

Analysis of HeXie Controllability and HeXie Observability of the Project Team

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Abstract

Based on the frame of HeXie Management Theory, in this article, HeXie-state model of the project team system is studied, two attributes, HeXie controllability and HeXie observability in the HeXie state model, are put forward, and those attributes are analyzed and defined. Judgement rules of those two attributes are described. The HeXie controllability is used to measure the influencing function of the project management activity to the HeXie-state, and the HeXie observability is to measure the initial HeXie-state. To analyze the HeXie controllability and the HeXie observability can estimate the project management risk, compute the influence of management activity to the project team and the project performance, and help to optimize the organization and structure of the project team.

Keywords: HeXie Management Theory, Project management, HeXie-state, HeXie controllability, HeXie observability

1. Introduction

With continual development of information science, the economic form of human society is continually transforming from the commodity economy under the industrial society to the knowledge economy under the information society. This transformation makes the leading activity of the enterprise which gives priority to various innovational activities gradually develop, and the model of enterprise management will essentially change with that. Because most innovational activities of the enterprise are actualized by means of the form of project (Tavares, 2002, p.1-18), so innovational components in activities led by the enterprise are more, they more need better project management. Though the research to the project process management has initially formed complete system (John, 2005, p.688-704), but the relation between better project management and enterprise performance has not been clear (Kam, 2006). And according to the contingency theory, the project management must match with the environment with high uncertainty (Wang, 2006), so the analysis of the influence of the project management to the performance as viewed from the system is very necessary (Tavares, 2002, p.1-18).

The enterprise can be looked as the system composed by factors which are closely associated and dependent each other (Richard, 1999, p.583-600), and the economic activity, human resource, structure characteristic are the factors to compose this complex system. Some researches thought the coherence, interior matching and interaction degree among these factors are positive correlative (Robert, 1985, p.514-539). The project team is the subsystem of the enterprise system, and the resource, personnel and organizational character of the team are factors of the project team system. The HeXie Management Theory is to utilize the system idea to describe the influence of enterprise management to the enterprise performance (Tang, 2003, p.1485-1487). Base on the HeXie Management Theory, the HeXie degree of the project team, i.e. the response of the project team system to the management, describes whether the team fully exerts member enthusiasm, creationary conditions and environment, and the total HeXie of subsystem activity under member and the team, which can be concretely divided into structure HeXie degree, organizational HeXie degree, interior HeXie degree and exterior HeXie degree (Xi, 2002). These four sorts of HeXie degree constitute the HeXie-state of the vector form. In the implementing process of the project, the project management activity possesses changeable management ability, and the project team system correspondingly produces the changeable response of HeXie-state which is represented as the changeable performance of the project team (Wang, 2007, p.1129-1133 & Wang, 2007, p.117-121). Some researches thought that the relationship among management activity, HeXie degree response and team performance of the project team system can be abstracted as the HeXie-state model (Wang, 2007, p.191-195). In the HeXie-state model, the project management can be described as

the following process. The HeXie-state is the intrinsic attribute of the project team system, and the management (input) arouses the change of the HeXie-state, and the HeXie-state and project management decide the change of the performance (output) together.

In this article, we stress to discuss two attributes, the HeXie controllability and the HeXie observability in the HeXie-state model. The HeXie controllability is used to measure the influencing function of the project management activity to the HeXie state, and the HeXie observability is to measure the initial HeXie state.

2. The HeXie-state model of the project team

This article is based on the hypothesis that when the management ability changes some times, the HeXie degree response of the project team system also changes some times. The HeXie-state model of the project team system thought that the change of HeXie-state induced by the management was the process of differential movement, and the changes of team performance influenced by the management and the HeXie-state was the process of variable transformation (Wang, 2007, p.191-195). The HeXie-state model of the project team system based on the hypothesis

is $L_S : \begin{cases} \frac{d\hat{x}(t)}{dt} = A(t)\hat{x}(t) + B(t)\hat{m}(t), \\ \hat{y}(t) = C(t)\hat{x}(t) + D(t)\hat{m}(t) \end{cases}$, where, (1) the HeXie-state of the project team system at the time of t ($t \geq t_0, t_0$ is

