Application of Earned Value Method in Project Cost Management and Schedule Management

Wenjing Xu*
Xi'an Shiyou University, Xi'an 710065, China
*Corresponding email: xuwenjing@sina.com

Abstract

At present, with the rapid development of China's economy, the development of the construction industry has made a new breakthrough. Project management requires the construction industry to continuously play its role and value and improve the ability of project management. Earned value method, as an important way in the field of project management, can make the whole project management rise to a new height. I will elaborate on the specific principle of earned value method, by fully introducing the specific role of earned value method in engineering projects, to provide reference and basis for practitioners to improve their management ability.

Keywords

Earned value method, Engineering project, Cost management

Introduction

At present, many modern construction projects are springing up. Construction projects are more towards higher and stronger direction, especially high-rise buildings, super high-rise buildings, and some large construction projects occupy a sizable proportion [1]. At the same time, it also leads to fierce competition in the construction market where people pay more attention to the meaning of "cost". We have cost in our daily life. The production and operation of enterprises also include costs. The cost can be large or small, which is reflected in many ways. The construction project cost is complex and changeable, which is determined by its own characteristics. A complete construction project from the start of construction means that it is a multi-component body, in the process of construction personnel, materials, equipment and other unforeseen factors. From the initial investment decision-making to the final completion and putting into use, there will be many factors that may affect the normal implementation of the project. The construction project cost is generated with the implementation of the project, and the complexity of the project determines the complexity of the project cost. It is not only affected by a series of interrelated activities within the engineering project, but also by many external unforeseen factors [2,3]. If these factors are not identified and analyzed well, it will lead to the failure of cost management, thus affecting the realization of engineering construction goals, leading to serious loss of funds and loss of market competitiveness. Therefore, the cost management of engineering projects is particularly important [4].

In the cost management of engineering projects, there are three important indicators and contents to measure the cost management, which involve engineering cost, construction period and engineering quality. Among them, cost management is a key basic work that can directly reflect the profitability of construction enterprises [5]. The important significance of cost management of engineering projects is that it has an enormous influence on the survival and development of engineering enterprises in the current market competition environment. The goal of project cost

management is to create value for the enterprise. The enterprise will manage the cost by making detailed plans, measures, and various means to achieve the time limit and quality objectives set in the contract [6]. If the managers of construction enterprises can establish a good project management system, constantly optimize the cost management, upgrade the project management ability, the cost management can be more reasonable. In project construction, cost management should be the top priority of project management [7]. Based on the principle of earned value management, this paper explores the specific application of earned value method in project cost management and schedule management, and finally clarifies the important role of earned value method, which can not only ensure the completion of the whole project on schedule but also take into account the timely adjustment of the project and ensure certain benefits and effects. At present, due to the large and complex personnel involved in the construction department, the earned value method has not been widely used, and the related optimization research is still in progress.

Principle of earned value management

Earned value method is also known as earned value method. Its core purpose is to calculate and compare the difference between the actual cost and the calculated cost in the project and then predict and adjust the remaining tasks of the next project in all aspects according to the deviation value of content, time, quality and cost in combination with the project schedule and its needs. It is a method to control project schedule and cost by calculating cost. The earned value method involves the management methods of project management and other aspects. The concept of earned value has appeared since 1990 and has been widely used in the world project management. Through the planning and prediction of the project, scientific and reasonable management and control measures are implemented for the project, and a series of management methods and prediction methods are conducted. The difference analysis of earned value management includes not only the quality of specific content, but also the difference of specific construction cost and project schedule.

The realization of project cost management needs to be determined by combining with the actual work effect, rather than simply comparing the actual value with the planned value or simply comparing the progress budget of the project task with the actual project progress Project management introduced the concept of earned value many years ago, which means that the actual work has a multi-dimensional relationship with its corresponding cost and creates a bridge between the plan and the reality [8,9].

Three basic indicators of earned value

Before understanding the application of earned value management, we need to be familiar with the meaning of earned value. The above has indicated the actual meaning of earned value. The so-called earned value management method is to analyze the difference between the planned progress and the actual progress of the project through data, to conduct more beneficial investigation and prediction for the follow-up work. The difference analysis includes construction content, construction quality, construction cost, construction cost, etc.

In earned value management, we need to understand three basic indicators:

(1) Plan value (PV) is the cost of completing the project according to the established plan; it can also be understood as the budget of work schedule (BCWS) when the plan is completed. BCWS is related to the workload of the project, which can be expressed as BCWS=planned work × Budget quota. Plan value is defined as the work allocation and approved budget for the progress of planned activities. In statistical theory, this variable can be regarded as “P0” in the compilation of comprehensive index×“Q0”.

(2) Earned value (EV) is the budget cost corresponding to the work completed, and it can also be understood as the budget cost of work performed (BCWP). The completion mentioned

here includes the quantity of work and the quality requirements. The so-called realized value can reflect the progress of the project task and whether it is in accordance with the contract plan. This variable can be regarded as "P0" in the compilation of the comprehensive index×"Q1".

