Integration of Capability Analysis and Its Impact on Process Capability: Evidence from the Constituency Development Fund Process for Project Approval and Funding in Zambia

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ABSTRACT

Processes by nature are affected by variation, either chronic or sporadic, which hinder them from consistently producing desirable outcomes relative to specifications. Existing research has rarely utilised analytical tools that quantify variation and capability within the constituency development fund process (CDF). They rely on qualitative or descriptive assessments, which do not capture the extent to which variability contributes to process delays. The study aimed at demonstrating how integrated capability metrics provide objective, quantifiable measures of process variation to capture the extent to which it contributes to process capability. For example, the use of descriptive statistics on selected projects revealed differences in mean, standard deviation and sigma levels that could not be captured by qualitative or descriptive assessment. The study used a quantitative-descriptive research design. Data were gotten from the Value Stream Map developed for CDF process for project approval and funding. Data analysis was done descriptively through Median, and Inter Quartile Range (IQR) to capture variation and its impact on process capability and funding. Key Result(s): while qualitative or descriptive assessment provide subjective impressions of process performance, it fails to capture the magnitude, distribution and implication of variability on process capability. The differences in median (14) and IQR (21), indicates high variability. Hence, the process is unstable and unpredictable, leading to delayed project implementation, under-utilization or late utilization of funds. Recommendation: There is need to prioritize and improve data collection and record keeping to stabilize the process and enable better forecasting and capability monitoring. Conclusion: Improving process stability should be the first step before meaningful capability analysis can be performed.

Key Words: Variation, Process stability, Approval and funding Time, Cycle Time, Digital Tracking,

INTRODUCTION

The constituency development fund (CDF) is a public fund mechanism, established to accelerate community development in various constituencies. However, the utilization of the said fund has faced a lot of recurring challenges in Zambia, for example, underutilisation and bureaucratic delays in approval and funding, leading to compromised development. In order to address such challenges, it is critical to integrate capability analysis so as to capture the extent to which variation affects process capability a reality that can never be captured by qualitative or descriptive assessment only as most studies have demonstrated (Kwilinski and Kardas, 2024).Quantity determines the measurable aspects that give structure to qualities; the manifestation of quality is inherently linked to its quantifiable aspects. Without quantity, quality remains an abstract concept, elusive and impractical. Therefore, by grounding the philosophical abstraction of quality in the quantitative reality of process capability indices, the gap between theory and practice is bridged (Kwilinski and Kardas, 2024).

METHODOLOGY

Research Design

The study utilised a quantitative-descriptive research design to capture the extent of variation through descriptive statistics in the CDF process.

Objective

To demonstrate how integrated capability metrics provide objective, quantifiable measures of process variation

Sampling Frame

The sampling frame comprised all process steps in the CDF process that have cycle time namely, proposal development(1-2weeks), technical appraisal(1-2weeks), submission of recommended projects(1week), ministerial and treasury approval(2-4weeks), fund disbursement(1week) and procurement(1-3months).

Sampling Technique

The study utilised purposive sampling by targeting only process steps with cycle time as identified above.

Data Source instruments

Data was obtained from the developed value stream map of the CDF process and personal interviews

Data Analysis and interpretation

Data was analysed through descriptive statistics and interpreted by comparing the differences between the mean and standard deviation and range to determine the extent of variation.

Capability Analysis

Montgomery (2013), describes Capability analysis as a set of activities that quantify variability of a process, analyses it in relation to the requirements and specifications of the product and to support the reduction of the variability. Capability analysis finds its expression in capability indices or metrics (Yang, 2023, Swamy and Nagesh, 2014). The natural existence of any process is that it always has variability, either common cause or special cause (Namane, 2023). As such, understanding and managing it is critical to solving issues of inconsistent quality, delays, or rising costs (Peterka, 2024). It is of paramount importance to always measure processes in order to get a true picture of the size of variation. Without a true picture of process variation, it is impossible to come up with an appropriate action plan. Therefore, tools like standard deviation, mean and range, are metrics that identify, quantify and monitor variation. They are the primary gauges and dashboards on which action plans are based (Fernandes, 2022). It is therefore impossible to even consider continuous process improvement without capability analysis.

Variation

process variation refers to uncontrolled or unexpected differences in a process's outputs (Six Sigma, 2024)

Types of variation

Fernandes (2022) postulates that within common cause variation, there exists within subgroup and overall variation. The former is critical for technical process improvement while the latter is what affects the stakeholders or beneficiaries whether they are satisfied or otherwise. It is important to note that while the two types of variation exist, in common cause variation, there exists within subgroup variation and overall variation. In the former, the standard deviation is useful for understanding the variation within groups, excluding the variation between groups, offering a more accurate representation of the inherent variability within each group.

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In the latter, the standard deviation provides a broader measure of variability across the entire dataset. Therefore, it is imperative to compare the within-subgroup standard deviation with the overall standard deviation because a substantial difference between them is a strong signal that the process may not be stable, or that the process has other sources of variation in addition to the variation within subgroups. Hence, the utilization of control charts is critical to verify process stability before performing capability analysis (Fernandes, 2022).

