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Research on Excessive Road Fuel Problem Based on Extension Strategy Generating Method

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Abstract

The increase of the demand for gasoline in transportation and traffic vehicles results in excessive fuel consumption problem. However, by the extension strategy generating methods, the way of urban transportation changing from bus into metro may be analyzed and evaluated through extension reasoning, extension transformation and optimal calculation in order to solve the problem of excessive fuel consumption of the urban roads.

Index Terms: Fuel oil consumption; extension; strategy generating

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1. Introduction

With the development of the economic and extension of urban size, urban population and vehicle keep increasing [1]. Thus the urban transportation petrol oil consumption which adopts the vehicle as the main tools will increase accordingly. But the decreasing of the petrol oil day by day due to the non-renewability of petrol oil resources make people want to reduce the petrol oil consumption and prolong its service time. This research adopted extension strategy generating method [2], using formalized tools, through the combination of the qualitative & quantitative to analyze the root cause and find out the effective and comparatively better strategy to solve the excessive urban transportation petrol oil consumption situation. And then find out the solution for the incompatible problem [2] of the increasing objective demands and the decreasing expectations.

2. Extension Strategy Generating Method Basic Knowledge

Extension strategy generating method is the process of generating strategy for incompatible problem based on the basic idea of Extension Theory to intimate human thinking model and use formalization & quantification method [3].

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1. Extension strategy generating process

The extension strategy generating theoretical principle is extension theory, the purpose of this theory is to solve those incompatible problem. The basic ideas are as follows:

(1) To define the target and factor of the existing problem, and set up problem extension strategy model with primitive representation.

(2) To determine the core problem according to the condition value (present value) and target value of the index provided by practical incompatible problem.

(3) To set up core problem compatible function and judge the incompatible level through calculation.

(4) If the core problem is incompatible, then making extension analyze on its target or condition to set up problem implication tree or interrelated tree[4] (Net) .

(5) To make divergent or Conjugate analyze on implication tree or interrelated tree. Generate extension strategy generating tree through extension conversion and transmit conversion [5].

(6) To Calculate the problem tolerance degree after conversion, if tolerance degree change from less than 0 to no less than 0, then incompatible problems convert into compatible problems. Namely the convert process is the strategy for the practical problem.

(7) To calculate the strategy goodness through related function. The bigger the value is the better the strategy is.

2. Simple related function

It's required to determine the tolerance degree or strategy goodness by quantitative calculation of the fixed problem during the extension strategy generating process. This research adopted simple related function [3] calculation method.

Positive field is finite interval $X = \langle a, b \rangle$, optimum value $x_0 \in X$. Among the rest, when $x_0 = a$, simple related function $k(x)$ at its maximum value, then

$$k(x) = \begin{cases} \frac{x-a}{b-a}, & x < a, \\ \frac{b-x}{b-a}, & x > a, \\ k(a) = 0 \vee 1, & x = a. \end{cases} \tag{1}$$

This function can be used for solving problem degree of association (Function 1) .

3. Goodness evaluation method

Goodness evaluation method is to evaluate a strategy capability through independent function quantification [6].

Suppose the solution conformity to the problem I on measure condition M is $K(I)$, then

$$k_I = \begin{cases} \frac{K(I)}{\max_{x \in X_0} K(x)} , & K(I) > 0 \\ \frac{K(I)}{\max_{x \in X_0} |K(x)|} , & K(I) < 0 \end{cases} \tag{2}$$

Become the standard conformity of solution I on M (Function 2) .

Suppose one problem measure condition is $M = \{M_1, M_2, \dots, M_n\}$, Solution of I on M standard conformity is $k_i (i = 1, 2, \dots, n)$, Then $C(I) = \sum_{i=1}^n k_i \alpha_i$ is called problem solution I goodness.(Function 3).

3. Research On Excessive Road Fuel Problem Based On Extension Strategy Generating Method

To solve the problem of excessive road fuel problem, we combine extension strategy generating process to study strategy generating method.

4. Core problem set up

First we take the oil fuel consumption of city A as example. City A current oil fuel consumption is 20 million tons per year, it has reduce to 15 million tons per year according to energy saving requirement. Obviously there's a incompatible problem between the existing value (condition value) and target expecting value. In this case, we can use primitive to set up a core problem extenics model[2]: $p_{01} = g_{01} * l_{01} = (\text{City A, target oil fuel consumption, 15 million tons/ year}) * (\text{City A, existing oil fuel consumption, 20 million tons/year})$. For city A's smallest oil fuel consumption is 0 million tons/year, and the optimal road oil fuel consumption is 0 million tons/year, then come to $a=0, b=15, x_0=0, x=20$, According to simple independent functions, as function 1 indicated, we can calculate the core problem association degree:

$$k_0(p_{01}) = k(20) = \frac{15-20}{15-0} = -0.3333 < 0$$

According to the above quantitative calculation of the core problem association degree, we get to know that the core problem association degree is less than 0, so this problem is incompatible problem.