the initial time of the project) can be denoted as $\hat{x}(t) = [x_1(t) \ x_2(t) \ x_3(t) \ x_4(t)]^T$, and the interior state variables $x_1(t), x_2(t), x_3(t)$ and $x_4(t)$ respectively denote the structure HeXie degree, organizational HeXie degree, interior HeXie degree and exterior HeXie degree of the project team system at the time of t , (2) the project management at the time of t is denoted as $\hat{m}(t) = [m_1(t) \ m_2(t) \ m_3(t)]^T$, and the interior state variables $m_1(t), m_2(t)$ and $m_3(t)$ respectively denote the coherence of organizational mission and EOL (environment, organization and lead), the coherence of HeXie-Topic and EOL, and the coherence of HeXie and HeXie-Topic at the time of t , (3) the team performance at the time of t is denoted as $\hat{y}(t)$, (4) at the time of t , $A(t)$ is the state keep matrix of the project team system which represents the influence of the HeXie-state to its change,

and $B(t) = \begin{bmatrix} b_{11}(t) & b_{12}(t) & b_{13}(t) \\ b_{21}(t) & b_{22}(t) & b_{23}(t) \\ b_{31}(t) & b_{32}(t) & b_{33}(t) \\ b_{41}(t) & b_{42}(t) & b_{43}(t) \end{bmatrix}$ is the Management-Distribution-Matrix of the project team system which represents

the influence of the project management activity (the input of the project team system) to the change of HeXie-state ($b_{ij}(t) \ i = 1,2,3,4$ respectively represent the influences of the coherence of organizational mission and EOL (environment, organization and lead), the coherence of HeXie-Topic and EOL, and the coherence of HeXie and HeXie-Topic at the time of t to the structure of the HeXie, $b_{2i}(t), b_{3i}(t), b_{4i}(t) \ i = 1,2,3,4$ respectively represent the influences of the coherence of organizational mission and EOL (environment, organization and lead), the coherence of HeXie-Topic and EOL, and the coherence of HeXie and HeXie-Topic at the time of t to the organizational HeXie, the interior HeXie and the exterior HeXie), and the HeXie distribution matrix $C(t)$ represents the influence of the HeXie-state to the team performance, and the control optimized matrix $D(t)$ represents the influence of the input to the team performance.

Based on above HeXie-state model, in this article, we work out following definitions.

Definition 1 (HeXie controllability): Suppose that $\hat{x}(t)$, if the time of t_1 ($t \leq t_1 \leq T, T$ is the terminal time of the project, $\Delta t = t_1 - t$) and $\hat{m}(\varepsilon)$ ($\varepsilon \in [t, t_1]$) exist and make $\hat{x}(t_1) - \hat{x}(t) = \int^t A(\varepsilon)\hat{x}(\varepsilon)d\varepsilon + \int^t B(\varepsilon)\hat{m}(\varepsilon)d\varepsilon = R(t)$, where, $R(t)$ is the HeXie-state change anticipated by the manager, $\hat{x}(t_1)$ is the anticipative HeXie-state, so the HeXie-state $\hat{x}(t)$ of the project team system L_S is HeXie controllable in the stage of Δt when the project management is $\hat{m}(\varepsilon)$.

Some researches thought that the project team in the project lifecycle had five stages including establishment, adaptation, standard, effect and dismiss (Wang, 2007, p.117-121). For $\forall \hat{x}(t)$, if the time of τ (t and τ are in the same stage of the project lifecycle, $\Delta t = \tau - t$) and $\hat{m}(\varepsilon)$ ($\varepsilon \in [t, \tau]$) exist and make $\hat{x}(\tau) - \hat{x}(t) = \int^t A(\varepsilon)\hat{x}(\varepsilon)d\varepsilon + \int^t B(\varepsilon)\hat{m}(\varepsilon)d\varepsilon = \bar{R}$, where, $R(t)$ is the HeXie-state change anticipated by the manager and $\hat{x}(\tau)$ is the anticipative HeXie-state, so the project team system L_S is HeXie controllable in the stage of Δt .

