THE USE OF STATISTICAL QUALITY CONTROL CHARTS IN MONITORING THE COST AND PROJECT DURATION OF EXECUTIVE JACKET PRODUCTION IN A UNIVERSITY BUSINESS ENTERPRISE UNIT

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ABSTRACT. *A common technique for tracking and evaluating a project's success and advancement is earned value (EV). In this research, the manufacturing schedule and cost of executive coats for the business enterprise unit are tracked using statistical quality control charts and EV indicators. As a consequence, throughout the last twelve (12) weeks, the Earned Value has grown in value. The production's Schedule Performance Index (SPI) and Cost Performance Index (CPI) are both higher than one from weeks two through twelve. According to the review, more work than expected was completed, and the project's actual cost was in line with expectations. The research showed that SQC charts and EV indices were useful production monitoring tools for clothing.*

Key Words: Executive Jacket Production, Statistical Quality Control, Control Chart, Cost Performance Index, Schedule Performance Index, Earned Value Method

1. INTRODUCTION

The earned value management (EVM) approach is used to assess the effectiveness and progress of projects and includes indicators for scope, time, and resources. It is a common method for assessing how well a project is doing. The scope baseline is combined with the cost baseline, and the schedule baseline to create the performance baseline, which helps the project management team assess and monitor the performance and development of the project. A thorough baseline must be established in order to evaluate project performance using this project management technique. The guiding concepts of EVM may be used to any project, regardless of sector. EVM produces and tracks the following three crucial components for each work package and control account: (1) Planned value (PV) is the amount of money that can be spent on the planned task. It is the authorized budget, excluding management reserve, made aside for the tasks connected to an activity or WBS component. This funding is allocated during the duration of the project in stages, but at any one moment, intended value indicates the actual work that should have been finished. The total PV value, is often known as the performance measurement baseline (PMB). The project's total projected value is sometimes referred to as the project's budget upon completion (BAC). (2) Earned value (EV) is a means to show how much work has been completed in comparison to the allocated budget for it. The work that has been completed is the work that falls within the permitted task's budget. The measured EV must be connected to the PMB and cannot exceed the component's permitted PV budget. The EV is often used to calculate the completion rate of a project. For each WBS component, progress measurement criteria should be developed in order to track work in progress. Project managers continuously monitor the EV to determine the current status and cumulatively to determine long-term performance patterns. (3) The actual cost is the amount paid for the work completed on an activity during a certain time period (AC). The EV calculated the total expense incurred to execute the job. The PV's budget and the EV's measurements must line up with how the AC is defined (e.g., direct hours only, direct costs only, or all costs including indirect costs).

The AC has no maximum expenditure; everything used to achieve the EV will be measured.

The SV and CV values may be used to compare each project's cost and schedule performance with those of other projects or with other projects in a portfolio. The variations are beneficial for evaluating the project's status (PMBOK,2013) [5].

In the Leu and Lin (2008) study, statistical quality control charts were used to improve the standard EV indices' capacity for assessment. The use of Statistical Quality Control Charts might increase the effectiveness of EV indicators in monitoring and assessing construction projects [1].

In this research, executive jacket production for the business enterprise unit will be examined using EVM and SQC technologies to get a comprehensive understanding of the production process in 2021, when the pandemic was at its worst.

2. METHODOLOGY

Modern project management requires adaptable leaders who aren't wedded to any one methodology but rather have mastered the art of blending many approaches.

Using statistical methods, a process may be monitored to guarantee quality products or services (SPC). Both the CPI and the SPI were determined by using the earned value project tracking method described in the 2013 edition of the PMI's Project Management Body of Knowledge (PMBOK) (PMI). By analyzing the project's Upper and Lower Control Limits, we were able to further investigate CPI and SPI using Statistical Quality Control methods.

2.1 Data Gathering

Table-1: Planned Value and Actual Cost

Week No.	Planned Value (PV)	Actual Cost (AC)
1	₱18,512.91	₱4,725.00
2	₱18,512.91	₱9,450.00
3	₱18,512.91	₱8,400.00
4	₱18,512.91	₱7,350.00
5	₱18,512.91	₱21,525.00
6	₱18,512.91	₱15,225.00
7	₱18,512.91	₱12,075.00
8	₱18,512.91	₱11,025.00
9	₱18,512.91	₱7,875.00
10	₱18,512.91	₱11,550.00
11	₱18,512.91	₱11,025.00
12	₱18,512.91	₱11,025.00

Cost and time estimates were used to compile the data. The university's executive jackets were manufactured by the garments unit, which supplied the exact production statistics as indicated in Table-1.

2.2 Calculation of Earned Value

The primary contribution of the research is a method that successfully combines EV and statistical quality control charts to monitor EV indicators statistically and spot problems. Understanding the behavior of EV indices over time is one of the most significant advantages the combination may bring, as it helps in tracking the performance and development of projects. Statistical quality control charts, which are used in the research, are another addition. Multiplying the percentage of completion by the total budget yields the project's economic value.

