techniques for strategical and tactical responses to risk from PMBOK, TCM and GPCCAR[10]

For an effective analyse, we are going to eliminate those tools or techniques that are similar in the three groups. The main reason is that as they are similar, results will be the same for the three groups. So, it will not

(CaR) | Project Controls - planning, scheduling, cost management and forensic analysis (Planning Planet). (2016, January 08). Retrieved September, 2018, from http://www.planningplanet.com/guild/gpccar/risk-opportunity-response-strategies-and-tactics

[10] By Author

produce a differentiator between them which might not add value to the analysis. Also, Expert Judgement can be eliminated because as shown in the table above an individual or group of experts will produce same responses as described in other items that will go for further analysis. See risks Table 2.

PMBOK	TCM	GUILD OF PROJECT CONTROLS
~~**1. Expert Judgement**~~		
~~Threat Response Strategies~~		
~~Opportunity Response Strategies~~		
~~Contingent Response Strategies~~		
~~Overall project risk response strategies~~		
2. Data Gathering		
Interviews		
3. Interpersonal and Team Skills		
Facilitation		
4. Strategies for Threats	**1. Response Strategies for Threats**	**1. Risks**
Escalate		
~~Avoid~~	~~Avoid~~	~~Avoidance~~
~~Transfer~~	~~Transfer~~	~~Transfer~~
~~Mitigate~~	~~Reduce~~	~~Reduction/Mitigation~~
~~Accept~~	~~Accept~~	~~Acceptance~~
5. Strategies for Opportunities	**2. Response Strategies for Opportunities**	**2. Opportunities**
Escalate		
~~Exploit~~	~~Exploit~~	~~Exploit~~
~~Share~~	~~Share~~	~~Spreading/Sharing (Gain Sharing / Pain Sharing)~~
~~Enhance~~	~~Enhance~~	~~Enhance~~
~~Accept~~	~~Accept~~	~~Ignore~~
~~-~~	~~-~~	~~Buffer vs. Contingency~~
		Decision Trees using Expected Monetary Value
6. Contingent Response Strategies		
~~**7. Strategies for Overall Project Risk**~~		
~~Avoid~~		
~~Exploit~~		
~~Transfer/Share~~		
~~Mitigate/Enhance~~		
~~Accept~~		
8. Data Analysis		
Alternative Analysis		
Cost-Benefit Analysis		
9. Decision Making		
Multicriteria Decision Analysis		

Table 2 Elimination of similar tools and techniques for strategical and tactical responses for risks[11]

Therefore, we only are going to analyse the following list. As TCM's tools and techniques are similar to PMBOK and GPC , they were eliminated for the analysis.

[11] By Author

PMBOK	GUILD OF PROJECT CONTROLS
Data Gathering	
Interviews	
Interpersonal and Team Skills	
Facilitation	
Strategies for Threats	
Escalate	
Strategies for Opportunities	**Opportunities**
Escalate	
	Buffer vs. Contingency
	Decision Trees using Expected Monetary Value
Contingent Response Strategies	
Data Analysis	
Alternative Analysis	
Cost-Benefit Analysis	
Decision Making	
Multicriteria Decision Analysis	

Table 3 Final Tools and Techniques for strategical and tactical responses' List for Analysis[12]

To facilitate the analysis we are going to abbreviate the outcomes alternatives as follows:

	Tools and Techniques	Abbreviation
1	PMBOK – Data Gathering	PMBOK-DG
2	PMBOK – Interpersonal and Team Skills	PMBOK-I&TS
3	PMBOK – Strategies for Threats/Opportunities Escalate	PMBOK-Escalate
4	PMBOK – Contingent Response Strategies	PMBOK-Contingent
5	PMBOK - Data Analysis	PMBOK-DA
6	PMBOK – Decision Making	PMBOK-DM
7	GPC – Buffer vs. Contingency	GPC-BvsCont
8	GPC – Decision Trees using EMV	GC-EMV

Table 4 Abbreviation of Tools and Techniques for Strategical and Tactical Response[13]

[12] By Author
[13] By Author

Step 4

The acceptable criteria to determine if a tool or technique can serve as a strategical or tactical response in public projects are:

a. Mandatory to Produce a Quantitative response
b. It is possible to be assigned to project budget accounts
c. Increase Probability to Meeting Point Estimates

See the following matrix for analysis:

