Study on Project Progress Curve Model

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Abstract: Because of the discrepancy of project types, the project progress curves present different characteristics. Studying project progress curves can reduce management risk of project and overall grasp the enforcement condition of the project. Combining project characteristic, this paper reaches 4 kinds of project progress curve patterns. If the front of the progress curve is concave, and its rear is protruding in the break point, it is named as S model. If its front is protruding and its rear is concave in the break point, it is named as the reverse side of S model. If the front and rear are concave in the break point, it is named as J model, and two half sections are both upward protruding, it is named as the reverse side of J model. Through a case study, it shows that application project progress curve model can better raise project management.

Key words: progress curve model; reverse side of S model; reverse side of J model

1 Introduction

A project progress curve is a curve chart whose abscissa expresses time, and whose ordinate expresses the budget cost of accumulating totals or the completion project quantity. Its shape likes "S" that its middle is steep, and its both ends are gentle. Therefore, project progress curve is also frequently named as the curve of "S" model. Now, some domestic scholars study the method to draw project progress curve in Excel form [1]; some scholars study the application of the project progress curve for project supervisory and management [2]. But because of the discrepancy of project types and complex levels, the project progress curves present different characteristics. How many kinds can project progress curve be divided into? What characteristic do they have? How to raise project management level based on progress curve? This paper has carried out research around these problems.

2 Project Progress Curve Model

2.1 The Establishment and Analysis of Progress Curve Model

The mathematics expression of the curve of S model is $y = \exp(a + b/x)$. The coordinate of its break point is $(-b/2, \exp(a-2))$, the extreme value is $(+\infty, \exp(a))$. Through mathematics analysis, it can be known: when $x < -b/2$, $y'' > 0$; when $x > -b/2$, $y'' < 0$. That is, the front of the progress curve is concave, and its rear is protruding nearby the break point. Because of the discrepancy of project types and complex levels, the project progress curves present different forms. It is possible that the front of the progress curve is protruding, and its rear is concave nearby the break point. It is also possible that both of the ends of progress curve appear upward protruding or upward concave. The different forms signify different resource consumption ways, it is necessity that it should cause different management pattern. Therefore, it is necessary to depict accurately the progress curve.

From project characteristic, it can be known that the budget cost of accumulating totals or the completion project quantity increases with time increases. That is, y is increasing function of x, therefore it can be described with $y = Ax^n$. If second derivative is calculated for x, $y'' = An(n-1)x^{n-2}$ is reached. So when $0 < n < 1$, $y'' < 0$, the function $y = Ax^n$ is protruding in definition region; when $n > 1$, $y'' > 0$, the function $y = Ax^n$ is concave in definition region.

Under the usual condition, if the front of the progress curve of a certain project is concave, and its rear is protruding in the break point, it is named as S model. And if its front is protruding, its rear is concave in the break point, it is named as the reverse side of S model. If the front and rear are concave in the break point, it is named as J model, and two half sections are both upward protruding, it is named as the reverse side of J model. Specific graphs are shown as Fig. 1.

2.2 The Judgment on the Patterns

In the actual project, people must make rapid and accurate judgment for the progress curve. Two points $B(x_1, y_1)$ and $C(x_2, y_2)$ are taken out from the image

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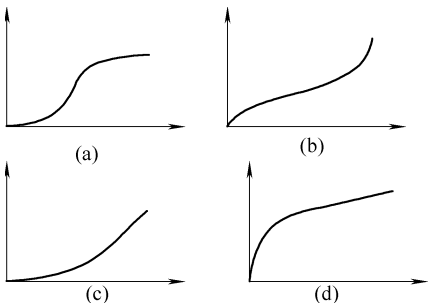

(a) S model (b) The reverse side of S
(c) J model (d) The reverse side of J

Fig. 1 4 kinds of different patterns of project progress curve

of the function $y = Ax^n$. Both of two points are not in the original point $A(0, 0)$, then $y_1 = Ax_1^n$, $y_2 = Ax_2^n$. The first formula is divided by the second, then, $n = \lg(y_1/y_2)/lg(x_1/x_2)$ is reached though simplifying and arranging the result. When $(y_1/y_2) > (x_1/x_2)$, $n > 1$, the image of $y = Ax^n$ is concave upward; when $(y_1/y_2) < (x_1/x_2)$, $0 < n < 1$, the image of $y = Ax^n$ is protruding upward.

According to this thought, actual calculation can adopt following method. The progress and time of general project are shown in Table1.

Table 1 The completion progress schedule of project

	1	2	3	…	m
Time	N_1	N_2	N_3	…	N_m
Progress	a_1	a_2	a_3	…	a_m

At first, judge preliminarily the general location of break point according to progress curve form and experience, then divide progress curve into two sections of front and rear to analyze. Suppose the average of abscissa front half section of the rear to be B_1, suppose the average of abscissa rear half section of the rear to be C_1, and calculate corresponding ordinate value. Rear section curve is carried out according to the same way. To analyze problem in convenience, take break point as the center point of curve, then Table 2 can be reached.