2.3 Calculation of Schedule and Cost Variance

The difference between earned value and anticipated value is known as schedule variance (SV), a metric used to assess schedule performance. At any one moment, it indicates how far the project is ahead of or behind schedule. A project's adherence to its timetable is one of the metrics tracked by this metric. It is calculated as the difference between the earned value (EV) and the projected value (PV) (PV). When compared to the baseline schedule, the EVM schedule variance may show whether or not the project is running behind or ahead of time. In the end, the earned values will be identical to the intended values, hence the EVM schedule variance will be zero after the project is finished.

$SV = EV - PV$ Eqn. (1)

Cost variance (CV) is the amount of budget deficit or surplus at a given point in time, expressed as the difference between earned value and the actual cost. It is a measure of cost performance on a project. It is equal to the earned value (EV) minus the actual cost (AC). The cost variance at the end of the project will be the difference between the budget at completion (BAC) and the actual amount spent. The CV is particularly critical because it indicates the relationship of physical performance to the costs spent. Negative CV is often difficult for the project to recover.

$CV = EV - AC$ Eqn. (2)

2.4 Development of SQC Control Charts

Measured by comparing earned value to projected value, the schedule performance index (SPI) provides insight into how well a schedule is performing. You can see how well the project team is making use of their time. It is often used with the CPI (cost performance index) to foretell when a project will be finished and at what cost. Since the SPI evaluates every aspect of the project, the critical path's progress must be examined as well to determine whether or not it will be completed on time. SPI is calculated by dividing EV by PV.

$SPI = EV/PV$ Eqn. (3)

CPI is the ratio of earned value to actual cost and is used to evaluate how effectively allocated funds are being used. It's the most important indicator for EVMs since it evaluates the value of the work done relative to its cost. The cost of living index is calculated as the EV divided by the average cost of living. The indices are helpful for tracking progress and making informed decisions about the project's budget and timeline.

$CPI = EV/AC$ Eqn. (4)

3. RESULTS AND DISCUSSION

3.1 The Earned Value

Table-2: Earned Value

Week No.	Planned Value (PV)	Actual Cost (AC)	Earned Value (EV)
1	₱18,512.91	₱4,725.00	₱3,997.58
2	₱18,512.91	₱9,450.00	₱15,995.50
3	₱18,512.91	₱8,400.00	₱14,217.91
4	₱18,512.91	₱7,350.00	₱12,440.67
5	₱18,512.91	₱21,525.00	₱36,433.40
6	₱18,512.91	₱15,225.00	₱25,769.97
7	₱18,512.91	₱12,075.00	₱20,438.25
8	₱18,512.91	₱11,025.00	₱18,661.01
9	₱18,512.91	₱7,875.00	₱13,329.29
10	₱18,512.91	₱11,550.00	₱19,549.63
11	₱18,512.91	₱11,025.00	₱18,661.01
12	₱18,512.91	₱11,025.00	₱18,661.01
	₱222,148.92		₱198,605.6

As can be shown in Table 2, the earned value of the project tracking system for making executive jackets over a twelve-week period. The Actual Cost (AC) in Week 1 is Greater Than the Estimated Value (EV). In contrast, the Actual Cost in the subsequent weeks has been less than the Planned Value. Earned Value thus delivers a lower cost of 198,605.6 pesos over the course of twelve (12) weeks.

3.2 The Schedule Variance (SV) and the Cost Variance (CV)

Schedule Performance Index (SPI) and Cost Performance Index (CPI) were also computed in addition to the SV and CV. Below, in Figure-1, is a chart depicting Earned Value (EV), Actual Cost (AC), and Planned Value (PV) (EV). While the PV is distributed throughout the course of the project in stages, the physical work that should have been completed at any one time is defined by the intended value.

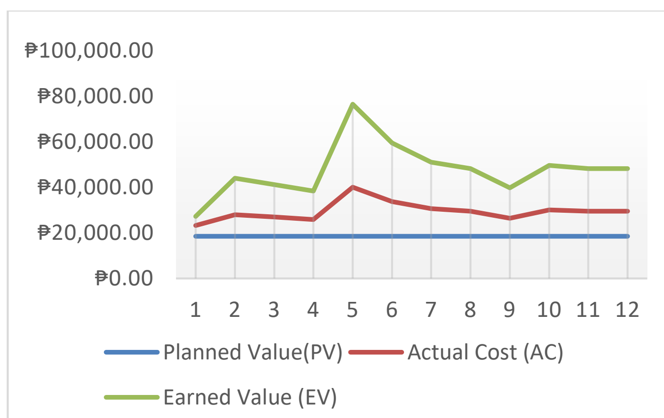

Figure-1: EV-AC-PV Graph

Table-3: Schedule Variance and Cost Variance

Week No.	Schedule Variance (SV)	Cost Variance (CV)
1	-₱14,515.33	-₱727.42
2	-₱2,517.41	₱6,545.50
3	-₱4,295.00	₱5,817.91

4	-₱6.072.24	₱5,090.67
5	₱17,920.49	₱14,908.40
6	₱7,257.06	₱10,544.97
7	₱1,925.34	₱8,363.25
8	₱148.10	₱7,636.01
9	-₱5,183.62	₱5,454.29
10	₱1,036.72	₱7,999.63
11	₱148.10	₱7,636.01
12	₱148.10	₱7,636.01

As indicated in Table 3,the cost variance is positive (₱7,636.01) and the schedule variance is positive (₱148.10) from weeks 11-12 which indicates that the project is within schedule and cost towards its end.