		Alternatives							
	Attributes	**PMBOK-DG**	**PMBOK-I&TS**	**PMBOK-Escalate**	**PMBOK-Contingent**	**PMBOK-DA**	**PMBOK-DM**	**GPC-BvsCont**	**GPC-EMV**
a.	Produce a Mandatory Quantitative response								
b.	It is possible to be assigned to project budget accounts								
c.	Increase Probability to Meeting Point Estimates								

Table 5 Matrix with Acceptable Criteria and final Tools and Techniques for strategical and tactical response[14]

Using Multi Attribute Decision Making, we will analyse as follows:

Non Compensatory Models

1. Dominance

We establish Best and Worst values as follows

Best Value	Worst Value

[14] By Author

	Attributes	PMBOK-DG	PMBOK-I&TS	PMBOK-Escalate	PMBOK-Contingent	PMBOK-DA	PMBOK-DM	GPC-BvsCont	GPC-EMV
a.	Produce a Mandatory Quantitative response	No	No	No	No	Yes	No	Yes	Yes
b.	It is possible to be assigned to project budget accounts	Low	Low	Low	Low	Middle	Middle	High	Middle
c.	Increase Probability to Meeting Point Estimates	Low	Low	Low	Low	Middle	Middle	High	High

Table 6 Matrix for Dominance Analysis[15]

We can see that alternative GPC – BvsCont dominate others and the second option is GPC – EMV.

2. Satisficing

	Attributes	Minimum Acceptable Value	Maximum Acceptable Value	Unacceptable Alternatives
a.	Mandatory to Produce a Quantitative response	Yes	Yes	PMBOK-DG,PMBOK-I&TS,PMBOK-Escalate,PMBOK-Contingent,PMBOK-DM
b.	It is possible to be assigned to project budget accounts	High	High	PMBOK-DG,PMBOK-I&TS,PMBOK-Escalate,PMBOK-Contingent,GPC-EMV
c	Increase Probability to Meeting Point Estimates	High	High	PMBOK-DG,PMBOK-I&TS,PMBOK-Escalate,PMBOK-Contingent

With this second analysis, the only alternative that meets all requirements is GPC Buffer vs Contingency. Alternatives PMBOK-DG, PMBOK-I&TS, PMBOK-Escalate, PMBOK-Contingent can be discarded.

3. Lexicography

Ordinal Ranking

A. Results of Paired Comparison

It is possible to be assigned to project budget accounts > Increase Probability to Meeting Point Estimates
Mandatory to Produce a quantitative response > Increase Probability to Meeting Point Estimates
It is possible to be assigned to project budget accounts > Mandatory to Produce a quantitative response

[15] By Author

B. Attribute	Numbers of times on left of >
Mandatory to Produce a Quantitative response	1
It is possible to be assigned to project budget accounts	2
Increase Probability to Meeting Point Estimates	0

Application of Lexicography

Attributes	Rank	Alternative Rank
a. It is possible to be assigned to project budget accounts	2	GPC BvsCont > GPC - EMV
b. Mandatory to Produce a Quantitative response	1	GPC BvsCont = GPC - EMV
c. Increase Probability to Meeting Point Estimates	0	GPC BvsCont = GPC - EMV

The result from this analysis is that GPC BvsCont is better than GPC - EMV

Compensatory Models

1. Non Dimensional Scaling

Attributes	**Value**	**Dimensionless Value**
a. Mandatory to Produce a Quantitative response	Yes	1
	No	0
c. It is possible to be assigned to project budget accounts	High	1
	Middle	0.5
	Low	0
d. Increase Probability to Meeting Point Estimates	Low	0
	Middle	0.5
	High	1

	Attributes	PMBOK-DA	PMBOK-DM	GPC-BvsCont	GPC-EMV
a.	Mandatory to Produce a Quantitative response	1	0	1	1
c.	It is possible to be assigned to project budget accounts	0.5	0.5	1	0.5
d.	Increase Probability to Meeting Point Estimates	0.5	0.5	1	1
		2	1	3	2.5

Best Choice

Based on this analysis, the best choice still remains GPC – BvsCont with the highest punctuation.