Definition 2 (HeXie observability): If the time of t_1 ($t \leq t_1 \leq T, t_0$ is the initial time of the project and T is the terminal time of the project, $\Delta t = t_1 - t_0$) exists and makes $\mathcal{Y}(t) \ t \in [t_0, t_1]$ only confirm $\mathcal{X}(t_0)$

and $\mathcal{X}(t_0) = W_G^{-1}(t_1, t_0) \int_0^{t_1} (C(\tau)\Phi(\tau, t_0))^T \mathcal{Y}(\tau) d\tau$, where, $\Phi(\tau, t_0) = \begin{bmatrix} \phi_{11}(\tau, t_0) & \phi_{12}(\tau, t_0) & \phi_{13}(\tau, t_0) & \phi_{14}(\tau, t_0) \\ \phi_{21}(\tau, t_0) & \phi_{22}(\tau, t_0) & \phi_{23}(\tau, t_0) & \phi_{24}(\tau, t_0) \\ \phi_{31}(\tau, t_0) & \phi_{32}(\tau, t_0) & \phi_{33}(\tau, t_0) & \phi_{34}(\tau, t_0) \\ \phi_{41}(\tau, t_0) & \phi_{42}(\tau, t_0) & \phi_{43}(\tau, t_0) & \phi_{44}(\tau, t_0) \end{bmatrix}$ is

the state transfer matrix of the project team system, $\phi_{ij}(\tau, t_0) \ i = 1,2,3,4$ respectively represent influences of structure HeXie, organizational HeXie, interior HeXie and exterior HeXie at the time of t_0 to the structure HeXie at the time of τ , $\phi_{2i}(\tau, t_0), \phi_{3i}(\tau, t_0), \phi_{4i}(\tau, t_0) \ i = 1,2,3,4$ respectively represent influences of structure HeXie, organizational HeXie, interior HeXie and exterior HeXie at the time of t_0 to the organizational HeXie, interior HeXie and exterior HeXie at the time of τ , and $W_G(t_1, t_0) = \int_0^{t_1} (C(\tau)\Phi(\tau, t_0))^T C(\tau)\Phi(\tau, t_0) d\tau$, so the project team system L_s is HeXie observable in the stage of Δt .

Suppose that $t_0^0, t_0^1, t_0^2, t_0^3$ and t_0^4 are respectively initial times of five stages such as establishment, adaptation, standard, effect and dismiss, and if $\tau_0, \tau_1, \tau_2, \tau_3$ and τ_4 (t_0^i and $\tau_i \ i = 0,1,2,3,4$ are in the same stage of the project lifecycle, $\Delta t_i = \tau_i - t_0^i$) exist and make $\mathcal{Y}(t^i) \ t \in [t_0^i, \tau_i]$ only confirm $\mathcal{X}(t_0^i)$ and $\mathcal{X}(t_0^i) = W_G^{-1}(\tau_i, t_0^i) \int_0^{\tau_i} (C(\varepsilon)\Phi(\varepsilon, t_0^i))^T \mathcal{Y}(\varepsilon) d\varepsilon$, $\Delta t = \max(\Delta t_i)$, so the project team system L_s is HeXie controllable in the stage of Δt .

3. Judgment rules of HeXie controllability and HeXie observability

Theorem 1: Suppose that $\mathcal{X}(t)$ exists in the project team L_s , and if the time of t_1 ($t \leq t_1 \leq T, T$ is the terminal time of the project) exists and makes that all four sorts of HeXie possess positive influences from the time of t to the four sorts of HeXie at the time of t_1 , and three coherences possess positive influences to four sorts of HeXie, so the project team L_s is HeXie controllable.

First we prove the Lemma 1.

Lemma 1: Suppose that for the project team L_s , if the time of t_1 exists and makes the matrix $W_K(t_1, t) = \int_t^{t_1} \Phi(t_1, \tau)B(\tau)(\Phi(t_1, \tau)B(\tau))^T d\tau$ is positive definite, so L_s is HeXie controllable.

Prove: Suppose that the time of t_1 exists and makes $W_K(t_1, t) > 0$, so $W_K(t_1, t)$ is positive definite.

Suppose that $\mathcal{X}(t)$ is the HeXie-state of L_s at the time of t , $\mathcal{M}(\varepsilon) = -(\Phi(t_1, \varepsilon)B(\varepsilon))^T W_K^{-1}(t_1, t)\Phi(t_1, t)\mathcal{X}(t)$, $t \leq \varepsilon \leq t_1$, so the expression of the solution of system state equation is $\mathcal{X}(t_1) = \int_0^1 \Phi(t_1, \tau)B(\tau)\mathcal{M}(\tau) d\tau$, so $\mathcal{X}(t_1) = \mathcal{R} + \mathcal{X}(t_0)$. According to the definition, the project team L_s is HeXie controllable.