5. Relative analysis

If the core problem is incompatible, then we can make extension analyze on its target or condition to set up problem implication tree or correlation tree (net). This paper only does correlation analysis on the core problem condition and set up correlation tree.

As the urban oil fuel consumption is related to city centre branch numbers, vehicle type, automobile energy type, pavement condition index etc[1]. We can set up its correlation tree as Fig. 3-1 shows:

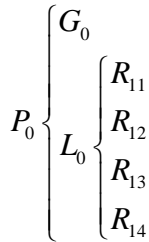


Fig. 3-1 Correlation Tree

Among them, $L_0 = (\text{City A, Current road oil fuel consumption, } V_0) \quad V_0 = \langle 0, 17 \rangle \text{ Million tons/year}$

$R_{11} = (\text{City A, city centre branches number, } V_{01}) \quad V_{01} = \langle 1, 10 \rangle \text{ Number}$

$R_{12} = (\text{City A, main vehicle, } V_{02}) \quad V_{02} = \{ \text{Bus, Metro, car} \}$

$R_{13} = (\text{City A, Vehicle energy type, } V_{03}) \quad V_{03} = \{ \text{Hybrid power[7], diesel oil, gasoline} \}$

$R_{14} = (\text{City A, Vehicle energy type, } V_{04}) \quad V_{04} = \{ \text{sandy clay pavement, asphalt pavement, Cement pavement} \}$

6. Strategy generating tree

To make divergent analysis on correlation tree, we can get extension strategy generating tree by extension conversion and conduction conversion. So we can make divergent analysis on correlation tree and then make extension conversion and conduction conversion.

(1) Divergent analysis

Divergent analysis is divided into “ One object more signs”, “ One signs more objects”, “Same object same sign more value” etc[3]. many kinds of divergent analysis method. Here we use “same object same sign more value” method. Now we will make divergent analysis on related factors to conditional indicators. (i.e.:R11, R12, R13, R14)

$$r_{111} \left\{ \begin{matrix} r_{112} \\ r_{113} \end{matrix} \right\}, r_{121} \left\{ \begin{matrix} r_{212} \\ r_{213} \end{matrix} \right\}, r_{131} \left\{ \begin{matrix} r_{132} \\ r_{133} \end{matrix} \right\}, r_{141} \left\{ \begin{matrix} r_{142} \\ r_{143} \end{matrix} \right\}$$

Among them, primitive r_{111} is initial similar primitive of R11; primitive r_{121} is initial similar primitive of R12; primitive r_{131} is initial similar primitive of R13; primitive r_{141} is initial similar primitive of R14;

- $r_{111} = (\text{City A, City center branches number, 3})$
- $r_{112} = (\text{City A, City center branches number, 6})$
- $r_{113} = (\text{City A, City center branches number, 9})$
- $r_{121} = (\text{City A, main vehicle, bus})$
- $r_{122} = (\text{City A, main vehicle, car})$
- $r_{123} = (\text{City A, main vehicle, metro})$
- $r_{131} = (\text{City A, vehicle energy type, gasoline})$
- $r_{132} = (\text{City A, vehicle energy type, diesel oil})$
- $r_{133} = (\text{City A, vehicle energy type, hybrid power})$
- $r_{141} = (\text{City A, pavement condition, cement})$
- $r_{142} = (\text{City A, pavement condition, sandy clay})$
- $r_{143} = (\text{City A, pavement condition, asphalt})$

(2) Extension conversion and conduction conversion

After the divergent analysis, we can make extension conversion for initial primitives and then get new condition primitives through conduction conversion. This is the extension strategy generating process. The Fig. 3-2 is the corresponding extension strategy generating tree:

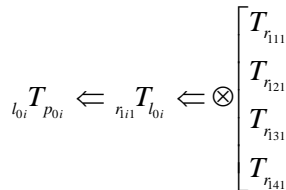


Fig. 3-2 Extension strategy generating tree

Extension conversion can indicate by affair-element, E.g. replace conversion φ_{112} can indicated as:

$$\varphi_{112} = \left(\begin{array}{l} \text{replace, dominant object, } r_{111} \\ \text{conversion result, } r_{112} \end{array} \right)$$