2. The additive weighting technique

		Relative Rank	Normalized Weight	PMBOK-DA		PMBOK-DM		GPC-BvsCont		GPC-EMV	
				Dimensionless Value	Score	Dimensionless Value	Score	Dimensionless Value	Score	Dimensionless Value	Score
	Attributes										
a	Mandatory to Produce a Quantitative response	2	0.33	1.00	0.33	-	-	1.00	0.33	1.00	0.33
b	It is possible to be assigned to project budget accounts	3	0.50	0.50	0.25	0.50	0.25	1.00	0.50	0.50	0.25
c	Increase Probability to Meeting Point Estimates	1	0.17	0.50	0.08	0.50	0.08	1.00	0.17	1.00	0.17
		6			**0.67**		**0.33**		**1.00**		**0.75**

Best Choice

Table 7 The Additive Weighting Technique matrix for tools and techniques analysis[16]

From this analysis, we determine that the best choice is GPC – BvsCont

[16] By Author

FINDINGS-

Step 5

What are best practices to a Risk Management Process that can help to implement the best strategical or tactical response to an event and especially that can adapt to Public Projects if we want a high confidence level of probability to meet project point estimates?

Step 6

It is important for Public Projects to avoid cost overruns. For that reason, the best choice that meets all of the attribute criteria is Guild of Project Controls – Buffer vs Contingency as shown in the previous steps.

As Contingency is not allowed it can be hidden or create a buffer so it still complies public policies. In addition, it will help to increase probabilities to meet point estimates.

Step 7

A good recommendation for further analysis is to identify which of the three best practices can help to track better this alternative as part of the risk monitoring process.

Step 1

As most of the point estimates in projects, they will become accurate to the true cost in time, for that reason it is necessary to assess with certain frequency if risk or opportunities remain after accomplishing certain milestones or a certain period of time passed. By consequence, Contingency should be always assessed to determine if we still need more or less money for certain risk or opportunities identified and tactical or strategical responses will perform accordingly.

As it was mentioned before, we can hide or create a buffer to add contingency in the point estimates for public projects.

For that reason, we also require to analyse which best practice suggests a good tracking tool or technique for the Buffer and Contingency alternative if we expect to meet Public Projects objectives.

What are best practices for Monitoring Risk that can help to implement the best tool or technique to track and control Contingency in Public Project Point Estimates?

Step 2

We can use the same three guidelines in project management which include also a risk monitoring process. This process in each of them suggests different or similar tools and techniques for monitoring risks. We are going to list them for further analysis.

Step 3

The following tools and techniques are part of the monitoring risk process in the three best practices mentioned before:

PMBOK	TCM	GUILD OF PROJECT CONTROLS
1.1 Data Analysis		
1.1.1 Technical Performance Analysis		
1.1.2 Reserve Analysis		
1.2 Audits		
1.3 Meetings	**1.1 Meetings**	
		1.1 Statistical Process Control Chart
		1.2 Pareto Analysis
		1.3 Process Capability Analysis
		1.4 Accuracy vs Precision vs Reliable Data
		1.4 Contingency Draw Down Graphs

Table 8 List of Tools and Techniques to Monitor Risks from PMBOK, TCM and GPCCAR[17]

As we can see, TCM only suggests one tool for a similar process. If we look closer at its Risk Management Process, there is an Analysis of Contingency as an output of Risk Control Process that belongs to the Risk Assessment Process. Besides, it is part of the Risk Management Process, therefore we can consider this tool in this list because a similar tool is included in PMBOK. We can see a definition of a similar tool for both best practices:

PMBOK	TCM
Throughout execution of the project, some individual project risks may occur with positive or negative impacts on budget or schedule contingency reserves. Reserve analysis compares the amount of the contingency reserves remaining to the amount of risk remaining at any time in the project in order to determine if the remaining reserve is adequate. This may be communicated using various graphical representations, including a burndown chart.	Contingency analysis, a sub-step of risk assessment, quantifies the risk impacts after all treatment efforts are complete, also known as residual risk. The team should guard against assumptions that the treatment efforts will be entirely successful, or not successful at all. Following treatment, more often than not, risk cannot be completely eliminated and there will be some degree of residual risk. In addition, many treatment efforts can introduce, inadvertently or knowingly, subsequent variation or secondary risks. Successful contingency analysis will account for all residual risk and secondary risk that cannot be treated in some way.

Table 9 12 Definition of Reserve Analysis from PMBOK and Analyse Contingency from TCM[18]

[17] By Author

[18] A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 6th ed. Newton Square, Pa: Project Management Institute, Inc. 2017. Page 456 and H. Lance Stephenson. (2015). *Total cost management framework: An Integrated Approach to Portfolio, Program, and Project Management* (2nd Ed.). Morgantown, WV: AACE International. Page 206.