Table 2 The coordinate values of the point *B* and *C*

	The front section of curve		The rear section of curve	
	B_1	C_1	B_2	C_2
Abscissa values x	$\left[\sum_{m=1}^{\frac{1}{4}m} N_m\right] \Big/ \left[\frac{1}{4}m\right]$	$\left[\sum_{m=\frac{1}{4}m+1}^{\frac{2}{4}m} N_m\right] \Big/ \left[\frac{1}{4}m\right]$	$\left[\sum_{m=\frac{2}{4}m+1}^{\frac{3}{4}m} N_m\right] \Big/ \left[\frac{1}{4}m\right]$	$\left[\sum_{m=\frac{3}{4}m+1}^{m} N_m\right] \Big/ \left[\frac{1}{4}m\right]$
Ordinate values y	$\left[\sum_{m=1}^{\frac{1}{4}m} a_m\right] \Big/ \left[\frac{1}{4}m\right]$	$\left[\sum_{m=\frac{1}{4}m+1}^{\frac{2}{4}m} a_m\right] \Big/ \left[\frac{1}{4}m\right]$	$\left[\sum_{m=\frac{2}{4}m+1}^{\frac{3}{4}m} a_m\right] \Big/ \left[\frac{1}{4}m\right]$	$\left[\sum_{m=\frac{3}{4}m+1}^{m} a_m\right] \Big/ \left[\frac{1}{4}m\right]$

Suppose

$$\frac{\left[\sum_{m=1}^{\frac{1}{4}m} a_m\right] \Big/ \left[\frac{1}{4}m\right]}{\left[\sum_{m=\frac{1}{4}m+1}^{\frac{2}{4}m} a_m\right] \Big/ \left[\frac{1}{4}m\right]} = \left[\sum_{m=1}^{\frac{1}{4}m} a_m\right] \Big/ \left[\sum_{m=\frac{1}{4}m+1}^{\frac{2}{4}m} a_m\right] = E_1 ;$$

$$\frac{\left[\sum_{m=1}^{\frac{1}{4}m} N_m\right] \Big/ \left[\frac{1}{4}m\right]}{\left[\sum_{m=\frac{1}{4}m+1}^{\frac{2}{4}m} N_m\right] \Big/ \left[\frac{1}{4}m\right]} = \left[\sum_{m=1}^{\frac{1}{4}m} N_m\right] \Big/ \left[\sum_{m=\frac{1}{4}m+1}^{\frac{2}{4}m} N_m\right] = F_1$$

If $E_1 > F_1$, the front of the project progress curve is concave upward. If $E_1 > F_1$, the rear of the project progress curve is protruding upward. At the same, it can be determined that the rear section of progress curve is concave or protruding.

3 The Application of Project Progress Curve Model

3.1 The Meaning of Application

1) Reduce the risk of project management.

To draw up corresponding strategy according to the different models of project progress curve can reduce the risk of project management. In the four kinds of project progress curve model, such as "S model', "the reverse side of S model", "J model", "the reverse side of J model", if the project progress curve model belongs to "S model" or "the reverse side of J model", the fronts of the project progress curves are both protruding upward. When resource level drops, work time shortens, the proportion that project progress drops is less than the proportion that resource level drops and work time shortens, the big problem will not rise. If the project progress curve model belongs to "J model", or "the reverse side of S model", the rear sections of the project progress curves are both concave upward. The influence that resource is scarcity and work time is insufficient is very serious. A little drop of resource level and a little reduction of work time will cause project progress to drop greatly.

2) Overall grasp the enforcement condition of the project.

To study project progress curve model is helpful to overall grasp the enforcement condition of the project and optimize the distribution of project resource. It can be found out from the project progress curve models that the implement progress of "S model" project is comparatively rapider in the mid-term, resource consumption is more, but at the early stage and at the later

stage the implement progress is slower comparatively, resource consumption is much less; the implement progress of "J model" project is comparatively slower at the early stage, resource consumption is littler, but at the later stage the implement progress is rapider comparatively, resource consumption is more; the implement progress of "the reverse side of S model" project is comparatively slower in the mid-term, resource consumption is littler, but at the early stage and at the later stage the implement progress is rapider comparatively, resource consumption is more; the implement progress of "the reverse side of J model" project is comparatively rapider at the early stage, resource consumption is more, but at the later stage the implement progress is slower comparatively, resource consumption is littler. Therefore, if the progress curve model of certain project can be determined, the enforcement condition of this project can be grasped overall.