(3) Actual cost (AC) is the actual cost of work performed (ACWP). This index can reflect the actual expenditure after the completion of the project and does not involve the budget cost. Therefore, this variable can be regarded as "P1" in the compilation of the composite index in the principle of statistics×"Q1".

Five important management indexes of earned value management

Based on the above three basic indicators, we can get another five important management indicators through the relationship between different indicators to evaluate the progress of the project.

(1) Cost deviation (CV) is the difference between actual cost and earned value. CV=EV−AC. CV greater than 0 means saving cost, CV less than 0 means wasting cost.

(2) Schedule deviation (SV) is the difference between planned value and earned value. SV=EV−PV. SV greater than zero means progress ahead of schedule, SV less than 0 means progress delay.

(3) Cost performance index (CPI) is the ratio of earned value to actual cost. $CPI = EV/AC$, CPI greater than 1 indicates that the actual cost of the project is less than the budget.

(4) Progress performance index (SPI) is the ratio of earned value to planned value, $SPI = EV/PV$, SPI greater than 1, indicating that the actual progress of the project exceeds the plan.

(5) EAC is the ratio of total budget cost and cost performance index, EAV=BAC/CPI.

Advantages and disadvantages of earned value method

Earned value method combines cost with project schedule, quantifies the abstract schedule, and has many advantages. First, the earned value method represents the cost, time, and other data as a curve, which is very intuitive. At the same time, it can express some problems and provide reference for the early warning scheme.

Secondly, the earned value method can predict the possibility of a project delay and cost overrun and provide the possibility for taking corrective measures.

Through the analysis of the problems existing in the cost control process, we can not only improve the comprehensive development of the project, but also timely and efficiently solve the pain points and difficulties in the project and effectively reduce the project cost to a certain extent, to maximize the target profit. The earned value method can not only monitor the cost, but also fully show the direction of cost use, and achieve the purpose of cost saving [10].

For the project side, the goal is to ensure the quality level of the project. If we can effectively reduce the cost value on this basis and ensure the quality level of the project at the same time, we can achieve a win-win situation of cost and benefit from the internal and external and achieve the purpose of improving our own advantages.

Cost control can not only ensure the steady progress of the project but also promote the efficient use of resources. During the project, in addition to the control of time and space, the project can also take some control measures from the three-dimensional space. Strict supervision of the project must take the planned cost as the bottom-line benchmark, effective and timely control of project progress.

Cost control is conducive to promoting enterprise engineering to achieve the purpose of profit. Obtaining economic benefits is the basic guarantee for the market to improve its competitiveness. According to the development of the construction market, a good construction enterprise operation and management ability lies in the good sustainable development ability of the enterprise.

Effective cost control is conducive to the considerable development of the construction enterprise, and constantly improves their competitiveness, to a certain extent, improving the

cost control ability of the enterprise. The disadvantage of the earned value method is that it contains less information, is not comprehensive, and cannot be processed by computer. In view of this, bar chart method and table method can be used to supplement. At the same time, the earned value method pays attention to the accuracy of data, emphasizes the need for real-time monitoring and timely feedback information in the specific construction process.

Application of earned value method in project cost management and schedule management

The construction of a residential project 2-2 started on April 15, 2019. The company takes the completion node on the key line as the cost statistics and analysis point and calculates the earned value data once a month. Collect and sort out the actual cost and progress data of 2-2 building project in October 2019.

Actual cost: the actual cost in October 2019 (see Table 1, the actual cost ACWP of the completed project in October 2019).

Progress data: in October 2019, the project progressed to the completion of the main body on the second and first floors of the main building, the main body on the first floor of the North podium, and the main body on the third floor of the South podium.

According to the actual cost in October, referring to the control target of project cost deviation, and combining with the value of BCWS, the budget cost of completed project (BCWP) of the project is calculated, which is the earned value as shown in Table 1.

According to the data and the theory of the earned value method, three basic parameters of earned value method are calculated: project budget cost (BCWS), actual cost of work (ACWP) and budget cost of completed work (BCWP) (Table 1, 2, 3 and 4).

Table 1. Actual cost ACWP of completed project of building 2-2 in October 2019.

Serial number	Name of unit project	Amount (yuan)
1	Civil engineering	1152425.37
2	Decoration engineering	60143.52
3	Water supply and drainage, heating engineering	12061.56
4	Electrical engineering	2665.00
5	Total	1227295.45

Table 2. Budget cost BCWS of 2-2 buildings in October 2019.

Serial number	Name of unit project	Amount (yuan)
1	Civil engineering	1152425.37
2	Decoration engineering	60112.65
3	Water supply and drainage, heating engineering	12167.76
4	Electrical engineering	2600.00
5	Total	1227305.78

Table 3. Budget cost BCWP of completed project of 2-2 building in October 2019.

Serial number	Name of unit project	Amount (yuan)
1	Civil engineering	1129376.86
2	Decoration engineering	58940.65
3	Water supply and drainage, heating engineering	12302.79
4	Electrical engineering	2691.65
5	Total	1145637.38

Table 4. Project cost deviation analysis in October 2019.