See the final list to be assessed:

PMBOK	TCM	GUILD OF PROJECT CONTROLS
1 Data Analysis		
Technical Performance Analysis		
Reserve Analysis	Analyze Contingency	
2 Audits		
3 Meetings	**Meetings**	
		1 Statistical Process Control Chart
		2 Pareto Analysis
		3 Process Capability Analysis
		4 Accuracy vs Precision vs Reliable Data
		5 Contingency Draw Down Graphs

Table 10 List of Tools and Techniques for Monitoring Risk[19]

For an effective analyse, we are going to merge those tools or techniques that are similar in two or three groups. The main reason is that as they are similar, results will be the same in both or three groups. So, it will not produce a differentiator between them which might not add value to the analysis. We can compare this merged tool against other tools.

Therefore, we only are going to analyse the following abbreviated list:

	Tools and Techniques	Abbreviation
1	PMBOK – Technical Performance Analysis	PMBOK- TPA
2	PMBOK/GPC – Analyze Reserve / Contingency	PMBOK/GPC – A R/C
3	PMBOK – Audits	PMBOK – Aud
4	PMBOK/GPC – Meetings	PMBOK/GPC – M
5	GPC – Statistical Process Control Chart	GPC – SPCC
6	GPC – Pareto Analysis	GPC – PA
7	GPC – Process Capability Analysis	GPC – PCA
8	GPC – Accuracy vs Precision vs Reliable Data	GPC – A/P/R
9	GPC – Contingency Draw Down Graphs	GPC - CDDG

Table 11 Abbreviation of Tools and Techniques for Monitoring Risks[20]

[19] By Author
[20] By Author

Step 4

The acceptable criteria to determine if a tool or technique can serve to monitor risks in public projects are

a. Mandatory to Quantify impacts from tactical response
b. Mandatory to Create Tendency Charts
c. Can analyse accuracy against baseline
d. Can analyse precision against baseline
e. Can analyse reliability against baseline

See the following matrix for analysis:

		Alternatives								
	Attributes	**PMBOK- TPA**	**PMBOK/GPC – A R/C**	**PMBOK – Aud**	**PMBOK/GPC – M**	**GPC – SPCC**	**GPC – PA**	**GPC – PCA**	**GPC – A/P/R**	**GPC - CDDG**
a.	Mandatory to Quantify impacts when event occurs									
b.	Mandatory to Create Tendency Charts									
c.	Can analyse accuracy against baseline									
d.	Can analyse precision against baseline									
e.	Can analyse reliability against baseline									

Table 12 Matrix with Acceptable Criteria and Tools and Techniques for Monitoring Risks[21]

Using Multi Attribute Decision Making, we will analyse as follows:

Non Compensatory Models

1. Dominance

We establish Best and Worst values as follows

Best Value	Worst Value

[21] By Author

		Alternatives								
	Attributes	**PMBOK- TPA**	**PMBOK/GPC – A R/C**	**PMBOK – Aud**	**PMBOK/GPC – M**	**GPC – SPCC**	**GPC – PA**	**GPC – PCA**	**GPC – A/P/R**	**GPC - CDDG**
a.	Mandatory to Quantify impacts when event occurs	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
b.	Mandatory to Create Tendency Charts	No	No	No	No	Yes	Yes	No	Yes	Yes
c.	Can analyse accuracy against baseline	Low	Low	Low	Low	Low	Middle	High	High	High
d.	Can analyse precision against baseline	Low	Low	Low	Low	Low	Middle	High	High	High
e.	Can analyse reliability against baseline	Low	Low	Low	Low	Low	Middle	High	High	High

Table 13 Matrix of Dominance Analysis[22]

The Tools and Techniques that meet most the acceptable criteria are **GPC - Accuracy vs Precision vs Reliable Data** and **GPC - Contingency Draw Down Graphs**.

