

# Study on Diffusion of Human Resource Technology in Guizhou Province

Jun Liu<sup>1,2,\*</sup>

1 Anshun city company, Guizhou tobacco company, Anshun, Guizhou 561000, China

2 Guizhou Business College, Guiyang, Guizhou, China

\*Corresponding author

**ABSTRACT.** Based on classical technology diffusion model, the diffusion model of Human Resource cities in Guizhou province is constructed, and the time path function of the technology diffusion of low carbon cities is deduced. the graphics is S-shaped curve. The results show that because of the differences of internal and external factors and the total number of “potential adopters”, the time path function of Human Resource cities in different regions is different, which shows the difference between different cities to promote the technology.

**KEYWORDS:** Human Resource Technology; S-shaped Curve; Technology Diffusion Model

## 1. Introduction

Over the past century, global climate is changing warming[1], Human activities, especially a large amount of greenhouse gases emissions during the process of urbanization, are main factors of global climate change[2]. Climate change leads to water resources distribution imbalance, biological diversity is threatened and severe weather events frequently occur which have an adverse impact on social activities, exacerbate disease spread and threat economic development and population health[3].

Intergovernmental Panel on Climate Change (IPCC) studied found carbon dioxide emissions mainly come from urban areas which is about 80% of the total global carbon emissions[4]. Therefore, from the city to start, let the city development and the high carbon emissions “separate each other” is the key to achieving sustainable development

The per capita resources endowment is poor in Guizhou province and climate conditions is complex. Its karst ecological environment is particularly fragile, is more susceptible by adverse effects of climate change. In recent years, with acceleration of urbanization, the emissions of urban carbon dioxide rose year after year which has already resulted in a greater threat to ecological environment. Since

2011, Guizhou's economic growth has been higher than national average. The province will maintain rapidly economic growth and large-scale urban construction in the future[5]. City is the gathering place where population, industry and resources. It is the main carrier of economic growth. Rapid population gathering bring a tremendous challenge to socio-economic development. Therefore, we should attach great importance to the diffusion of Human Resource technologies in the city of Guizhou province.

## 2. Diffusion Model of Human Resource Technology in Guizhou Province

Technology diffusion means “a technology from the first commercial application, vigorously promote, universal adoption, until eliminated for backward.” Since the concept of technology diffusion has been proposed, many scholars have studied diffusion model, produced some classic technology diffusion models, such as Bass cluster models. These models assume that the number of potential users to adopt new technologies is  $n$ . At time  $t$ , the number of users to adopt new technology is  $m_t$ . we assumed that if potential users understand the new technology, they will adopt it. Information about new technologies is transmitted through the interaction among users, and the rate of information transmission is constant  $\omega$ . The probability of potential users encountered adopted users is  $\omega (m_t/n)$ . At time  $t$ , the newly added number of adopted users is  $dm_t = \omega (m_t/n)(n-m_t)dt$ [6]. The classic technology diffusion model can more scientific describe the diffusion process of new technologies. As a new Human Resource Technology, its diffusion process can be described by technology diffusion model. In this paper, combining with the characteristics of Human Resource Technology diffusion, Human Resource technology diffusion model of Guizhou province is built.

### 2.1 Basic Assumptions and Variables

Before establish model, according to characteristics of Human Resource Technology diffusion, this paper gives following basic assumptions and related variables:

Hypothesis 1 The total number of potential adopters is  $N$  ( $N > 0$ , generally equal to the region's total population). At time  $t$ , there is  $y_{(t)}$  “potential adopters” has adopted Human Resource Technology, there is still  $\{N - y_{(t)}\}$  no adoption.

Hypothesis 2 The number of initial users is greater than 0; namely, at time  $t$ ,  $y_{(0)} = T > 0$ , and  $T$  is integer.