Serial number	Name of sub project	Actual cost of completed project ACWP
1	Civil engineering	1152425.37
2	Decoration engineering	60143.52
3	Water supply and drainage, heating engineering	12061.56
4	Electrical engineering	2665.00
5	Total	1227295.45

According to the cost data collected in October 2019, the cost deviation (CV value) and schedule deviation (SV value) are analyzed. In the earned value method, the difference between the budget cost and the actual cost of the project is called cost deviation, and the calculation formula is cost deviation (CV)＝earned value (EV)－actual cost (ACWP). Based on the above analysis of CV value, the cost deviation of residential project in October 2019 is calculated $CV = ev - acwp = 1145637.38 - 1227295.45 = -81658.07$ yuan.

(1) Schedule deviation is the difference between the budget cost of the completed work and the budget cost of the planned work. It shows the result of the comparison between the current schedule/progress and the baseline schedule/progress (in time progress unit). There are differences in numbers When SV is positive, it means that the current actual schedule/progress is ahead of the baseline schedule/progress, reflecting that the construction period performance is better and the construction period is ahead of schedule. When SV is negative, it means that the current work progress is behind the baseline schedule/progress, which reflects the poor performance of the construction period and the delay of the construction period. Therefore, combined with the actual data of the residential project in October 2019, the schedule deviation of the residential project in October 2019 is calculated $SV = ev - bcws = 1145637.38 - 1227305.78 = -81668.40$ yuan.

(2) Cost performance index CPI and schedule performance index SPI.CPI, this index measures the cost efficiency of ongoing projects, that is, in project management, The index used to measure performance is called cost performance index. The calculation formula of CPI is cost performance index CPI=earned value BCWP/actual cost of completed project ACWP When the CPI is less than 1 and gradually becomes smaller, the project should take specific measures.

According to the actual data of the project in October 2019, the cost performance index of the residential project in October 2019 is calculated CPI=earned value/actual cost of completed project＝BCWP/ACWP＝1145637.38/1227295.45 ＝0.93 SPI, expressed as the ratio of earned value to planned value, is an indicator to measure progress performance. The performance index can reflect the utilization of project time. Combined with the actual data of the residential project in October 2019, the schedule performance index of the residential project in October 2019 is calculated: SPI=earned value/budget cost of the proposed project, then in October 2019, the schedule performance index is calculated as follows: $SPI = BCWP/BCWS = 1145637.38/1227305.78 = 0.93$.

Conclusion

Earned value management plays an indispensable role in project management. As a management tool with cost and construction period as the main control factors, its role is to control the whole project by cost control and shortening construction period, so as to ensure that the whole project is completed on schedule, ensure certain benefits and effects, and have a more integrated analysis of the project, for the construction sector, due to the relatively large number of personnel involved, the use of earned value method is relatively difficult and complex, and sometimes it is difficult to achieve more accurate budget results. We need to

constantly sum up experience and lessons, gradually promote and improve it, and give full play to the specific role of earned value management method.

Funding

This work was not supported by any funds.

Acknowledgements

The authors would like to show sincere thanks to those techniques who have contributed to this research.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Aramali, V. (2024) An effective Earned Value Management System (EVMS) is based on 27 environmental factors. *International Journal of Project Management*, 42(5), 109-122.

[2] Reda, S. G., Belachew, K. T., Demiss, B. A., Ali, S. K. (2025) Performance evaluation of construction project by earned value management system in Amhara waterworks construction enterprise. *Discover Civil Engineering*, 2(1), 1-25.

[3] de Rezende, L. B., Denicol, J., Blackwell, P., Kimura, H. (2022) The main project complexity factors and their interdependencies in defence projects. *Project Leadership and Society*, 3, 100050.

[4] Gunduz, M., Aly, A. A., El Mekkawy, T. (2022) Value engineering factors with an impact on design management performance of construction projects. *Journal of Management in Engineering*, 38(3), 04022012.

[5] Rounaghi, M. M., Jarrar, H., Dana, L. P. (2021) Implementation of strategic cost management in manufacturing companies: overcoming costs stickiness and increasing corporate sustainability. *Future Business Journal*, 7(1), 31.

[6] Ren, S. (2022) Optimization of enterprise financial management and decision-making systems based on big data. *Journal of Mathematics*, 2022(1), 1708506.

[7] Elsaid, M. (2025) Comparative analysis of Earned Value Management techniques: Earned Duration, Earned Schedule, and Planned Value. *Scientific Reports*, 15(1), 1-12.

[8] Silva, C. S., Pereira, C., Magano, J. (2023) The value of project management to competitiveness: Key factors from a holistic and practical perspective. *International Journal of Managing Projects in Business*, 16(1), 67-91.

[9] Guo, K., Zhang, L. (2022) Multi-objective optimization for improved project management: Status and future directions. *Automation in Construction*, 139, 104256.

[10] Moradi, S., Ansari, R., Taherkhani, R. (2022) A systematic analysis of construction performance management: Key performance indicators from 2000 to 2020. *Iranian Journal of Science and Technology, Transactions of Civil Engineering*, 1-17.