2. Satisficing

	Attributes	**Minimum Acceptable Value**	**Maximum Acceptable Value**	**Unacceptable Alternatives**
a.	Mandatory to Quantify impacts when event occurs	Yes	Yes	PMBOK - Aud, PMBOK/GPC - M
b.	Mandatory to Create Tendency Charts	High	High	PMBOK - TPA, PMBOK/GPC - A R/C, PMBOK - Aud, PMBOK/GPC - M, GPC - PCA
c.	Can analyse accuracy against baseline	High	High	PMBOK - TPA, PMBOK/GPC - A R/C, PMBOK - Aud, PMBOK/GPC - M, GPC - PCA, GPC - PA
d.	Can analyse precision against baseline	High	High	PMBOK - TPA, PMBOK/GPC - A R/C, PMBOK - Aud, PMBOK/GPC - M, GPC - PCA, GPC - PA
e.	Can analyse reliability against baseline	High	High	PMBOK - TPA, PMBOK/GPC - A R/C, PMBOK - Aud, PMBOK/GPC - M, GPC - PCA, GPC - PA

The Tools and Techniques that satisfy minimum acceptable criteria are **GPC - Accuracy vs Precision vs Reliable Data** and **GPC - Contingency Draw Down Graphs**. As the others do not meet minimum acceptable criteria, they can be discarded.

[22] By Author

3. Lexicography

Ordinal Ranking

A. Results of Paired Comparison

Mandatory to Quantify impacts when event occurs > Mandatory to Create Tendency Charts
Mandatory to Quantify impacts when event occurs > Can analyse precision against baseline
Mandatory to Quantify impacts when event occurs > Can analyse accuracy against baseline
Mandatory to Quantify impacts when event occurs > Can analyse reliability against baseline
Mandatory to Create Tendency Charts > Can analyse precision against baseline
Mandatory to Create Tendency Charts > Can analyse accuracy against baseline
Mandatory to Create Tendency Charts > Can analyse reliability against baseline
Can analyse precision against baseline > Can analyse accuracy against baseline
Can analyse precision against baseline > Can analyse reliability against baseline
Can analyse accuracy against baseline > Can analyse reliability against baseline

B. Attribute	Numbers of times on left of >
Mandatory to Quantify impacts when event occurs	4
Mandatory to Create Tendency Charts	3
Can analyse accuracy against baseline	1
Can analyse precision against baseline	2
Can analyse reliability against baseline	0

Application of Lexicography

	Attributes	Rank	Alternative Rank
a.	Mandatory to Quantify impacts when event occurs	4	GPC – A/P/R = GPC - CDDG
b.	Mandatory to Create Tendency Charts	3	GPC – A/P/R = GPC - CDDG
c.	Can analyse precision against baseline	2	GPC – A/P/R = GPC - CDDG
d.	Can analyse accuracy against baseline	1	GPC – A/P/R = GPC - CDDG

e.	Can analyse reliability against baseline	0	GPC – A/P/R = GPC - CDDG

The best tools and techniques continue to be **GPC - Accuracy vs Precision vs Reliable Data** and **GPC - Contingency Draw Down Graphs.**

Compensatory Models

1. Non Dimensional Scaling

	Attributes	Value	Dimensionless Value
a.	Mandatory to Quantify impacts when event occurs	Yes	1
		No	0
b.	Mandatory to Create Tendency Charts	Yes	1
		No	0
c.	Can analyse accuracy against baseline	Low	0
		Middle	0.5
		High	1
d.	Can analyse precision against baseline	Low	0
		Middle	0.5
		High	1
e.	Can analyse reliability against baseline	Low	0
		Middle	0.5
		High	1

	Attributes	PMBOK- TPA	PMBOK/GPC – A R/C	GPC – SPCC	GPC – PA	GPC – PCA	GPC – A/P/R	GPC - CDDG
a.	Mandatory to Produce a Quantitative response	1	1	1	1	1	1	1
c.	It is possible to be assigned to project budget accounts	0	0	1	1	0	0.5	0.5
d.	Increase Probability to Meeting Point Estimates	0	0	0	0.5	1	1	1
d.	Increase Probability to Meeting Point Estimates	0	0	0	0.5	1	1	1
d.	Increase Probability to Meeting Point Estimates	0	0	0	0.5	1	1	1
		1	1	2	3.5	4	4.5	4.5
							Best Choice	Best Choice

Based on this analysis, the best choices are **GPC - Accuracy vs Precision vs Reliable Data** and **GPC - Contingency Draw Down Graphs.**