Next, we prove the Theorem 1.

Prove: To prove L_s is HeXie controllable, we must prove $W_K(t_1, t_0)$ is positive definite. Because all four sorts of HeXie possess positive influences from the time of t to the four sorts of HeXie at the time of t_1 , i.e. $\phi_{ij}(\tau, t_0) > 0$, $t_0 \leq \tau \leq t_1$, $i, j = 1,2,3,4$, and since the time of t , all three coherences possess positive influences to four sorts of HeXie, i.e. $b_{ij}(\tau) > 0$, so $\sum_{j=1}^4 \left(\sum_{i=1}^4 \phi_{ki}(\tau, t_1) b_{ij}(\tau) \right)^2 > 0$, $k = 1,2,3,4$.

If $\lambda_k = 2 \sum_{j=1}^4 \left(\sum_{i=1}^4 \phi_{ki}(\tau, t_1) b_{ij}(\tau) \right)^2$, so $\det(\lambda I - \Phi(\tau, t_1)B(\tau)(\Phi(t_1, \tau)B(\tau))^T) = 0$, and $W_K(t_1, t)$ is positive definite.

According to Lemma 1, the project team L_s is HeXie controllable.

Theorem 2: Suppose that $B(t)$ of the project team L_s is the vector composed by following three parts, (1) the sum of influences of certain HeXie and the coherence of organizational mission and EOL at the time of τ to four sorts of HeXie at the time of τ and the time of t_1 , (2) the sum of influences of certain HeXie and the coherence of HeXie-Topic and EOL at the time of τ to four sorts of HeXie at the time of τ and the time of t_1 , (3) the sum of influences of certain HeXie and the coherence of HeXie and EOL at the time of τ to four sorts of HeXie at the time of τ and the time of t_1 . If the time of t_1 exists and makes four vectors can not transform reciprocally through linear transform, so L_s is HeXie controllably.

Prove: Above four vectors can not transform reciprocally through linear transform, i.e. various vectors are linear independent. Suppose that the matrix $\Phi(t_1, \tau)B(\tau)$ is linear independent in $[t_0, t_1]$, but L_s is not HeXie controllable, so $W_K(t_1, t_0)$ is non-positive definite, so for $t_1 > t_0$, the nonzero vector \bar{z} certainly exists and makes $\bar{z}^T W_K(t_1, t_0) \bar{z} = 0 \Rightarrow \int_0^{t_1} \bar{z}^T \Phi(t_1, \tau) B(\tau) (\Phi(t_1, \tau) B(\tau))^T \bar{z} d\tau = 0$. Because $A(t)$ and $B(t)$ are successive, so $\bar{z}^T W_K(t_1, t_0) B(\tau) \equiv 0, t_0 \leq \tau \leq t_1$, which is ambivalent. So the hypothesis can not come into existence. According to the definition, the project team L_s is HeXie controllable.

In the same way, we can prove Theorem 3: if the time of t_1 exists and makes the matrix $C(\tau)\Phi(\tau, t_1)$ is linear independent in $[t_0, t_1]$, so L_s is HeXie observable.

4. Conclusions

Based on the HeXie management theory, in this article, we analyze the HeXie controllability and the HeXie observability of the project team L_s . The theorem proved in the article shows that the problem of the HeXie controllability of the project team L_s is only decided by the state keep matrix $A(t)$ and the Management-Distribution-Matrix $B(t)$ of L_s , and the problem of the HeXie observability of the project team L_s is only decided by the HeXie-Distribution-Matrix $C(t)$. That indicates that the HeXie controllability and the HeXie observability are the essential attributes of the project team, which are confirmed when the project team is established, and don't depend on the project management.

In this article, we define the HeXie controllability and the HeXie observability and describe the judgment theorem. The HeXie controllability is used to measure the influencing function of the project management activity to the HeXie state, and the HeXie observability is to measure the initial HeXie state. These two attributes of the project team have important help to optimize the project management and elevate the structure of the project team, and have abroad application space. With the deepening of research, the matching degree of the HeXie-state and the stability of the management activity to the function process of the project team system are the direction for the future study.

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