Hypothesis 3 Information is spread from external information sources, at each moment, the percentage of reaching  $N - y_{(t)}$  “non adopters” is  $\alpha \times 100\%$ .  $\alpha$  ( $\alpha < 1$ ) is the rate that external information reach to “non adopters”, which is called external influence coefficient, determined by external factors.

**2.2 Time Path Functions of Human Resource Technology Diffusion**

**2.2.1 Time Path Function Derivation**

Starting from the point of time  $t$ , within the time interval  $\Delta t$ , the existing “non adopters” are influenced by external and internal information sources, so there are:

1) Within the time interval  $\Delta t$ , the number of “adopters” caused by external information sources is  $\Delta y(t)^* = \alpha \{N - y(t)\} \Delta t$ .

2) Within the time interval  $\Delta t$ , the number of “adopters” caused by internal information sources is  $\Delta y(t)^{**} = \beta y(t) \{N - y(t)\} \Delta t$ .

If the effect that either “non adopters” were told by external information sources or internal information sources is equivalent, within the time interval  $\Delta t$ , the increase number of “ adopters” is  $\Delta y(t) = \Delta y(t)^* + \Delta y(t)^{**} = \{ \alpha + \beta y(t) \} \{N - y(t)\} \Delta t$  (1). Equation (1) is divided by  $\Delta t$  on both sides , taking the limit  $\Delta t \rightarrow 0$ , obtain differential equation  $\frac{dy(t)}{dt} = \{ \alpha + \beta y(t) \} \{N - y(t)\}$  (2). Equation (2)

for the equivalent transformation, the integral is obtained  $y(t) = \frac{CN \exp[(\alpha + \beta N)t] - \alpha}{\beta + C \exp[(\alpha + \beta N)t]}$  (3). In equation (3), C is constant. With the initial

conditions of hypothesis 2  $y_{(0)} = T$ , we can get  $T = \frac{CN - \alpha}{\beta + C}$  (4) and,  $C = \frac{T\beta + \alpha}{N - T}$  (5). Equation (5) is substituted into equation (3), the solution of differential

equation(2) can be obtained.  $y(t) = \frac{\frac{T\beta + \alpha}{N - T} N \exp[(\alpha + \beta N)t] - \alpha}{\beta + \frac{T\beta + \alpha}{N - T} \exp[(\alpha + \beta N)t]}$  (6). Due to time

path function reflects the proportion change process of “adopter” accounted for “potential adopters” over time. so time path function of Human Resource

Technology diffusion is  $Y(t) = \frac{1}{N} y(t) = \frac{1}{N} \frac{\frac{T\beta + \alpha}{N - T} N \exp[(\alpha + \beta N)t] - \alpha}{\beta + \frac{T\beta + \alpha}{N - T} \exp[(\alpha + \beta N)t]}$  (7).

**2.2.2 Curve of Time Path Function**

Curve diagram of time path function is drawn by using function graph. First, in order to find the inflection point of time path function, we get the first order derivative and the second order derivative of  $Y_{(t)}$ . then in order to obtain the concave convex interval of time path function, we get the third derivative of  $Y_{(t)}$ .

Since equation (7) is an elementary function, it must be continuous, so its first order derivative is obtained.  $Y'(t) = \frac{1}{N} \left\{ \frac{T\beta + \alpha}{N - T} \exp[(\alpha + \beta N)t] (\alpha + \beta N)^2 \right\}$

$$\left\{ \beta + \frac{T\beta + \alpha}{N - T} \exp[(\alpha + \beta N)t] \right\}^{-2} \quad (8).$$

In the same way, the first derivative of equation (8) is obtained.  $Y'(t) = \left\{ (\alpha + \beta N) - 2 \frac{C(\alpha + \beta N) \exp[(\alpha + \beta N)t]}{\beta + C \exp[(\alpha + \beta N)t]} \right\} Y'(t)$  (9).