2. The additive weighting technique

		Relative Rank	Normalized Weight	PMBOK- TPA		PMBOK/GPC - A R/C		GPC - SPCC		GPC - PA		GPC - PCA		GPC - A/P/R		GPC - CDDG	
				Dimensionless Value	Score	Dimensionless Value	Score	Dimensionless Value	Score	Dimensionless Value	Score	Dimensionless Value	Score	Dimensionless Value	Score	Dimensionless Value	Score
	Attributes																
a.	Mandatory to Quantify impacts when event occurs	5	0.33	1.00	0.33	1.00	0.33	1.00	0.33	1.00	0.33	1.00	0.33	1.00	0.33	1.00	0.33
b.	Mandatory to Create Tendency Charts	4	0.27	-	-	-	-	1.00	0.27	1.00	0.27	-	-	0.50	0.13	0.50	0.13
c.	Can analyse accuracy against baseline	2	0.13	-	-	-	-	-	-	0.50	0.07	1.00	0.13	1.00	0.13	1.00	0.13
d.	Can analyse precision against baseline	3	0.20	-	-	-	-	-	-	0.50	0.10	1.00	0.20	1.00	0.20	1.00	0.20
e.	Can analyse reliability against baseline	1	0.07	-	-	-	-	-	-	0.50	0.03	1.00	0.07	1.00	0.07	1.00	0.07
		15			**0.33**		**0.33**		**0.60**		**0.80**		**0.73**		**0.87**		**0.87**

Table 14 The Additive Weighting Technique Analysis[23]

The best choices are **GPC - Accuracy vs Precision vs Reliable Data** and **GPC - Contingency Draw Down Graphs.**

[23] By Author

Step 5

What are best practices for Monitoring Risk that can help to implement the best tool or technique to track and control Contingency in Public Project Point Estimates?

Step 6

One of the main reasons that we want to monitor Buffer or Buried Contingency is because we want to track responses to events and the best way is having tendency charts. For that reason, the best choices that meet all of the attribute criteria are **GPC - Accuracy vs Precision vs Reliable Data** and **GPC - Contingency Draw Down Graphs.**

With these tools it is possible to Manage Contingency also in Public Projects because we can also evaluate the precision, accuracy and reliability of projected final cost in projects if we can predict big deviations against original estimates, perhaps it will be necessary to draw down contingency or add more buried or buffer cost or time to our project accounts.

Step 7

To track if tools are supporting correctly Management Contingency is through Change Management Process. A short list of Change Orders should be submitted or a short list of Change Orders might be produced to request transfer budgets between accounts.

How can it be applied?

Step 1

During the preparation of Cost Estimates, US Government Accountability Office (GAO) recommends as a best practice a Sensitivity Analysis in order to identify Cost Drivers in the Cost Estimate and how it is affected when a change in a cost driver's value happens. This Sensitivity Analysis must be complemented with Risk and Uncertainty Analysis therefore mitigation steps will be part of the assumptions in a Basis of Estimate Document. This analysis will help to determine ranges of potential cost as a previous step of Risk and Uncertainty assessment.

What is the best strategy that responds to a variation in factors used in sensitivity analysis?

Step 2

There are two strategies or tactical response to allocating contingency. The following options will be taken into consideration:

1. Buffer and Contingency
   1.1. Include it and show it and put it in a contingency project account
   1.2. Include it but Bury it in project accounts

Step 3

We will determine a qualitative analysis to determine which of the following factors have the most impact on a project based on the author experience. Then, we will choose which strategy responds better to an impact of the following factors suggested by GAO in a sensitivity analysis:

1. A shorter or longer economic life;

2. The volume, mix, or pattern of workload;

3. Potential requirements changes;

4. Configuration changes in hardware, software, or facilities;

5. Alternative assumptions about program operations, fielding strategy, inflation rate, technology heritage savings, and development time;

6. Higher or lower learning curves;

7. Changes in performance characteristics;

8. Testing requirements;

9. Acquisition strategy, whether multiyear procurement, dual sourcing, or the like;

10. Labour rates;

11. Growth in software size or amount of software reuse; and

12. Down-scoping the program.

Using the following Risk Scoring Matrix, we will determine which factors have most probability of occurrence and rank of consequence. See table below:

		1	2	3	4	5
		Very Low	**Low**	**Medium**	**High**	**Very High**
Probability of Occurrence	Qualitative Description	Rare, Very Unlikely	Unlikely But Not Impossible	Possible	Moderately Likely	Almost Certain, Will probably arise
	Event Description	Remote Chance of Happening	May Happen less than once during the BU/facility/project lifetime	Expected to occurr in the BU/facility/project Lifetime	Expected to occurr several times in the BU/facility/project Lifetime	Occurrs once or more per year in the BU/facility/project Lifetime
	% Description	Less than 10% Chance	10% - 40 % Chance	40% - 70 % Chance	70% - 90 % Chance	Higher than 90% Chance
	Frequency of occurrence (times / year)	< 1/100	1/100 -1/10	1/10 - 1/1	1/1 - 10/1	> 10/1
Consequences	Qualitative Description	Negligible	Minor, easily remedied	Moderate,some objectives affected	Major, most objectives threatened	Most Objectives will not be met