It can also indicated with extension conversion as: $\varphi_{112}r_{111} = r_{112}$, due to the conduction effect, i.e. the conversion implication will result in the following conduction conversion: $\varphi_{112} \Rightarrow \varphi_{02}$, and $\varphi_{02}l_{01} = l_{02}$. We can get the following extension conversion and conversion implication:

$$\begin{aligned} \varphi_{113}r_{111} &= r_{113}, \varphi_{113} \Rightarrow \varphi_{03}, \varphi_{03}l_{01} = l_{03}; \\ \varphi_{122}r_{121} &= r_{122}, \varphi_{122} \Rightarrow \varphi_{04}, \varphi_{04}l_{01} = l_{04}; \\ \varphi_{123}r_{121} &= r_{123}, \varphi_{123} \Rightarrow \varphi_{05}, \varphi_{05}l_{01} = l_{05}; \\ \varphi_{132}r_{131} &= r_{132}, \varphi_{132} \Rightarrow \varphi_{06}, \varphi_{06}l_{01} = l_{06}; \\ \varphi_{133}r_{131} &= r_{133}, \varphi_{133} \Rightarrow \varphi_{07}, \varphi_{07}l_{01} = l_{07}; \\ \varphi_{142}r_{141} &= r_{142}, \varphi_{142} \Rightarrow \varphi_{08}, \varphi_{08}l_{01} = l_{08}; \\ \varphi_{143}r_{141} &= r_{143}, \varphi_{143} \Rightarrow \varphi_{09}, \varphi_{09}l_{01} = l_{09}. \end{aligned}$$

Among them: l_{01} =(City A, current road oil fuel consumption, 20 million tons/year);

l_{02} =(City A, current road oil fuel consumption, 16 million tons/year);

l_{03} = (City A, current road oil fuel consumption, 12 million tons/year);

l_{04} =(City A, current road oil fuel consumption,80 million tons/year); l_{05} = (City A, current road oil fuel

consumption, 11 million tons/year); l_{06} =(City A, current road oil fuel consumption,17 million tons/year); l_{07} =

(City A, current road oil fuel consumption, 13 million tons/year); l_{08} =(City A, current road oil fuel

consumption,26 million tons/year); l_{09} = (City A, current road oil fuel consumption, 18 million tons/year);

(3) Problem association degree after conversion

The conversion of φ_{112} result in the final city A road oil fuel consumption variation, from the initial 20 million tons/year change to 16 million tons /year we can get $a=0, b=15, x_0=0, x=16$, according to the simple independent functions, as indicated by function 1, calculate the core problem degree of association:

$$k_0(p_{02}) = k(16) = \frac{15-16}{15-0} = -0.0667 > 0$$

i.e. with the strategy S_1 problem association degree $k(p_{02})$ change to -0.0667, as the association degree less than 0, so the strategy is infeasible. Same logical we can get the following:

Core problem association degree by replace conversion φ_{113} and conduction conversion (i.e. strategy S_2)

$$k_0(p_{03}) = k(12) = \frac{15-12}{15-0} = 0.2 > 0$$

Core problem association degree by replace conversion φ_{113} and conduction conversion (i.e. strategy S_3)

$$k_0(p_{04}) = k(90) = \frac{15-80}{15-0} = -4.3333 < 0$$

Core problem association degree by replace conversion φ_{113} and conduction conversion (i.e. strategy S_4)

$$k_0(p_{05}) = k(11) = \frac{15-11}{15-0} = 0.2667 > 0$$

Core problem association degree by replace conversion φ_{113} and conduction conversion (i.e. strategy S_5)

$$k_0(p_{06}) = k(17) = \frac{15-17}{15-0} = -0.1333 < 0$$

Core problem association degree by replace conversion φ_{113} and conduction conversion (i.e. strategy S_6)

$$k_0(p_{07}) = k(13) = \frac{15-13}{15-0} = 0.1333 > 0$$

Core problem association degree by replace conversion φ_{113} and conduction conversion (i.e. strategy S_7)

$$k_0(p_{07}) = k(26) = \frac{15-26}{15-0} = -0.7333 < 0$$

Core problem association degree by replace conversion φ_{113} and conduction conversion (i.e. strategy S_8)

$$k_0(p_{07}) = k(18) = \frac{15-18}{15-0} = -0.2 < 0$$

Through the calculation of relative strategy association degree, problem S_2, S_4, S_6 association degree is equal or greater than 0, so the three strategies is feasible. Among them, strategy S_2 change the city A city center branches from 3 to 9; Strategy S_4 change city A main vehicle from bus to metro; Strategy S_6 change city A vehicle energy from gasoline to hybrid power.