Equation (8) is substituted into equation (9).

$$Y''(t) = \left\{ (\alpha + \beta N) - \frac{2C(\alpha + \beta N) \exp[(\alpha + \beta N)t]}{\beta + C \exp[(\alpha + \beta N)t]} \right\} \left\{ \frac{C}{N} \exp[(\alpha + \beta N)t] (\alpha + \beta N)^2 \right\} \left\{ \beta + C \exp[(\alpha + \beta N)t] \right\}^{-2}$$

(10). Order  $Y''(t)=0$ , we get the inflection point of equation (7). From hypothesis 2, 3, 4, we know  $Y'(t)>0$ , so  $Y''(t)=0$  is equivalent to

$$(\alpha + \beta N) - 2 \frac{C(\alpha + \beta N) \exp[(\alpha + \beta N)t]}{\beta + C \exp[(\alpha + \beta N)t]} = 0 \quad (11).$$

Equation (10) is an elementary function, which first order derivative is

$$Y'''(t) = \varphi^4 C \exp(\varphi t) [\beta + C \exp(\varphi t)]^{-3} \left\{ \beta - 2C \exp(\varphi t) - 3C \exp(\varphi t) [\beta - C \exp(\varphi t)] \cdot [\beta + C \exp(\varphi t)]^{-1} \right\} \frac{1}{N}$$

$$Y''(0) = \left( \frac{\alpha\beta + \beta^2 N}{\beta + C} \right) \left( \frac{C(\alpha + \beta N)^2}{(\beta + C)^2} \right) > 0,$$

and in the interval  $t \in [0, t_{\text{inflection}})$ ,  $Y'''(t) > 0$ , namely,  $Y''(t)$  is monotone increasing in the interval  $t \in [0, t_{\text{inflection}})$ . So  $Y''(t) > 0$ , equation (7) is concave in the interval  $t \in [0, t_{\text{inflection}})$ . In the interval  $t \in (t_{\text{inflection}}, +\infty)$ ,  $Y'''(t) < 0$ , namely,  $Y''(t)$  is monotone decreasing in the interval  $t \in (t_{\text{inflection}}, +\infty)$ . So  $Y''(t) < 0$ , equation (7) is convex in the interval  $t \in (t_{\text{inflection}}, +\infty)$ .

In summary, equation (7) can be made as shown in Figure 1, which is a S shaped curve. The proportion of “adopted” accounted for “potential adopters” is decided by four parameters  $\alpha/\beta/N/T$ . The change is reflected in the graphics, that is, the diffusion of the low carbon city technology has a S-shaped growth pattern over time.

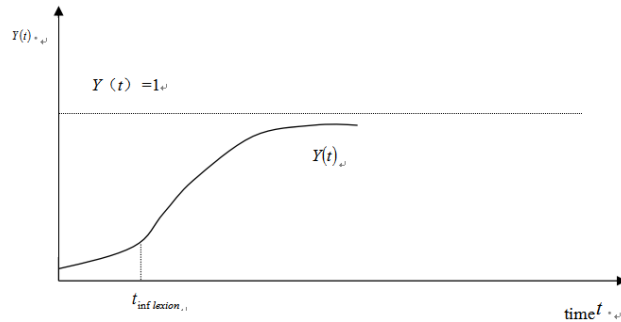


Figure. 1 Time Path Function Curves of Technology Diffusion in Human Resource Cities

### 3. Conclusion

First, the difference of external factors in different regions lead to different parameter  $\alpha$ . Second, the difference of internal factors in different regions lead to different parameter  $\beta$ . In addition, the total number of potential adopters  $N$  and the number of initially users  $T$  in different regions is generally different. Therefore, the difference of parameters  $\alpha/\beta/N/T$  in different regions lead to the difference of time path function. At the same time, the difference of time path function values show the difference between the two regions.

As time goes on, this difference will be gradually expansion, stability, and gradually narrow. The evolution of this three stage has a universal law. Therefore, the conclusion of this paper can be used to explain the difference of Human Resource cities technology diffusion between different regions.

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