Table 15 Risk Scoring Matrix[24]

After assigning to each factor a probability and a consequence we get the following rank:

	Probability of Ocurrence	Consequence	Weight
6. higher or lower learning curves;	5	2	10
10. Labour rates;	5	2	10

[24] Guild of Project Controls. (2016, January 05). 04.4 Asses_prioritize_and_quantify_risks_opportunities_-rev_1.00. Retrieved September 15, 2018, from http://www.planningplanet.com/guild/gpccar/asses_prioritize_and_quantify_risks_opportunities

2. the volume, mix, or pattern of workload;	4	3	12
3. potential requirements changes;	4	4	16
5. alternative assumptions about program operations, fielding strategy, inflation rate, technology heritage savings, and development time;	4	3	12
7. changes in performance characteristics;	4	2	8
8. testing requirements;	4	3	12
1. a shorter or longer economic life;	3	4	12
4. configuration changes in hardware, software, or facilities;	3	3	9
9. acquisition strategy, whether multiyear procurement, dual sourcing, or the like;	3	4	12
11. growth in software size or amount of software reuse;	2	2	4
12. down-scoping the program.	1	3	3

Table 16 Rank of Probabilities and Consequences for Cost Drivers Factors in a Sensitivity Analysis[25]

The rank ordered from highest to lowest is as follows:

	Rank
2. the volume, mix, or pattern of workload;	16
9. acquisition strategy, whether multiyear procurement, dual sourcing, or the like;	12
4. configuration changes in hardware, software, or facilities;	12
8. testing requirements;	12
12. down-scoping the program.	12
7. changes in performance characteristics;	12
1. a shorter or longer economic life;	10
3. potential requirements changes;	10
6. higher or lower learning curves;	9
5. alternative assumptions about program operations, fielding strategy, inflation rate, technology heritage savings, and development time;	8
10. Labour rates;	4
11. growth in software size or amount of software reuse;	3

Table 17 Rank of Cost Drivers ordered from highest probability and consequence to lowest ones[26]

Step 4

We will determine which type of contingency can be better applied to a variation in each factor and also present a comment or justification in order to respond to suggest an alternative tactical response.

[25] By Author
[26] By Author

Once we have identified the most influenced factors that might impact the cost estimate, we can determine what strategy and tactical response we might implement. See the following table:

	Rank	Strategy	Tactical Response
2. the volume, mix, or pattern of workload;	16	Mitigate	Submission of Detailed Engineering drawings for construction. In addition, a very close monitoring of MTO's
9. acquisition strategy, whether multiyear procurement, dual sourcing, or the like;	12	Mitigate	Implementation of a Procurement Management Plan.
4. configuration changes in hardware, software, or facilities;	12	Mitigate	Implement a good Change Management Process
8. testing requirements;	12	Mitigate	Definition of Project Scope in Early Phases and Best Alternative.
12. down-scoping the program.	12	Avoid	Definition of Project Scope in Early Phases and Best Alternative.
7. changes in performance characteristics;	12	Accept	To Hire experienced resources in each phase of the project.
1. a shorter or longer economic life;	10	Avoid	Assess NPV, IRR, ROI regularly, to determine if a delay in schedule and increase in cost might affect Financial Indicators
3. potential requirements changes;	10	Mitigate	Implement a good Change Management Process
6. higher or lower learning curves;	9	Accept	Hire experienced resources in each phase of the project.
5. alternative assumptions about program operations, fielding strategy, inflation rate, technology heritage savings, and development time;	8	Transfer	Assumptions should be reviewed at the beginning of each project phase. In addition, Cost Estimate should be very well documented
10. Labour rates;	4	Mitigate	Negotiate increase of salaries if duration is longer than a year to fix a salary rate increase.
11. growth in software size or amount of software reuse;	3	Mitigate	Definition of Project Scope in Early Phases and Best Alternative.

Table 18Assignation of Strategical Response for Cost Drivers[27]

After assigning strategic and tactical responses, we can also add another quantitative strategy if we want to avoid cost overruns. Table below shows what is suggested as a contingency tool in order to allocate contingency.