3.3Calculation of Schedule Performance Index and Cost Performance Index

Schedule Performance Index (SPI) and Cost Performance Index (CPI) are two indices often used to measure the success of a project (CPI). If the SPI is below 1.0, then less work was accomplished than expected. If the SPI is more than 1, then more work was accomplished than anticipated. Since the SPI evaluates every aspect of the project, the critical path's progress must be examined as well to determine whether or not it will be completed on time. With a CPI below 1.0, there has been an overrun in costs relative to the amount of work performed. If the CPI is larger than 1, then the performance to far has been at a lower cost than expected. The indices are helpful for tracking progress and making informed decisions about the project's budget and timeline.

Table-4: CPI and SPI

Week No.	**CPI**	**SPI**	**Mean or X-Bar**	**Range**
1	0.220	0.850	0.535	0.630
2	0.860	1.690	1.275	0.830
3	0.770	1.690	1.230	0.920
4	0.670	1.690	1.180	1.020
5	1.970	1.690	1.830	0.280
6	1.390	1.690	1.540	0.300
7	1.100	1.690	1.395	0.590
8	1.010	1.690	1.350	0.680
9	0.720	1.690	1.205	0.970
10	1.060	1.690	1.375	0.630
11	1.010	1.690	1.350	0.680
12	1.010	1.690	1.350	0.680
Estimate Mean of Sampling Population			1.301	0.684
Standard Deviation of Sampling Population			0.298	

As shown in Table 4,the range of values for the CPI and SPI from weeks 5 to 12 are greater than 1 which indicates that the project is performing well starting from week 5 (SPI=1.970,CPI=1.690,Mean=1.830) compared to week 1 which indicates that the start was slow (CPI=0.220,SPI=0.850,Mean=0.535).

The SQC chart is used in this study to determine the acceptability of the data. The Lower Control Limit value is 0.80 while the Upper Control Limit value is 1.80. Some data were out of control as shown in Figure-2 .

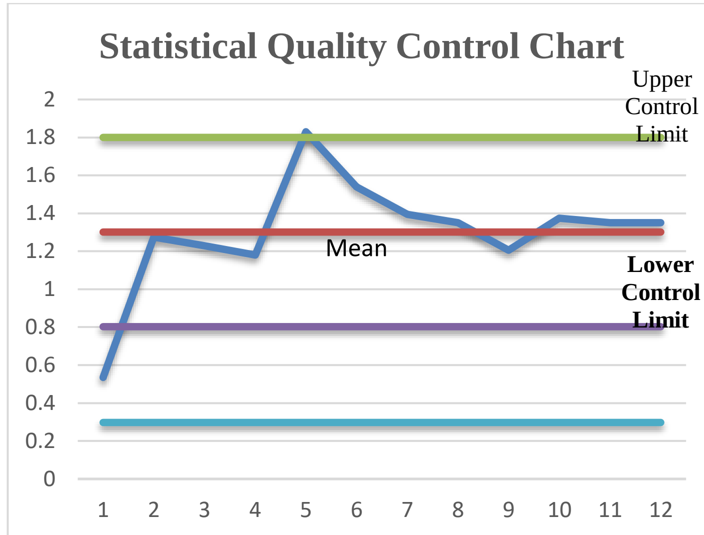

Figure-2: Control Chart of SPI and CPI-X Bar(Mean)

$$\text{Upper control limit (UCL)} = \bar{\bar{x}} + A_2\bar{R}$$

$$\text{Lower control limit (LCL)} = \bar{\bar{x}} - A_2\bar{R}$$

CONCLUSION

The Earned Value showed a positive trend in the production of executive jackets in this study as indicated in Table 2 with an EV of ₱3,997.58 for Week 1 and an EV of ₱18,661.01 for week 12 . The project's present status is tracked, and the long-term performance trends are calculated. As a result, the Earned Value has increased in value during the last twelve (12) weeks. From week 2 through week 12, the garments production Schedule Performance Index (SPI) and Cost Performance Index (CPI) are both greater than one as indicated in Table 4 . The assessment found that more work was accomplished than anticipated, and the project's actual cost did not exceed the projected cost. The study indicated that EV indices and SQC charts were effective tools for garments production monitoring.

RECOMMENDATION

Further study is recommended on the use of statistical quality control charts to determine the individual operator efficiency in garments production since the data analyzed only reflected the overall production information.

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