7. Strategy goodness evaluation

Through calculation of strategy problem association degree, we can get the feasibility of the strategy. But different strategy has different goodness. Goodness measurement can be calculated by extension strategy goodness evaluation method. Here we do goodness evaluation on the three strategies: S_2, S_4, S_6

(1) Fix the measurement condition

Definite measurement condition set $M = \{M_1, M_2\}$, among them, characteristic element $M_i = (c_i, V_i), i = 1, 2$, and V_i has been quantized. The measurement condition in this paper is $M_1 = (\text{fund input}, V_1)$, its value domain $V_1 = [1, 500]$ billion yuan, optimum value $x_{01} = 1$ billion yuan; $M_2 = (\text{responding time}, V_2)$, and value domain $V_2 = [1, 20]$ year, optimum value $x_{02} = 1$ year. And M_1 weight coefficient $\alpha_1 = 0.6$, M_2 weight coefficient $\alpha_2 = 0.4$, and $\sum_{i=1}^2 \alpha_i = 1$.

Among them strategy S_2 $M_{12} = (\text{Fund input}, 1000 \text{ billion yuan}), M_{22} = (\text{responding time}, 50 \text{ years})$.

Strategy S_4 $M_{14} = (\text{Fund input}, 400 \text{ billion yuan}), M_{24} = (\text{responding time}, 50 \text{ years})$.

Strategy S_6 $M_{16} = (\text{Fund input}, 600 \text{ billion yuan}), M_{22} = (\text{responding time}, 15 \text{ years})$.

(2) Goodness calculation

We now calculate relative strategy goodness through provided measurement condition and weight coefficient: First, calculate relative strategy goodness through function 1:

$$K_1(S_2) = k(1000) = \frac{500-1000}{500-1} = -1.0020$$

$$K_2(S_2) = k(50) = \frac{20-50}{20-1} = -1.5789$$

$$K_1(S_4) = k(400) = \frac{500-400}{500-1} = 0.2004$$

$$K_2(S_4) = k(10) = \frac{20-10}{20-1} = 0.5263$$

$$K_1(S_6) = k(600) = \frac{500-600}{500-1} = -0.2004$$

$$K_2(S_6) = k(15) = \frac{20-15}{20-1} = 0.2632$$

Second, calculate relative strategy standard conformity through function 2.

$$\max_{x \in V_1} K_1(S_i) = 0.2004 \quad \max_{x \notin V_1} |K_1(S_i)| = 1.0020$$

among them $i = 2, 4, 6$.

$$\max_{x \in V_2} K_2(S_i) = 0.5263 \quad \max_{x \notin V_2} |K_2(S_i)| = 1.5789$$

among them $i = 2, 4, 6$.

$$k_{12} = k_1(S_2) = \frac{K_1(S_2)}{\max_{x \notin V_1} |K_1(S_i)|} = \frac{-1.0020}{1.0020} = -1$$

$$k_{22} = k_2(S_2) = \frac{K_2(S_2)}{\max_{x \notin V_2} |K_2(S_i)|} = \frac{-1.5789}{1.5789} = -1$$

$$k_{14} = k_1(S_4) = \frac{K_1(S_4)}{\max_{x \in V_1} K_1(S_i)} = \frac{0.2004}{0.2004} = 1$$

$$k_{24} = k_2(S_4) = \frac{K_2(S_4)}{\max_{x \in V_2} K_2(S_i)} = \frac{0.5263}{0.5263} = 1$$

$$k_{16} = k_1(S_6) = \frac{K_1(S_6)}{\max_{x \notin V_1} |K_1(S_i)|} = \frac{-0.2004}{1.0020} = -0.2$$

$$k_{26} = k_2(S_6) = \frac{K_2(S_6)}{\max_{x \in V_2} K_2(S_i)} = \frac{0.2632}{0.5263} = 0.5$$

Last, calculation strategy goodness:

$$C_{S_2} = \sum_{i=1}^2 k_{i2} \alpha_i = -1 \quad C_{S_4} = \sum_{i=1}^2 k_{i4} \alpha_i = 1$$

$$C_{S_6} = \sum_{i=1}^2 k_{i6} \alpha_i = 0.08$$

We can get the conclusion that strategy S_2 goodness is -1, strategy S_4 goodness is 1, strategy S_6 goodness is 0.08, and we can see that S_4 goodness is the best one among the three strategies. Strategy S_2 goodness less than 0, although strategy feasible, but not advisable. So we use extension strategy generating method to solve the incompatible problem of excessive road oil fuel consumption by changing the city A main vehicle from bus to metro and realize city A road oil fuel consumption from 20 million tons/year to 11 million tons/year.

4. Conclusion

Extension strategy generating method is a kind of strategy generating method based on extenics and imitate human thinking model to solve incompatible problem. This paper introduced this method on the research of excessive road oil fuel consumption problem and realized the strategy generating process by formalization & quantification. Thereby, it provides reference to the reduction of the road oil fuel consumption & the set up sustainable development of city transportation.

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