[27] By Author

	Tactical Response	Contingency	Comments
2. the volume, mix, or pattern of workload;	Submission of Detailed Engineering drawings for construction. In addition, a very close monitoring of MTO's	Buried	MTO has always a range when work is executed. It will vary when validating work progress
9. acquisition strategy, whether multiyear procurement, dual sourcing, or the like;	Implementation of a Procurement Management Plan.	Buffer	A good Procurement Plan might lead to savings when buying equipment. Also, it might guarantee equipments or materials will be delivered on time
4. configuration changes in hardware, software, or facilities;	Implement a good Change Management Process	Buffer	This is related to scope change. It can be identified as a risk if project is using new technologies, so when designing it might become obsolete when installing.
8. testing requirements;	Definition of Project Scope in Early Phases and Best Alternative.	Buffer	It is difficult to estimate with accuracy changes during commissioning phase.
12. down-scoping the program.	Definition of Project Scope in Early Phases and Best Alternative.	Buffer	When Down-scoping better to have a well-documented estimated in order to reassess contingency
7. changes in performance characteristics;	To Hire experienced resources in each phase of the project.	Buried	Performance is based on optimistic bias from estimator. Better to allocate contingency to project account
1. a shorter or longer economic life;	Assess NPV, IRR, ROI regularly, to determine if a delay in schedule and increase in cost might affect Financial Indicators	Buffer	Worst case scenario is a longer life and it financial indicators might be assessed regularly

3. potential requirements changes;	Implement a good Change Management Process	Buffer	Potential risk or opportunities could be identified during risk assessment of the estimate. A well-documented Basis of Estimate can detail what might be potential impacts and the amount allocate it to mitigate them
6. higher or lower learning curves;	Hire experienced resources in each phase of the project.	Buried	Estimator always consider learning curves when performing activities
5. alternative assumptions about program operations, fielding strategy, inflation rate, technology heritage savings, and development time;	Assumptions should be reviewed at the beginning of each project phase. In addition, Cost Estimate should be very well documented	Buffer	Changes during execution of projects and then operations cannot be estimated at the beginning of an early point estimates. Rather documenting in a Basis of Estimate what are amounts to mitigate future impacts on these matters.
10. Labour rates;	Negotiate increase in salaries if duration is longer than a year to fix a salary rate increase.	Buried	As negotiations or laws establishes rate of increase. It can be allocated to project accounts.
11. growth in software size or amount of software reuse;	Definition of Project Scope in Early Phases and Best Alternative.	Buffer	This is related to effort required to conduct database of the project or operations. It can be determined when tests are running.

Table 19 Contingency Strategy for Tactical Responses[28]

Step 5

What is the best strategy that responds to a variation in factors used in sensitivity analysis?

Step 6

As shown in Table 19, most cost drivers' variation could be assigned a Buffer (7 out of 12) because most of the tactical response cannot be applied to specific activities at this level of the point estimate.

[28] By Author

A combination of both can be elaborated. But this depends on risk management processes established to assess contingency regularly.

Step 7

As Sensitivity Analysis is a previous step to Risk and Uncertainty analysis, this can be a preliminary assessment of what strategy should the company or the project team conduct in order to determine if contingency can be buried in project Accounts or a buffer must be created.

CONCLUSIONS-

This research is important to help Public Entities to avoid cost overruns and to meet point estimates if tools from best practices in risk responses as Buried and Contingency and risk monitoring through Guild of Project's Accuracy, Precision and Reliability or Contingency Draw Down Graphs are implemented.

A simulation of what would be a good application of buffer and buried contingency could be during the estimating process when conducting a Sensitivity Analysis, we can anticipate what would be a good strategy to allocate contingency as buffer or buried it in project accounts based on a predetermined but not limited list of cost drivers. This might help to which account to hide or what groups of activities to create a buffer. Then after Risk and Uncertainty process, the preliminary strategy can be confirmed.

Are buffer or buried contingencies good strategies to implement in public project estimates? Yes. They can meet the main criteria in public project estimates which is being hidden or sub accounts can be created to allocate a contingency.

This will also help to increase probability of low differences between final cost and project estimates if tendency charts with an optimism frequency are conducted to determine the precision and accuracy of projected costs. This can be reflected in few change orders or few budget transfer between accounts.

FOLLOW ON RESEARCH-

It would be recommended to collect real information, that most of the contractors in the public sector would apply this strategical response and elaborate graphs in order to obtain real data in real projects to establish those main deviations can be identified with the use of tools to monitor risk and management contingency.

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