3) Be reference for project financing

The implement progress of "S model" project is comparatively rapider in the mid-term, resource consumption is more, but at the early stage and at the later stage the implement progress is slower comparatively, resource consumption is much less. Therefore, the project of "S model" progress curve model has an urgent financing need in the mid-term. At the same, the project of "J model" progress curve model has an urgent financing need at the later stage. The capital of the project of "the reverse side of S model" progress curve model is relatively sufficient in the mid-term, but at the early stage and at the later stage early stage and the capital is relatively deficient, it has an urgent financing need. The project of "the reverse side of J model" progress curve model has an urgent financing need at the early stage. Therefore, as long as the progress curve model of certain project can be determined, the time that the project needs financing can be preliminary determined.

3.2 The Integration Analysis of Related Curve Parameter

The mainly parameters in project progress management are: budget cost of working scheme($BCWS$), budget cost of working past($BCWP$), actual cost working past ($ACWP$), progress deviation ($SV = BCWP - BCWS$), cost deviation($CV = BCWP - ACWP$). Its integration analysis and corresponding measure are shown as Table 3.

4 The Application Example

4.1 Basic Condition

Certain project is planned to be completed in 24 months, the $BCWS$ curve, the $BCWP$ curve, the $ACWP$ curve are shown as Fig. 2.

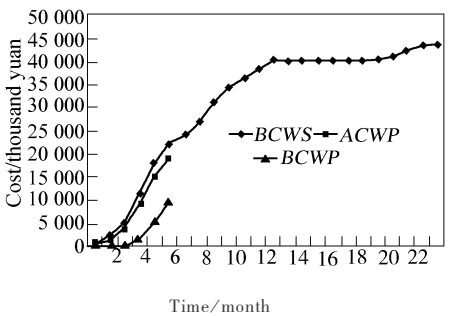

Fig. 2 The related project curves

Table3 The integration analysis of progress management and corresponding measure

Number	The relation of parameters	Analysis	Measure
1	$ACWP > BCWS > BCWP$ $SV < 0$ $CV < 0$	Efficiency is low; Progress is slow; Investment is in advance.	Replace people with low efficiency by people with high efficiency.
2	$BCWP > BCWS > ACWP$ $SV > 0$ $CV > 0$	Efficiency is high; Progress is relatively rapid; Investment is late.	If deviate is not large, maintain original state.
3	$BCWP > ACWS > BCWS$ $SV > 0$ $CV > 0$	Efficiency is high; Progress is rapid; Investment is in advance.	Take out partial people, slow the speed.
4	$ACWP > BCWP > BCWS$ $SV > 0$ $CV < 0$	Efficiency is low; Progress is rapid; Investment is in advance.	Take out partial people, increase key people.
5	$BCWS > ACWP > BCWP$ $SV < 0$ $CV < 0$	Efficiency is low; Progress is relatively slow; Investment is late.	Increase people with high efficiency
6	$BCWS > BCWP > ACWP$ $SV < 0$ $CV > 0$	Efficiency is high; Progress is relatively slow; Investment is late.	increase rapidly people

4.2 The Establishment of Model

According to above-mentioned theoretical analysis, the average coordinate values of the points B and C in the project progress curve can be reached and are shown as Table4.

$E_1 = 9950/31899 = 0.312$, $F_1 = 9.5/3.5 = 0.368$;

$E_2 = 40455/42015 = 0.963$, $F_2 = 15.5/21.5 =$

0.721.

Because of $0.312 < 0.368$, and $0.963 > 0.721$, it can be reached that this project belongs to "the reverse side of S model".

Table 4 The coordinate values of the points *B* and *C* in the project progress curve

	The front section of project curve		The rear section of project curve	
	B_1	C_1	B_2	C_2
Abscissa values x	3.5	9.5	15.5	21.5
Ordinate values y	9 950	31 899	40 455	42 015

4.3 Conclusion

1) This project progress curve model belongs to "the reverse side of S model", the front half section of the progress curve is protruding upward, the rear half section is concave upward, therefore The implement progress of this kind of project is comparatively slower in the mid-term, resource consumption is littler, but at the later stage the implement progress is comparatively rapider, resource consumption is more. The capital of this kind of project is relatively sufficient in the mid-term, but at the early stage and at the later stage early stage and the capital is relatively deficient, it has an urgent need to be melted capital.

2) If the rear half section of this project progress curve is concave upward, the influence of resource scarcity and insufficient work time is very serious. A little drop of resource level and a little reduction of work time will cause project progress to drop greatly.

3) The important stage of this project implement is the later stage and the early stage of project. When forming project scheme and drawing up the project plan, when the project resource such as person, property is distributed, the important stage of the project implement course should be accommodated especially. And in the course of implement, the group teams of project should pay full attention to the project working.

4) It can be discovered combined Fig1 and Table3 that This project belongs to 5th condition, its characteristic is low efficiency, slow progress, late investment, the measure that should be adopted is increase people with high efficient.

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