In order to capture the extent to which overall variation affects process capability and funding in the CDF process, the study only computed the various process steps with cycle times as shown in figure 1 of the current CDF process because there was not enough data to compute withing subgroup variation.

Figure 1: Current CDF Process Flowchart

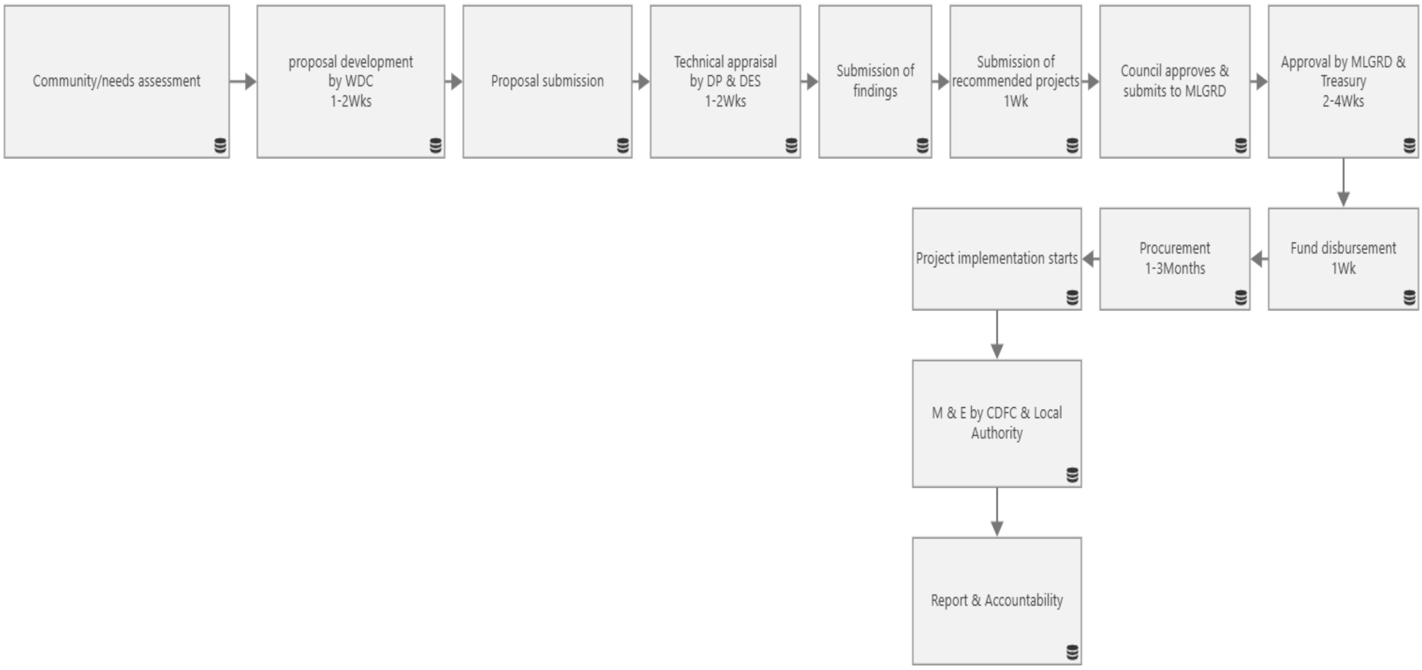

Figure 1 above shows that out of 13 process steps, only 6 have cycle time namely, Proposal development: **1-2 weeks**, technical appraisal: **1-2 weeks**, Submission of recommended projects: **1 week**, MLGRD and Treasury approval: **2-4 weeks,** Fund disbursement: **1 week** and procurement: **1-3 months**. Table 1 shows a step-by-step lead time calculation derived from the developed Value Stream Map (VSM) of CDF. All durations were converted to days (1 week = 7 days, 1 month = 30 days).

Table 1: Lead time components for CDF project approval and funding process (minimum, maximum and midpoint).

Activity	Minimum (days)	Maximum (days)	Midpoint (days)	Midpoint (weeks)
Proposal development by WDC	7	14	10.5	1.5
Technical appraisal by DP & DES	7	14	10.5	1.5
Submission of recommended projects to MLGRD	7	7	7.0	1.0
Approval by MLGRD & Treasury	14	28	21.0	3.0
Fund disbursement	7	7	7.0	1.0
Procurement	30	90	60.0	8.57

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KEY RESULTS

The key results were based on the values in table 1 above and was done in two parts, 1st calculation of the minimum total lead time (sum of specified minimums): 72 days (10.29 weeks, ~2.4 months), the maximum total lead time (sum of specified maximus): 160 days (22.86 weeks, ~5.33 months) and the average (Midpoint) total lead time: 116.0 days (16.57 weeks, ~3.87 months). The 2nd part was to analyse the absolute values in the Maximum number of days column using descriptive statistics. The first task was to ascertain the distribution of the data set. Measures of central tendency were calculated to determine which one should be used, mean and standard deviation or median and interquartile range.

Based on the raw data set concerned (14,14,7, 28,7, 90), the data distribution was found to be not normally distributed hence the median and interquartile range were used to determine the extent to which variation affects process capability.

- Median = (X[n/2] + X [n/2 + 1]) / 2

n = 6 (even number) Position 1: n/2 = 6/2 = 3rd value = 14 Position 2: n/2 + 1 = 4th value = 14. Median = (14 + 14) / 2 = 28 / 2 = 14

- Range = Maximum – Minimum, therefore, Range = 90 - 7 = 83,

- Interquartile Range (IQR), Q1 (25th Percentile), Position = (n + 1) × 0.25 = (6 + 1) × 0.25 = 1.75, Since 1.75 is between positions 1 and 2, interpolation was made: as such, Q1 = X[1] + 0.75 × (X[2] - X[1]) Q1 = 7 + 0.75 × (7 - 7) Q1 = 7 + 0 = 7 and the last part was to Calculate Q3 (75th Percentile). Actually, for n=6, using Tukey's hinges method Q3 =28 since it is the median of upper half: (14,28,90) and by the same method confirm Q1 =7 since it is the median of lower half: (7,7,14).

- In short: Median = 14, Q1 = 7, Q3 = 28 and IQR = Q3 - Q1 = 21

The determination of skewness was done using Bowley's Coefficient = (Q3 - 2×Median + Q1) / (Q3 - Q1). Therefore, the computation was as follows:

(28 - 2×14 + 7) / (28 - 7)

= (28 - 28 + 7) / 21

= 7 / 21

= 0.33 as the Bowley's coefficient representing a moderate positive skew.

The data set also revealed that the value 90 was the outlier by use of IQR method as follows;

Lower fence = Q1 - 1.5 × IQR Upper fence = Q3 + 1.5 × IQR, by substitution, the computation was as follows: Lower fence = 7 - 1.5 × 21 = 7 - 31.5 = -24.5 and Upper fence = 28 + 1.5 × 21 = 28 + 31.5 = 59.5. By applying the rule of thumb, which states that any value < lower fence OR > upper fence is an outlier. As such, 90 > 59.5, which confirms it as an outlier, falling in 1.45 IQR units as determined by the formula, Distance from fence = (Outlier value - Upper fence) / IQR translating into (90 - 59.5) / 21 = 30.5 / 21 = 1.45 IQRs beyond the fence.

DISCUSSION

Implication Of Results On:

(A) Process Capability

A median of 14 describes a process that is not likely capable and the IQR of 21 signals very high variation relative to the central value (Median 14). This indicates a process that is very wide spread hence unpredictable.

The confirmed high variation of the CDF process means that it is unstable and therefore unpredictable. Fernades (2022) emphasizes that the purpose of capability analysis is to predict the performance of processes that is why it is critical to make sure that they are in statistical control. Otherwise, capability becomes impossible and process improvement becomes compromised as well, which is against the culture of operational excellence. No wonder Participant A complained that, "*It is frustrating because projects take a very long time to be implemented despite submitting project proposals in good time*." And Respondent B intimated that sometimes implementation of projects takes up to 10 to 12 months. It is very clear that such delays are due to the identified high variation. Unfortunately, high variation also has negative consequences on resources allocation

(B) Funding Or Resource Allocation

High variation causes budget unreliability as fund disbursement and project completion cannot be predicted. Since budgets are prepared on assumptions, forecasting becomes very problematic as actual timings could vary. This eventually leads to under-utilization or late utilization of allocated funds, which is the status quo in the current CDF process in Zambia. The fact that Government allocates CDFs annually, projects meant to be implemented in Q1 or 2 may spill into Q3 or Q4 hence funds meant for earlier use are delayed. This is evidenced by the fact that there is no determined period in Zambia for projects that are funded in phases.

RECOMMENDATION

The local councils must prioritize and improve data collection and record keeping in order to stabilize the process. Usable data enables accurate forecasting and capability monitoring. This should be done by implementing among other things the following interventions:

- Digital tracking of every proposal application
- Timestamps for all process steps
- Dashboards for pending, approved and delayed projects
- Real-time updates on application progress
- Reduce special cause variation by monitoring long delays beyond the approved time frame

CONCLUSION

The quantitative analysis shows that the current CDF process is highly variable, unpredictable and statistically unstable. The fact that the process does not follow a normal probability distribution, proves that most projects do not meet the expected time requirements and fund disbursements are unpredictable. These inefficiencies negatively affect budgeting and resource allocation among other things, and overall project implementation timelines. As such, improving process stability is vital before meaningful capability analysis can be performed.

Ethical Considerations

The study was approved on 11th April, 2025 by humanities and social science ethics committee at the University of Zambia. Human participants and Respondents were issued with consent forms, which they signed before answering questions.

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Conflict Of Interest: The Author(s) declares no conflict of interest

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